MEASURING EVIDENCE-INFORMED DECISION-MAKING COMPETENCE

DEVELOPMENT AND PSYCHOMETRIC ASSESSMENT OF THE EVIDENCE-INFORMED DECISION-MAKING COMPETENCE MEASURE FOR PUBLIC HEALTH NURSING

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Lay Abstract

Nurses who work in public health have professional expectations to participate in evidence-informed decision-making (EIDM). Because of this, it is important to measure how competent they are in EIDM. The purpose of this study was to develop and test a tool that measures EIDM competence among public health nurses using a three-stage study. The first stage involved reviewing literature on existing tools that measure different components of EIDM competence including EIDM knowledge, skills, attitudes/beliefs, and behaviours among nurses. The second stage involved using existing tool items and developing new items for a new tool named the EIDM Competence Measure. In the third stage, the EIDM Competence Measure was tested to assess its validity, reliability, and acceptability among public health nurses in Ontario. The EIDM Competence Measure was found to have strong validity, reliability, and acceptability, showing that there is potential for its use in public health nursing practice.

Abstract

Background: There are professional expectations for public health nurses to engage in and develop competencies in evidence-informed decision-making (EIDM). The purpose of this research study was to develop and psychometrically test a measure to assess competence in EIDM among public health nurses.

Methods: Guided by the Standards for Educational and Psychological Testing (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014), a three stage study was employed to develop and psychometrically evaluate the new self-report EIDM Competence Measure: 1) Stage one: a systematic review of existing measures assessing four EIDM competence attributes of knowledge, skills, attitudes/beliefs, and behaviours; 2) Stage two: item development for the EIDM Competence Measure comprised of four subscales (knowledge, skills, attitudes/beliefs, and behaviours); and 3) Stage three: psychometric testing (reliability, validity, acceptability) which included item reduction from an original 40-item to a final 27-item tool.

Results: The EIDM Competence Measure consists of 27 items aligning with a four-factor model of EIDM knowledge, skills, attitudes/beliefs, and behaviours establishing internal structure validity. Cronbach's alpha for these four factors was 0.96, 0.93, 0.80, and 0.94, respectively. Significant associations between EIDM competence subscale scores and education, EIDM training/project involvement, and organizational culture established validity based on relationships to other variables. For the original 40-item tool, missing data was minimal as 93% of participants completed all items and mean completion time was 7 minutes and 20 seconds.

Conclusions: The EIDM Competence Measure is a conceptually and psychometrically robust instrument that has potential for use in public health nursing practice.

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List of Abbreviations and Symbols

APN: Advanced practice nurse

COSMIN: Consensus-based standards for the selection of health measurement instruments

CVI: Content validity index

EBP: Evidence-based practice

EBPQ: Evidence-based practice questionnaire

EIDM: Evidence-informed decision-making

KMO: Kaiser-Meyer-Olin

LPN: Licensed practical nurse

NCCMT: National Collaborating Centre for Methods and Tools

PCA: Principal components analysis

PHN: Public health nurse

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RPN: Registered practical nurse

RN: Registered nurse

α: Cronbach's alpha

Declaration of Academic Achievement

I, Emily Belita served as the lead Student Investigator of this thesis research project which began in September 2015 and was supervised by Dr. Maureen Dobbins, Dr. Jennifer Yost, and Dr. Rebecca Ganann. Dr. Janet Squires also provided supervision from September 2015 until February 2020. As Student Investigator, my primary responsibilities for each stage of the study included:

1) Stage one: Systematic review – I was responsible for leading the design of the systematic review with guidance from Dr. Dobbins, Dr. Yost, Dr. Ganann, and Dr. Janet Squires. Ms. Laura Banfield (Health Sciences Librarian) assisted with development of the search strategy. Ms. Donna Fitzpatrick Lewis provided guidance on reference management and Ms. Sharon Peck-Reid assisted with running literature searches. I led and conducted data extraction with assistance from Ms. Trish Burnett and Ms. Tiffany Dang. I conducted data synthesis and interpretation. I wrote the original manuscripts of the systematic review protocol and results and conducted subsequent edits based on critical review and feedback from co-authors Dr. Dobbins, Dr. Yost, Dr. Ganann, Dr. Squires, and Ms. Burnett.

2) Stage two: Item development for the EIDM Competence Measure – I was responsible for leading the design of the item development process, content validation, and response process assessment (sampling, data collection and analysis, ethical considerations) with guidance from Dr. Dobbins, Dr. Yost, Dr. Ganann and Dr. Squires. I completed sample recruitment, managed data collection via online surveys, conducted participant interviews and performed data analysis. I wrote the original manuscript related to item development and performed edits based on critical review and feedback from co-authors Dr. Dobbins, Dr. Yost, Dr. Ganann and Dr. Squires.

3) Stage three: Psychometric testing of the EIDM Competence Measure – I was responsible for leading the design of psychometric testing processes with guidance from Dr. Dobbins, Dr. Yost,

Dr. Ganann and Dr. Squires. I completed sample recruitment and managed data collection via online surveys. I performed data analysis with statistical guidance from Dr. Kathy Fisher. I wrote the original manuscript related to psychometric testing and performed edits based on critical review and feedback from co-authors Dr. Dobbins, Dr. Yost, Dr. Ganann and Dr. Fisher.

Chapter 1

Introduction

Importance of Evidence-informed Decision-making in Public Health

Evidence-informed decision making (EIDM) involves identifying, sharing, and applying the best available evidence into public health practice (National Collaborating Centre for Methods and Tools, 2020). Evidence in this regard, is defined as credible knowledge from different sources including research, professional/clinical experience, patient experiences/ preferences, and local data and information (Rycroft-Malone, 2004; Rycroft-Malone et al., 2004). EIDM remains a critical endeavour due to the burden of chronic disease in an aging population, emerging infectious diseases, growing rates of substance use and related harms, and environmental and natural disasters (Public Health Agency of Canada, 2019). A recent systematic review of 52 studies determined that local and national public health interventions provide sizeable returns on investment and help to save costs for the economy (Masters, Anwar, Collins, Cookson, & Capewell, 2017). Because of this substantial impact, it is imperative that public health services and interventions are informed by the best available evidence. EIDM is associated with improved client outcomes, the use of more effective and cost-efficient interventions (Brownson, Fielding, & Maylahn, 2009; Im & Kong, 2017; Melnyk & Fineout-Overholt, 2011), as well as nursing job satisfaction (Kim et al., 2016), and may support nursing retention (Melnyk, Fineout-Overholt, & Mays, 2008).

Public Health Nursing and EIDM

The most current available data estimates there are 7,602 registered nurses working in the field of public health in Canada, 3,595 of whom are employed in Ontario (Canadian Institute for Health Information, 2017). As such, public health nurses (PHNs) have great potential in realizing evidence-informed public health practice across the country and in the province of Ontario. In

addition, there is growing expectation for PHNs to demonstrate EIDM as observed in various standards and competencies (see Appendix A). For example, the current Ontario Standards for Public Health Programs and Services mandate that public health programs and services, many of which PHNs are responsible for developing and implementing, must be evidence-informed and continually evaluated (Ontario Ministry of Health and Long-Term Care, 2018). Both the newly revised 2019 Canadian Community Health Nursing Standards of Practice (Community Health Nurses of Canada, 2019), which include the addition of one new standard domain focused on evidence-informed practice, and the Public Health Agency of Canada's Core Competencies for Public Health in Canada (2008) have identified critical appraisal and use of best available evidence in the development of public health policies and practice as core competencies for all public health staff.

However, despite the anticipated benefits of and professional expectations for EIDM, its implementation across the nursing workforce has been described as undeveloped, low, or moderate (Brownson et al., 2009; Saunders & Vehviläinen-Julkunen, 2016). Two recent integrative reviews determined that across different practice contexts (community, hospital, primary care) nurses have low confidence in their EIDM knowledge and skills and believe such levels preclude them from engaging in the implementation of EIDM (Camargo et al., 2018; Saunders & Vehviläinen-Julkunen, 2016). Specific to the field of public health, in a cross-sectional study of public health practitioners in the United States (inclusive of nurses), only approximately 50% of the public health programs being delivered were deemed evidence-informed (Dreisinger et al., 2008). Furthermore, in a large study to determine perceived important sources used in program planning or policy development among 849 public health professionals (inclusive of nurses) in the United States, few participants ranked research

evidence with high importance, instead ranking federal or local funding partners, organizational leadership, and anecdotal stories from peers as the most important influences (Fields, Stamatakis, Duggan, & Brownson, 2015). These findings are similarly demonstrated in a study by Leeman and colleagues (2013) in which authors described a consistent theme across focus groups of 20 community practitioners (including nurses) in the United States who reported that they valued practice experience more, compared to research evidence as it related to decision-making around breast cancer screening programs and strategies. Practitioners cited issues of irrelevance or lack of currency of research evidence in relation to the communities they worked with (Leeman et al., 2013). In addition, Weum, Bragstad, and Glavin (2018) conducted a study in Norway with over 700 public health nurses and reported that primary sources used to guide their practice included knowledge obtained from public health nurse training and personal experience.

Barriers and Facilitators of EIDM

The observed gap in EIDM implementation can be attributed to many organizational barriers that PHNs face putting it into practice. These include lack of protected time for EIDM work, lack of access to resources (e.g., library staff, computers), and limited strategic vision and leadership related to EIDM (Melnyk, Gallagher-Ford, Long, & Fineout-Overholt, 2014; Peirson, Ciliska, Dobbins, & Mowat, 2012; Solomons & Spross, 2011; Williams, Perillo, & Brown, 2015). A part of organizational culture that largely hinders EIDM relates to a lack of clarity and deficient measurable indicators related to EIDM processes and expectations to guide practitioners in practice or program decision-making (Armstrong et al., 2014; Brownson et al., 2009; Melnyk et al., 2014). In general, limited attention has been placed on developing competence indicators to assess how nurses engage in clinical decision-making using evidence (Melnyk et al., 2014).

While organizational barriers to EIDM implementation exist, the literature also indicates organizational facilitators. For example, the articulation of EIDM as a priority in strategic goals and organizational workplans can move EIDM engagement forward by validating its widespread importance across the organization (Allen et al., 2018; Dobbins, Traynor, Workentine, Yousefi-Nooraie, & Yost, 2018). Leadership or authority figures prioritizing EIDM work through a commitment to workforce management and development can also facilitate EIDM endeavours (Bryant & Ward, 2017; Ward & Mowat, 2012). For example, health department leaders can foster workforce capacity through strategically hiring staff with expertise or specialty training in EIDM and the inclusion of EIDM expectations in job postings, interview processes, and new employee orientations (Allen et al., 2018; Bryant & Ward, 2017). As well, allocating staff time to participate in education and training opportunities related to different components of EIDM and organizational change, lends well to building capacity among existing staff members (Jacob et al., 2014; Leeman et al., 2015; Ward & Mowat, 2012).

A critical component of workforce development and human resource management related to EIDM is the integration of explicit EIDM indicators to performance evaluation systems or documents to help clarify role expectations (Dobbins et al., 2018; Peirson et al., 2012). This can facilitate the development of learning and practice goals, and a systematic process for frequent monitoring/assessment and providing feedback based on clear EIDM expectations (Allen et al., 2018; Brownson, Fielding, & Green, 2018).

EIDM Competence Assessment in Public Health Nursing

While EIDM competencies have been established at a national and provincial level, factors related to the competencies themselves may prevent nurses from achieving them. These include: lack of clear, consistent, well defined, and complete EIDM practice statements

(Brownson et al., 2018; Melnyk et al., 2014; Peirson et al., 2012) and a lack of awareness about the existence of competencies (Cross et al., 2006; Reckinger, Cross, Block, Josten, & Savik, 2013). Compounding the problem is the need for regional health authorities or health units to interpret the competencies and determine how to assess a PHN's level of competence. Notably, the aforementioned EIDM competencies are broad in nature, lack specificity of the different elements of EIDM, and measures, if they do exist, may not have been psychometrically tested in the public health workforce. These factors present significant barriers to organizations, contributing to limited attention toward EIDM. Given this, the measurement of EIDM competence for PHNs is an area of research in need of advancement. The focus on assessment of competence and continuing competence (i.e., maintenance and continual improvement of competence) is supported by the College of Nurses of Ontario to ensure high quality patient care and promote the advancement of nursing and continued professional learning (Campbell & Mackay, 2001). The College of Nurses of Ontario (2002) asserts that "competence is the nurse's ability to use her/his knowledge, skill, judgment, attitudes, values and beliefs to perform in a given role, situation and practice setting" (p. 5).

Research Questions

Given the lack of comprehensive, consistent, and clearly articulated EIDM competence measures specific to the field of public health nursing, the overall objective of this thesis was to develop a self-report EIDM competence measure for use among public health nurses using a three-stage approach: 1) conduct a systematic review of existing measures that assess EIDM competence attributes (i.e., knowledge, skills, attitudes/beliefs, behaviours) among nurses; 2) determine if an existing measure was appropriate for adaptation or the development of new EIDM competence measure was necessary; 3) conduct psychometric testing of adapted or newly

developed EIDM competence measure among public health nurses. The following research questions guided each project stage:

Stage One: Systematic Review

1. What are existing measures of EIDM competence attributes used among nurses in any health care setting?
2. What are the psychometric properties (i.e., acceptability, reliability, validity evidence) of test scores for these existing measures?

Stage Two: Adapt or Develop a New EIDM Competence Measure

3. Is there an existing measure that can be used in its current form or modified to assess EIDM competence among a population of PHNs?
4. If an existing measure is not available, what indicators of EIDM competence should be included in a new measure to assess EIDM competence among public health nurses?

Stage Three: Psychometrically Test the Adapted or New Measure

5. What are the psychometric properties (i.e., acceptability, reliability, validity evidence) of test scores for the existing/adapted/new measure among PHNs in Ontario?

Thesis Structure

This dissertation is presented as a sandwich thesis consisting of work that is unpublished (Chapters 1, 2, and 7), published (Chapters 3, and 4), has been submitted for publication (Chapter 5), and prepared for publication submission (Chapter 6). Chapter 1 introduces the overall thesis, providing context and the rationale for developing an EIDM competence measure specific to public health nursing. Chapter 1 also establishes the overall study objective and research questions that guided this thesis project. Chapter 2 presents a literature review of the conceptual and empirical literature discussing conceptualizations of EIDM and

competence, and the state of existing EIDM competence attribute measures, respectively. Chapters 3 and 4 present stage one of this thesis; a systematic review of existing EIDM competence attribute measures. Chapter 3 consists of the published protocol for the systematic review, while Chapter 4 comprises the published narrative synthesis of results. Stage two of this thesis is presented in Chapter 5 which consists of a manuscript submitted for publication that focuses on the item development process of the new self-report EIDM Competence Measure. Following this, Chapter 6 includes a manuscript prepared for submission that presents the psychometric findings for the new EIDM Competence Measure with respect to acceptability, validity, and reliability evidence. The thesis concludes with Chapter 7, a discussion of overall results, study strengths and limitations, as well as implications for nursing practice, education, and research.

Chapter 2

Literature Review

A critical analysis of the conceptual literature is presented to establish conceptualizations of competence, EIDM, and EIDM competence that will be used throughout the proposed study. Following this, a critical appraisal of the empirical literature is presented to establish gaps or limitations in existing literature on EIDM competence assessment in nursing and other health care disciplines and identify areas for focused research.

Conceptual Literature Review

This discussion of conceptual literature includes a critical analysis of the concepts *EBP/EIDM* and *competence* separately, and a discussion of the *EIDM competence* literature. These discussions identify strengths and limitations across the literature using any of the following criteria: conceptual maturity/stability (i.e., consensus in defining concept's characteristics/attributes); the pragmatic value of a conceptualization (i.e., does operationalization support robust measurement in a real world public health setting); and appropriateness of a conceptualization to a given context (i.e., nursing principles and the field of public health) (Morse, Hupcey, Mitcham, & Lenz, 1996).

Conceptual literature on EIDM.

Introduction to terminology.

According to Sackett, Rosenberg, Gray, Haynes, and Richardson (1996) evidence-based practice (EBP) is defined as "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients" (p. 71). Sackett, Richardson, Rosenberg, and Haynes (1997) further explain that this encompasses the integration of the best and current systematic research evidence with clinical expertise, patient preferences and rights in

clinical decision-making. Other discipline specific terms have also surfaced, notably evidence-based nursing, defined as the use of high-quality research, practitioner expertise, patient values, in addition to health care resources in clinical practice decision-making (DiCenso, Guyatt, & Ciliska, 2005). Melnyk and Fineout-Overholt (2011) also consider evidence-based nursing to be a "lifelong problem-solving approach to clinical practice" (p. 4) that integrates both external evidence (e.g., relevant and best research) and internal evidence (e.g., clinical expertise).

The term EIDM was introduced in response to criticism that use of the term EBP over-emphasizes the use of only research evidence in clinical practice (Ciliska (2012). Similar to EBP, EIDM is defined as a process in which high quality, available evidence from research, local data, patient and professional experiences are synthesized, disseminated, and applied to decision-making in health care practice and policy (Canadian Foundation for Healthcare Improvement, 2017). Proponents of this term believe that use of the word "informed" explicitly denotes that research alone is insufficient for clinical decision making and cannot take precedence over other factors (Culyer & Lomas, 2006). In public health, the terms evidence-informed public health and EIDM are used interchangeably. EIDM in public health is defined as the integration of evidence from various sources including: research, community health data, community and political values and actions, and public health resources and expertise in the decision making process (National Collaborating Centre for Methods and Tools, 2018). Based on the above discussion, the terms EBP and EIDM are used interchangeably, as they share similar foundations and principles. Due to its common use in Canada and in the field of public health, the term EIDM will be used for consistency, throughout this dissertation (Ciliska, 2012; Culyer & Lomas, 2006).

Strengths and limitations across the EIDM literature.

Several different terms are used interchangeably with EIDM based on different contexts which may be viewed as contributing to conceptual confusion. Examples of these terms include evidence-based nursing (DiCenso et al., 2005) or evidence-based public health (Brownson et al., 2009). However, this may also be seen as a strength since variations of the EIDM term convey applicability and positive reception to the EIDM movement across multiple health care settings and disciplines. Despite term inconsistency, a strength across the literature is the consensus that EIDM integrates evidence related to research, the practitioner, patient or community in clinical decision-making. This provides a strong argument against prominent criticisms of EIDM – that it reduces clinical practice to a mechanistic process dismissing the importance of patient individuality and practitioner expertise (Falk-Rafael, 2000; Mitchell, 1999; Nevo & Slonim-Nevo, 2011).

Contrary to this, many EIDM frameworks depict the mutual relationship and weighting of factors that should be considered in practice decisions (DiCenso et al., 2005; Haynes, Devereaux, & Guyatt, 2002; National Collaborating Centre for Methods and Tools, 2018; Spring et al., 2008). One such seminal framework was developed by Haynes et al. (2002) (see Appendix B). Haynes et al. (2002) establish a prescriptive model that provides guidance for clinical decision-making. The model depicts the inter-relationships between patients' preferences and actions, clinical state and circumstances, and research evidence, which are all overlaid by and integrated in decision-making using one's clinical expertise (Haynes et al., 2002). The authors underscore the importance of considering patient preferences and not simply clinical expertise or research evidence, which has been traditionally emphasized when making clinical decisions. While minor modifications have been made to the model developed by Haynes et al. (2002) over the past 15 years, such as the inclusion of health care resources, language to reflect the public

health context, and replacing clinical expertise in the centre of the model with decision making, generally, the model continues to depict a process whereby each factor influences decisions for unique patients or communities (see Appendix B). This inclusive nature of EIDM decision-making advances the nursing profession and knowledge by grounding practice in current research evidence, validates the credibility of other ways of knowing by acknowledging clinical expertise, while also valuing patient-centred care (Estabrooks, 1999; Falk-Rafael, 2000).

A second strength across the literature is that EIDM is consistently conceptualized as a stepwise decision-making process, with some nuances based on context and setting. EIDM is commonly described as including the following five step process as outlined in seminal work by Sackett et al. (1997): 1) developing a clinical research question; 2) searching for best available research evidence; 3) critically appraising the evidence; 4) applying the evidence in clinical practice which includes consideration of patient preferences, practice setting, and clinical expertise; and 5) evaluating outcomes and process of EIDM.

The evolution of the EIDM step-wise process is seen in later iterations of Sacket et al.'s (1997) original work (see Appendix C). These later iterations reflect a broader population approach to EIDM in the context of public health practice, programming, and policy as compared to earlier work that focuses on clinical decision-making. For example, Brownson, Gurney, and Land (1999) propose a six-step framework to encourage evidence use in decision-making related to public health programs and policies among public health practitioners: 1) develop an initial, concise statement of the issue; 2) determine what is known about the issue using scientific literature; 3) quantify the issue using existing sources of data; 4) develop potential program/policy options; 5) develop an action plan; 6) evaluate the program or policy. This framework differs slightly from original work by Sackett et al. (1997) in that it does not specify as distinct steps the activities of 'searching' and 'critical appraisal', but combines them under step #2 (determine what

is known about the issue). Another difference is that Brownson et al. (1999) expand on Sackett et al.'s (1997) 'apply' step by dividing it into two separate steps of developing and prioritizing options, and developing and implementing an action plan.

The National Collaborating Centre for Methods and Tools [NCCMT] (2020) provides even greater clarity to the EIDM process by articulating a seven-step process to support public health professionals in finding, appraising, and using the best available evidence to inform public health practice and policy. These steps include: 1) clearly defining a question or public health program (i.e., formulating a question in a searchable and answerable way); 2) efficiently searching for research evidence (i.e., conducting a literature search using online databases to identify the strongest quality and most applicable evidence); 3) critically appraising research evidence (i.e., using criteria to assess the quality of a study's methods to determine if findings are trustworthy, meaningful, and relevant); 4) synthesizing evidence (i.e., interpreting the research evidence and forming recommendations into actionable messages for practice or policy); 5) adapting research evidence to the local context (i.e., tailoring actionable messages to the local context by considering the extent of the public health issue, the relevance of an intervention, the local community or targeted population, and other stakeholders); 6) implementing the evidence (i.e., developing a plan of action to implement the adapted evidence by conducting a situational assessment, planning a program, disseminating an intervention); and 7) evaluating implementation efforts (i.e., evaluating the effectiveness of the implementation plan).

While the NCCMT's seven step framework is similar to earlier work by Sackett et al. (1997) and Brownson et al. (1999) there is one slight difference. NCCMT's framework further explicates the "apply" step by dividing it into additional steps of "synthesize" (i.e., forming recommendations from the evidence), "adapt" (i.e., tailoring the recommendations to the local context), and "implement" (i.e., creating and implementing action plans for practice change). The

well understood conceptualization of EIDM as a stepwise process and the inclusion of foundational steps across frameworks contribute to conceptual clarity and promote shared language about EIDM. This common understanding lends well to robust testing of validity evidence for competence measures. Explicating EIDM as process steps also helps to operationalize this complex concept for practitioners and decision-makers. Such process frameworks are directive and can provide guidance on competency development for the public health workforce.

The proposed study will be guided by the NCCMT definition and model for EIDM, given national organizations and provincial governing public health bodies endorse the definition and 7-step process, and therefore they are part of the shared language among Canadian public health organizations. And lastly, the NCCMT framework uses language that coincides with a public health context (e.g., community/population) and thus is most relevant and familiar to public health practitioners.

Conceptual literature on competence.

Across the literature, conceptualizations of competence fall under three primary viewpoints: 1) task oriented/behavioural approach; 2) competence as a stage along a continuum; and 3) holistic approach. A critical analysis of each viewpoint is presented with rationale provided for selecting a holistic framework to conceptualize competence for the proposed study.

Task-oriented/behavioural approach.

A common understanding of, and likely the first conceptualization of competence, is the task-oriented or behavioural approach (Gonczi, 1994). Arising from the post-war era in North America, the behaviourist tradition grew from the need to improve job training programs and establish organizational accountability (Eraut, 1998). In this respect, competence is action-oriented, viewed simply as the completion of standardized tasks for a particular job (Eraut, 1998;

Garside & Nhemachena, 2013; Gonczi, 1994; Norris, 1991). Proponents of the behaviourist tradition note that there is no separation between knowledge, skill, and behaviour (Garside & Nhemachena, 2013; Gonczi, 1994). Mere task performance infers that an individual possesses the appropriate knowledge and skill required to engage in that behaviour.

A strength of this behavioural approach is its simplicity and transparency in competence assessment (Gonczi, 1994). For organizations, focusing on task completion provides an uncomplicated and straightforward way of assessing competence by using concrete measures (Eraut, 1998). Competence is seen as binary, either one is assessed as competent, if able to complete tasks, or incompetent, if unable to complete them (Eraut, 1998). As Gonczi (1994) notes, the articulation of expected performance outcomes prevents discrepancies and provides clarity for society, professionals, and organizations in establishing competent behaviours.

A limitation of the behavioural approach, however, is that it is reductionist (Cowan, Norman, & Coopamah, 2007; Norris, 1991). It reduces competence to accomplishing a series of simple, technical tasks. Such orientation may result in the treatment of EIDM competence as the mere completion of basic tasks. However, the execution of EIDM is complex. While it requires the use of skills in searching and appraising the literature, it also necessitates the use of clinical judgment and communication to integrate a myriad of factors in decision making, and engages critical thinking in the implementation of recommendations to improve nursing practice (Melnyk et al., 2014). As the behaviourist approach negates the separation of knowledge, skill, and behaviour (Gonczi, 1994), little attention may be paid to the higher cognitive requirements and skills involved in EIDM.

Competence as a stage along a continuum.

Competence has also been conceptualized as a stage along a performance continuum. This tradition has been popularized in nursing by Benner's (1982) "novice" to "expert"

framework. Based on the Dreyfus Model of Skill Acquisition (Dreyfus & Dreyfus, 1980), Benner (1984) defines competence as one level of proficiency which nurses pass through in clinical practice. Competence is described as a nurse with two to three years of nursing experience, who understands nursing action in the context of long-term goals and has mastered planning and organization to manage multiple nursing issues (Benner, 1984). While Benner characterizes competence as a stage in real world clinical practice, Miller (1990) positions competence on a continuum in a pyramid model, but in the context of educational assessment. According to Miller, competence is defined as "knowing how" and entails possessing the appropriate amount of judgement and skill in the application of knowledge. Converse to the behavioural approach, Miller acknowledges the separation of knowledge, skill, and behaviour. Although, in his conceptualization, competence only appears to relate to skill development and serves as a precursor to performance and action.

One limitation of this approach is that competence is described as a stage, rather than an end goal. As Short (1984) notes, confusion surrounding the conceptualization of competence stems from it being treated as a descriptive rather than a normative construct. Rather than promoting competence as an endpoint level of achievement, both Benner (1982) and Miller (1990) situate competence in the middle of a continuum. As a result, competence may not be perceived as the highest standard performance level to be attained. However, in standards that guide EIDM role expectations, competence is attained when several directive competencies are met (Melnyk et al., 2014). Competence achievement and maintenance are clearly articulated as end goals (Eraut, 1998). There is significance in nurses explicitly knowing their professional expectations in relation to EIDM competence (Melnyk & Fineout-Overholt, 2011; Melnyk et al., 2014). Clearly articulated competencies can increase motivation and thus facilitate greater uptake

of EIDM (Melnyk et al., 2014).

Another limitation of the perspective that views competence as a performance continuum relates to a misinterpretation of Benner's novice to expert framework. Benner (1982) clearly notes that her framework is based on the application of a model that focuses on skill acquisition. Competence is definitively described as only one level of skill development in the model. However, it is striking in the literature that many inaccurately refer to Benner's model as a competence framework. For example, Meretoja, Ericksson, and Leino-Kilpi (2002) misinterpret Benner's understanding of competence as a developmental process ranging from having basic knowledge to advanced expertise. Garside and Nhemachena (2013) indicate that "competence for Benner is a progressive experience that she calibrates in five distinct stages" (p. 542). These interpretations clearly misconstrue the construct of skill development as competence. This misunderstanding limits competence assessment to skills, and compromises validity testing as an incomplete conceptualization of EIDM competence would be used to generate items and scales.

Holistic approach.

Competence is also commonly conceptualized according to a holistic or integrated approach (Cowan et al., 2007; Epstein & Hundert, 2002; Eraut, 1998; Gonczi, 1994) which has been articulated in a model developed by (Cheetham & Chivers, 1998) (see Appendix D). Proponents of this approach consistently assert that competence is conceived of as the amalgamation of attributes including knowledge, skills, attitudes/values, and behaviours applied to performance (Cheetham & Chivers, 1998; Cowan et al., 2007; Gonczi, 1994). Nagelsmith (1995) conveys the interrelatedness of these attributes by stating that a strategy used to strengthen any underdeveloped attribute would have a significant impact on overall competence and increase level of functioning and efficiency. In their conceptual model, Cheetham and

Chivers (1998) illustrate how these attributes are inextricably linked and contingent upon each other, contributing to overall professional competence.

However, having to assess a multitude of attributes in competence assessment may create complexity or confusion. For example, Watson, Stimpson, Topping, and Porock (2002) question how each attribute is to be weighted in competence assessment and how interactions between attributes are to be captured. Cheetham and Chivers (1998) address this by establishing the terms *occupational and individual competence mix*, meaning that between and within a profession, the value of individual attributes and relationships between them are contingent on the role under assessment. Despite this complexity, professional competence cannot sufficiently develop if each attribute was to support it independently (Baartman, Bastiaens, Kirschner, & van der Vleuten, 2007). Adding to this, Eraut (1994) and Hand (2006) contest the exclusion of knowledge, skill, or behaviour in competence assessment. Knowledge without skill, or the ability to use knowledge, renders knowledge useless Eraut (1994). Similarly, performing a skill without understanding the reasoning behind it contributes to unsafe and incompetent practice (Eraut, 1994; Hand, 2006). Also, possessing knowledge and skill without the experience of their application in the real world is insufficient to qualify as competent (Eraut, 1998). Most importantly, this understanding of competence aligns with the College of Nurses of Ontario's (2002) definition as "the nurse's ability to use her/his knowledge, skill, judgment, attitudes, values and beliefs to perform in a given role, situation and practice setting" (p. 5).

Another element of this approach concerns its context dependent nature. Eraut (1998) contends that competence is "the ability to perform the tasks and roles required to the expected standard" (p. 129) in a specific domain. Standards and attributes of competence are not necessarily generic and transferable across different health care situations. An interaction exists

between one's ability, the given tasks to be completed, and the systems and environments that surround a particular client (Epstein & Hundert, 2002). This understanding supports the provision of competence reference points for a specific practice role. Establishing standards provides transparency and clarity about professional competence in each domain.

Finally, the holistic approach identifies that competence is developmental. Epstein (2007) determines that competence evolves through an increase in clinical practice experience and continued self-reflection. This is conveyed in Cheetham and Chivers' model (1998) by highlighting the critical role of feedback through self and others to promote reflection and sustain ongoing improvement in each competence attribute. Competence differs across progressive stages of one's professional career. As a consequence of this, Smith (2012) indicates that competence assessment requires a two-tiered approach. Entry-to-practice competence provides the first tier of assessment while continuing competence is the second tier (Smith, 2012). According to this perspective then, competence evolves well beyond initial professional qualification. A strength of this is that it counters a viewpoint of seeing competence as merely a minimum standard. Eraut (1998) stresses the need to associate competence with excellence. This viewpoint recognizes the opportunity for self-development and supports reflective practice.

As a holistic understanding of competence includes well-defined attributes, promotes context-specific reference points to facilitate competence assessment, and supports professional reflection and development in nursing, this appears to be the most suitable conceptualization to guide the proposed study.

Conceptual literature on EIDM competence.

While there is an abundance of literature that explores the concepts of EIDM and competence independently, conceptual discussions on the combination of the two constructs are

limited. Of the information that does exist, there are noteworthy limitations. The existing literature on EIDM competence consists of two concept analyses following Walker and Avant's concept analysis process (Alqahtani, 2016; Laibhen-Parkes, 2014). The purpose of these concept analyses was to establish an operational definition of EIDM competence. There are notable differences between the two analyses with respect to results. First, both authors define EIDM competence differently. Alqahtani (2016) defines the construct as "the ability to use of [sic] EBP process" (p. 25), while Laibhen-Parkes (2014) defines EIDM competence as "the ability to ask clinically relevant questions for the purposes of acquiring, appraising, applying and assessing multiple sources of knowledge within the context of caring for a particular patient, group or community" (p. 180). Both definitions incorporate the term *ability* which is used in the previously noted definition of competence by Eraut (1998). Although, missing from the concept analyses discussions and final definitions is the notion that competence denotes quality of ability or comparison to a specific standard (Eraut, 1998). Incorporating this in the definition is important as competence indicates a level of accountability, professional expectation and specific qualification (Eraut, 1994). Both authors also cite literature in their analysis process that recognize the defining competence attributes as knowledge, attitudes, values, and skills, which align with the holistic definition of competence previously discussed. Missing however, is the attribute of behaviour, cited in literature as critical to competence (Girot, 2003; While, 1994). Acknowledging all of these attributes (i.e., knowledge, attitudes, values, skills, and behaviours) in a definition of EIDM competence is important, as they provide a foundation to define competent practice, from which measures can be developed and used in the assessment of nurses (Waddell, 2001).

In addition to missing features of competence in their final definitions, more detail and clarification in reference to the conceptualization of EIDM are also needed. Alqahtani's (2016) definition incorporating the phrase *use of EIDM process* does not articulate what is specifically involved in the process. Contrary to this, Laibhen-Parkes (2014) does explicitly identify each of the five steps of the EIDM process. However, the arrangement of her wording places emphasis only on ability to ask relevant clinical questions while the remaining steps appear secondary. In order to capture the construct holistically and comprehensively measure competence, explicit mention and equal attention must be provided to all EIDM steps in an operational definition.

Individually the operational definitions established by Alqahtani (2016) and Laibhen-Parkes (2014) lack distinct characteristics of the constructs of EIDM and competence. As such, combining components of both definitions with previously discussed principles of EIDM and competence provides a more comprehensive definition of EIDM competence: the ability to perform EIDM tasks and roles to an expected standard by integrating EIDM related knowledge, skills, attitudes/values, and behaviours.

Given this proposed definition of EIDM competence, existing literature helps to establish how EIDM competence may be operationalized. Across the existing literature, there is congruence among definitions of EIDM competence attributes that can be framed within the model of professional competence by Cheetham and Chivers (1998; see Appendix E). EIDM knowledge refers to an understanding about the defining theoretical, practical concepts and principles of EIDM and the different levels of evidence (Buchanan, Siegfried, & Jelsma, 2016; Glegg & Holsti, 2010; Leung, Trevena, & Waters, 2014; Shaneyfelt et al., 2006; Tilson et al., 2011). EIDM skills are universally understood as the application of such knowledge to perform tasks related to EIDM (Buchanan et al., 2016; Glegg & Holsti, 2010; Leung et al., 2014;

Shaneyfelt et al., 2006; Tilson et al., 2011). Tilson et al. (2011) and Buchanan et al. (2016) offer the most developed definition of attitudes/values which are described as perceptions, personal beliefs about, and the importance assigned to EIDM. This includes believing that EIDM is associated with positive outcomes and valuing each of the separate steps of the EIDM process (Tilson et al., 2011). Behaviours related to EIDM represent the enactment of EIDM steps in a real-world clinical setting (Buchanan et al., 2016; Shaneyfelt et al., 2006; Tilson et al., 2011). Melnyk, Gallagher-Ford, and Fineout-Overholt (2017) have provided leadership in defining EIDM behaviors through the development of 13 EIDM competencies for registered nurses. While this provides an excellent starting point for competency development, the consensus process used in their establishment included only clinical nursing experts, excluding a community/public health perspective as reflected in the language used in the competencies.

Summary of conceptual literature.

This review of the conceptual literature helps establish an understanding of the constructs of EIDM and competence separately, to develop a better perspective on defining EIDM competence. The definition of EIDM competence best suited for use in the context of assessment in public health nursing encompasses two primary elements. First, it includes the conceptualization of EIDM as an integrative decision-making process that considers different sources of evidence related to community/population, public health expertise, high quality research, and local community data. Second, it includes a holistic understanding of competence that denotes quality of ability to perform EIDM roles requiring the integration of knowledge, skills, attitudes/values and behaviours.

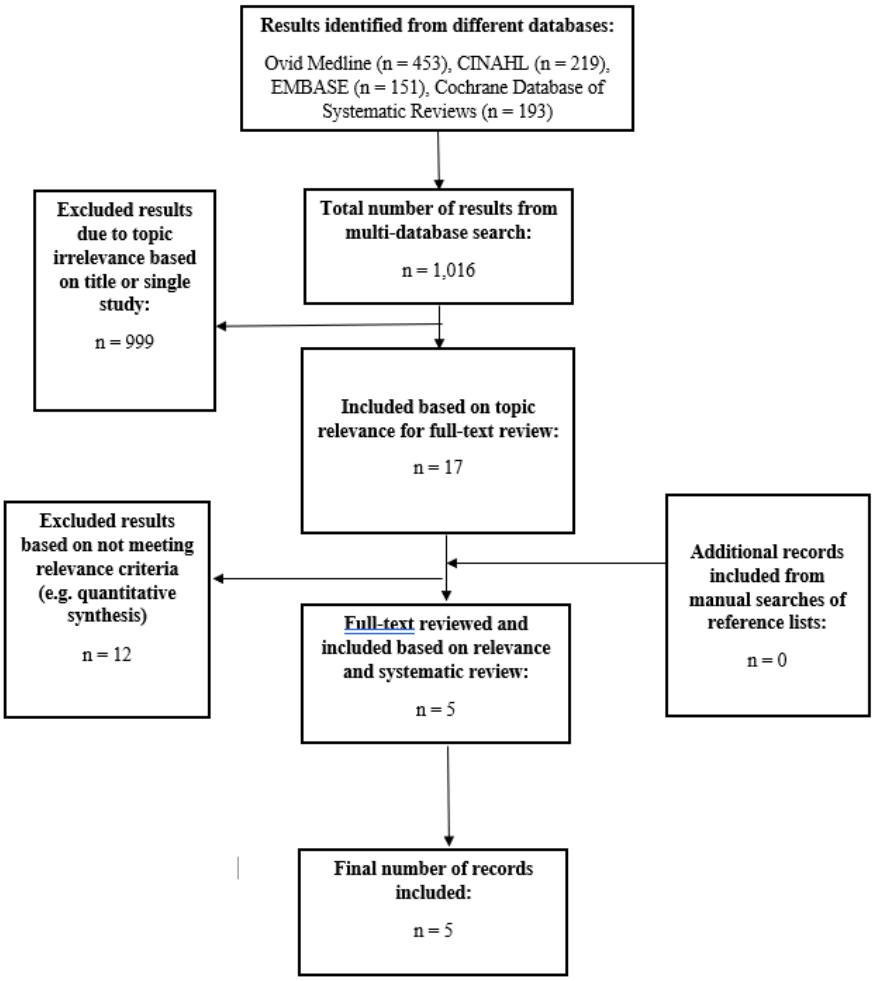
Empirical Literature Review

In addition to reviewing conceptual literature to establish conceptualizations for use, a review of the empirical literature related to EIDM competence is also warranted. Exploring the empirical literature demonstrates the state of evidence regarding EIDM competence measures, highlighting critical gaps that require addressing, providing specific direction and rationale for the proposed study.

Search strategy for empirical literature on EIDM competence.

To identify empirical literature about EIDM competence, the following databases were searched from inception to April 2020: Ovid Medline, CINAHL, EMBASE, and Cochrane Library. Key search terms included evidence-based practice, evidence-informed decision-making, outcome assessment, measurement, competence, and psychometrics. The search yielded 1,016 results. For all databases, literature was limited to systematic reviews as they represent a higher level of evidence according to the 6S hierarchy of evidence model (DiCenso, Bayley, & Haynes, 2009). The titles and abstracts of the 1,016 identified records, were screened using the relevance criteria of: 1) sample population consisted of health care providers; and 2) studies included instruments that measured any EIDM competence attribute (i.e. knowledge, skills, attitudes/values, and/or behaviours). Seventeen records were retained after initial screening and 999 records deemed not relevant. The reference lists of the 17 articles were screened although no new articles were identified. The full-text of the 17 records were screened with the addition of a third criterion (i.e. reporting of psychometric testing of instruments), where another twelve records were eliminated, leaving a total of 5 records. A summary of the search strategy is provided in Figure 1.

Figure 1. Summary of search strategy for empirical literature



Overview of systematic reviews.

Synthesized evidence from five systematic reviews reflects the highest level of evidence related to EIDM competence assessment (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Glegg & Holsti, 2010; Leung et al., 2014; Shaneyfelt et al., 2006) (see Appendix F). In their review, Buchanan et al. (2016) evaluated the methodological quality of 35 primary studies across which 34 unique instruments assessing EIDM knowledge, skills, attitudes or behaviours were cited. Studies were included in this review if a portion or the full sample included qualified occupational therapists and/or undergraduate or graduate occupational therapy students. Similarly, with a focus on rehabilitative healthcare, Fernandez-Dominguez et al. (2014) reviewed

24 studies that included instruments measuring EIDM knowledge, skills, attitudes, behaviours, as well as perceived barriers and facilitators to EIDM in physiotherapy. Studies were included if physiotherapists were identified as the main sample population. Glegg and Holsti (2010) focused their review on 15 studies with instruments that measured only EIDM knowledge and skills among samples of practicing occupational therapists. Notably, the only nursing-focused review was by Leung et al. (2014). In this synthesis of 59 studies, 24 unique instruments were reviewed which measured EIDM knowledge, skills, and/or attitudes in studies that included nurse clinicians (i.e., enrolled nurses, registered nurses and/or midwives practicing in clinical settings) as part of the sample. Last, Shaneyfelt et al. (2006) reviewed 115 studies consisting of 104 unique instruments. These instruments evaluated a combination of EIDM knowledge, skills, behaviours, and attitudes among an interdisciplinary population, with a large portion of the sample consisting of physicians or medical students.

The ensuing critical analysis of these reviews includes an appraisal of the methods in conducting the review, identification of commonalities and gaps across reviews, discussion about the quality of the primary studies included in the reviews, and presentation of review results.

Quality of systematic reviews: AMSTAR results.

The AMSTAR (first version) critical appraisal tool by Shea et al. (2009) was used to assess the quality of each systematic review and their strengths and limitations are discussed below. Among the five reviews, the AMSTAR score ranged from 3 to 4 out of a total possible score of 11.

A priori design provided.

None of the reviews referred to either protocol development or registration. A search in PROSPERO did not reveal any protocol registrations for the five reviews. This is an important criterion to consider as protocol establishment and registration may reduce the risk of bias due to

selective outcome reporting (Liberati et al., 2009).

Study selection and data extraction.

Across four of the five reviews, study selection was conducted independently by at least two reviewers, with consensus discussions used to resolve disagreements involving either the reviewers or the entire research team (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Leung et al., 2014; Shaneyfelt et al., 2006). However, in the review by Glegg and Holsti (2010), only the first author conducted study selection. This is a critical limitation as the use of a single reviewer may threaten objectivity and increase risk of excluding potentially relevant results (Liberati et al., 2009).

With regard to data extraction, three reviews employed two or more reviewers to conduct this process independently along with consensus procedures for disagreement resolution (Fernandez-Dominguez et al., 2014; Leung et al., 2014; Shaneyfelt et al., 2006). For the review by Buchanan et al. (2016), one data extractor was used, while there was no explicit description of how data extraction was conducted and by whom in the review by Glegg and Holsti (2010). Possible limitations due to lack of duplicate data extraction with regard to outcome data (Higgins, Lasserson, Chandler, Tovey, & Churchill, 2016) and lack of clarity in data extraction processes may increase risk for human error and reviewer bias (Liberati et al., 2009).

Comprehensive literature search.

A strength across all reviews includes a comprehensive literature search, defined as the use of at least two electronic sources and at least one supplementary strategy (Shea et al., 2009). Examples of common databases used included MEDLINE, CINAHL, and EMBASE, combined with supplementary strategies of hand searching reference lists, indexes of related speciality journals, and contacting experts in the field. Only one review by Leung et al. (2014) identified that a search for grey literature was included in their search strategy.

Status of publication used as inclusion criterion.

Two reviews (Glegg & Holsti, 2010; Shaneyfelt et al., 2006) do not explicitly mention whether publication status was considered in the inclusion of primary studies. While, Buchanan et al. (2016) and Fernandez-Dominguez et al. (2014) identify that unpublished studies were excluded during their literature search. This presents a critical limitation, as negative studies (i.e., no statistically significant findings) are less likely to be published compared to positive studies (i.e., those with statistically significant findings; DiCenso et al., 2005). The exclusion of unpublished material, categorized as grey literature, influences the confidence in findings from these reviews as they may present skewed results, over-estimating positive findings in relation to certain instruments. Only one review (Leung et al., 2014) included unpublished literature in the search, identified through contact with relevant organizations and expert authors in the field.

Language limitations across reviews varied. Buchanan et al. (2016) and Leung et al. (2014) did not establish any language limits. Glegg and Holsti (2010) did not address language limitations in their inclusion or exclusion criteria. However, in two reviews, included studies were limited to English (Shaneyfelt et al., 2006) and English, Spanish, French, Italian and Portuguese (Fernandez-Dominguez et al., 2014). Language limitation may skew results toward positive findings. Positive studies with a non-English language origin may be more likely to be published in English-language journals while those with negative results may be more likely to be published in non-English-language journals (DiCenso et al., 2005).

Thus, with the exclusion of unpublished results and specific language limitations in certain reviews, publication bias may pose a risk to confidence in review findings.

List of included and excluded studies with characteristics.

While a list of included studies and some study characteristics were included across reviews, the information in most reviews was insufficient to help readers determine applicability

or gauge heterogeneity. The review by Buchanan et al. (2016) was the only review to present a full list of included studies with comprehensive descriptions. Leung et al. (2014) and Shaneyfelt et al. (2006) did not provide a full list of their included studies, and only presented a select group of studies that measured certain EIDM competence attributes or met specific appraisal criteria respectively. None of the reviews included a list of excluded studies. Providing a list of both included and excluded studies creates transparency of the review process.

Quality of included primary studies assessed and documented.

Critical appraisal or quality assessments of individual studies across reviews were diverse. Review authors adapted established critical appraisal criteria or developed their own. There were diverse limitations in the assessment of design/method and psychometric findings across studies. For example, in the review by Glegg and Holsti (2010), while the appraisal domains of scale construction, reliability, and overall utility were ranked for each study, sources of validity evidence were not assessed through a ranking, but rather only listed. As well, Buchanan et al. (2016) adapted and used only a select number of criteria from the **Co**nsensus-based **S**tandards for the selection of health **M**easurement **In**struments (COSMIN) (Terwee et al., 2012) checklist, notably deleting the domains of criterion validity and responsiveness without rationale. Rating descriptions to denote rankings of excellent, good, fair, and poor for each appraisal criterion were also incomplete, making it difficult to ascertain how review authors selected rankings when appraising individual studies. The appraisal process used by Fernandez-Dominguez et al. (2014) and Leung et al. (2014) focused largely on the quality of instruments and if specific psychometric testing guidelines were met, albeit using an outdated perspective of validity testing. Shaneyfelt et al. (2006) were the only authors to develop their own criteria of three different levels based on applicability to specific evaluation settings and the method and results of psychometric testing.

Limitations with the critical appraisals conducted by review authors such as vague assessment processes, lack of integration of contemporary views on validity testing, and lack of an established guiding framework to substantiate new appraisal criteria raise concerns about how conclusions were formulated in each review. If a low-quality appraisal is conducted and used to justify certain conclusions, this decreases confidence in the accuracy of findings. Given the limitations noted above, the empirical literature is classified as low quality. Total AMSTAR scores ranged from 3-5 out of a total score of 11 (see Appendix G). Confidence in review findings as a result is limited.

Consistencies, inconsistencies, and gaps across reviews.

Currency of literature.

A lack of currency is a consistent gap across reviews indicating that the evidence is dated and requires updating. Buchanan et al. (2016) published the most recent review with literature included until 2014. Notably, the only nursing focused review by Leung et al. (2014) includes literature until 2013. With EIDM gaining greater attention in practice standards (Ontario Ministry of Health and Long-Term Care, 2018), growing organizational expectations for EIDM among nurses (Community Health Nurses of Canada, 2019), and more attention given to EIDM competency development (Melnyk et al., 2014), there is need for a current review of the EIDM competence assessment literature among nurses.

Participants and settings.

An inconsistency across the five reviews was that the populations of focus differed. Sample populations included nurses/midwives, occupational therapists, physiotherapists, medical practitioners and students, along with other allied health care professionals. Reviews aimed to include studies that focused only on one primary population. However, if that population consisted of a portion of the sample, such studies were also included in the review. The authors'

attempts to address a specific profession in a review reflect an understanding of diverse EIDM needs, differing reception to and expectations of EIDM held by each profession (Glegg & Holsti, 2010). With the exception of one review (Fernandez-Dominguez et al., 2014), reviews recommended certain EIDM assessment tools for specific disciplines. However, as Streiner, Norman, and Cairney (2015) identify, reliability and validity are contingent not solely on scale properties, but on the sample with whom and specific situation in which they are tested. Thus, reliability and validity established in one population cannot be inferred to another (Streiner et al., 2015). With the inclusion of diverse populations in each review, caution should be used in interpreting authors' discipline specific recommendations. Moving forward, future systematic reviews can establish stringent inclusion criteria with a focused study population. Although, if the use of stringent criteria limits search results, reviews which include interdisciplinary populations can analyze and present findings according to separate disciplines and settings. This may help determine if differences exist between groups. A critical gap to note is that the type of setting (e.g., public health, primary care, acute care) was not extracted as a data item from primary studies across four reviews. Such data are important to consider in determining applicability of population and due to differences in role and environment across practice settings.

Constructs measured across systematic reviews.

Across all five reviews, there was some consistency in the EIDM competence attributes measured. These included knowledge, skills, attitudes, and behaviours (see Appendix H) for definitions), in addition to EIDM barriers, facilitators, and patient outcomes. Three reviews assessed the number of instruments that measured individual EIDM attributes (Buchanan et al., 2016; Leung et al., 2014; Shaneyfelt et al., 2006). In the review by Buchanan et al. (2016), the majority of tools included measurement of attitudes (61%) and behaviour (97%). While

Shaneyfelt et al. (2006) reported that over half of their reviewed instruments included measurement of EIDM skills (57%) primarily in medical education settings. Out of 16 instruments, Leung et al. (2014) reported that under half of the tools assessed all three of knowledge, skill, and attitudes (41.7%), with the majority including an assessment of other variables such as EIDM facilitators and barriers (77.8%) tested mostly among nurses. The difference of focus between reviews may again be reflective of diverse EIDM professional development needs in a specific discipline. The attention afforded assessment of EIDM facilitators and barriers in nursing is unsurprising given historical evidence that nurses' uptake of EIDM has been slow and lacking standardization (Melnyk et al., 2014). A critical limitation of the review by Leung et al. (2014) is that they did not explicitly establish a conceptualization of EIDM competence. This may be the reason why tools with the EIDM attribute of behaviour were excluded, which is integral to a holistic understanding of competence. Future EIDM competence systematic reviews should consider employing a conceptualization of competence that includes all attributes (i.e., knowledge, skills, attitudes/values, behaviours).

Three of the reviews included research utilization instruments (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Leung et al., 2014). The relationship between EIDM and research utilization is well articulated in the literature. Research utilization is housed under the broader definition of EIDM (Estabrooks, 1999; Falk-Rafael, 2000; Melnyk et al., 2017). EIDM is known as the integration of other sources of knowledge (i.e., patient preferences, clinical expertise) with research evidence in decision-making (Melnyk et al., 2017). While, research utilization is primarily conceptualized as research evidence use in practice as an outcome or, less often, as a decision-making process (Squires et al., 2011). Because of this relationship between EIDM and research utilization, three reviews included an analysis of research utilization measures (Buchanan et al., 2016; Fernandez-Dominquez et al., 2014; Leung et al., 2014).

However, a limitation of the review by Leung et al. (2014) was that the search strategy purposely excluded the key search term of 'research utilization' which may have resulted in a failure to identify all related research utilization measures. Given the association between the two terms, measures of research utilization may contribute content to support the development of an EIDM competence scale. However, it would be imperative to ensure that such tools conceptualize research utilization as a process, to align with the common understanding of EIDM as a stepwise decision-making or problem-solving process. This emphasizes the importance of developing a clear construct definition, to establish distinctions from other constructs and prevent deficient representation of construct aspects in validity testing (American Educational Research Association [AERA], American Psychological Association [APA], and the National Council on Measurement in Education [NCME], 2014). To address this limitation in the future, systematic reviews should clearly articulate an operational definition and framework of EIDM.

Type of instruments.

A consistent gap across systematic reviews was that there was only a focus on self-report EIDM measures. Across three of the systematic reviews only measures of a self-evaluation/self-assessment nature were included (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Leung et al., 2014). Self-evaluation measures include self-ratings that reflect an individual's perception of his own knowledge, attitudes, or performance level (Davis et al., 2006; Waltz, Strickland, & Lenz, 2010). In comparison, the review by Glegg and Holsti (2010) included both self-evaluation measures and achievement test measures (e.g., short answer tests). Achievement tests which include multiple choice or essay questions, measure how well knowledge and/or skill standards have been met (Waltz et al., 2010). While, Shaneyfelt et al. (2006) included self-assessment, achievement test measures, as well as instruments that used objective methods of

external assessment or observation (e.g., chart audit or audiotape analysis of physician performance) in their review.

The use of self-evaluation measures in measuring EIDM competence attributes is not surprising given self-assessment is viewed as a cornerstone to the nursing profession, encouraging critical self-reflection and life-long learning (Levett-Jones, 2007). While achievement tests, according to Lai and Teng (2011), are often acknowledged as the standard in competence assessment, given the emphasis on self-reflection and professional accountability by the College of Nurses of Ontario (Campbell & Mackay, 2001), it is important to include self-assessment as a component of EIDM competence assessment. Given that the review by Leung et al. (2014) includes only self-evaluation measures, it is timely to conduct a new review of the nursing literature that includes competence tools of self-assessment, achievement testing, and external assessment/observation which can be used in different contexts of a practice setting.

Quality of included primary studies.

In conducting the critical appraisals of individual studies, review authors identified that the quality of evidence was compromised due to several limitations in the psychometric testing of the tools. A consistent gap across the literature was that authors noted a lack of reporting on psychometric findings, inadequate psychometric testing being conducted, or no such testing being conducted at all (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Glegg & Holsti, 2010). For example, Buchanan et al. (2016) identified that for 18 out of the 34 instruments appraised, validity and reliability testing were not conducted. As well, Fernandez-Dominguez et al. (2014) and Leung et al. (2014) cite that the most common psychometric characteristics reported for instruments were only content validity and internal consistency. This

is consistent with Shaneyfelt et al. (2006) who indicated that of the 104 instruments they assessed, only half (53%) included at least one type of validity testing.

Expectations for tool development have been established in The Standards for Educational and Psychological Testing (AERA et al., 2014). This is recognized as the gold standard for reliability and validity testing in psychometric studies (Streiner et al. as cited in Squires et al., 2011). The Standards for Educational and Psychological Testing provide comprehensive recommendations for testing the reliability/precision and various sources of validity evidence (i.e., based on content, response process, internal structure, relations to other variables) of a tool (AERA et al., 2014). None of the reviews mentioned use of The Standards for Educational and Psychological Testing in individual studies and, based on the quality of testing reported by reviewers, it can be assumed that such standards may not have been followed or attained by the majority of studies and tools. Other limitations with the quality of evidence included a lack of theoretical frameworks to guide tool development (Fernandez-Dominguez et al., 2014) and individual studies failing to clearly articulate EIDM (Buchanan et al., 2016; Glegg & Holsti, 2010; Leung et al., 2014).

Systematic review findings.

Across reviews and once duplicate recommendations were accounted for, only 13 instruments out of those identified in the systematic reviews were perceived by their authors as being of sufficiently high quality for measuring the EIDM competence attributes of knowledge, skills, attitudes, and/or behaviour in specific health care disciplines (see Appendix I) based on diverse criteria (see Appendix J).

Research utilization instruments.

Of the 13 instruments identified, five measured attributes related to research utilization through self-report including the: 1) Knowledge, Attitudes and Practices of Research Survey (Van Mullem et al., 1999); 2) BARRIERS to Research Utilization Scale (Funk, Champagne, Wiese, & Tornquist, 1991); 3) Barriers and Attitudes to Research Therapies (Metcalfe et al., 2001); 4) Edmonton Research Orientation Survey (Pain, Hagler, & Warren, 1996); and 5) Untitled questionnaire (Philibert, Snyder, Judd, & Windsor, 2003). Attitudes toward research utilization were measured in most tools (n = 4; Funk et al., 1991; Metcalfe et al., 2001; Philibert et al., 2003; Van Mullem et al., 1999). Three tools measured behaviours and two tools included items on knowledge related to research utilization. Reliability assessment of scores from the five tools consisted of calculating an internal-consistency coefficient (i.e. Cronbach's alpha). Three out of the five tools, considered to be in their early stages of development, met acceptable guidelines of $\alpha \geq 0.70$ according to Streiner et al. (2015; Van Mullem et al., 1999; Pain et al., 1996; Philibert et al., 2003). Reliability was also assessed by determining test-retest coefficients for two instruments (Funk et al., 1991; Van Mullem et al., 1999). Test-retest correlation coefficients for these two instruments ranged from 0.68–0.83, with only some of the subscales in each instrument reaching acceptable coefficient guidelines of 0.70-0.80 (Keszei, Novak, & Streiner, 2010).

Across the five reviews, assessments of validity evidence based on test content (n = 1), internal structure (n = 3), and relations to other variables (n = 1) were conducted. A content validity index of 0.85 for the Knowledge, Attitudes and Practices of Research Survey provides support for validity evidence based on test content, meeting the minimum standard for a scale content validity index of 0.80 (Polit & Beck, 2006). Principal component analyses were

conducted on three new instruments providing evidence to support internal structure, with either four or eight factor scales identified (Funk et al., 1991; Metcalfe et al., 2001; Pain et al., 1996). In support of validity evidence based on relations to other variables, positive correlations were found between high overall scores on the Edmonton Research Orientation Survey and levels of education, completion of research/statistics courses, and participation in research activities (Pain et al., 1996).

EIDM instruments.

Achievement tests.

Of the 13 instruments identified across reviews, eight focused on assessing various EIDM competence attributes**.** Three measures evaluate EIDM knowledge and skills through achievement tests (i.e., short answer questions related to clinical scenarios) which included the: 1) Fresno Test of Competence in Evidence-based Medicine (Ramos, Schafer, & Tracz, 2003); 2) Berlin Questionnaire (Fritsche, Greenhalgh, Falck-Ytter, Neumayer, & Kunz, 2002); and 3) Adapted Fresno Test (McCluskey & Bishop, 2009). Regarding reliability, internal consistency coefficients calculated for the original Fresno Test (Ramos et al., 2003) and the Berlin Questionnaire (Fritsche et al., 2002) met acceptable Cronbach alpha guidelines of ≥ 0.70 for new measures in basic research (Streiner et al., 2015). Inter-rater reliability was assessed by calculating intra-class correlation coefficients for both the original (Ramos et al., 2003) and adapted Fresno test (MCluskey & Bishop, 2009), which exceeded Streiner's (1993) guideline of ≥ 0.80. Validity evidence based on test content for the Fresno Test was supported by the use of content experts. Validity evidence based on relations to other variables demonstrated statistically significant differences in overall test scores, with EIDM experts scoring higher than novices for both the Fresno Test and Berlin Questionnaire.

Self-evaluation/self-assessment measures.

Four of the eight instruments focused on assessing various EIDM competence attributes were of a self-assessment nature and included the: 1) Knowledge, Attitude and Behaviour Survey (Stronge & Cahill, 2012); 2) Evidence Based Practice Questionnaire (Upton & Lewis, 1998); 3) Revised Evidence Based Practice Questionnaire (Upton & Upton, 2006); and 4) Revised Evidence Based Practice Survey (Koehn & Lehman, 2008). One instrument measures EIDM knowledge, attitude, and behaviours (Stronge & Cahill, 2012), while the remaining three assess all competence attributes of EIDM knowledge, attitudes, skills, and behaviours (Upton & Lewis, 1998; Koehn & Lehman, 2008; Upton & Upton, 2006). The definitions of competence attributes used in the development of these tools were consistent among studies. Most notably, two instruments were psychometrically tested among a population of nurses (Koehn & Lehman, 2008; Upton & Upton, 2006). The remaining instruments were tested among occupational therapy students (Stronge & Cahill, 2012), and diverse healthcare professionals (e.g., nursing, midwifery, medicine; Upton & Lewis, 1998). Reliability of scores was assessed across all four measures through calculation of internal consistency coefficients (i.e., Cronbach's alpha), which ranged from 0.71-0.95 for various subscales. Only two studies (Koehn & Lehman, 2008; Upton & Upton, 2006) provide Cronbach's alpha estimates for individual subscales. Within these measures, there are combined knowledge and skills subscales and behaviour subscales which have alphas meeting the standard of ≥0.80 for established scales (Streiner et al., 2015). While the attitudes subscales have lower coefficient values of <0.80.

Across the four EIDM self-assessment instruments, testing for validity evidence based on test content (n = 2), internal structure (n = 2), and relations to other variables (n = 2) was conducted. Evidence in support of validity based on test content was determined for the original

Evidence Based Practice Questionnaire (Upton & Lewis, 1998) and a revised version by Upton and Upton (2006) through use of an expert panel. Factor analysis performed on two measures provided evidence to support internal structure by confirming a four factor scale (i.e., EIDM knowledge, attitudes toward EIDM, application and use of EIDM, future use of EIDM) (Stronge & Cahill, 2012) and a three factor scale (i.e., practice of evidence-based practice, attitude towards EIDM, EIDM knowledge/skills) by Upton and Upton (2006). Validity evidence related to other variables was also collected for the same latter instruments. Testing on the revised Evidence-based Practice Questionnaire (Upton & Upton, 2006), demonstrated a positive correlation between overall scores and knowledge of a local EIDM initiative. In addition, analyses revealed that those with increased knowledge about this local EIDM initiative had a more positive attitude toward EIDM, performed EIDM tasks more frequently and had increased knowledge about EIDM, compared to those without knowledge about the local initiative. Similarly, for the Knowledge, Attitude, Behaviour Questionnaire (Stronge & Cahill, 2012), analyses revealed positive correlations between students' application/use of EIDM and how frequently they accessed evidence, as well as a positive correlation between EIDM knowledge and the need to access evidence weekly.

Combined achievement test and self-evaluation measures.

The EBP Survey by McCluskey and Lovarini (2005), psychometrically tested on a sample of occupational therapists included both an achievement test evaluating EIDM knowledge and skills (i.e., short answer questions) and self-assessment items related to EIDM attitudes, knowledge, and skills. Psychometric testing was lacking for this measure. Internal consistency and inter-rater reliability coefficients were calculated for scores on achievement test items. Calculated Cronbach's alphas (0.74-0.84) met acceptable guidelines of ≥0.70, considering

its status as a new instrument (Streiner et al., 2015). However, inter-rater reliability coefficients differed considerably from 0.20-0.94, failing to meet guidelines of 0.80-0.90 (Streiner, 1993). Only validity evidence based on test content was established in relation to self-report items.

Summary of systematic review findings.

Based on their assessments, review authors identified measures assessing research utilization or EIDM competence attributes that they perceived to be of the highest quality out of their entire review using diverse criteria. With respect to reliability, internal consistency was reported across all measures, meeting minimum guidelines in most cases. Rarely was inter-rater and test-re-test reliability evaluated, with alternate form reliability not assessed at all among measures. In addition, testing for validity evidence was severely lacking among these measures. For some measures, validity testing was not conducted at all, whereas for others, it varied between one to three sources of validity evidence assessed, with evidence of content validity (albeit with limited detail) and internal structure, being most frequently identified. Measures with validity evidence based on relations to other variables demonstrated weak evidence between EIDM competence attributes and external variables through correlational and independent t-test analyses. These results reveal weak psychometric testing of existing tools and/or poor psychometric performance, providing strong rationale for improvements to this field of research.

Summary of empirical literature review.

A review of the empirical literature confirms the need to further investigate if there is an existing tool, one that requires modification or if a newly developed measure is warranted in the assessment of EIDM competence among PHNs, in addition to its psychometric testing. While there are systematic reviews focused on tools measuring EIDM competence in different health care disciplines (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Glegg & Holsti,

2010; Leung et al., 2014; Shaneyfelt et al., 2006), they have several limitations. As previously noted, these reviews have been assessed as having poor methodological quality based on critical appraisal using the AMSTAR tool. Primary methodological limitations include: increased risk of bias due to selective outcome reporting attributed to lack of a priori protocols; use of a single reviewer in study selection and outcome data extraction; increased risk of publication bias due to literature exclusions based on language and publication status; limited identification of included and excluded studies; and less rigorous critical appraisal of included primary studies. These limitations significantly decrease confidence in subsequent review conclusions established.

Gaps across reviews, and most importantly in the only nursing focused review by Leung et al. (2014) include: lack of a focused sample population; lack of knowledge about the practice settings in which tools were used or tested to help ascertain applicability; exclusion of other types of competence measures aside from self-assessment (e.g., achievement tests or external assessment that can be used in different practice contexts such as in intervention testing, performance appraisal, or, in hiring practices); and lack of an established and holistic conceptualization of EIDM competence to guide the review.

While existing systematic reviews have identified instruments that measure EIDM competence attributes of knowledge, skills, attitudes, and behaviours in various combinations, there are critical limitations in terms of the quality of such measures. With respect to methodology, review authors have determined there is poor quality of psychometric testing of existing instruments and reporting of results due to lack of comprehensiveness or no testing conducted at all, and incomplete reporting, respectively (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Glegg & Holsti, 2010). It is also difficult to ascertain if any tools have

been tested in the setting of public health nursing, as data on health care setting was not extracted in the previous review by Leung et al. (2014).

From a theoretical standpoint, weaknesses in instrument development include lacking a guiding theoretical framework and established conceptualization of EIDM (Buchanan et al., 2016; Fernandez-Dominguez et al., 2014; Glegg & Holsti, 2010; Leung et al., 2014). Moreover, while existing tools aim to measure EIDM competence attributes including knowledge, skills, attitudes/values, and/or behaviours, they do not explicitly define a conceptualization of competence used to guide the development of their instrument. These limitations create substantial concerns over the validity of scores interpreted from these measures and may encourage one to question if they are in fact measuring competence, specifically of EIDM.

Chapter 3:

Measures Assessing Attributes of Evidence-Informed Decision-Making (EIDM) Competence Among Nurses: A Systematic Review Protocol

Citation: Belita, E., Yost, J., Squires, J. E., Ganann, R., Burnett, T., & Dobbins, M. (2018). Measures assessing attributes of evidence-informed decision-making (EIDM) competence among nurses: a systematic review protocol. *Systematic Reviews, 7*(181), 8.

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Abstract

Background: There are growing professional expectations for nurses to engage in and develop competence in evidence-informed decision-making (EIDM) due to opportunities for improved client and community outcomes and provision of the highest quality of care. However, EIDM is underdeveloped, with low implementation rates among nurses. The use of indicators to assess EIDM performance has potential to encourage nurses' engagement in EIDM through competence recognition and support assessment of strengths and competency gaps for individual nurses and organizations. Currently, the state of evidence regarding measures that assess EIDM competence attributes (i.e., knowledge, skills, beliefs/values, behaviours) among nurses, is unknown. This systematic review aims to address this gap through a narrative synthesis of the characteristics and psychometric properties of EIDM competence measures.

Methods: The search strategy, developed in consultation with a Health Sciences Librarian, consists of online databases, contacting experts, hand searching reference lists, key journals, websites, conference proceedings, and grey literature. Studies will be included if the following criteria are met: 1) sample includes practicing nurses and data for nurses are reported separately; 2) conducted in any healthcare setting; 3) quantitative or mixed methods design; 4) reports use or testing of a measure assessing EIDM competence attributes (i.e., knowledge, skills, attitudes/values and/or behaviours); and 5) published in English. Screening will be conducted independently by two reviewers using a two-stage process: 1) title and abstract level; and 2) full-text level. Data extraction of study characteristics (e.g., sample, setting) will be conducted by a single reviewer and checked for accuracy by a second reviewer. Psychometric properties of acceptability, reliability, and validity evidence for each measure will be independently extracted by two reviewers. Data on measures will be synthesized narratively according to acceptability,

number of validity evidence sources established, and reliability of scores. Data pertaining to population and healthcare setting will also be reported for each measure.

Discussion: This systematic review will provide a current understanding about the state of evidence with respect to EIDM competence measures in nursing to assist in determining potentially relevant and robust measures for use in different nursing practice settings.

Systematic review registration: Protocol registered in PROSPERO Registration #: CRD42018088754

Keywords: evidence-informed decision-making, competence, assessment, psychometrics, nursing

Background

Evidence-informed decision-making (EIDM) is defined as a process in which high quality, available evidence from research, local data, patient and professional experiences are synthesized, disseminated, and applied to decision-making in healthcare practice and policy [1, 2]. Considerable attention to the integration of EIDM in clinical practice is warranted given substantial benefits to the healthcare system, healthcare professionals, clients, and communities. The most critical reason for implementing EIDM is the potential of providing the highest quality of care due to the use of more effective and cost-efficient interventions, resulting in the best client outcomes across healthcare settings [3, 4]. Examples of improved client care and outcomes following EIDM implementation are best demonstrated in knowledge translation studies that support integration of research evidence in practice. In a systematic review of 10 knowledge translation studies focused on mentoring, Abdullah and colleagues [5] report outcomes of improved physician prescribing behaviours for acute myocardial infarction and improved documentation of pain assessments by nurses following increased uptake of best practice clinical guidelines. Yost et al. [6] also conducted a systematic review of 30 studies with an aim to determine the effect of knowledge translation interventions on client outcomes. Across these studies, diverse client outcomes are reported including a reduction in patient falls, reductions in pain intensity following uptake of guidelines for pain assessment and management in older adults, a clinically significant reduction in death risk and dependency, and improved physical health after implementation of best practice guidelines for acute stroke care.

In considering benefits for nurses, EIDM also promotes empowerment and job satisfaction [7, 8], facilitates professional development and advances the nursing profession [9], and may support nursing retention [10].

The importance of EIDM is further underscored by its inclusion in national practice frameworks and provincial practice standards for nurses. In the Framework for the Practice of Registered Nurses in Canada [11], the Canadian Nurses Association identifies EIDM as a fundamental principle to nurses' development of clinical expertise and maintenance of overall competence. In a position statement on EIDM and nursing practice, the Canadian Nurses Association establishes professional responsibilities related to EIDM for various nursing roles including frontline clinicians, educators, researchers, nursing regulatory bodies and professional associations [2]. The professional expectation is that nurses develop the necessary competencies to engage in EIDM which include, but are not limited to, reading and critically appraising scientific literature, identifying and articulating clinical research questions for investigation, as well as supporting the evaluation and promotion of EIDM [2]. EIDM competency expectations are emphasized even further in specific nursing practice settings. For example, the Community Health Nurses of Canada [12] has identified critical appraisal and use of evidence in the development of public health policies and practice as core competencies for all nurses practicing in a community setting. Provincially, the College of Nurses of Ontario [13] established professional practice standards with respect to accountability, knowledge, and knowledge application. Within these, indicators demonstrating achievement of standards describe nurses' abilities to develop evidence-informed rationale for interventions and apply evidence in every day practice [13].

Despite professional expectations to engage in EIDM and benefits to the healthcare system, professionals, and clients, there remain critical deficits in EIDM implementation and competence. Across diverse and international nursing practice settings, EIDM implementation has been primarily deemed low [14-17] and at its very best, moderate [18]. In a recent integrative

review [18], studies reported many shortfalls among nurses with respect to EIDM competence attributes of knowledge, skills, and behaviours. EIDM knowledge varied considerably among nurses, and in some cases, there was a discrepancy between nurses' understanding of EIDM primary concepts and how EIDM is most commonly conceptualized [18]. For example, in international samples of nurses, EIDM was believed to be nursing practice based solely on intuition, tradition, or professional experience without the integration of other forms of evidence such as research or client preferences and values [18]. Across studies, nurses also consistently reported that the EIDM knowledge and skills they possessed were insufficient to engage in EIDM implementation and practice change [18]. Additionally, in a recent cross-sectional study, a large sample of hospital nurses from the United States collectively rated themselves as below 'competent' across 24 EIDM competencies [19].

In the nursing literature, barriers hindering EIDM are well documented. Prominent organizational barriers reported by nurses include lack of protected work time for EIDM, lack of strategic vision or leadership in EIDM, and exclusion from clinical decision-making [17, 20, 21]. Related to this is a lack of clarity, consistency, formal processes and structures to define EIDM roles and expectations [22], as well as lack of specificity in EIDM competencies, preventing organizations from meeting standards of high quality healthcare that is evidence-informed [14, 23]. In contrast, an overarching facilitator of EIDM is a supportive organizational culture that includes nursing leaders championing EIDM work through mentorship and participation in strategic visioning to support frontline EIDM uptake [20, 24]. Proposed organizational strategies to encourage EIDM implementation include the explicit addition of EIDM indicators to appraisal processes for practitioners [22], development of EIDM practice standards [25], and use of clear EIDM competencies specific to general class nurses and those in advanced practice [23].

Establishing clarity, consistency, and a rigorous assessment method for EIDM competence provides clear direction for knowledge and skill development, in addition to competence recognition providing further motivation for EIDM engagement [26].

Given this, competence assessment serves a critical role in sustaining and improving EIDM implementation among nurses. The focus on assessment of competence and continuing competence (i.e., maintenance and continual improvement of competence) is supported by the College of Nurses of Ontario to ensure high quality patient care and promote the advancement of nursing and continued professional learning [27]. The College of Nurses of Ontario [13] asserts that "competence is the nurse's ability to use her/his knowledge, skill, judgment, attitudes, values and beliefs to perform in a given role, situation and practice setting" (p. 5). More specifically, competence is conceived of as the amalgamation of attributes including knowledge, skills, attitudes/values, and behaviours applied to performance [28-30].

Critical attributes of EIDM competence are articulated across the literature. EIDM knowledge refers to an understanding about the defining theoretical, practical concepts and principles of EIDM and the different levels of evidence [31-35], whereas EIDM skills are universally understood as the application of such knowledge to perform EIDM tasks [31-35]. Tilson et al. [33] and Buchanan et al. [31] offer the most developed definition of attitudes/values, which are described as perceptions, personal beliefs about, and the importance assigned to EIDM. This includes believing that EIDM is associated with positive outcomes and valuing each separate step of the EIDM process [33]. The enactment of EIDM steps in a real-world clinical setting (e.g., searching databases for evidence, accessing information sources) define the competence attribute of behaviour [31, 33, 35].

Measures assessing individual EIDM competence attributes separately exist in different healthcare disciplines including nursing [36], allied healthcare [37, 38] and medicine [39, 40]. To date, there is only one systematic review [32] that identifies measures to assess nurses' and midwives' knowledge, skills, and attitudes for EIDM. However, while the intent of the review was to focus on a population of nurses and midwives in clinical environments, its included studies, to some extent, did include samples of medical practitioners and allied health professionals. Leung et al. acknowledge different EIDM competence attributes such as knowledge, skills, and attitudes [32]; missing from this, however, is the competence attribute of 'behaviour' with the consequence of potentially excluding such critical measures in the review.

Also noteworthy is the inclusion of research utilization measures in the review by Leung et al. [32]. Conceptually, the difference between EIDM and research utilization is well articulated in the literature [41, 42]. Research utilization encompasses a component of, and is housed under the broader definition of EIDM [41-43]. The critical difference between these concepts involves the form of evidence applied to healthcare practice. Research utilization emphasizes the use of research evidence that is scientific/empirical in nature [41]. While, EIDM denotes use of a broader understanding of evidence that includes integration of not only research, but also evidence from clinical experience, clients and caregivers, and local context or environment [44]. Despite this conceptual difference, measures originally developed to assess research utilization were still included in the review if their use in subsequent studies was cited as measuring EIDM. Data extraction also did not include healthcare setting (e.g., acute care, community), which would make it difficult to determine a measure's relevance for use in a specific nursing setting. Coupled with this, assessment of validity evidence was guided by the traditional Trinitarian approach of treating criterion, content and construct validity as separate

entities [45], rather than using the contemporary approach of understanding validity evidence as a unified concept according to the Standards for Educational and Psychological Testing [46]. Not having a comprehensive assessment of validity evidence for a measure in relation to a specific population and healthcare setting would make it difficult to determine appropriateness given a particular context.

As such, the proposed systematic review aims to address these limitations within the existing literature and contribute to a current understanding about the state of evidence in EIDM competence assessment in nursing.

Objectives

The objectives of this systematic review are to: 1) comprehensively identify existing measures of EIDM competence attributes (i.e., knowledge, skills, attitudes/values, and/or behaviours) used among nurses; and 2) assess and synthesize their psychometric properties (i.e. acceptability, reliability, validity). The contemporary understanding of psychometric assessment will be guided by the Standards for Educational and Psychological Testing [46]. Narrative synthesis of this data, coupled with identification of practice settings and sample population, will provide a current understanding of existing EIDM competence measures to assist healthcare institutions in determining relevant and robust measures for use in specific nursing practice settings.

Methods

This protocol has been registered a priori in PROSPERO (#CRD42018088754) and follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines as included in Additional file 1 [47].

Search Strategy

A comprehensive search strategy was developed in consultation with a Health Sciences Librarian. The primary online databases to be searched include Ovid Medline, EMBASE, CINAHL, and ERIC. Statistical databases (Health and Psychosocial Instruments [HaPI] and MathSciNet) will also be searched as they index primarily psychometric studies. Search terms will differ according to unique subject headings in each database. An example of a search strategy for Medline is available in Additional file 2. Date limitations will be from 1990 until the current date. The year limit of 1990 was selected as this was when the concept of evidence-based medicine was officially coined with further development of the construct's conceptual nature occurring throughout the 1990s. Reference lists of included studies, highly relevant journals (Implementation Science, Worldviews on Evidence Based Nursing), and conference abstracts and/or proceedings of highly relevant conferences (Annual Conference on the Science of Dissemination and Implementation in Health, Community Health Nurses of Canada Conference, Knowledge Translation Canada Annual Scientific Meeting) will be hand searched. Strategies for locating grey literature will include: contacting experts in the field of EIDM competence assessment; searching grey literature databases including ProQuest Dissertations and Theses, Greylit.org, Canadian Health Research Collection; and using a targeted approach of searching publication portals on websites of the Canadian Nurses Association, Community Health Nurses Association of Canada, and American Nurses Association for assessment tools. Duplicates will be removed and all unique references will be screened for relevance.

Inclusion Criteria

Studies will be included if they meet the following criteria: 1) study sample consists entirely of nurses or a portion of the sample comprises nurses for which data is presented

separately or can be extracted; 2) take place in any healthcare setting (e.g., public health, hospital, primary care, long-term care); 3) report results from testing or the use of a measure that assesses any EIDM competence attribute (i.e., knowledge, skills, attitudes/values, behaviours). (See Additional file 3 for attribute definitions); 4) includes measures with a quantitative design or mixed-methods design; and 5) written in English.

Exclusion Criteria

Studies will be excluded based on the following criteria: 1) they include measures of EIDM competence used among healthcare professionals other than nurses and nursing specific data is not reported separately or cannot be extracted; 2) the full sample or a portion consists of undergraduate nursing students and data for practicing nurses is not reported separately or cannot be extracted; and 3) measures that solely evaluate research utilization (defined as only one component of EIDM).

Study Selection

Two independent reviewers will screen references at the title and abstract level using the aforementioned inclusion criteria. Citations will be classified into three groups labelled "include," "exclude" or "unsure". Those classified under "include" or "unsure" by either reviewer will move forward into the next round of full-text review. From these results, full-text articles will be assessed independently by two reviewers using more detailed screening inclusion criteria. Screening criteria at the title and abstract level, as well as full-text review is provided in Additional File 4. Citations will be classified in groups for "inclusion" or "exclusion". Consensus will be used to resolve disagreement at this stage of full-text review. If consensus cannot be met, a third team member will serve as an arbitrator to decide on final inclusion or exclusion. The number of studies identified from information sources, screened for eligibility,

included in the review, and excluded studies with reasons identified will be presented in a flow chart using PRISMA guidelines [47]. DistillerSR will be used to screen citations, upload references, and document reasons for study inclusion or exclusion.

Data Extraction

Data extraction will be conducted using a predetermined online data extraction form. The form will be piloted independently by two reviewers on five randomly selected references, discussed, and revised as needed following the pilot. One reviewer will independently extract data pertaining to study characteristics. Thereafter, a second reviewer will check study characteristic data for accuracy. Study characteristics include: study design, sample size, professional designation of sample, healthcare setting, geographic location of study, funding, name of measure, format, purpose of measure, item development process, number of items, theoretical framework used, conceptual definitions established, EIDM attributes measured, EIDM domains/steps covered, and description of marking key or scale for self-report measures.

Two reviewers will independently extract data relating to the primary outcomes consisting of the psychometric properties of measures, which include evidence for acceptability, reliability, and validity. Acceptability refers to how acceptable it is for an individual to complete an instrument and will be assessed by extracting data on the proportion of missing responses and time to complete the instrument [48]. Data extraction pertaining to evidence of reliability and validity will be guided by the Standards for Educational and Psychological Testing [46]. Reliability is defined as the consistency of scores from a measure across repeated measurements of different circumstances [46]. Reliability evidence to be extracted may be presented in the form of standard errors of measurement, reliability or generalizability coefficients, or test information functions based on item response theory [46]. Validity is defined as “the degree to which

evidence and theory support the interpretations of test scores for proposed uses of tests" (p. 11) [46]. As such, a measure cannot be identified as being valid or not valid, rather, validity is a property of the interpretation of test scores [49]. Producing a strong validity argument to support the interpretation of test scores requires an accrual of various sources of validity evidence [46, 49]. Therefore, data extraction as it relates to validity will focus on different types of evidence based on: test content; response processes; internal structure; and relations to other variables. To assist with extracting data from study results that support validity evidence based on relations to other variables, tables will be developed with established theoretical and empirical literature that can be used as guidelines. These tables will be used as guides to determine support for or against validity evidence for a particular measure in which agreement by both data extractors on these decisions will be required. Any discrepancies in data collection will be resolved by consensus between the two reviewers. If during extraction information is incomplete or missing, attempts will be made by one reviewer to contact publication authors and obtain further information. If consensus is not achieved, a third team member will serve as arbitrator for final decisions. DistillerSR will be used by reviewers to document data extraction.

Data Synthesis

Evidence of acceptability, reliability, and validity will be presented narratively. A summary of acceptability findings will be reported for each separate measure. Reliability findings will also be reported for scores of each measure according to the different categories (i.e., standard error measurement, reliability/generalizability coefficients, test information functions) outlined in the Standards for Psychological and Educational Testing [46]. In synthesizing validity evidence data, other reviews have developed their own system of classifying measures according to various levels [35, 50] or by assigning scores [51, 52] based

on the number of validity evidence sources for scores of a particular measure. To follow suit, measures will be categorized into four groups, based on the number of validity evidence sources established across studies (e.g., Group 1 = 4 sources of validity evidence established, Group 2 = 3 sources of validity evidence). The groupings will help identify the state of validity evidence for scores of each measure, contributing to an understanding about the psychometric performance of measures. Along with psychometric data, study characteristics will also be presented with regard to population and healthcare setting.

Discussion

While this study features a comprehensive search strategy and rigorous systematic review methodology, the authors acknowledge a limitation with respect to quality assessment of primary studies. Such assessment has varied widely across previous psychometric systematic reviews. Commonly, modified versions or components of the original COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) [53] have been used to critically appraise single studies in systematic reviews focused on measuring EIDM among allied healthcare professionals [31, 54]. An updated COSMIN risk of bias tool was developed [55] and applied in a recent systematic review of self-report measures for alcohol consumption [56]. However, limitations in using the COSMIN in the above cases exist. Leung et al. [32] note that the intended use of the COSMIN is for patient reported outcome measures, and the use of such out of this context potentially skews overall study quality assessment due to some irrelevant criteria. This is an important consideration as the context of patient-reported outcome measures differs critically from that of the proposed study focused on measures of EIDM competence among healthcare professionals (i.e., nurses). McKenna et al. [56] also identify a limitation with the updated COSMIN tool using a ‘lowest score counts’ method in different categories, as one

low score heavily influences overall quality assessment despite high ratings on other assessment criteria.

Other methodological quality assessment criteria such as the CanChild Outcome Measures Guidelines [57] have also been used in previous reviews [34]. Although, its original purpose was to support rating the adequacy of childhood disability measures. Testing for evidence of validity or reliability has also not been reported with respect to this tool. While, critical appraisal in the review by Leung et al. [32] was conducted using their self-developed Psychometric Grading Framework [58] which measures the strength or quality of an instrument based on reliability and validity outcomes, rather than on study methodology.

Across all existing measures (i.e., COSMIN, CanChild Outcome Measures Guidelines, Psychometric Grading Framework) intended to assess study or instrument quality in the context of a psychometric systematic review, there is one common limitation. All measures employ a Trinitarian understanding of validity and assesses quality of the study or measure only as it pertains to criterion, construct, and content validity [45]. This proposed study however, is guided by a modern perspective of validity established in the Standards for Education and Psychological Testing [46] which posits that validity is a unified concept and all types of validity evidence (i.e., content, internal structure, response process, relationships to other variables) contribute equally to a validity argument [45]. This approach requires an assessment of all evidence across studies to rate validity, and such cannot be determined until all data on validity evidence is extracted and synthesized. Given this, methodological quality assessment after data extraction is not appropriate. As such, this review instead, will focus on the synthesis of validity evidence in reference to the strength of a validity argument using a classification approach based on the number of validity evidence sources established similarly applied in other reviews [35, 50].

Conclusions

Despite limitations of the proposed study, there is critical contribution to the field of EIDM in nursing practice. The narrative synthesis resulting from this review will present important data on measure characteristics, such as population, healthcare setting, and EIDM competence attributes, in addition to the psychometric properties of validity evidence, reliability, and acceptability; this is largely missing from previous psychometric systematic reviews on EIDM measurement. The comprehensiveness of this synthesis facilitates easy selection or determination of relevance for nursing leaders or individual nurses that are seeking a relevant and robust measure to use in their unique practice setting.

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Additional file 1 PRISMA Checklist

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title					
Identification	1a	Identify the report as a protocol of a systematic review	X	☐	1
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	☐	X	
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	X	☐	73-74
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	X	☐	8-40
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	X	☐	394-396
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	☐	X	
Support					
Sources	5a	Indicate sources of financial or other support for the review	X	☐	392-393
Sponsor	5b	Provide name for the review funder and/or sponsor	☐	X	
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	☐	X	
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	X	☐	90-198
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	X	☐	221-224
METHODS					

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	X	☐	255-269
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	X	☐	235-254
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	X	☐	Additional file 2
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	X	☐	282-283
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	X	☐	270-281
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	X	☐	284-319
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	X	☐	285-293
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	X	☐	294-319
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	☐	X	
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	☐	X	
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau)	☐	X	

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	☐	X	
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	X	☐	320-334
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective reporting within studies)	☐	X	
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	☐	X	

Additional file 2 Search Strategy Example MEDLINE

Date limitations: 1990 – December 6, 2017

1. nurse*.mp.
2. exp Nurses/
3. 1 or 2
4. evidence based practice.mp.
5. evidence informed decision making.mp.
6. evidence based nursing.mp.
7. Evidence-Based Practice/
8. Evidence-Based Nursing/
9. 4 or 5 or 6 or 7 or 8
10. measurement*.mp.
11. assessment*.mp.
12. psychometric*.mp.
13. reliability*.mp.
14. validity*.mp.
15. questionnaire*.mp.
16. survey*.mp.
17. scale*.mp.
18. tool*.mp.
19. "Surveys and Questionnaires"/
20. Psychometrics/
21. 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
22. knowledge.mp.
23. understanding.mp.
24. comprehension.mp.
25. Knowledge/
26. Comprehension/
27. 22 or 23 or 24 or 25 or 26
28. skill*.mp.
29. "competency assessment".mp.
30. 28 or 29
31. behavio?r*.mp.
32. competenc*.mp.
33. clinical decision making.mp.
34. Professional Competence/
35. Clinical Competence/
36. Clinical Decision-Making/
37. 31 or 32 or 33 or 34 or 35 or 36
38. attitude*.mp.
39. belief*.mp.
40. professional value.mp.
41. Attitude/
42. "Attitude of Health Personnel"/
43. 38 or 39 or 40 or 41 or 42
44. 3 and 9 and 21
45. 27 or 30 or 37 or 43
46. 44 and 45

Additional file 3 Definitions of EIDM Competence Attributes

	Knowledge	Skills	Attitudes/Values	Behavioural
Definition	Understanding the defining theoretical, practical concepts and principles of EIDM and the different levels of evidence [31-34]	The application of EIDM knowledge to perform tasks related to EIDM in a practical setting [31-34]	Perceptions, personal beliefs about, and the importance assigned to EIDM [31, 33]	The enactment of EIDM steps in a real-life health care setting [31, 33, 35]
Example	Knowing the different steps of EIDM or the hierarchy of evidence.	The ability to apply research evidence to a clinical case scenario.	The belief that EIDM is associated with positive outcomes or the valuing each of the separate steps of the EIDM process.	Identifying a gap in patient care or critically appraising evidence related to a real world clinical practice question.

Additional file 4 Screening Criteria

Title and Abstract Screening
1) Does the study occur in a health care setting? 2) Does the study sample consist of nurses or a portion nurses? **Notes:** (e.g., Registered Nurses, Licensed Practical Nurses, Public Health Nurses, Registered Practical Nurses) 3) Does the study involve a measure assessing any of the EIDM competence attributes (i.e., knowledge, skills, attitudes/values and/or behaviours)? **Notes:** **a) Knowledge:** an understanding of key theoretical and practical principles of EIDM, as well as the different levels of evidence **b) Skills:** application of EIDM knowledge required to perform EIDM tasks such as developing a PICO question or critically appraising evidence **c) Attitudes/Values:** perceptions, personal beliefs about, and the importance provided to EIDM **d) Behaviour:** the practice of EIDM steps in a real world clinical setting
Full Text Screening
1. Does the study occur in a health care setting? 2. Does the study consist of a quantitative design or mixed methods design? 3. Does the study sample consist of nurses or a portion of nurses? 4. If the study sample consists of a portion of nurses, is the data presented separately for nurses or can it be extracted separately? 5. Does the study involve a measure assessing any of the EIDM competence attributes (i.e., knowledge, skills, attitudes/values and/or behaviours)? 6. Is the study written in the English language? **Notes:** **a) Knowledge:** an understanding of key theoretical and practical principles of EIDM, as well as the different levels of evidence **b) Skills:** application of EIDM knowledge required to perform EIDM tasks such as developing a PICO question or critically appraising evidence **c) Attitudes/Values:** perceptions, personal beliefs about, and the importance provided to EIDM **d) Behaviour:** the practice of EIDM steps in a real world clinical setting

Chapter 4:

Measures of Evidence-Informed Decision-Making Competence Attributes: A Psychometric Systematic Review

Citation: Belita, E., Squires, J. E., Yost, J., Ganann, R., Burnett, T., & Dobbins, M. (2020). Measures of evidence-informed decision-making competence attributes: a psychometric systematic review. *BMC Nursing*, *19*(1), 44. doi:10.1186/s12912-020-00436-8

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Abstract

Background: The current state of evidence regarding measures that assess evidence-informed decision-making (EIDM) competence attributes (i.e., knowledge, skills, attitudes/beliefs, behaviours) among nurses is unknown. This systematic review provides a narrative synthesis of the psychometric properties and general characteristics of EIDM competence attribute measures in nursing.

Methods: The search strategy included online databases, hand searches, grey literature, and content experts. To align with the Cochrane Handbook of Systematic Reviews, psychometric outcome data (i.e., acceptability, reliability, validity) were extracted in duplicate, while all remaining data (i.e., study and measure characteristics) were extracted by one team member and checked by a second member for accuracy. Acceptability data was defined as measure completion time and overall rate of missing data. The Standards for Educational and Psychological Testing was used as the guiding framework to define reliability, and validity evidence, identified as a unified concept comprised of four validity sources: content, response process, internal structure and relationships to other variables. A narrative synthesis of measure and study characteristics, and psychometric outcomes is presented across measures and settings.

Results: A total of 5,883 citations were screened with 103 studies and 35 unique measures included in the review. Measures were used or tested in acute care (n=31 measures), public health (n=4 measures), home health (n=4 measures), and long-term care (n=1 measure). Half of the measures assessed a single competence attribute (n=19; 54.3%). Three measures (9%) assessed four competence attributes of knowledge, skills, attitudes/beliefs and behaviours. Regarding acceptability, overall missing data ranged from 1.6%-25.6% across 11 measures and completion times ranged from 5-25 minutes (n=4 measures). Internal consistency reliability was

commonly reported (21 measures), with Cronbach's alphas ranging from 0.45-0.98. Two measures reported four sources of validity evidence, and over half (n=19; 54%) reported one source of validity evidence.

Conclusions: This review highlights a gap in the testing and use of competence attribute measures related to evidence-informed decision making in community-based and long-term care settings. Further development of measures is needed conceptually and psychometrically, as most measures assess only a single competence attribute, and lack assessment and evidence of reliability and sources of established validity evidence.

Registration: PROSPERO #CRD42018088754

Keywords: Evidence-informed decision-making, nursing, evidence-based practice, psychometrics, competence assessment

Background

Nurses play an important role in ensuring optimal health outcomes by engaging in evidence-informed decision making (EIDM). EIDM, used synonymously with the term evidence-based practice (EBP) [1] involves "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients" [2] (p. 71). The use of the word 'informed' in EIDM denotes that research alone is insufficient for clinical decision making and cannot take precedence over other factors [3]. Evidence in this regard then, is defined as credible knowledge from different sources including research, professional/clinical experience, patient experiences/preferences, and local data and information [4, 5]. There are numerous examples of improved patient outcomes following implementation of best practice guidelines such as reductions in length of hospital stay [6] and adverse patient events related to falls and pressure ulcers in long-term care settings [7].

Despite knowledge of such benefits, competency gaps and low implementation rates in EIDM persist among nurses across diverse practice settings [8-10]. A barrier to EIDM implementation has been the lack of clarity and understanding about what nurses should be accountable for with respect to EIDM as well as how it can be best measured [11, 12]. As such, considerable effort has occurred in the development of EIDM competence measures as a strategy to support EIDM implementation in nursing practice [12].

EIDM competence attributes of knowledge, skills, attitudes/beliefs, and behaviours have been well defined in the literature. EIDM knowledge is an understanding of the primary concepts and principles of EIDM and hierarchy of evidence [13-17]. Skills in EIDM refer to the application of knowledge required to complete EIDM tasks (e.g., developing a comprehensive strategy to search for research evidence) [13-17]. Attitudes and beliefs related to EIDM include

perceptions, beliefs, and values ascribed to EIDM (e.g., belief that EIDM improves patient outcomes) [13, 15]. EIDM behaviours are defined by the performance of EIDM steps in real-life clinical practice (e.g., identifying a clinical problem to be addressed) [13, 15, 17].

Multiple uses for measures assessing EIDM competence attributes in nursing practice and research exist. Such measures can be integrated into performance appraisals [18] to monitor progressive changes in overall EIDM competence or specific domains. At an organizational level, EIDM competence standards can support human resource management by establishing clear EIDM role expectations for prospective, newly hired, or employed nurses [18, 19]. With respect to nursing research, there has been great attention afforded to the development and testing of different interventions to increase EIDM knowledge, attitudes, skills, and behaviours among nurses [20-22]. The use of EIDM competence instruments that produce valid and reliable scores can help to ascertain effective interventions in developing EIDM competence areas.

Previous systematic reviews have focused on EIDM competence attribute measures used among allied health care professionals [13, 16, 23] as well as nurses and midwives [14]. However, several limitations exist among these reviews. A conceptual limitation is that many reviews included research utilization measures despite stating a focus on EIDM [13, 14, 23]. Research utilization, while considered a component of EIDM, is conceptually distinct from it. Research utilization includes the use of scientific research evidence in health care practice [24]. While, EIDM encompasses the application of multiple forms of evidence such as clinical experience, patient preferences, and local context or setting [5]. Conceptual clarity is of critical importance in a psychometric systematic review, as it can impact findings of reported validity evidence. Reviews by Glegg and Holsti [16] and Leung et al. [14] were also limited in focus, as they included measures that assessed only a few, but not all four of the attributes that comprise

competence, potentially resulting in the exclusion of existing EIDM measures. Methodologically, across all reviews, psychometric assessment was limited as validity evidence was either not assessed [16] or assessed only by reviewing data that was formally reported as content, construct, or criterion validity [13, 14, 23], neglecting other critical data that could support validity evidence of a measure. As well, none of the reviews reported on or extracted data on specific practice settings. This is an essential component of psychometric assessment, as Streiner et al. [25] identify that reliability and validity are contingent not solely on scale properties, but on the sample with whom and specific situation in which measures are tested. Consideration of setting is important when determining the applicability of a measure for a specific population due to differences in role and environment. Despite these existing reviews, most importantly, none of them focused only on nurses. A systematic review unique to nursing is imperative given the diversity of needs, reception to, and expectations of EIDM across health care professional groups [16]. These differences may be reflected across measures to assess discipline specific EIDM competence.

The current review aimed to address limitations of existing reviews by: including measures that address a holistic conceptualization of EIDM which includes the use of multiple forms of evidence in nursing practice; focusing on the four EIDM competence attributes of knowledge, skills, attitudes and behaviours; utilizing a modern understanding of validity evidence in which sources based on test content, response process, internal structure, and relations to other variables were assessed according to the Standards for Educational and Psychological Testing [26]; extracting data on and presenting findings within the context of practice setting; and targeting the unique population of nurses.

The objectives of this systematic review were to: 1) identify existing measures of EIDM competence attributes of knowledge, skills, attitudes/beliefs, and/or behaviours used among nurses in any healthcare setting; and 2) determine the psychometric properties of test scores for these existing measures.

Methods

The protocol for this systematic review was registered (PROSPERO #CRD42018088754), was published [27] a priori, and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline.

Search Strategy

A comprehensive search strategy consisting of online databases, hand searches, grey literature, and content experts, was developed in consultation with a Health Sciences Librarian. Searches were limited from 1990 until December 2017, as the term evidence-based medicine was first introduced and defined in 1990 [28]. Search strategy sources are summarized in Table 1. A detailed search strategy is provided

in Additional file 1.

Table 1. Search strategy

Electronic databases (inception until December, 6, 2017) • Cumulative Index to Nursing and Allied Health Literature (CINAHL) • EMBASE • Education Resources Information Centre (ERIC) • Health and Psychological Instruments (HaPI) • MathSciNet • Ovid Medline
Other sources: • Hand searches of included studies • Hand searches of relevant journals including Implementation Science and Worldviews on Evidence Based Nursing • Grey Literature Report (http://greylit.org/) • Canadian Health Research Collection • Nursing association resource portals

  - Canadian Nurses Association (https://www.cna-aiic.ca/en)
  - Community Health Nurses of Canada (https://www.chnc.ca/)
  - American Nurses Association (https://www.nursingworld.org/)
- Four content experts with high frequency citations related to EIDM assessment
- Relevant conference proceedings:
  - Annual Conference on the Science of Dissemination and Implementation in Health (https://cancercontrol.cancer.gov/IS/training-education/index.html#conference)
  - National Community Health Nursing Conference – Community Health Nurses of Canada (https://www.chnc.ca/en/conferences)
  - Knowledge Translation Canada Annual Scientific Meeting

Inclusion and Exclusion Criteria

Studies were included if they met the following criteria: study sample consists of all nurses or a portion of nurses; conducted in any healthcare setting; reported findings from the use or psychometric testing of measures that assesses EIDM knowledge, skills, attitudes/values, and/or behaviours; quantitative or mixed-method design; and English language. Studies were excluded if the sample consisted of solely other healthcare professionals or nursing undergraduate students, or in which data specific to nurses was not reported separately. As well, studies testing or using measures assessing research utilization were excluded [5, 24].

Study Selection

Titles and abstracts of initial references and full-text records were screened independently by two team members (EB and TB) for inclusion/exclusion. All disagreements were able to be resolved by consensus between those whom extracted the data.

Data Extraction

Data extraction was piloted using a standard form completed independently by two team members (EB and TB) on five randomly selected references. Data extracted pertaining to study and measure characteristics included: study design, sample size, professional designation of sample, healthcare setting, study country, funding, name of measure, format, purpose of

measure, item development process, number of items, theoretical framework used, conceptual definition of competence established, EIDM attributes measured, EIDM domains/steps covered, and marking key or scale for self-report measures. Data extraction on these characteristics was performed by one team member (EB) and checked for accuracy by a second team member (TB/TD).

Data extraction of primary outcomes included psychometric outcomes of acceptability, reliability, and validity evidence. Data extracted relating to acceptability consisted of completion time and missing data reported for each measure. Missing data were extracted from reports of incomplete surveys or calculated based on the number of complete surveys included in the analysis. Reliability data extracted for scores of measures related to internal consistency, inter-rater, and test-re-test reliability coefficients. Sources of validity evidence were extracted following guidelines from the Standards for Educational and Psychological Testing [26]. Data were extracted on four sources of validity evidence: test content; response process, internal structure, and relationships to other variables. Test content refers to the relationship between the content of the items and the construct under measure, which includes analyzing the adequacy and relevance of items [26]. Validity evidence of response process involves understanding the thought processes participants use when responding to items and their consistency with the construct of focus [26]. Internal structure is defined as the degree to which test items are related to one another and coincide with the construct for which test scores are being interpreted [26]. The last source of validity evidence, relations to other variables, is the relationship of test scores to other external variables, from which it can be determined the degree to which these relationships align with the construct under measure [26].

To determine if study findings supported validity evidence based on relationships to other

variables, a review of the literature was conducted and guiding tables on variable relationships were established (see Additional file 2). Data on psychometric outcomes were extracted by two independent reviewers (EB and TB/TD). All disagreements were able to be resolved by consensus between those whom extracted the data. Measures were grouped according to the number of sources of validity evidence that were reported in the study(ies) associated with each measure. In the event that multiple studies were reported for a measure, group classification was determined based on the number of sources indicated by 50% or more of the associated studies [29].

Quality assessment was not conducted due to limitations across varying and inconsistent criteria for appraising studies involving psychometric measures [27]. Instead, aligning with previous reviews [17, 29], a thorough assessment of reliability and validity evidence for scores of measures was conducted to align with the Standards for Educational and Psychological Testing [26].

Data Synthesis

A narrative synthesis of results is presented. Study statistics as they relate to setting and population are summarized. Measures are also categorized according to the number of EIDM attributes addressed. Acceptability defined as completion time and overall missing data are summarized across measures and settings. Reliability data is summarized for each measure across settings. Similar to previous psychometric systematic reviews [17, 29], measures are categorized into distinct groups based on the number of validity evidence sources reported for each measure (e.g., Group 1= 4 sources of validity evidence). This aligns with the Standards for Psychological and Educational Testing [26] which identifies that the strength of a validity argument for scores on a measure is cumulative and contingent on the number of validity

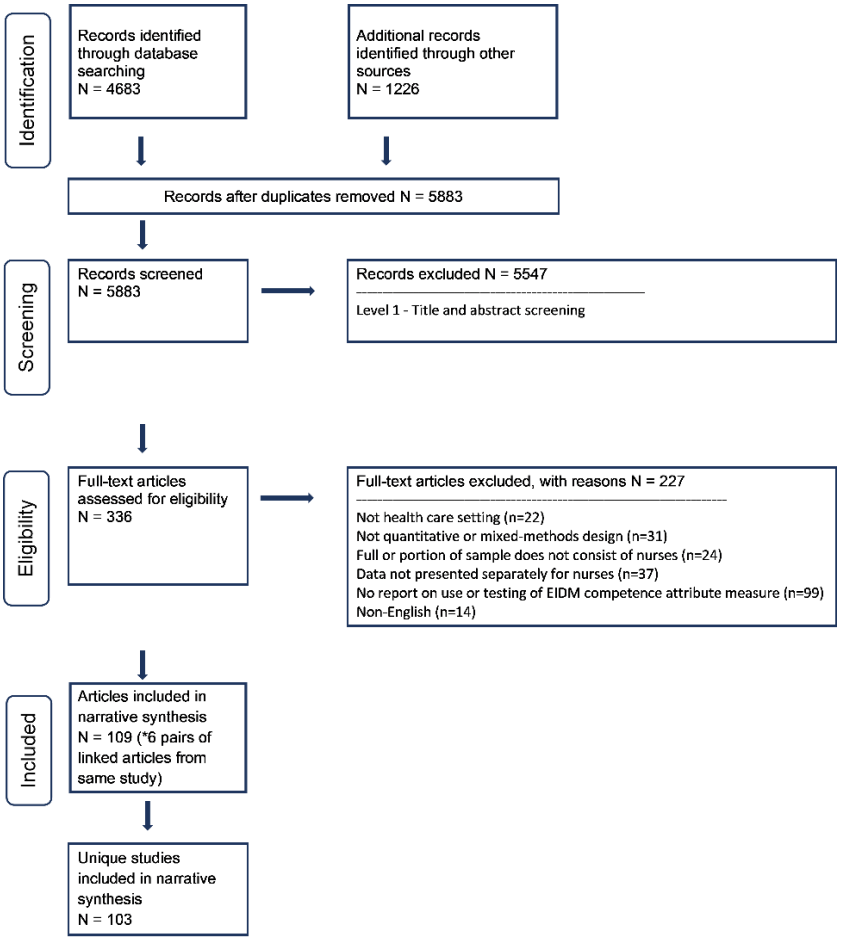
evidence sources established. As psychometric properties are based on the context in which a measure is used or tested, healthcare settings are integrated into the presentation of results.

Results

Review Statistics

In total, 5,883 references were screened for eligibility at the title and abstract level. Of the 336 screened at full-text, 109 articles were included in the final review. Six pairs of articles (n=12) were linked (i.e., associated with the same parent study) and the remainder of the articles were unique studies. Therefore, the review included 103 studies (see Additional file 3) and 35 unique measures (see Figure 1 for PRISMA details).

Figure 1. PRISMA details



Study Characteristics

Of the 103 studies, over half were conducted in the United States (n=57; 55.3%). Twenty studies were conducted in Europe (57.1%), with 19 (54.3%) taking place in Asia. Two studies were conducted each in Africa, Australia, Canada, and one in New Zealand. Publication years spanned 2004-2017. One additional measure was identified after contacting content experts; its associated study was published in 2018.

Settings

The 35 included measures were used or tested most often in acute care (n=31 measures) followed by primary care (n=9 measures). Measures were used less often in public health (n=4 measures), home health (n=4 measures), and long-term care (n=1 measure). An overview of measures with identified settings is presented in Table 2.

Population

Measures were primarily used or tested among registered nurses (n=26 measures; 74.3%), followed by advanced practice nurses (n=7 measures; 20%), and licensed/registered practical nurses (n=4 measures; 11.4%). A licensure group for 13 of the measures (37.1%) was not specified. Associated population groups are presented for each measure in Table 2.

EIDM Competence Attributes Addressed

Measures addressed a variety of EIDM competence attributes (see Table 2). Only three measures (8.6%) assessed all four EIDM competence attributes of knowledge, skills, attitudes/beliefs, and behaviours. These included the Evidence-Based Practice Questionnaire (EBPQ) [30], the School Nursing Evidence-based Practice Questionnaire [31] and a self-developed measure by Chiu et al. [32]. Seven measures (20%) assessed three of the four EIDM competence attributes, with differing foci [33-39]. These measures all assessed knowledge, but

varied on assessment of attitudes/beliefs, skills, and behaviours. Six measures (17%) addressed two EIDM competence attributes [40-45]. Over half of the total measures (n=19; 54.3%) assessed only a single EIDM attribute. Among these single attribute measures, attitudes/beliefs were assessed the most (n=6 measures) [46-53]. Overall, knowledge was the attribute addressed by most measures (n=19), followed closely by attitudes/beliefs (n=17 measures), skills (n=15 measures), and behaviours (n=13 measures; see Table 2).

Psychometric Outcomes

Acceptability.

Missing data.

Overall, missing data related to percentage of incomplete surveys were reported for 10 measures (28.6%). The range of missing data was 1.6% (EBP Beliefs Scale) - 25.6% (EBPQ) and differed across health care settings. Missing data across seven measures yielded percentages below excessive missing data limits of >10% [54]. Reported missing data is summarized in Table 3.

Completion time.

Data for completion time were extracted where times were explicitly stated or calculated using time to complete each item if a combined time was reported to complete multiple measures in a study. Completion time was reported for four measures, ranging from 5 (EBP Beliefs Scale) - 25 (EBPQ) minutes [44, 46, 55, 56]. A summary of reported completion time is provided in Table 3.

Table 2. Description of EIDM competence attributes measures across setting, population (35 measures)

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
FOUR EIDM COMPETENCE ATTRIBUTES MEASURED (n=3)																
Evidence-Based Practice Questionnaire (EBPQ) (n=36 studies) [30, 48-50, 56, 60, 88-118]	A 24-item self-report measure that assesses knowledge, practice, and attitudes toward evidence-based practice (EBP). Knowledge/skills (14 items) are assessed collectively using a 7-point scale (1=poor to 7=best). Practice is assessed with six items with a scale to determine the frequency with which that item has been completed over the past year on a 7-point scale ranging from never to frequently. Attitudes are assessed using four items also on a 7-point scale with higher scores indicating more positive attitudes towards EBP.	√	√			√	√	√	√		√	√	√	√	√	√
School Nursing Evidence-Based Practice Questionnaire (SN-EBP) (n=1 study) [31]	A measure with the most applicable categories: EBP (21 items rated from 1= strongly disagree to 5=strongly agree); Computer use (7 items rated from 1=avoid all together to 4=skillfull); Information sources (10 items rated from 1 = never to 4 = all the time)			√					√				√	√	√	√
Self-developed measure by Chiu et al. (2010) (n=1 study)	A self-report measure to assess EBP beliefs, attitudes, knowledge, skills, behaviours and barriers. Respondents rate agreement on a 5-point Likert scale (from strongly agree to strongly disagree). EBP behaviours is		√									√	√	√	√	√

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
[32]	defined by identifying the frequency of access to online databases.															
THREE EIDM COMPETENCE ATTRIBUTES MEASURED (n=7)																
Johns Hopkins Nursing EBP Assessment Survey (n=1 study) [33]	An online self-report survey in which respondents were asked to rate their confidence in ability to achieve specific EBP competencies on a 6-point scale ranging from 1=completed disagree to 6=completely agree (I feel confident I can…).		√						√				√	√		√
Persian translated EBP measure (n=1 study) [34]	A four-part self-report measure combining items from various existing measures to assess EBP knowledge, attitudes, and practice.		√						√				√	√	√	
Self-developed measure by Yip et al. (n=1 study) [35]	Measure consisting of three sections with most applicable: beliefs and attitudes (5 items) rated on a Likert scale with highest score of 5=strongly agree and knowledge and skills (9 items) rated on Likert scale with highest score of 5=excellent.		√						√				√	√	√	
Self-developed measure by Chew et al. (n=1 study) [36]	Self-report measure that assesses EBP attitude and knowledge (5 items) and resource utilization when searching for EBP (3 items).	√							√				√	√	√	

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
Self-developed EBP measure by Melnyk et al. (2004) (n=1 study) [37]	Self-report measure with the most applicable domains: Seven items measuring knowledge, beliefs, extent of EBP on a scale from 0 (nothing, not at all) to 100 (expert, all); Nine dichotomous items about EBP implementation (e.g. Do you currently use Cochrane Database of Systematic Reviews)							√				√	√		√	√
Modified Evidence-Based Nursing Education Questionnaire (EBEQ) (n=1 study) [38]	A 45-item self-report measure focused on assessing beliefs, knowledge, and self-perceived ability in EBP implementation divided into five domains: 1) knowledge 2) finding and reviewing evidence, 3) clinical practices, 4) change in clinical strategies/practices, and 5) finding and judging evidence. Response scale is a 5-point Likert scale ranging from strongly agree to strongly disagree. Higher scores are associated with positive beliefs, greater knowledge and self-perceived ability for EBP implementation.	√	√							√			√		√	√
Quick EBP VIK (Values, Implementation, Knowledge) Survey (n=2 studies) [39, 61]	A 25-item self-report survey that assesses values, implementation and knowledge of EBP. Values (8 items) are assessed using a 5-point scale from 1=strongly disagree to 5=strongly agree. Implementation (8 items) is assessed by indicating the frequency with which an EBP activity has been performed on a 5-point scale in the last 12 months (1=none; 2=1 or 2 times; 3=3-5 times; 4=6-		√						√	√		√	√		√	√

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
	10 times; 5=more than 10 times). Knowledge (9 items) is assessed on a 5-point scale for each item ranging from 1=not at all knowledgeable; 2=minimally knowledgeable; 3=knowledgeable; 4=very knowledgeable; 5=extremely knowledgeable/expert.															
TWO EIDM COMPETENCE ATTRIBUTES MEASURED (n=6)																
Self-developed measure by Barako et al. (n=1 study) [40]	Self-report measure that assesses numerous domains but most applicable are attitudes toward EBP (7 items) and EBP application (1 item) with a dichotomous response of either 'fully practice' or "don't fully practice'.		√									√			√	√
EBP measure developed by Majid et al. [41] (n=2 studies) [59, 60]	A self-report measure that assesses attitude towards EBP, skills in performing EBP activities, training needs, and supporting factors and barriers in EBP implementation. Most applicable is attitudes (5-items) measured on a 5-point scale from strongly disagree to strongly agree. EBP skills are assessed (9 items) using a 5-point scale ranging from 1=poor to 5=excellent.		√						√			√		√	√	
Modified Stevens EBP Readiness	A 25-item measure divided into two sections: 1) Consists of 20 EBP competencies which respondents rate their confidence in their ability to perform the		√						√				√	√		

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
Inventory (ERI) (Finnish ERI) (n=1 study) [42]	competency (scored on a 6-point Likert scale ranging from 1 = very little confidence to 6 = a great deal of confidence in employing EBP); and 2) 15 multiple choice item to assess knowledge about major concepts in EBP. These are scored based on number of correct questions ranging from 0-15.															
Self-developed measure by Gerrish et al. (n=1 study) [43]	A self-report measure. Many areas covered but most applicable: understanding of EBP (respondents provide open-text description of EBP understanding), 11-items for self-assessment of EBP knowledge and skills (rated on a 5-point ordinal scale (complete beginner to expert).	√	√							√			√	√		
Knowledge and Skills in Evidence-Based Nursing (KS-EBN) (n=1 study) [44]	A 10-item short answer, multiple choice, and ranking measure to assess EBP nursing knowledge and skills. Each question is awarded a specific point score. Range of scores are from 0-12.		√									√	√	√		
Adapted Fresno Test (n=1 study) [45]	A measure used to assess EBP knowledge and skills using three different pediatric nursing case scenarios. The questions relate to the case scenario and consist of both open-ended and close-ended questions. Questions are scored on a scale		√						√				√	√		

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
	from 0-212 with higher scores indicating greater EBP knowledge and skill.															
ONE EIDM COMPETENCE ATTRIBUTE MEASURED (n=19)																
Evidence-based Practice Implementation Scale (n=35 studies) [46, 55, 83, 84, 102, 111, 115, 119-150]	An 18-item self-report measure that assesses the extent of EBP implementation. Response scale is on a 5-point frequency scale. Respondents identify the frequency (in past 8 weeks) with which they have performed that item. Scale ranges from 0=0 times to 4=more than 8 times. Total score ranges from 0-72.	√	√	√	√		√	√	√	√	√	√				√
Self-developed measure by Bostrom et al. (n=1 study) [62]	Six item measure that assesses the extent to which nurses practice EBP. Nurses respond to each item by answering the question: "To what extent do you perform the following tasks in your work as a nurse?" Each item is rated on a 4-point scale (1 = to a very low extent, 2 = to a low extent, 3 = to a high extent, 4 = to a very high extent).	√	√						√							√
Self-developed measure by Kim et al. (1 study)	Self-report 7-item measure that assesses perceived ability to follow EBP steps. Responses are rated on a 5-point Likert scale based on Benner's model		√						√							√

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
[100]	(1=novice, 2=advanced beginner, 3=competent, 4=proficient, 5=expert).															
Evidence-Based Practice Confidence Scale (EPIC) (n=1 study) [48, 49]	An 11-item self-report measure in which respondents rate the confidence in their ability to perform specific EBP activities/steps using an 11-point scale ranging from 0-100.		√						√							√
EBP Competency Tool *identified from content expert (n=1 study) [10]	A self-report measure of 24 EBP competencies (items). Response scale consists of participants rating competency level on a 4-point Likert scale: 1 (not at all competent), 2 (need improvement), 3 (competent), and 4 (highly competent). Possible scores range from 0 to 96.		√				√		√	√						√
Self-developed measure by Gerrish et al. (n=1 study) [64]	A self-report measure with four sections. The most applicable section is the self-assessment of nurses' skills related to finding, reviewing, and using different evidence sources (6 items). These are ranked on a 5-point scale from 1=complete beginner to 5=expert.		√									√		√		

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
Developing Evidence-based practice questionnaire (n=6 studies) [8, 63, 151-154]	A self-report measure aimed to identify factors that influence the development of EBP. Forty-nine items are divided into five sections. Most applicable section is: self-assessment of skills in finding and reviewing evidence (eight items) which are scored on a 5-point scale from 1=complete beginner to 5=expert.	√	√	√	√				√	√	√	√		√		
Information literacy tool (n=1 study) [111]	Nine questions to assess information searching ability.		√						√					√		
Evidence-based Practice Beliefs Scale (n=42 studies) [45, 46, 55, 83, 84, 102, 111, 115, 119-150, 155-161]	A 16-item self-report measure that assesses beliefs about the value of EBP and ability in implementing it. Response scale is a 5-point Likert scale to rate agreement level (1=strongly disagree to 5=strongly agree). Total scores can range between 16-80.	√	√	√	√		√	√	√	√	√	√			√	
Modified Korean Evidence-Based Medicine questionnaire	A 23 item self-report measure that assesses participants' perceptions (13 items), attitudes (9 items) and utilization intention (1 item) of		√						√						√	

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
(n=1 study) [47]	evidence-based nursing (EBN). Participants respond on a 4-point Likert scale for perceptions and attitudes and a 3-point Likert scale for intention to use EBN to indicate their agreement with the statement ('strongly disagree' to 'strongly agree').															
Evidence-Based Practice Attitudes Scale (EBPAS) (n=1 study) [48, 49]	An 18-item self-report scale to determine attitudes toward adopting EBP. Response for each item indicate agreement level and include: 0=not at all; 1=to a slight extent; 2=to a moderate extent; 3=to a great extent; 4=to a very great extent.		√						√						√	
Attitudes to Evidence-Based Practice Questionnaire (n=1 study) [50]	A self-report survey (originally 26-items), with 17 items used to assess attitudes/barriers toward EBP rated on a 5-point Likert scale.		√									√			√	
Evidence-Based Nursing Attitude Questionnaire (EBNAQ) (n=2 studies) [51, 52]	A 15-item self-report measure that assesses attitudes towards evidence-based nursing (EBN) as it relates to the benefits of EBN, behaviours/intentions in participating in EBN, and importance level ascribed to EBN. Response scale rates the level of agreement with each	√	√		√				√						√	

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
	item on a 5-point Likert scale ranging from 1=strongly disagree to 5=strongly agree.															
Nurses' Attitudes Toward EBP Scale (NATES) (n=1 study) [53]	An 11-item self-report measure used to assess EBP attitudes and beliefs. Response scale is a 5-point Likert scale to assess agreement (1=strongly disagree to 5=strongly agree). Score ranges from 5-55 with higher scores indicating more positive attitudes related to EBP.		√						√						√	
Single item measure for EBP knowledge by Skela-Savic et al. (n=1 study) [140]	One self-report item in which respondents are asked to rate their EBP knowledge on a 5-point scale from 1=insufficient to 5=excellent.		√						√				√			
Perceived EBP Knowledge Measure (1 study) [53]	A 3-item measure that assesses a nurse's perception of having enough knowledge, skills, and access to resources to engage in EBP. Each item is scored on an agreement scale (strongly disagree = 1 to strongly agree = 5). Total scores range from 3 to 15 with higher scores denoting increased perception of EBP knowledge.		√						√				√			

Name of measure (n=# of studies) [related citations]	Purpose of measure and description	Setting							Population				EIDM Competence Attributes			
		Primary care	Acute care	Public health	Home health	Long-term	Other	Not reported	RNs	APNs	RPNs/LPNs	Does not specify	Knowledge	Skills	Attitudes/Belief	Behaviours
Evidence-Based Practice Knowledge Assessment in Nursing (EKAN) (n=1 study) [97]	A 20-item multiple choice measure that assesses EBP knowledge. Total number correct is scored out of 20.		√						√				√			
Knowledge Assessment Test (KAT) (1 study) [118]	Objective measure assessing EBP knowledge.							√				√	√			
Core Knowledge Questionnaire (1 study) [114]	A 12-item multiple choice question test to measure EBP knowledge.		√						√				√			
Total # of Measures		**9**	**31**	**4**	**4**	**1**	**4**	**5**	**26**	**7**	**4**	**13**	**19**	**15**	**17**	**13**

Table 3. Acceptability findings: Missing data and completion time [related citations]

Measure	Setting					
	Acute care	**Primary care**	**Public health**	**Home health**	**Long-term care**	**Not specified**
PROPORTION OF MISSING DATA (n=10 measures)						
EBP Beliefs Scale	10%-15.9% [55, 129, 134]	Not reported	1.6% [119]	Not reported	N/A	12.8% [159]
EBP Implementation Scale	10%-25.6% [55, 129, 134]	Not reported	6.3% [119]	Not reported	N/A	Not reported
Evidence-based Practice Questionnaire (EBPQ)	4.9%-25% [48, 92, 97, 99]	1.8%-23% [105, 107]	N/A	N/A	23% [105]	Not reported
Evidence-Based Nursing Attitude Questionnaire	7.8% [52]	Not reported	N/A	Not reported	N/A	Not reported
Evidence-Based Practice Attitudes Scale (EBPAS)	11.8% [48]	N/A	N/A	N/A	N/A	N/A
Evidence-Based Practice Confidence Scale (EPIC)	11.8% [48]	N/A	N/A	N/A	N/A	N/A
Quick EBP VIK (Values, Implementation, Knowledge) Survey	5.6% [61]	N/A	N/A	N/A	N/A	N/A
Knowledge and Skills in Evidence-Based Nursing (KS-EBN)	17.2% [44]	N/A	N/A	N/A	N/A	N/A
Evidence-Based Practice Knowledge Assessment in Nursing (EKAN)	4.9% [97]	N/A	N/A	N/A	N/A	N/A
School Nursing Evidence-Based Practice Questionnaire (SN-EBP)	N/A	N/A	5.2% [31]	N/A	N/A	N/A

Measure	Setting					
	Acute care	**Primary care**	**Public health**	**Home health**	**Long-term care**	**Not specified**
COMPLETION TIME (n=4 measures)						
EBP Beliefs Scale	~5 minutes [55]	Not reported	Not reported	Not reported	N/A	~7 minutes [46]
EBP Implementation Scale	~6 minutes [55]	Not reported	Not reported	Not reported	N/A	~8 minutes [46]
Evidence-based Practice Questionnaire (EBPQ)	20-25 minutes [56]	Not reported	N/A	N/A	Not reported	N/A
Knowledge and Skills in Evidence-Based Nursing (KS-EBN)	10-15 minutes [44]	N/A	N/A	N/A	N/A	N/A

Reliability.

Across measures and studies reporting reliability evidence, internal consistency was the most commonly assessed. Inter-rater and test-re-test reliability were also reported, although, for only one measure each.

Internal consistency.

Reliability of scores, reported as Cronbach's alpha (α), was reported for 21 measures (60%). Cronbach's alpha values ranged widely across settings of: Acute care (0.45-0.99); primary care (0.57-0.98); public health (0.79-0.91); home health (0.63-0.87); and long-term care (0.79-0.96). Cronbach's alphas are presented for individual measures and settings in Table 4.

Out of the 21 measures for which internal consistency was reported, seven measures had multiple study findings reported across unique practice settings. Reported Cronbach's alphas were varied across and within settings for the same measure as evident by wide alpha ranges (see Table 4). Among these findings, two measures assessing EIDM attitudes with the lowest

reported alphas were the Evidence-based Nursing Attitude Questionnaire (0.45) and the EBPQ (0.63 for attitude subscale) in acute care settings. The Modified Evidence-based Nursing Education Questionnaire also had a low alpha reported (0.57) in both acute and primary care settings. Regarding high range values, the EBPQ had the highest overall reported alpha (0.99) also in an acute care setting.

All 21 measures met a minimum of Cronbach's alpha ≥0.80 [57] in at least one study instance (see Table 4).

Table 4. Reported Cronbach's alphas for measures (n=21) across settings [related citations]

Measure	Acute care	Primary care	Public health	Home health	Long-term care	Not specified
Measures assessing *four* EIDM competence attributes						
School Nursing Evidence-Based Practice Questionnaire	N/A	N/A	α=0.85-0.88 1 study [31]	N/A	N/A	N/A
EBPQ	α = 0.63-0.99 28 studies [30, 49, 56, 60, 88-93, 95, 97-106, 108, 110-112, 114, 116, 117]	α = 0.694-0.98 5 studies [90, 102, 105, 107, 162]	N/A	N/A	α = 0.79-0.96 1 study [105]	α = 0.74-0.98 2 studies [30, 90]
Measures assessing *three* EIDM competence attributes						
Quick EBP Values, Implementation, Knowledge Survey (VIK)	α = 0.66 – 0.96 2 studies [39, 61]	N/A	N/A	N/A	N/A	N/A
Persian translated EBP measure	α = 0.89 – 0.93 1 study [34]	N/A	N/A	N/A	N/A	N/A
Modified Evidence-Based Nursing Education Questionnaire (EBEQ)	α = 0.57 – 0.91 1 study [38]	α = 0.57 – 0.91 1 study [38]	N/A	N/A	N/A	N/A
Self-developed measure by Yip et al.	α = 0.69 – 0.90 1 study [35]	N/A	N/A	N/A	N/A	N/A

Measure	Acute care	Primary care	Public health	Home health	Long-term care	Not specified
Measures assessing *two* EIDM competence attributes						
EBP measure developed by Majid et al. [41]	α = 0.71 – 0.94 2 studies [59, 60]	N/A	N/A	N/A	N/A	N/A
Knowledge and Skills in Evidence-Based Nursing	α = 0.96 1 study [44]	N/A	N/A	N/A	N/A	N/A
Modified Stevens EBP Readiness Inventory (ERI) (Finnish ERI)	α = 0.98 1 study [42]	N/A	N/A	N/A	N/A	N/A
Measures assessing *one* EIDM competence attribute						
EBP Beliefs Scale	α = 0.776 – 0.95 27 studies [55, 83, 84, 102, 111, 123, 124, 126-128, 131, 133, 134, 136-138, 140, 141, 143, 144, 146-150, 155, 156, 158-160]	α = 0.88-0.92 2 studies [102, 137]	Not reported	Not reported	N/A	α = 0.90 1 study [46]
EBP Implementation Scale	α = 0.85 – 0.969 21 studies [55, 83, 102, 111, 123, 124, 126-128, 131, 133, 134, 136-138, 140, 141, 143, 144, 147-150]	α = 0.88 – 0.96 2 studies [102, 137]	Not reported	Not reported	N/A	α = 0.96 1 study [46]
DEBPQ	α = 0.77 – 0.913 3 studies [63, 151, 154]	α = 0.83 – 0.914 3 studies [63, 152, 153]	α = 0.788 – 0.913 3 studies [8, 63, 153]	α = 0.865 1 study [8]	N/A	N/A
Evidence-based Nursing Attitude Questionnaire	α = 0.45 – 0.82 1 study [52]	α = 0.63 – 0.86 1 study [51]	N/A	α = 0.63 – 0.86 1 study [51]	N/A	N/A
EBP Attitudes Scale	α = 0.771 – 0.794 1 study [49]	N/A	N/A	N/A	N/A	N/A
EBP Confidence Scale	α = 0.897 – 0.912 1 study [49]	N/A	N/A	N/A	N/A	N/A

Measure	Acute care	Primary care	Public health	Home health	Long-term care	Not specified
EBP Competency Scale	α = 0.98 1 study [10]	N/A	N/A	N/A	N/A	N/A
Attitudes to Evidence-Based Practice Questionnaire	α = 0.973 1 study [50]	N/A	N/A	N/A	N/A	N/A
Modified Korean Evidence-Based Medicine Questionnaire	α = 0.85 1 study [47]	N/A	N/A	N/A	N/A	N/A
Information literacy tool	α = 0.93 1 study [111]	N/A	N/A	N/A	N/A	N/A
Perceived EBP Knowledge Measure	α = 0.80 1 study [53]	N/A	N/A	N/A	N/A	N/A
Self-developed measure by Bostrom et al.	α = 0.90 1 study [62]	α = 0.90 1 study [62]	N/A	N/A	N/A	N/A

Inter-rater and test-retest reliability.

Test-retest reliability was assessed in only one measure, the Quick EBP Values, Implementation, Knowledge Survey [39]. Average item level test-retest coefficients ranged from below marginal to acceptable [58] at 0.51-0.70 [39].

Inter-rater reliability was reported for scores on the Knowledge and Skills in Evidence-Based Nursing measure [44]. Intraclass correlations were reported for three sections of this measure and exceeded a guideline of ≥ 0.80 [58].

Sources of validity evidence.

Group 1: Measures reporting four sources of validity evidence.

Two of the 35 measures (5.7%) used/tested across three studies, were assigned to Group 1 [31, 51, 52] (see Table 5). Common across these two measures was the use of exploratory factor analysis to assess internal structure. Pertaining to validity based on relationships with other variables, this differed between the two measures. For the School Nursing Evidence Based

Practice Questionnaire, the use of correlation and regression analyses supported validity evidence with significant associations between use of EBP and demographic variables (e.g., education; see Additional file 4). For the Evidence-Based Nursing Attitude Questionnaire, correlation and t-test analyses were used to establish relationships between EBP attitudes and variables related to EBP knowledge, EBP training, and education level (see Additional file 4). The measures also varied with respect to setting with the former being tested in a public health setting and the latter in acute care, primary care, and home healthcare settings.

Table 5. Group 1: Measures with four sources of validity evidence (n=2)

Measure	Study	Setting/Licensure Group	Source of Validity Evidence			
			Content	Response process	Internal structure	Relationships to variables
School nursing evidence-based practice questionnaire	[31]	Public health/RNs	√	√	√	√
Evidence-Based Nursing Attitude Questionnaire (EBNAQ)	[51]	Home health/RNs	√	√	√	√
	[52]	Acute/RNs				√

Group 2: Measures with three sources of validity evidence.

Five measures (14%) used/tested across seven studies, were categorized in group 2 [35, 39, 44, 53, 59-61] (see Table 6). Common across all these measures was the report of validity evidence related to content and relationships to other variables. Similar to group 1, the strength of variable relationships differed, with varied use of correlational, t-test, ANOVA, and regression analyses to report significant relationships between EBP competence attributes (i.e., knowledge, implementation, skills, attitudes) and demographic, organizational variables or education interventions (see Additional file 4). Internal structure validity evidence via exploratory factor

analysis was reported for three measures [35, 39, 53, 61], while response process validity evidence was reported for two measures [44, 60]. All measures were tested or used in acute care.

Table 6. Group 2: Measures with three sources of validity evidence (n=5)

Measure	Study	Setting/Licensure Group	Source of Validity Evidence			
			Content	Response process	Internal structure	Relationships to variables
Self-developed measure by Yip et al.	[35]	Acute/RNs	√		√	√
Quick Values, Implementation, Knowledge Survey	[39]	Acute/APNs, "nurses in any role"	√		√	√
	[61]	Acute/RNs			√	√
EBP measure developed by Majid et al.	[59]	Acute/not specified	√			√
	[60]	Acute/RNs	√	√		√
Knowledge and Skills in Evidence-Based Nursing	[44]	Acute/not specified	√	√		√
Perceived EBP Knowledge Measure	[53]	Acute/RNs	√		√	√

Group 3: Measures with two sources of validity evidence.

Six measures (17%) were categorized in group 3 [10, 33, 34, 37, 42, 62] (see Table 7). Content validity evidence was commonly reported across all six measures using an expert group. Validity evidence based on relationships to other variables was reported for five of the six measures with correlational and ANOVA analyses used most often (n=3 measures). Once again, regarding this source of validity evidence, significant relationships were demonstrated between EBP knowledge, attitudes, skills, and individual characteristics or organizational factors (see Additional file 4). Acute care was the most common healthcare setting (n=5 measures).

Table 7. Group 3: Measure with two sources of validity evidence (n=6)

Measure	Study	Setting/Licensure Group	Source of Validity Evidence			
			Content	Response process	Internal structure	Relationships to variables
Modified Stevens EBP Readiness Inventory	[42]	Acute/RNs	√			√
Johns Hopkins Nursing EBP Assessment Survey	[33]	Acute /RNs	√	√		
Persian translated EBP measure	[34]	Acute/RNs	√			√
Self-developed EBP measure by Melnyk et al.	[37]	Not specified	√			√
Self-developed measure by Bostrom et al.	[62]	Acute/RNs	√			√
EBP Competency Tool	[10]	Acute, not specified/RNs, APNs	√			√

Group 4: Measures with one source of validity evidence.

Over half of the measures were categorized in group 4 (n=19; 54%; see Table 8). For all these measures, except one [63], validity evidence based on relationships to other variables was reported. With respect to strength of these variable relationships, t-test (n=12 measures), correlational (n=11 measures), and ANOVA (n=8 measures) analyses were primarily conducted. Regression analyses were used less commonly (n=6 measures). Similarly, as in previous groups, significant relationships between EIDM competence attributes and demographic, organizational factors, and interventions were established (see Additional file 4).

Table 8. Group 4: Measures with one source of validity evidence (n=19)

Measure	Study	Setting/Licensure Group	Source of Validity Evidence			
			Content	Response process	Internal structure	Relationships to variables
EBP Implementation Scale (35 studies)	[123, 124]	Acute/RNs			√	√
	[46]	Not specified/Not specified	√		√	√
	[146]	Acute/Not specified				√
	[135]	Acute/RNs				√
	[136]	Acute/RNs	No supporting validity evidence			
	[132]	Home health/RNs				√
	[83]	Acute /RNs	No supporting validity evidence			
	[55]	Acute/RNs				√
	[133]	Acute/RNs				√
	[138]	Acute/RNs				√
	[137]	Acute, primary, not specified/Not specified	√			
	[163]	Acute/RNs	√	√	√	√
	[121]	Acute, primary, not specified/Not specified				√
	[127]	Acute/RNs				√
	[129]	Acute/RNs, LPNs, APNs				√
	[143]	Acute/RNs				√
	[122]	Acute/RNs				√
	[84]	Acute/RNs, APNs				√
	[144]	Acute/RNs				√
	[111]	Acute/RNs				√
	[130, 131]	Acute/RNs, APNs				√
	[140, 141]	Acute/RNs, not specified			√	√
	[149]	Acute/RNs				√
	[150]	Acute/RNs				√
	[128]	Acute/Not specified				√
	[120, 139]	Acute/RNs				√
	[119]	Public health/RNs, LPNs				√
	[147]	Acute/RNs				√
	[126]	Acute/RNs				√
	[125]	Acute/RNs				√
	[142]	Acute/RNs				√
	[102]	Acute/RNs, LPNs				√
	[115]	Acute/RNs				√
	[134]	Acute/RNs				√
	[145]	Not specified/Not specified				√

EBP Beliefs Scale (42 studies)	[123, 124]	Acute/RNs			√	√
	[46]	Not specified/Not specified	√		√	√
	[146]	Acute/Not specified				√
	[135]	Acute/RNs				√
	[136]	Acute/RNs	No supporting validity evidence			
	[132]	Home health/RNs				√
	[156]	Acute/Not specified				√
	[137]	Acute, primary, not specified/Not specified	√			√
	[158, 159]	Acute/RNs	√	√	√	√
	[163]	Acute/RNs	√	√	√	√
	[83]	Acute/RNs				√
	[55]	Acute/RNs				√
	[133]	Acute/RNs				√
	[138]	Acute/RNs				√
	[121]	Acute, not specified/Not specified	No supporting validity evidence			
	[127]	Acute/RNs				√
	[155]	Acute/RNs	No supporting validity evidence			
	[143]	Acute/RNs				√
	[129]	Not specified/RNs, APNs, LPNs				√
	[160]	Acute/RNs				√
	[45]	Acute/RNs				√
	[122]	Acute/RNs				√
	[84]	Acute/RNs, APNs				√
	[161]	Not specified/RNs, APNs				√
	[144]	Acute/RNs				√

	[111]	Acute/RNs				√
	[130, 131]	Acute/RNs, APNs				√
	[140, 141]	Acute/RNs, not specified			√	√
	[149]	Acute/RNs				√
	[150]	Acute/RNs				√
	[128]	Acute/Not specified				√
	[120, 139]	Acute/RNs				√
	[119]	Public health/RNs, LPNs				√
	[157]	Acute/RNs	No supporting validity evidence			
	[102]	Acute/RNs, LPNs				√
	[147]	Acute/RNs				√
	[126]	Acute/RNs				√
	[125]	Acute/RNs	No supporting validity evidence			
	[142]	Acute/RNs				√
	[115]	Acute/RNs				√
	[134]	Acute/RNs				√
	[145]	Not specified/not specified				√
Evidence-Based Practice Questionnaire (36 studies)	[30]	Acute, not specified/ not specified	√	√	√	√
	[101]	Acute/RNs				√
	[93]	Acute/Not specified				√
	[92]	Acute/RNs				√
	[107]	Primary/RNs				√
	[96]	Primary/Not specified				√
	[50]	Acute/Not specified				√
	[116]	Acute/RNs				√

	[114]	Acute/RNs				√
	[100]	Acute/RNs				√
	[162]	Primary/RNs			√	√
	[105]	Acute, primary, long-term care/RNs				√
	[110]	Acute/Not specified	√			√
	[91]	Acute/RNs				√
	[112]	Acute/RNs		√	√	√
	[94]	Acute/RNs				√
	[95]	Acute/RNs	No supporting validity evidence			
	[56]	Acute/RNs		√		√
	[118]	Not specified/Not specified	No supporting validity evidence			
	[90]	Acute, primary, not specified/Not specified	No supporting validity evidence			
	[60]	Acute/RNs	√			√
	[104]	Acute/Not specified			√	
	[99]	Acute/Not specified			√	√
	[106]	Acute/Not specified				√
	[108]	Acute/RNs			√	√
	[117]	Acute/RNs				√
	[48, 49]	Acute/RNs				√
	[89]	Acute/Not specified				√
	[111]	Acute/RNs				√
	[102]	Acute, primary/RNs, LPNs				√
	[97]	Acute/RNs				√
	[113]	Acute/RNs	No supporting validity evidence			
	[98]	Acute/RNs				√

	[103]	Acute/RNs	No supporting validity evidence			
	[88]	Acute/RNs				√
	[115]	Acute/RNs				√
DEBPQ (6 studies)	[63]	Acute, primary, public health/Not specified	√		√	√
	[151]	Acute/RNs	No supporting validity evidence			
	[152]	Primary/RNs, LPNs/RPNs				√
	[8]	Public health, home health/Not specified	No supporting validity evidence			
	[153]	Primary, public health, home health/RNs, APNs				√
	[154]	Acute/RNs				√
Modified Evidence-Based Nursing Education Questionnaire (1 study)	[38]	Acute, primary/APNs				√
Self-developed measure by Barako et al. (1 study)	[40]	Acute/Not specified				√
Self-developed measure by Gerrish et al. (1 study)	[43]	Acute, primary/APNs				√
Adapted Fresno Test (1 study)	[45]	Acute/RNs				√
Self-developed measure by Kim et al. (1 study)	[100]	Acute/RNs				√
EBP confidence scale (1 study)	[48, 49]	Acute/RNs				√
Information literacy tool (1 study)	[111]	Acute/RNs				√
Modified Korean EBM questionnaire (1 study)	[47]	Acute/RNs				√
EBP Attitudes Scale (1 study)	[48, 49]	Acute/RNs				√

Attitudes to Evidence-Based Practice Questionnaire (1 study)	[50]	Acute/Not specified				√
Nurses' Attitudes Toward EBP Scale (1 study)	[53]	Acute/RNs				√
Single item measure for EBP knowledge (1 study)	[140]	Acute/RNs				√
EBP Knowledge Assessment in Nursing (1 study)	[97]	Acute/RNs				√
Knowledge Assessment Test (1 study)	[118]	Not specified/Not specified				√
Core Knowledge Questionnaire (1 study)	[114]	Acute/RNs				√

Group 5: Measures with no sources of validity evidence.

No sources of validity evidence were found for three measures [32, 36, 64].

See Additional file 4 for detailed information on validity evidence sources for each measure with supporting evidence.

Validity evidence and settings.

Most of the measures (n=29; 83%) reported validity evidence in the context of acute care settings. For nine measures, validity evidence was reported across multiple settings. For three of these measures (EBP Implementation Scale, EBP-Beliefs Scale, EBPQ), multiple sources of validity (>1) were more often reported in acute care settings compared to other practice settings where only one source of validity evidence was commonly found. In contrast, one measure (Evidence-based Nursing Attitude Questionnaire) had four sources of validity evidence established in primary and home care settings but not in acute care. While, the same number of validity sources were established for five additional measures (Developing Evidence-based

Practice Questionnaire, modified Evidence-based Nursing Education Questionnaire, two unnamed self-developed measures, EBP Competency Tool) across varied healthcare settings.

Discussion

This review furthers our understanding about measures assessing EIDM competence attributes in nursing practice. Findings highlight limitations in the existing literature with respect to use or testing of measures across practice settings, the diversity in EIDM competence attributes addressed, and variability in the process and outcomes of psychometric assessment of existing measures.

Settings

This review contributes new insight about settings in which EIDM measures have been used or tested that previous systematic reviews have not addressed. This review reveals a concentration on use or testing of EIDM measures in acute care (n=31 measures; 89%) compared to other healthcare contexts (primary care, home health, public health, long-term care). This imbalance was also observed in an integrative review of 37 studies exploring the knowledge, skills, attitudes and capabilities of nurses in EIDM [9] where the majority of studies (n=27) were conducted in hospitals, with fewer conducted in primary, community, and home healthcare, and none in long-term care. While there is a large body of evidence to support understanding of the psychometric rigor of EIDM measures in acute care, more attention and investment is required for this type of understanding in community-based and long-term care contexts. Given current trends and priorities in healthcare such as the reorientation toward home care [65], attention toward disease prevention and management, and health promotion [66], and a large aging population with growing projections of residence in long-term care facilities [67], it is of great

importance to assess EIDM competence across all nursing practice settings to ensure efficient, safe, and patient-centred care.

EIDM Competence Attributes Addressed

This review also adds to the current literature on nursing EIDM competence measures using a broader conceptualization of competence. That is, the measures reviewed focus on four competence attributes of knowledge, skills, attitudes/beliefs, and behaviours. In comparison, Leung et al. [14] assess measures focused on three attributes; knowledge, attitudes and skills. In our current review, three measures [30-32] addressed all four EIDM attributes (e.g., knowledge, skills, attitudes/beliefs, behaviours). Measures that address all four attributes are of critical importance given the inextricable link between knowledge, skills, attitudes and behaviours to comprise professional competence [68-70]. Professional competence cannot sufficiently develop if each attribute was to support it independently [71]. Knowledge without skill, or the ability to use knowledge, renders knowledge useless [72]. Similarly, performing a skill without understanding the reasoning behind it contributes to unsafe and incompetent practice [72, 73]. And lastly, possessing knowledge and skill without the experience of their application in the real world is insufficient to qualify as competent [74].

However, despite these measures addressing all four competence attributes, based on their response scales used, they do not conceptually reflect an assessment of competence, defined as *quality* of ability or performance to an expected standard [74], but rather, focus on mere completion or frequency of completing tasks. Quality versus frequency of behaviours are distinct concepts and have been measured separately in nursing performance studies [19, 75]. The provision of a high standard of patient care includes nursing competence assessment, which is a critical component of quality improvement processes, workforce development and

management [19, 76]. This conceptual limitation of existing EIDM measures highlights a need for a measure that aligns with the conceptual understanding of competence as an interrelation between knowledge, skills, attitudes/beliefs, behaviours [68] and quality of ability [74].

Psychometric Outcomes

Acceptability.

Despite acceptability, measured as amount of missing data and completion times, being identified as a critical aspect of psychometric assessment [77], discussion of acceptability among included primary studies was lacking compared to an emphasis on reliability or validity. In this review, only 10 measures (28.6%) reported missing data. In addition, only four measures (11%) reported completion times. This limited discussion of acceptability is reinforced by findings from a systematic review of research utilization measures by Squires et al. [29] in which no studies reported acceptability data. As well, acceptability was not mentioned or discussed in systematic reviews of EIDM measures for nurses, midwives [14], medical practitioners [17] and allied health professionals [23]. Discussions about acceptability have typically been explored in the context of patient-reported outcome measures [77]. These discussions also hold relevance for measures with healthcare professionals as end users [78, 79]. Time and ease of completing a measure are important considerations for nurses or managers who work in fast-paced clinical settings, which can influence their decision to integrate these measures into their practice.

Reliability.

Findings from the current review determine gaps in reliability testing of measures in addition to variable findings across EIDM measures and healthcare contexts.

Internal consistency reported as Cronbach's alpha was the most commonly assessed type of reliability in this review. This appears to be a trend similarly found among EIDM related

psychometric reviews [14, 23]. Cronbach's alpha is a commonly used statistic in psychometric research perhaps due to its ease of calculation as it can be computed with a one-time administration [80]. While Nunnally [81] identifies that the "coefficient alpha provides a good estimate of reliability in most cases" (p. 211), there are important considerations with its use. One consideration is that interpretation of Cronbach's alpha requires an understanding that it must be re-evaluated in each new setting or population a measure is used in [82]. In the current review, many of the studies associated with frequently used measures (EBP-Implementation Scale, EBP Beliefs Scale) did not re-evaluate internal consistency when using the measure in a new or different setting from where it was originally tested. This was evident from unreported data in multiple studies associated with the same measure but taking place across various healthcare settings. Other reviews have reported similar findings, whereby measures have not been re-assessed in new contexts, and have reported either no data or only original internal consistency findings [13, 16]. The importance of re-assessing and interpreting this reliability statistic in new contexts is further underscored by current review findings in which Cronbach's alphas varied widely across unique practice settings for the same measure.

Moreover, there were heterogenous findings among studies taking place in the same type of setting for the same measure. Within each setting, there were instances in which the same measure would result in varying Cronbach's alphas with range values falling both below and above minimum guidelines of ≥0.80 [57]. For example, Mooney [83] reported a Cronbach's alpha of 0.776 for the EBP Beliefs Scale when used in an acute care setting, while Underhill et al. [84] reported α=0.95 with the same measure also used in acute care practice. Variability in internal consistency findings has been reported in other systematic reviews as well [16, 23], perhaps due to the use of measures in diverse populations, settings, and countries. This further

indicates the effect of nuanced populations within similar practice settings on internal consistency findings.

In addition, lower alphas were typically reported for EIDM attitude scales, such as for the self-developed measure by Yip et al. [35] (α=0.69), the EBNAQ [51, 52] (α=0.45) and the EBPQ (α=0.63) [30]. A possible explanation of these low alphas may be related to the low number of items on an EIDM attitude subscale compared to other EIDM competence attributes. As Streiner [25] indicates, the length of a scale highly impacts internal consistency, and as such, reliability could plausibly be improved through the addition of conceptually robust items. Further to this, in a literature review of the uses of the EBPQ [85], authors note that low alpha scores for the attitude subscale were consistently reported, due to repeated item deletions or modifications, calling for further refinement of EIDM attitudes items.

Overall, there was a lack of reliability assessment as 40% of measures did not report reliability. This occurred for both newly developed and established measures. The lack of reliability testing has also been identified in existing reviews assessing EIDM measures among allied healthcare professionals [13, 16, 23] as early as 2010. The ongoing lack of attention to reliability assessment highlights a need for more rigorous and standardized reliability testing not only in the original development of measures but also in its subsequent use in different healthcare environments.

Validity.

Findings pertaining to validity evidence when compared to existing literature show both alignment and contrast with respect to how validity evidence was assessed, and the number and type of validity sources established across measures.

As noted, psychometric assessment of the current review was based on the contemporary understanding that the strength of a validity argument is dependent on the accumulation of different validity evidence sources [26]. In this review, only one source of validity evidence was reported for over half of the measures (n=19; 54%). Very few measures were reported with four (n=2 measures) or three (n=5 measures) validity evidence sources established. Employing a similar approach to validity evidence assessment, Squires et al. [29] reported similar findings in their review of research utilization measures: the majority of measures were categorized under level three of their hierarchy (i.e., one source of validity evidence); no measures were reported as having all four sources of validity evidence; and six measures were associated with three sources of validity evidence.

Since existing reviews did not present validity evidence in the context of practice settings, this presents challenges with comparison of results. However, this review presents some insight on contextualizing validity evidence. In the current review, much of the validity evidence was presented in the context of an acute care setting, and in particular, for three measures most widely used (EBP Implementation Scale, EBP Beliefs Scale, EBPQ), more sources of validity evidence were established by the original developers in acute care practice. Similar to reliability findings, this brings to light a critical gap in nursing research with respect to the use of measures after their original development, and lack of validity evidence assessment in different settings and populations. This demonstrates a call to action for nursing researchers that a consistent level of rigor must be applied to comprehensively re-assess sources of validity evidence for a measure when using it in a new practice setting. This strengthens a cumulative body of validity evidence to support continued use of a measure in varied nursing contexts.

Compared to the current review, previous EIDM psychometric systematic reviews [13, 14, 16] included traditional assessments of content, criterion, and construct validity and demonstrated variable findings. Buchanan et al. [13] reported no findings related to validity for 18 measures and failure to re-test validity by authors when original measures were used in a new study setting. Glegg and Holsti [16] only provided a description of validity data and did not perform an assessment through scoring or ranking of this evidence. While, Leung et al. [14] used their self-developed Psychometric Grading Framework [86] to assess validity of instruments in their review. These authors determined that most of the studies reported measures as having 'weak' or 'very weak' validity according to their matrix scoring, with only three studies reporting the tested measures as having adequate validity [14].

Included studies in this review also limited validity assessment to sources based on test content and relationships to other variables, focusing on construct validity. This appears to be a consistent theme reported across existing reviews as well [14, 23]. A new contribution from this review is an in-depth understanding about the strength of validity evidence based on relationships to other variables. Data extracted on the statistical analyses associated with this source of validity evidence showed relationships established primarily through correlational, t-test or ANOVA analyses. In less instances, regression analyses were used to demonstrate strong relationships, highlighting a need in psychometric evaluation of tools to validate more robust relationships between variables.

Findings from the current review and existing literature highlight limitations in assessing validity evidence and the psychometric rigor of existing EIDM measures. Variability in testing and results of validity evidence creates challenges and confusion for end users in research or nursing practice who look to this body of literature to determine appropriate and robust EIDM

measures. Scholarly support for the use of a comprehensive and contemporary approach in psychometric development of tools can help to standardize assessments and produce findings representative of a unified understanding of validity evidence.

Considerations for Tool Selection in Nursing Practice or Research

This systematic review can serve as a helpful resource for nursing administrators, frontline staff, or researchers who are interested in using a measure to assess a specific EIDM competence attribute. In selecting measures for nursing practice or research, the specific population and setting in which measures have been previously used or tested, in addition to specific EIDM competence attributes they address, all serve as important considerations. As well, looking to the acceptability of measures, taking into account tool completion time given demands of busy clinical environments and if high rates of missing data >10% are present [54], are also critical factors to consider for decision-making. Acceptable reliability of a measure should also be given weight in tool selection ($\alpha \geq 0.80$) [57], in addition to determining how comprehensively all four sources of validity evidence (content, internal structure, response process, relationships to other variables) have been established for a given measure [26].

Limitations

A limitation of this review relates to the absence of quality assessments of included primary studies. Given that traditional quality assessment was not conducted, this may influence the confidence in study findings and thus results are to be interpreted with caution. However, among tools previously used to assess quality of psychometric studies, several limitations exist [27]. These include the development of quality assessment tools for use only with patient reported outcome measures [14], using a lowest score ranking method providing an imbalance in the overall quality score [87], and a lack of validity and reliability testing [27]. Most importantly,

existing quality assessment tools employ a traditional approach of assessing construct, content, and criterion validity, rather than a contemporary perspective of viewing validity evidence as a unified concept [26], as used to guide the current review. Given this, to align with other reviews using a similar contemporary approach [17, 29] assessment was focused on the categorization of measures according to the number of sources of validity evidence established for scores in related studies. A second limitation pertains to the exclusion of non-English literature as there were 14 articles identified from full-text screening requiring translation for seven languages, which were excluded from the review. Given the large number of studies included in the final review, it is unlikely that the small number of non-English studies would have a critical impact on results. A third limitation is that with the use of a classification system for assessing validity evidence, the number of studies for a particular measure could influence the strength of the validity argument [29]. A measure which has one or a small number of studies may appear to have strong validity evidence [29] as compared to those measures with more cited studies. Implications of this are most relevant for more established measures, in that more sources of validity evidence may have in fact been established, but only in a small amount of studies, which may not be reflected in its final categorization. However, the advantage of using this synthesis process is that it highlights the types of validity evidence that require further testing for a particular measure [29].

Conclusions

There is a diverse collection of measures that assess EIDM competence attributes of knowledge, skills, attitudes/beliefs, and/or behaviours in nurses. Among these measures is a concentration on the assessment of single EIDM competence attributes. Review findings determined that three measures addressed all four EIDM attributes, although with some

conceptual limitations, highlighting a need for a tool that comprehensively assesses EIDM competence. More rigorous and consistent psychometric testing is also needed for EIDM measures overall, but particularly in community-based and long-term care settings in which the data is limited. A contemporary approach to psychometric assessment of EIDM measures in the future may also provide more robust and comprehensive evidence of their psychometric rigor.

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Additional file 1: Electronic database search strategy

Ovid MEDLINE

1. Nurse*.mp.
2. exp Nurses/
3. 1 or 2
4. evidence based practice.mp.
5. evidence informed decision making.mp.
6. evidence based nursing.mp.
7. Evidence-Based Practice/
8. Evidence-Based Nursing/
9. 4 or 5 or 6 or 7 or 8
10. measurement*.mp.
11. assessment*.mp.
12. psychometric*.mp.
13. reliability*.mp.
14. validity*.mp.
15. questionnaire*.mp.
16. survey*.mp.
17. scale*.mp.
18. tool*.mp.
19. Surveys and Questionnaires/
20. Psychometrics/
21. 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
22. Knowledge.mp.
23. “professional knowledge”.mp.
24. “nursing knowledge”.mp.
25. Understanding.mp.
26. Comprehension.mp.
27. Knowledge/
28. Comprehension/
29. 22 or 23 or 24 or 25 or 26 or 27 or 28
30. Skill*.mp.
31. “competency assessment”.mp.
32. 30 or 31
33. Behavio?r*.mp.
34. “Professional behaviour”*.mp.
35. “professional competence”.mp.
36. Competence.mp.
37. Clinical decision making.mp.
38. Professional Competence/
39. Clinical Competence/
40. Clinical Decision-Making/

41. 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40
42. Attitude*.mp.
43. Belief*.mp.
44. “Professional value”.mp.
45. Nurse attitude.mp.
46. Attitude/
47. "Attitude of Health Personnel"/
48. 42 or 43 or 44 or 45 or 46 or 47 or 48
49. 3 and 9 and 21
50. 3 and 9 and 21 and 29 or 32 or 41 or 49

EMBASE

1. Nurse*.mp.
2. exp nurse/
3. 1 or 2
4. evidence based practice.mp.
5. evidence informed decision making.mp.
6. evidence based nursing.mp.
7. evidence based nursing/
8. evidence based practice/
9. 4 or 5 or 6 or 7 or 8
10. measurement*.mp.
11. assessment*.mp.
12. psychometric*.mp.
13. reliability*.mp.
14. validity*.mp.
15. questionnaire*.mp.
16. survey*
17. scale*
18. tool*
19. measurement/
20. questionnaire/
21. reliability/
22. rating scale/
23. outcome assessment/
24. questionnaire/
25. 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24
26. Knowledge.mp.
27. Understanding.mp.
28. Comprehension.mp.
29. “professional knowledge”.mp.
30. “nursing knowledge”.mp.
31. professional knowledge/

32. knowledge base/
33. nursing knowledge/
34. 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33
35. Skill*.mp.
36. “competency assessment”.mp.
37. skill/
38. 35 or 36 or 37
39. Behavio?r*.mp.
40. “Professional behaviour”*.mp.
41. “professional competence”.mp.
42. Competence.mp.
43. Clinical decision making.mp.
44. clinical decision making/
45. behavior/
46. professional competence/
47. 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46
48. Attitude*.mp.
49. Belief*.mp.
50. Nurse attitude.mp.
51. “Professional value”*.mp.
52. nurse attitude/
53. attitude assessment/
54. attitude/
55. 48 or 49 or 50 or 51 or 52 or 53 or 54
56. 3 and 9 and 25
57. 3 and 9 and 25 and 34 or 38 or 47 or 55

CINAHL

1. Nurse*.mp.
2. 1 or 2
3. evidence based practice.mp.
4. evidence informed decision making.mp.
5. evidence based nursing.mp.
6. MH "Professional Practice, Evidence-Based"
7. MH "Nursing Practice, Evidence-Based"
8. 3 or 4 or 5 or 6 or 7
9. measurement*.mp.
10. assessment*.mp.
11. psychometric*.mp.
12. reliability*.mp.
13. validity*.mp.
14. questionnaire*.mp.

15. survey*
16. scale*
17. tool*
18. MH "Psychometrics"
19. MH "Measurement Issues and Assessments"
20. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21. Knowledge.mp.
22. Understanding.mp.
23. Comprehension.mp.
24. “nursing knowledge”.mp.
25. “professional knowledge”.mp.
26. MH "Knowledge"
27. MH "Nursing Knowledge"
28. MH "Professional Knowledge"
29. 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28
30. Skill*.mp.
31. “competency assessment”.mp.
32. MH "Competency Assessment"
33. 30 or 31 or 32
34. Behavio?r*.mp.
35. “Professional behaviour”*.mp.
36. “professional competence”.mp.
37. Competence.mp.
38. Clinical decision making.mp.
39. MH "Professional Competence"
40. 34 or 35 or 36 or 37 or 38 or 39
41. Attitude*.mp.
42. Belief*.mp.
43. Nurse attitude.mp.
44. “Professional value”*.mp.
45. 41 or 42 or 43 or 44
46. 2 and 8 and 20
47. 2 and 8 and 20 and 20 or 29 or 33 or 40

ERIC and MathSciNet

Nurse* AND

"Evidence based practice" OR "Evidence informed decision making" OR "Evidence based nursing" AND

Measurement* OR assessment* OR tool* OR Psychometric* OR Reliability* OR Validity* OR Questionnaire* OR survey* OR scale* AND

Knowledge OR understanding OR comprehension OR professional knowledge OR nursing knowledge OR Skill* OR competency assessment OR Behavio?r* OR Professional behaviour* OR professional competence OR competence OR clinical decision making OR Attitude* OR Belief* OR Professional value* OR nurse attitude

HaPI

1. Nurse*.mp.
2. evidence based practice.mp.
3. evidence informed decision making.mp.
4. evidence based nursing.mp.
5. 2 or 3 or 4 or 5
6. measurement*.mp.
7. assessment*.mp.
8. psychometric*.mp.
9. reliability*.mp.
10. validity*.mp.
11. questionnaire*.mp.
12. survey*.mp.
13. scale*.mp.
14. tool*.mp.
15. 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14
16. 1 and 5 and 15

Additional file 2: Theoretical and empirical literature to guide data analysis of sources of validity evidence

Theoretical literature

Theory, Model, Framework	Citation	Description
Stetler Model	Stetler, C. (2001). Updating the Stetler model of research utilization to facilitate evidence-based practice. *Nursing Outlook, 49*(6), 272-279. Ciliska, D. et al. (2011). Models to guide implementation of evidence-based practice. In *Evidence-Based Practice in Nursing and Healthcare: A Guide to Best Practice* (Melnyk B. & Fineout-Overholt, E., eds). Wolters Kluwer, Philadelphia, PA,	Key assumptions: • An organization may or may not be involved in a professional's use of research: o If the individual has the appropriate competencies and updates knowledge base, use of research findings can occur at the individual level. Organizations may also support research use through education, policies, procedures. • Utilization may be instrumental, conceptual, and/or symbolic: o Research can be used in many ways (e.g., change personal way of thinking, influence an action of change, used to change others' thinking and/or behaviour). • Decision-making can be influenced by other types of evidence/non-research information together with research evidence: o This may include theoretical, experiential, local program data or consensus information. • Factors (internal and external) impact a person's or group's view and use of evidence: o These factors may include professional's characteristics, surrounding environment • Research and evaluation is not considered absolute information: o Research may not be applicable to all patients in every situation. There must be some understanding about specific patient preferences/needs, and other variations in the application of research. • Lack of knowledge and skills related to EIDM/research utilization (RU) may hinder their use: o Specific EIDM/RU knowledge and skills are required for their implementation, in addition to critical thinking skills Steps (emphasis on individual): 1. Preparation: identify priority need and begin search for evidence 2. Validation: critique and summarize evidence 3. Comparative Evaluation and Decision-Making: decide about evidence to be used in response to need

	pp. 241-275.	4. Translation and Application: create evidence-based action plan and implement it 5. Evaluation: identify if EIDM goals were achieved
PARIHS (Promoting Action on Research Implementation in Health Services) Framework	Rycroft-Malone, J. (2004). The PARIHS framework – a framework for guiding the implementation of evidence-based practice. *Journal of Nursing Care Quality, 19*(4), 297-304.	Emphasis on organizational use: Successful EIDM implementation is a function of the following inter-connected elements: 1. *Evidence:* credible knowledge from different sources (e.g. research, clinical experience, patient experience, local data/information) 2. *Context:* innovation adoption is influenced by organizational culture (e.g. decentralized decision-making, relationships between frontline staff and managers, facilitative management styles), leadership (e.g. transformational leadership), and evaluation practices (e.g. evaluation frameworks that rely on multiple sources of evidence to show effectiveness) 3. *Facilitation*: individuals who use their knowledge and skills to help other staff, teams and the organization to make the EIDM change
ARCC (Advancing Research and Clinical Practice Through Close Collaboration) Model	Melnyk, B., Fineout-Overholt, E., Gallagher-Ford, L., & Stillwell, S. (2011). Sustaining evidence-based practice through organizational policies and an innovative model. *American Journal of Nursing, 111*(9), 57-60.	Four key assumptions: • EIDM barriers to and facilitators at the individual and health care systems level • EIDM barriers must be mitigated and facilitators put in place for EIDM implementation • EIDM beliefs, values, and confidence in ability to implement EIDM serve as facilitators to EIDM implementation and therefore should be strengthened • An EIDM mentoring culture helps to advance and sustain EIDM among professionals and in health care systems Steps (emphasis on organizational use): 1. Assess organizational culture and readiness for EIDM implementation 2. Identify organization strengths and barriers to EIDM 3. Identify EIDM mentors for frontline staff 4. Implementation of evidence in practice 5. Evaluate outcomes

Empirical literature

Citation	Sample	Dependent Variable	Other Variables	Description of Relationship
Individual factors				
Lizarondo, L., Grimmer-Somers, K., & Kumar, S. (2011). A systematic review of the individual determinants of research evidence use in allied health. *Journal of Multidisciplinary Healthcare, 4*, 261-272.	• Allied healthcare professionals	• Perceptions, attitudes, knowledge, and self-report use of EIDM or research	• Level of education (Working toward or having a graduate degree, advanced certification) • Involvement in research EIDM-related activities (e.g. engaged in research activities at work, taken a research or EIDM course)	• Positive effect: associated with higher perceptions, attitudes, knowledge, use of EIDM or positive perceived importance of research • Positive effect: associated with increased self-report of EIDM, positive perceptions and attitudes toward research
Squires, J., Estabrooks, C., Gustavsson, P., & Wallin, L. (2011). Individual determinants of research utilization by nurses: a systematic review. *Implementation Science, 6*, 1-20.	• Nurses	• Research utilization (RU)	• Attitude toward research • Attendance at conference and/or in-services • Level of education (when a nurse possesses a graduate degree compared to bachelor's degree or diploma) • Advanced practice and leadership role	• High moderate positive effect • Positive association; unable to compute magnitude effect • Positive effect • Positive effect (those in advance current roles had higher levels of RU)

			• Working on specialty wards (e.g. critical care) • Job satisfaction	• Positive effect (those in speciality wards had higher RU levels than those in general wards) • Positive effect
Eizenberg, M. (2010). Implementation of evidence based nursing practice: nurses' personal and professional factors? *Journal of Advanced Nursing, 67*(1): 33-42.	• Nurses	• Self-report of evidence based nursing practice behaviours	• Role (those in managerial role compared to non-managerial role) • Education (those with a degree compared to those without a degree) • Six predicting factors of evidence-based nursing practice behaviours: 1. Belief in skills of finding, reading, and applying various research sources 2. Sources of knowledge based on reading professional literature 3. Education (higher levels of education) 4. System support in reading and searching professional literature 5. Sources of knowledge based on experience/intuition 6. Sources of knowledge	• Positive effect • Positive effect • Positive effect (#1 - #5) • Negative effect (the more colleagues and procedures were depended on for knowledge sources, the lower

			based on colleagues and system procedures	probability of self-report EIDM behaviours)
Interventions				
Häggman-Laitila, A., Mattila, L., & Melender, H. (2016). Educational interventions on evidence-based nursing in clinical practice: A systematic review with qualitative analysis. *Nurse Education Today, 43*, 50-59.	• Nurses	• EIDM beliefs, attitudes, skills, implementation	• Interventions: lecture/educational classes/interactive sessions/computer-based learning modules, EIDM toolkit, EIDM mentor, environmental prompts	• Positive effect
Young, T., Rohwer, A., Volmink, J., & Clarke, M. (2014). What Are the Effects of Teaching Evidence-Based Health Care (EBHC)? Overview of Systematic Reviews. *PLoS ONE 9*(1), e86706	• Various healthcare professionals	• EIDM skill related to question formulation • Critical appraisal knowledge, skill, reading habit, attitude • EIDM knowledge, skills, behaviours • EIDM	• Multifaceted interventions (e.g. lectures, tutorials, e-learning, journal clubs, etc.) • Critical appraisal teaching/seminars • EIDM workshops • Journal clubs	• Positive effect on EIDM skill (specifically clinical question formulation/problem identification) • Positive effect • Positive effect • Positive effect

		knowledge and research reading behaviour		
Organizational Factors				
Williams, B., Perillo, S., & Brown, T. (2014). What are the factors of organizational culture in health care settings that act as barriers to the implementation of evidence-based practice? A scoping review. *Nurse Education Today, 35*, e34-e41.	• Various healthcare professionals	• EIDM implementation	Factors influencing EIDM implementation: • Workload – most frequently reported barrier due to emphasis on patient-based tasks. Influenced by belief that EIDM is an 'add-on' to existing workload and lack of protected time for 'EIDM activities'. • Other staff/management not supportive of EIDM - Culture in which EIDM is not highly valued • Lack of resources – lack of easily accessible resources, lack of library/staff • Lack of authority to change practice – hierarchies prevents staff from feeling that their ideas are valued and they can contribute to EIDM change • Workplace culture resistant to change –	• Barriers *Scoping review

			reliance on rigid, outdated protocols; mentality of 'this is how it's always been done'	
Solomons, N., & Spross, J. (2011). Evidence-based practice barriers and facilitators from a continuous quality improvement perspective: an integrative review. *Journal of Nursing Management, 19*, 109–120.	• Nurses	• EIDM implementation	Factors influencing implementation organized according to different dimensions: *Strategic* ○ Lack of time/demanding workload ○ Lack of infrastructure to support research activities ○ Lack of administrative support for EIDM changes ○ Nursing presence on hospital wide committees ○ Chief nursing officer leadership in EIDM *Cultural* • Resistance to changing practice from manager/co-worker • Lack of authority of change practice • Employment of Health Science librarian • Institution of EIDM champions (to cultivate staff ownership of EIDM) *Technical*	*Integrative review • Barrier • Barrier • Barrier • Facilitator • Facilitator • Barrier • Barrier • Facilitator • Facilitator • Barrier

			• Lack of initial and ongoing training related to EIDM knowledge/skills • Lack of accessible resources (e.g. online databases) • Hands-on training to address EIDM knowledge/skill deficiencies *Structural* • Lack of awareness of research • Distilling and dissemination of research to employees of organization • Journal clubs	• Barrier • Facilitator • Barrier • Facilitators • Facilitator

Additional file 3: Included studies

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
B. Skela-Savic, S. Hvalic-Touzery, K. Pesjak [140] B. Skela-Savic, K. Pesjak, B. Lobe [141] *linked articles	Professional values and competencies as explanatory factors for the use of evidence-based practice in nursing Evidence-based practice among nurses in Slovenian Hospitals: a national survey	Journal of Advanced Nursing International Nursing Review	2017 2016	Cross-sectional Cross-sectional Correlational	Slovenia	780 534	Yes. Describe	Ministry of Higher Education, Science and Technology of the Republic of Slovenia
R. Lovelace, M. Noonen, J. F. Bena, A. S. Tang, M. Angie, R. Cwynar, R. Field, J. Rosenberger, D. Ross, D. Walker, N. M. Albert [102]	Value of, Attitudes Toward, and Implementation of Evidence-Based Practices Based on Use of Self-Study Learning Modules	Journal of Continuing Education in Nursing	2017	Other: please describe : single group post-test only	Ohio and Florida	1,033 (14.8%)	Yes. Describe	Cleveland Clinic Health System, Nursing Institute
H. Saunders, K. R. Stevens, K. Vehvilainen-Julkunen [42]	Nurses' readiness for evidence-based practice at Finnish university	Journal of Advanced Nursing	2016	Cross-sectional	Finland	943	Yes. Describe	Finnish Nurses' Education Foundation, the Finnish Nurses'

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	hospitals: a national survey							Association, the Saastamoinen Foundation and the Finnish Work Environment Fund, e University of Eastern Finland, Faculty of Health Sciences, Department of Nursing Sciences
E. Shafiei, A. Baratimarnani, S. Goharinezhad, R. Kalhor, M. Azmal [110]	Nurses' perceptions of evidence-based practice: a quantitative study at a teaching hospital in Iran	Medical Journal of the Islamic Republic of Iran	2014	Cross-sectional	Iran	195	Yes. Describe	Research affairs of Bushehr University of Medical Sciences
A. A. Ammouri, A. A. Raddaha, P. Dsouza, R. Geethakrishnan, J. A. Noronha, A. A. Obeidat, L. Shakman [91]	Evidence-Based Practice: Knowledge, attitudes, practice and perceived barriers among nurses in Oman	Sultan Qaboos University Medical Journal	2014	Cross-sectional Correlational	Muscat Oman	414	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description
K. Stokke, N. R. Olsen, B. Espehaug, M. W. Nortvedt [143]	Evidence based practice beliefs and implementation among nurses: a cross-sectional study	BMC Nursing	2014	Cross-sectional	Norway	185	No. Not reported
A. Seyyedrasooli, V. Zamanzadeh, L. Valizadeh, F. Tadaion [34]	Individual Potentials Related to Evidence-Based Nursing among Nurses in Teaching Hospitals Affiliated to Tabriz University of Medical Sciences, Tabriz, Iran	Journal of Caring Sciences	2012	Correlational	Tabriz, Iran	600	No. Not reported
J. I. Shin, E. Lee [154]	The Influence of Social Capital on Nurse-Perceived Evidence-Based Practice Implementation in South Korea	Journal of Nursing Scholarship	2017	Cross-sectional Correlational	South Korea	432	No. Not reported
H. Verloo, M. Desmedt, D. Morin [147]	Beliefs and implementation of evidence-based practice	Journal of Evaluation in Clinical Practice	2017	Cross-sectional	Valais, Switzerland	329	No. Not reported

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	among nurses and allied healthcare providers in the Valais hospital, Switzerland							
M. G. Harper, L. Gallagher-Ford, J. I. Warren, M. Troseth, L. T. Sinnott, B. K. Thomas [126]	Evidence-Based Practice and U.S. Healthcare Outcomes: Findings From a National Survey With Nursing Professional Development Practitioners	Journal for Nurses in Professional Development	2017	Cross-sectional Correlational	United States (43 States and District of Columbia)	253	Yes. Describe	Elsevier Clinical Solutions
A. Hagedorn Wonder, A. M. McNelis, D. Spurlock, P. M. Ironside, S. Lancaster, C. R. Davis, M. Gainey, N. Verwers [97]	Comparison of Nurses' Self-Reported and Objectively Measured Evidence-Based Practice Knowledge	Journal of Continuing Education in Nursing	2017	Cross-sectional Correlational	United States	151	Yes. Describe	Ethel Clarke Fellowship at Indiana University
J. Y. Sim, K. S. Jang, N. Y. Kim [111]	Effects of Education Programs on Evidence-Based Practice Implementation for Clinical Nurses	Journal of Continuing Education in Nursing	2016	Quasi-experimental (e.g. pre-post-test)	South Korea	63	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
S. C. Kim, L. Ecoff, C. E. Brown, A. M. Gallo, J. F. Stichler, J. E. Davidson [130]	Benefits of a Regional Evidence-Based Practice Fellowship Program: A Test of the ARCC Model	Worldviews on Evidence-Based Nursing	2017	Quasi-experimental (e.g. pre-post-test)	San Diego, California	120	No. Not reported	
S. C. Kim, J. F. Stichler, L. Ecoff, C. E. Brown, A. M. Gallo, J. E. Davidson [131] *articles linked	Predictors of Evidence-Based Practice Implementation, Job Satisfaction, and Group Cohesion Among Regional Fellowship Program Participants		2016	Correlational		175		
K. M. Bissett, M. Cvach, K. M. White [33]	Improving Competence and Confidence With Evidence-Based Practice Among Nurses: Outcomes of a Quality Improvement Project	Journal for Nurses in Professional Development	2016	Quasi-experimental (e.g. pre-post-test)	United States	17	No. Not reported	
Y. J. Son, Y. Song, S. Y.	A psychometric evaluation of the Korean	Contemporary Nurse	2014	Cross-sectional	Korea	801	Yes. Describe	National Research Foundation of

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
Park, J. I. Kim [112]	version of the evidence-based practice questionnaire for nurses							Korea (NRF) grant funded by the Korean government
R. P. Pereira, A. C. Guerra, M. J. Cardoso, A. T. dos Santos, C. de Figueiredo Mdo, A. C. Carneiro [104]	Validation of the Portuguese version of the Evidence-Based Practice Questionnaire	Revista Latino-Americana de Enfermagem	2015	Cross-sectional	Portugal	358	No. Not reported	
S. Hellier, T. Cline [38]	Factors that affect nurse practitioners' implementation of evidence-based practice	Journal of the American Association of Nurse Practitioners	2016	Cross-sectional Correlational	United States	480	No. Not reported	
L. Connor, F. Paul, M. McCabe, S. Ziniel [39]	Measuring Nurses' Value, Implementation, and Knowledge of Evidence-Based Practice: Further Psychometric Testing of the Quick-EBP-VIK Survey	Worldviews on Evidence-Based Nursing	2017	Other: please describe : identified as 'descriptive study'	United States	382	No. Not reported	
M. A. Friesen, J. M. Brady, R. Milligan, P.	Findings From a Pilot Study: Bringing Evidence-Based	Worldviews on Evidence-Based Nursing	2017	Other: please describe : mixed methods design	United States	57	Yes. Describe	Inova Seed Grant

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
Christensen [125]	Practice to the Bedside							
J. W. Park, J. A. Ahn, M. M. Park [47]	Factors influencing evidence-based nursing utilization intention in Korean practice nurses	International Journal of Nursing Practice	2015	Cross-sectional	Korea	420	Yes. Describe	Ajou University College of Nursing, Suwon, Republic of Korea
D. C. Stavor, J. Zedreck-Gonzalez, R. L. Hoffmann [113]	Improving the Use of Evidence-Based Practice and Research Utilization Through the Identification of Barriers to Implementation in a Critical Access Hospital	Journal of Nursing Administration	2017	Other: please describe: descriptive, quality improvement study	US	51	No. Not reported	
J. Farokhzadian, R. Khajouei, L. Ahmadian [59]	Evaluating factors associated with implementing evidence-based practice in nursing	Journal of Evaluation in Clinical Practice	2015	Cross-sectional	Iran	182	No. Not reported	
J. I. Hwang, H. A. Park [99]	Relationships between evidence-based practice, quality improvement	Journal of Nursing Management	2015	Cross-sectional	Korea	443	Yes. Describe	National Research Foundation of Korea – Grant funded by the

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	and clinical error experience of nurses in Korean hospitals							Korean Government (NRF-2009-327-H00039).
J. I. Warren, M. McLaughlin, J. Bardsley, J. Eich, C. A. Esche, L. Kropkowski, S. Risch [149]	The Strengths and Challenges of Implementing EBP in Healthcare Systems	Worldviews on Evidence-Based Nursing	2016	Cross-sectional	United States	1608	No. Not reported	
J. I. Warren, K. L. Montgomery, E. Friedmann [150]	Three-Year Pre-Post Analysis of EBP Integration in a Magnet-Designated Community Hospital	Worldviews on Evidence-Based Nursing	2016	Other: please describe : Retrospective	United States	275	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
J. R. Duffy, S. Culp, K. Sand-Jecklin, L. Stroupe, N. Lucke-Wold [49]	Nurses' Research Capacity, Use of Evidence, and Research Productivity in Acute Care: Year 1 Findings From a Partnership Study	Journal of Nursing Administration	2016	Quasi-experimental (e.g. pre-post-test)	United States	67	No. Not reported	
J. R. Duffy, S. Culp, C. Yarberry, L. Stroupe, K. Sand-Jecklin, A. Sparks Coburn [48] *articles linked	Nurses' research capacity and use of evidence in acute care: baseline findings from a partnership study		2015	Correlational		75	Yes. Describe	West Virginia University Nursing Research Investment Fund
C. Phillips [106]	Relationships between duration of practice, educational level, and perception of barriers to implement evidence-based practice among	International Journal of Evidence-Based Healthcare	2015	Correlational	United States	60	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	critical care nurses							
A. J. Ramos-Morcillo, S. Fernandez-Salazar, M. Ruzafa-Martinez, R. Del-Pino-Casado [108]	Effectiveness of a Brief, Basic Evidence-Based Practice Course for Clinical Nurses	Worldviews on Evidence-Based Nursing	2015	Quasi-experimental (e.g. pre-post-test)	Spain	109	Yes. Describe	Nursing Council of Jaen´ (Reference Number: 01-2014 CEJ).
L. M. Baird, T. Miller [153]	Factors influencing evidence-based practice for community nurses	British Journal of Community Nursing	2015	Not reported	Canada	68	No. Not reported	
L. H. Eaton, A. R. Meins, P. H. Mitchell, J. Voss, A. Z. Doorenbos [122]	Evidence-based practice beliefs and behaviors of nurses providing cancer pain management: a mixed-methods approach	Oncology Nursing Forum	2015	Cross-sectional Other: mixed methods	United States	40	No. Not reported	
K. M. Williamson, M. Almaskari, Z. Lester, D. Maguire [117]	Utilization of evidence-based practice knowledge, attitude, and skill of clinical nurses in the planning of professional	Journal for Nurses in Professional Development	2015	Other: descriptive mixed methods	United States	151	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	development programming							
M. Underhill, K. Roper, M. L. Siefert, J. Boucher, D. Berry [84]	Evidence-based practice beliefs and implementation before and after an initiative to promote evidence-based nursing in an ambulatory oncology setting	Worldviews on Evidence-Based Nursing	2015	Quasi-experimental (e.g. pre-post-test)	US	112 (T1) and 113 (T2)	No. Not reported	
M. O. Gu, Y. Ha, J. Kim [44]	Development and validation of an instrument to assess knowledge and skills of evidence-based nursing	Journal of Clinical Nursing	2015	Other: psychometric study	South Korea	48 nurses from the EBP group and 43 from the non-EBP group participated in the study.	Yes. Describe	the Fund of Research Promotion Program, Gyeongsang National University, 2011
M. A. Perez-Campos, I. Sanchez-Garcia, P. L. Pancorbo-Hidalgo [105]	Knowledge, Attitude and Use of Evidence-Based Practice among nurses active on the Internet	Investigacion y Educacion en Enfermeria	2014	Correlational Other: observational		314	No. Not reported	
L. Kaplan, E. Zeller, D. Damitio, S.	Improving the culture of evidence-based	Journal for Nurses in	2014	Quasi-experimental (e.g. pre-post-test)		207	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
Culbert, K. B. Bayley [129]	practice at a Magnet hospital	Professional Development						
A. Sese-Abad, J. De Pedro-Gomez, M. Bennasar-Veny, P. Sastre, J. C. Fernandez-Dominguez, J. M. Morales-Asencio [109]	A multisample model validation of the evidence-based practice questionnaire	Research in Nursing & Health	2014	Cross-sectional Other: psychometric	Spain	1,673	Yes. Describe	” financed by the Health Research Fund (PI 09/90512. Health Ministry)
H. S. Thorsteinsson, H. Sveinsdottir [160]	Readiness for and predictors of evidence-based practice of acute-care nurses: a cross-sectional postal survey	Scandinavian Journal of Caring Sciences	2014	Cross-sectional	Iceland	343	Yes. Describe	partially funded with grants from the University Hospital Research fund and the Icelandic Nurses’ Association Research
B. M. Toole, J. F. Stichler, L. Ecoff, L. Kath [114]	Promoting nurses' knowledge in evidence-based practice: do educational methods matter?	Journal for Nurses in Professional Development	2013	Experimental (e.g. RCT)	US	596	No. Not reported	
M. J. Dropkin [121]	Review of "The State of Evidence-based	ORL - Head & Neck Nursing	2013	Other: descriptive survey	US	1015	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	Practice in US Nurses"							
A. M. Bostrom, A. Rudman, A. Ehrenberg, J. P. Gustavsson, L. Wallin [62]	Factors associated with evidence-based practice among registered nurses in Sweden: a national cross-sectional study	BMC Health Services Research	2013	Cross-sectional	Sweden	1256	Yes. Describe	AFA insurance
C. White-Williams, P. Patrician, P. Fazeli, M. A. Degges, S. Graham, M. Andison, A. Shedlarski, L. Harris, K. A. McCaleb [116]	Use, knowledge, and attitudes toward evidence-based practice among nursing staff	Journal of Continuing Education in Nursing	2013	Correlational	US	593	No. Not reported	
M. J. Linton, M. A. Prasun [50]	Evidence-based practice: collaboration between education and nursing management	Journal of Nursing Management	2013	Other: descriptive survey	US	286	No. Not reported Funding was not provided for this research project.	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
H. S. Thorsteinsson [159]	Icelandic nurses' beliefs, skills, and resources associated with evidence-based practice and related factors: a national survey	Worldviews on Evidence-Based Nursing	2013	Other: descriptive survey	Iceland	540	Yes. Describe	The Landspitali University Hospital Research Fund and the Icelandic Nurses Association Research Fund
H. S. Thorsteinsson [158] *articles linked	Translation and validation of two evidence-based nursing practice instruments	International Nursing Review	2012	Other: psychometric study				
S. Hauck, R. P. Winsett, J. Kuric [127]	Leadership facilitation strategies to establish evidence-based practice in an acute care hospital	Journal of Advanced Nursing	2013	Other: prospective descriptive comparative	US	475	No. Not reported	
D. Hagler, M. Z. Mays, S. B. Stillwell, B. Kastenbaum, R. Brooks, E. Fineout-Overholt, K. M.	Preparing clinical preceptors to support nursing students in evidence-based practice	Journal of Continuing Education in Nursing	2012	Not reported	US	160	Yes. Describe	Funding for the project was provided through the Division of Nursing, Bureau of

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
Williamson, J. Jirsak [156]								Health Professions, Health Resources and Services Administration , Department of Health and Human Services grant #D11HP09753, Leveraging Educational Technology for EvidenceBased Practice
B. M. Melnyk, E. Fineout-Overholt, L. Gallagher-Ford, L. Kaplan [137]	The state of evidence-based practice in US nurses: critical implications for nurse leaders and educators	Journal of Nursing Administration	2012	Other: descriptive survey	US	876	No. Not reported	
S. Gonzalez-Torrente, J. Pericas-Beltran, M. Bennasar-Veny, R. Adrover-Barcelo, J. M. Morales-Asencio, J. De Pedro-Gomez [96]	Perception of evidence-based practice and the professional environment of primary health care nurses in the Spanish context: a cross-sectional study	BMC Health Services Research	2012	Cross-sectional	Spain	377	Yes. Describe	the Health Research Fund (PI 09/90512. Health Ministry)

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
S. C. Wang, L. L. Lee, W. H. Wang, H. C. Sung, H. K. Chang, M. Y. Hsu, S. C. Chang, C. H. Tai [148]	Psychometric testing of the Chinese evidence-based practice scales	Journal of Advanced Nursing	2012	Other: psychometric instrument design	Taiwan	676	Yes. Describe	This project was financially supported by the Buddhist Tzu Chi General Hospital (Project number: TCRD 98-48).
M. Ruzafa-Martinez, L. Lopez-Iborra, M. Madrigal-Torres [51]	Attitude towards Evidence-Based Nursing Questionnaire: development and psychometric testing in Spanish community nurses	Journal of Evaluation in Clinical Practice	2011	Other: psychometric study	Spain	395	Yes. Describe	The study was supported by the EMCA Programme from the Government of Murcia Health Affairs. Financial programme for the development of research related to the Quality of Health Services 2007 (registry number: EMCA 07/01).
K. Gerrish, L. Guillaume, M. Kirshbaum, A. McDonnell, A.	Factors influencing the contribution of advanced practice nurses	Journal of Advanced Nursing	2011	Cross-sectional	England	855	Yes. Describe	This research was funded by the Policy Research Programme of

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
Tod, M. Nolan [43]	to promoting evidence-based practice among front-line nurses: findings from a cross-sectional survey							the Department of Health, England. Grant number 0160072.
R. F. Levin, E. Fineout-Overholt, B. M. Melnyk, M. Barnes, M. J. Vetter [132]	Fostering evidence-based practice to improve nurse and cost outcomes in a community health setting: a pilot test of the advancing research and clinical practice through close collaboration model	Nursing Administration Quarterly	2011	Experimental (e.g. RCT)	US	46	Yes. Describe	Hugoton Foundation.
P. Prior, J. Wilkinson, S. Neville [107]	Practice nurse use of evidence in clinical practice: a descriptive survey	Nursing Praxis in New Zealand	2010	Other: descriptive survey	Auckland, New Zealand	55	No. Not reported	
C. E. Brown, L. Ecoff, S. C. Kim, M. A. Wickline, B. Rose, K.	Multi-institutional study of barriers to research utilisation and evidence-based	Journal of Clinical Nursing	2010	Cross-sectional	US	1301	Yes. Describe	Sigma Theta Tau local chapter, Gamma Gamma

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
Klimpel, D. Glaser [92]	practice among hospital nurses							
Y. W. Chiu, Y. H. Weng, H. L. Lo, Y. H. Shih, C. C. Hsu, K. N. Kuo [32]	Impact of a nationwide outreach program on the diffusion of evidence-based practice in Taiwan	International Journal for Quality in Health Care	2010	Cross-sectional	Taiwan	2069	Yes. Describe	National Health Research Institutes, Taiwan
B. M. Melnyk, T. Bullock, J. McGrath, D. Jacobson, S. Kelly, L. Baba [136]	Translating the evidence-based NICU COPE program for parents of premature infants into clinical practice: impact on nurses' evidence-based practice and lessons learned	Journal of Perinatal & Neonatal Nursing	2010	Other: single cohort before and after	Southwest United States	81	Yes. Describe	Phoenix Children's Hospital Competitive Grant Award
J. Mills, J. Field, R. Cant [152]	The place of knowledge and evidence in the context of Australian general practice nursing	Worldviews on Evidence-Based Nursing	2009	Cross-sectional	Australia	590	Yes. Describe	An Australian Government National Health and Medical Research Council Primary Health Care Fellowship

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
C. E. Brown, M. A. Wickline, L. Ecoff, D. Glaser [93]	Nursing practice, knowledge, attitudes and perceived barriers to evidence-based practice at an academic medical center	Journal of Advanced Nursing	2009	Cross-sectional	United States	458	Yes. Describe	Sigma Theta Tau International, Gamma Gamma chapter and from University of California, San Diego
B. M. Melnyk, E. Fineout-Overholt, M. Z. Mays [46]	The evidence-based practice beliefs and implementation scales: psychometric properties of two new instruments	Worldviews on Evidence-Based Nursing	2008	Cross-sectional	United States	394	No. Not reported	
L. Thiel, Y. Ghosh [53]	Determining registered nurses' readiness for evidence-based practice	Worldviews on Evidence-Based Nursing	2008	Cross-sectional	United States	121	No. Not reported	
G. Varnell, B. Haas, G. Duke, K. Hudson [146]	Effect of an educational intervention on attitudes toward and implementation of evidence-based practice	Worldviews on Evidence-Based Nursing	2008	Quasi-experimental (e.g. pre-post-test)	United States	49	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
M. L. Koehn, K. Lehman [101]	Nurses' perceptions of evidence-based nursing practice	Journal of Advanced Nursing	2008	Cross-sectional	United States	422	No. Not reported	
K. Gerrish, P. Ashworth, A. Lacey, J. Bailey [151]	Developing evidence-based practice: experiences of senior and junior clinical nurses	Journal of Advanced Nursing	2008	Cross-sectional	England	598	Yes. Describe	identified that funding was obtained but no description provided
K. Gerrish, P. Ashworth, A. Lacey, J. Bailey, J. Cooke, S. Kendall, E. McNeilly [63]	Factors influencing the development of evidence-based practice: a research tool	Journal of Advanced Nursing	2007	Cross-sectional	England	1287	Yes. Describe	identifies funding obtained but does not specify granting organization
D. Upton, P. Upton [30]	Development of an evidence-based practice questionnaire for nurses	Journal of Advanced Nursing	2006	Cross-sectional	Wales	751	Yes. Describe	identifies funding obtained but does not specify granting organization
B. M. Melnyk, E. Fineout-Overholt, N. Fischbeck Feinstein, H. Li, L. Small, L. Wilcox, R. Kraus [37]	Nurses' perceived knowledge, beliefs, skills, and needs regarding evidence-based practice: implications for	Worldviews on Evidence-Based Nursing	2004	Cross-sectional	United States	160	Yes. Describe	Agency for healthcare research and quality

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description
	accelerating the paradigm shift						
K. Gerrish, J. Clayton [64]	Promoting evidence-based practice: an organizational approach	Journal of Nursing Management	2004	Cross-sectional	England	330	No. Not reported
M. O. A. Hasheesh, M. E. AbuRuz [98]	Knowledge, attitude and practice of nurses towards evidence-based practice at Al-Medina, KSA	Jordan Medical Journal	2017	Cross-sectional Correlational	Saudi Arabia	303	No. Not reported
J. B. Carlone, O. Igbirieh [94]	Measuring attitudes and knowledge of evidence-based practice in the qatar nursing workforce: A quantitative cross-sectional analysis of barriers to empowerment	Avicenna	2014	Cross-sectional	Qatar	400	No. Not reported
Lora Moore [103]	Effectiveness of an Online Educational Module in Improving Evidence-Based Practice Skills of Practicing	Worldviews on Evidence-Based Nursing	2017	Quasi-experimental (e.g. pre-post-test)		77 post-tests were used in analysis	No. Not reported

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	Registered Nurses							
Kim Son Chae, Jaynelle F. Stichler, Laurie Ecoff, Ana-Mari Gallo, Judy E. Davidson [142]	Six-Month Follow-up of a Regional Evidence-based Practice Fellowship Program	Journal of Nursing Administration	2017	Quasi-experimental (e.g. pre-post-test)	United States	66	No. Not reported	
Mohannad Eid AbuRuz, Haneen Abu Hayeah, Ghadeer Al-Dweik, Hekmat Yousef Al-Akash [88]	Knowledge, Attitudes, and Practice about Evidence-Based Practice: A Jordanian Study	Health Science Journal	2017	Cross-sectional	Amman Jordan	500	Yes. Describe	Applied Science Private University, Amman, Jordan
Kang Younhee, Yang In-Suk [128]	Evidence-based nursing practice and its correlates among Korean nurses	Applied Nursing Research	2016	Cross-sectional, Correlational	Korea	392	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description
Leonie Rose Bovino, Anne Aquila, Richard Feinn [120]	Evidence-Based Nursing Practice in a Contemporary Acute Care Hospital Setting	Nursing Research	2016	Cross-sectional	United States	402	No. Not reported
L. Rose Bovino, A. M. Aquila, S. Bartos, T. McCurry, C. E. Cunningham, T. Lane, N. Rogucki, J. DosSantos, D. Moody, K. Mealia-Ospina, J. Pust-Marcone, J. Quiles [139] *linked articles	A Cross-sectional Study on Evidence-Based Nursing Practice in the Contemporary Hospital Setting: Implications for Nurses in Professional Development	Journal for Nurses in Professional Development	2017				
Donna Agnew [89]	A Survey of Nurses' Knowledge, Attitude and Skills with Evidence-Based Practice in the Practice Setting	Nursing Research	2016	Other: please describe : descriptive comparative self-report survey	United States	259	No. Not reported
Debra Hain Mary Haras [161]	Continuing Nursing Education.	Nephrology Nursing Journal	2015	Other: please describe : descriptive	United States	52 (12 included in data	No. Not reported

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	Changing Nephrology Nurses' Beliefs about the Value of Evidence-Based Practice and Their Ability to Implement in Clinical Practice					analysis in April 2014 session and 40 included in data analysis in October 2014)		
Nicole Allen, Barbara G. Lubejko, Julie Thompson, Barbara S. Turner [90]	Evaluation of a Web Course to Increase Evidence-Based Practice Knowledge Among Nurses	Clinical Journal of Oncology Nursing	2015	Other: pre-post retrospective	United States	225	No. Not reported	
Aliyu Adamu, Joanne Rachel Naidoo [60]	Exploring the perceptions of registered nurses towards evidence-based practice in a selected general hospital in Nigeria	Africa Journal of Nursing & Midwifery	2015	Other: quantitative descriptive	Nigeria	133	No. Not reported	
Jed Duff, Margaret Butler, Menna Davies, Robyn Williams, Jannelle Carlile [95]	Perioperative nurses' knowledge, practice, attitude, and perceived barriers to	ACORN: The Journal of Perioperative Nursing in Australia	2014	Cross-sectional	New South Wales.	493	Yes. Describe	NSW Operating Theatre Association

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	evidence use: A multisite, cross-sectional survey							
Susanne Tacaraya Fehr [56]	Examining the Relationship Between Nursing Informatics Competency and Evidence-Based Practice Competency Among Acute Care Nurses		2014	Cross-sectional	United States, Northern Virginia	197	No. Not reported	
Natasha Laibhen-Parkes [45]	Web-Based evidence based practice educational intervention to improve EBP competence among BSN-prepared pediatric bedside nurses: A mixed methods pilot study		2014	Other: mixed methods	Southeastern United States	29	Yes. Describe	Jonas Nurse Leader's Scholarship, Georgia Baptist College of Nursing, Nurse Faculty Load Program
Kate Gerrish, Jo Cooke [8]	Factors influencing evidence-based practice among community nurses	Journal of Community Nursing	2013	Not reported	South Yorkshire	337	No. Not reported	
Son Chae Kim, Caroline E. Brown, Laurie Ecoff, Judy E. Davidson, Ana-Maria Gallo, Kathy Klimpel, Mary A. Wickline [100]	Regional Evidence-Based Practice Fellowship Program: Impact on Evidence-Based Practice Implementation and Barriers	Clinical Nursing Research	2013	Quasi-experimental (e.g. pre-post-test)	San Diego, USA	142	Yes. Describe	Consortium for Nursing Excellence, San Diego, CA, USA and Alumni Faculty Grant 12-1804 from Point Loma Nazarene University, San

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
								Diego, CA, USA.
Dawna L. Cato [155]	The relationship between a nurse residency program and evidence-based practice knowledge of the incumbent nurse across a multihospital system: a quantitative correlational design		2013	Correlational	United State	44	No. Not reported	
Talaso D. Barako, Margaret Chege, Sabina Wakasiaka, Lilian Omondi [40]	Factors influencing application of evidence-based practice among nurses	African Journal of Midwifery & Women's Health	2012	Cross-sectional	Nairobi, Kenya	156	No. Not reported	
Steve Mooney [83]	The Effect of Education on Evidence-Based Practice and Nurses' Beliefs/Attitudes Toward and Intent to use Evidence-Based Practice		2012	Quasi-experimental (e.g. pre-post-test)	United States	5	No. Not reported	
Lynn Gallagher-Ford [55]	The influence of nurse leaders and nurse educators on registered nurses' evidence-based practice		2012	Correlational	United States	269	No. Not reported	
Susan Hall Lynch [133]	Nurses' Beliefs About and Use of Evidence-Based Practice		2012	Cross-sectional	United States	326	No. Not reported	
Yvette M. Pryse [138]	Using evidence based practice: the relationship between work environment, nursing leadership, and nurses at the bedside		2012	Other: descriptive	US	422	No. Not reported	
K. G. Mariano, L. M. Caley, L. Eschberger, A. Woloszyn, P. Volker, M. S.	Building evidence-based practice with staff nurses	Journal of Neonatal Nursing	2009	Quasi-experimental (e.g. pre-post-test)	United States	20	Yes. Describe	Sigma Theta Tau Gamma Kappa Chapter for financial support.

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description
Leonard, Y. Tung [135]	through mentoring						
N. A. Estrada [124]	Learning organizations and evidence-based practice by RNs		2007	Other: descriptive non-experimental	United States	592	No. Not reported
N. Estrada [123] *articles linked	Exploring perceptions of a learning organization by RNs and relationship to EBP beliefs and implementation in the acute care setting	Worldviews on Evidence-Based Nursing	2009	Cross-sectional		594	
Susan Lynn Adams [31]	Understanding the variables that influence translation of evidence-based practice into school nursing		2007	Cross-sectional	United States	386	No. Not reported
M. L. Chew, K. H. Sim, Y. F. Sim, C. C. Yan [36]	Attitudes, skills and knowledge of primary healthcare nurses on the use of evidence-based nursing (EBN) and barriers influencing the use of EBN in the primary	Annals of the Academy of Medicine Singapore	2015	Cross-sectional	Singapore	219	No. Not reported

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description	
	healthcare setting							
H. T. Xie, Z. Y. Zhou, C. Q. Xu, S. Ong, A. Govindasamy [118]	Nurses' attitudes towards research and evidence-based practice	Annals of the Academy of Medicine Singapore	2015	Other: descriptive survey	SIngapore	68	No. Not reported	
W. K. Yip, S. Z. Mordiffi, M. S. Majid, E. K. N. Ang [35]	Nurses' perspective towards evidence-based practice: A descriptive study	Annals of the Academy of Medicine Singapore	2010	Cross-sectional	Singapore	1144	Yes. Describe	Funding provided by the Ministry of Health Nursing Research Committee.
Lai Ping Atalanta Wan [115]	Educational Intervention Effects on Nurses' Perceived Ability to Implement Evidence-Based Practice		2017	Quasi-experimental (e.g. pre-post-test)	US	39	No. Not reported	
Mohammed Almaskari [52]	Omani Staff Nurses' and Nurse Leaders' Attitudes Toward and Perceptions of Barriers and Facilitators to the Implementation of Evidence-Based Practice		2017	Other: please describe : exploratory descriptive comparative research design	Oman	260	Yes. Describe	Ministry of Higher Education, the Ministry of Health, The Directorate of Education and Training, and Ibra Nursing Institute
Linda Connor [61]	Pediatric Nurses' Knowledge, Values, and Implementation of Evidence-Based Practice and Use of Two Patient Safety Goals		2017	Other: please describe : descriptive quantitative research design	US	190	No. Not reported	

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description
				using survey methodology			
Irene Macyk [134]	Staff Nurse Engagement, Decisional Involvement, Staff Nurse Participation in Shared Governance Councils and the Relationship to Evidence Based Practice Belief and Implementation		2017	Correlational	US	156	No. Not reported
Michelle Baxley [119]	School nurse's implementation of evidence-based practice: A mixed method study		2016	Other: mixed method	US	59	No. Not reported
Sherri L. Smith-Keys [157]	Education and Mentoring of Staff Nurses in Evidence Based Practice		2016	Other: Descriptive study	US	7	No. Not reported
Carolyn Sweetapple [144]	Change Adoption Willingness: Development of a measure of willingness to adopt evidence-based practice in registered nurses		2015	Other: survey development	US	356	No. Not reported
Temple, B. Sawatzky-Dickson, D. Pereira, A. Martin, D. McMillan, D. Cepanec, D. Goodwin, B. Harwood, R [145]	Improving Nurses' Beliefs and Use of Evidence in their Practice, Nursing Education and Health Care Organizations		2014	Cross-sectional	Canada	257	No. Not reported
Melnyk, Bernadette Mazurek	The First U.S. Study on Nurses'	Worldviews on Evidence-Based Nursing	2018	Cross-sectional	US	2,344	No. Not reported

Authors	Citation title	Journal	Year	Study design	Country	Sample size	Funding description
Gallagher-Ford, Lynn Zellefrow, Cindy Tucker, Sharon Thomas, Bindu Sinnott, Loraine T. Tan, Alai [10] ***Identified from contact with content expert Dr. Melnyk**	Evidence-Based Practice Competencies Indicates Major Deficits That Threaten Healthcare Quality, Safety, and Patient Outcomes						

Additional file 4: Sources of validity evidence for measures (n=35)

LEGEND	
Internal Structure	
+	Exploratory Factor Analysis – Principal Components Analysis
*	Confirmatory Factor Analysis
Relationships to Other Variables	
+	Correlation
#	T-Test/Mann-Whitney U test/Wilcoxon Sign test
♠	Chi-square
♦	ANOVA/MANOVA/ANCOVA/MANCOVA/Kruskal-Wallis
♣	Linear mixed model
*	Regression

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
Group 1: Four sources of validity evidence (n=2 measures)												
School nursing evidence-based practice questionnaire (1 study)	Susan Lynn Adams (2007) [31]	United States RNs			√				Content validation assessed by three experts in EBP, translation research and/or school nursing.	Pilot tested with five school nurses. Feedback used to modify, increase clarity and readability, and add or eliminate questions.	+ Principal components factor analysis: • Section 1 (Evidence-Based Practice) Four factors explained 57% of the variance. • Section 2 (Current practice) Five factors accounting for 60.9 % of the variance. • Section 3 (Computer access & skill): Five factors 57% of the variance. • Section 4 (information sources): Three factors explaining 60% of the variance. • Section 5 (barriers to implementation): Five factors accounting for 60% of the variance.	+* <u>Correlation</u> Current EBP practice with: Significant at p<.05 • Years RN (.131) Significant at p<.01 • Diploma/Associate degree (-.263) • Advanced degree (.155) • Professional membership (.256) • Use of web-based resources (.178) <u>Regression analyses</u> Dependent variable: current use of EBP Independent variables: nurse and school characteristics • 22% variance explained by all variables entered into regression analyses Significant coefficients: • Professional membership (β=.114, p=.029) • Use of traditional sources (conferences, other school nurses for practice information) (β=-.102, p=.049)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
Evidence-Based Nursing Attitude Questionnaire (EBNAQ) (2 studies)	M. Ruzafa-Martinez, L. Lopez-Iborra, M. Madrigal-Torres (2011) [51]	Spain RNs				√			Six experts evaluated the level of relevance of each item for its corresponding dimension of attitude. The items were classified according to whether the categories representing each dimension were relevant, quite relevant or irrelevant.	Ten nurses were interviewed using this final version. After modifying the items according to the nurses' suggestions in the instrument pretesting, the quantitative pilot stage was carried out in two rounds.	+ Principal component factor analysis yielded three factors, each with an eigenvalue >1. The total amount of variance explained was 54.70% and each of the items of the subscales loaded onto separate factors. • Factor 1: 'Beliefs and expectations towards EBN' (35.09% variance; eigenvalue 5.26) • Factor 2: 'Intention of conduct towards EBN' (11.62% variance; eigenvalue 1.74) • Factor 3: 'Feelings towards EBN' (8% variance; eigenvalue 1.20)	+# Correlation • Construct validity established: Significant positive correlation between questionnaire scores and an independent measure of attitude towards research. Correlation coefficients were found to be around 0.255 ($p < 0.001$). t-test Significant differences in EBP attitudes based on: • EBP knowledge ($t = 2.261$; d.f. 189; $p = 0.025$) ○ Yes (M=59.25; SD=8.94) ○ No (M=56.19; SD=7.45) • Experience ($t = 2.284$; d.f. 188; $p=0.024$) ○ ≤15 years (M=57.99; SD=7.41) >15 years (M=54.81; SD=9.73)
	Mohammed Almaskari (2017) [52]	Oman RNs	√						Original findings reported	Not reported	Original findings reported	#♦ t-test Significant differences in EBP attitudes based on: • Learned EBP in school $t(193)=-2.90$; $p=0.004$ ○ No (M=3.77; SD=0.37) ○ Yes (M=4.11; SD=0.46) • Continuing EBP education $t(252)=-2.47$, $p=0.014$ ○ No (M=3.92; SD=0.43) ○ Yes (M=4.06; SD=0.49) ANOVA • Education $F(2,254)=12.93$, $p<.001$ ○ Diploma (M=3.88, SD=0.47) ○ Specialized diploma (M=4.16; SD=0.44) ○ Bachelor's (M=4.20; 0.41)
Group 2: Three sources of validity evidence (n=5)												
Self-developed measure by Yip et al. (2011) (1 study)	W. K. Yip, S. Z. Mordiffi, M. S. Majid, E. K. N. Ang (2010) [35]	Singapore RNs	√						An expert panel of six nurse leaders and academics reviewed the contents of the survey questionnaire with minor modifications made to the questionnaire.	Not reported	+ Factor analysis with Varimax rotation showed that there were two major factors for all the domains except for the domain of beliefs and attitude, which had only one major factor (factor loadings 0.71-0.73).	* Two independent variables that predicted positive attitude towards EBP. √ Nurse managers, senior nurse managers, senior nurse educators, senior nurse clinicians (OR=2.67, 95% CI: 1.50-4.76, p = 0.001) more likely to display positive attitude towards EBP than staff nurses √ Participants who had attended EBP training course (OR=1.45, 95% CI: 1.01-2.08, p=0.045) were more likely to display positive attitude towards EBP, than staff nurses those who did not attend EBP training.

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
Quick EBP VIK (Values, Implementation, Knowledge) Survey (2 studies)	L. Connor, F. Paul, M. McCabe, S. Ziniel (2017) [39]	United States APNs, "nurses in any role"	√						An expert panel of six found 24 of the 26 initial items to be clear and relevant with an Item-Level Content Validity Index (I-CVI) of >0.80	Not reported	+ Exploratory factor analysis identified three theoretical measurement dimensions (factor loadings): • Value (.28-.84) • Knowledge (.76-.90) • Implementation (.50-.78)	# Statistically significant differences between the groups who attended an EBP workshop and those who did not. Lower scores for those who did not attend EBP workshop versus those who did attend EBP workshop [M(SE)]: *Knowledge* • Steps of EBP 2.54 (0.05) versus 3.31 (0.07) p<0.001 • How to form PICO question 1.92 (0.06) versus 3.20 (0.09) p<0.001 • Ranking system for hierarchy of evidence 2.00 (0.06) versus 3.02 (0.08) p<0.001 • Performing literature search 2.70 (0.07) versus 3.39 (0.09) p<0.001 • Critically appraising systematic review 1.91 (0.06) versus 2.90 (0.10) p<0.001 • Critically appraising qualitative research study 2.10 (0.06) versus 2.86 (0.09) p<0.001 • Critically appraising quantitative research study 2.05 (0.06) versus 2.90 (0.09) p<0.001 • Frequency of literature searches 1.98 (0.07) versus 2.89 (0.13) p<0.001 • Frequency of critical appraisals of literature search evidence 1.59 (0.06) versus 2.42 (0.11) p<0.001 *Implementation* • Frequency of performing EBP steps 1.62 (0.06) versus 2.12 (0.08) p<0.001 • Frequency of developing PICO question 1.20 (0.03) versus 1.76 (0.06) p<0.001 • Frequency of having shared EBP process knowledge 1.29 (0.05) versus 1.67 (0.03) p<0.001 • Frequency of having used EBP results to propose change 1.28 (0.03) versus 1.49 (0.06) p<0.002 • Frequency of EBP results having resulted in a change 1.29 (0.04) versus 1.49 (0.06) p<0.005
	Linda Connor (2017) [61]	United States RNs	√						Original findings reported.	Not reported	+ Factor analysis conducted indicating three factors with eigenvalues exceeding 1 (variance explained): • Value (45.59%) • Knowledge (11.52%) • Implementation (9.29%)	+♦ <u>Correlation</u> *Magnet hospitals:* • positive correlation between level of education and knowledge domain, r (128) = .566, p < .001 • positive correlation between level of education and the implementation domain, r (128) = .518, p < .001. • positive correlation between years of nursing experience and value, r (128) = .214, p = .014 • positive correlation between value and knowledge r (128) = .278, p = .001 • positive correlation between value and implementation r (128) = .284, p = .001

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• positive correlation between knowledge and implementation r (128) = .725, p = .001. *Non-magnet hospitals* • positive correlation between highest nursing degree and knowledge r (58) = .397, p = .002 • positive correlation between highest nursing degree and implementation r (58) = .353, p = .006 • positive correlation between the knowledge and implementation domains r (58) = .697, p < .001. ANOVA √ Statistically significant differences between the Magnet® and non-Magnet® participants only for the value domain, F (1, 188) = 6.48, p = .012, partial eta square = .033
EBP measure developed by Majid et al. (2011; 2 studies)	J. Farokhzadian, R. Khajouei, L. Ahmadian (2015) [59]	Iran Licensure group not specified	√						Three medical informatics specialists and eight faculty members of nursing confirmed content validity.	Not reported	Not reported	+#♦ Correlation • Significant association between EBP skills and nurses attitudes (r = 0.20, P < 0.01) • Nurses who had positive attitude towards EBP and felt more competent to implement EBP perceived more supporting factors for implementing EBP. Significant association between subscale of supporting factors for EBP (p<0.05) and: ○ attitude (r=0.18) ○ skills (r=0.20) t-test • Significant differences in EBP skills based on attending EBP training (t = 3.87, P < 0.001) ANOVA Attitudes towards EBP • Significant differences in EBP attitudes based on age groups (F = 2.80, P < 0.05) • Significant differences in EBP attitudes based on years of nursing experience (F = 4.24, P < 0.001) EBP skills • Significant differences in EBP skills based on years of nursing experience (F = 4.95, P < 0.01)
	Aliyu Adamu, Joanne Rachel Naidoo (2015) [60]	Nigeria RNs	√						Nursing expert evaluated content of questionnaire	Piloted with 20 hospital registered nurses to ensure understandability and comprehensibility.	Not reported	+ • Significant positive association between: ○ EBP attitude and age (r=0.137; p=.05) ○ EBP knowledge and EBP attitude (r=0.137; p=.01)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
Knowledge and Skills in Evidence-Based Nursing (KS-EBN; 1 study)	M. O. Gu, Y. Ha, J. Kim (2015) [44]	South Korea Licensure group not specified	√						Content validity of assessed by five experts: three nursing scholars and two nurse managers with EBP expertise. Content validity underwent two rounds of expert review and revision. Content validity index (CVI) of each item was calculated, and a CVI of more than 0.8 was interpreted as indicating validity. Final 10 items and scoring rubric had CVI levels of more than .80.	Pilot survey conducted with five nurses (three nurses with experience in EBP projects and two without such experience). They were asked to correct difficult-to-understand or ambiguous questions.	Not reported	# Construct validity determined using known-groups method • Significant differences in EBP knowledge and skills scores between EBP and non-EBP group for individual items: Step #1 item: ○ Asking a clinical question (PICO) – EBP group (M=1.58; SD=0.49) versus non-EBP group (M=0.48; SD=0.69); t=8.63; p<0.001 Step #2 items: ○ Source for the evidence: databases - EBP group (M=0.75; SD=0.25) versus non-EBP group (M=0.23; SD=0.25); t=9.55; p<0.001 ○ Search terms (keywords) - EBP group (M=0.82; SD=0.36) versus non-EBP group (M=0.24; SD=0.41); t=7.05; p<0.001 ○ Additional search strategies (Boolean, limits) - EBP group (M=0.68; SD=0.27) versus non-EBP group (M=0.30; SD=0.25); t=7.01; p<0.001 ○ Limiting searches (study design) - EBP group (M=0.87; SD=0.33) versus non-EBP group (M=0.41; SD=0.49); t=5.06; p<0.001 Step #3 items: ○ Applicability of study findings -EBP group (M=0.86; SD=0.24) versus non-EBP group (M=0.73; SD=0.33); t=2.12; p=0.036 ○ Validity of RCT - EBP group (M=1.61; SD=0.36) versus non-EBP group (M=1.05; SD=0.65); t=4.93; p<0.001 ○ Effect size - EBP group (M=0.39; SD=0.49) versus non-EBP group (M=0.18; SD=0.39); t=2.25; p=0.027 ○ Levels of evidence - EBP group (M=0.66; SD=0.47) versus non-EBP group (M=0.16; SD=0.37); t=5.64; p<0.001 • Significant difference (t=9.93; p<0.001) in subtotal step #2 EBP knowledge and skills scores between EBP group (M= 3.13; SD=0.81) and non-EBP group (M=1.20; SD=1.03) • Significant difference (t=5.72; p<0.001) in subtotal step #3 EBP knowledge and skills scores between EBP group (M= 4.44; SD=1.16) and non-EBP group (M=2.91; SD=1.37) • Significant difference (t=9.51; p<0.001) in total EBP knowledge and skills total scores between EBP group (M= 9.16; SD=1.95) and non-EBP group (M=4.58; SD=2.56)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
Perceived EBP Knowledge Measure (1 study)	L. Thiel, Y. Ghosh (2008) [53]	United States RNs	√						Expert review by three reviewers	Not reported	+ Factor analysis allowed identification of the three items as a single factor with an eigenvalue of 2.1	+ Significant positive associations between perceived EBP knowledge scores and: • Unit culture (rho=0.450, p<0.01) • Organizational culture (rho=0.504, p<0.01) • EBP attitudes (rho=0.379, p<0.01) • Education (rho=0.254, p<0.01) • Years in nursing (rho=0.223, p<0.05)
Group 3: Two sources of validity evidence (n=6 measures)												
Modified Stevens EBP Readiness Inventory (ERI) (Finnish ERI) (1 study)	H. Saunders, K. R. Stevens, K. Vehvilainen-Julkunen (2016) [42]	Finland RNs	√						Content validity of confirmed by a Finnish nurse expert panel consisting of eight nurse scientists, clinicians, educators and leaders. The Content Validity Index (SCVI) for the self-efficacy section of the scale was assessed favorably by the expert panel at 0.90.	Not reported	Not reported	+♦ <u>Correlation</u> • Significant association between overall self-efficacy score and number of correct responses on EBP knowledge test (r = 0.221) <u>ANOVA</u> • Statistically significant difference (p < 0.05) total self-efficacy (i.e. confidence) in employing EBP F (3, 804) = 169.6, P < 0.001 based on four levels of EBP knowledge (no EBP knowledge, beginner, intermediate, advanced). • Post hoc comparisons: ○ RNs rating EBP knowledge at an intermediate level were significantly more confident in employing EBP than either those who indicated having no knowledge of EBP (M_{diff}= 39.1, P < 0.001) or those who rated themselves at a beginning level (M_{diff}= 20.5, P < 0.001). • RNs rating EBP knowledge at a beginning level, were significantly more confident in employing EBP than those who indicated having no knowledge of EBP (M_{diff}= 18.6, P < 0.001).
Johns Hopkins Nursing EBP Assessment Survey (1 study)	K. M. Bissett, M. Cvach, K. M. White (2016) [33]	United States RNs	√						Five nursing experts assessed accuracy of competencies	Five nursing experts assessed competencies for face validity, ease of use	Not reported	No supporting validity evidence

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
Persian translated EBP measure by Seyyedrasooli et al. (2012) (1 study)	A. Seyyedrasooli, V. Zamanzadeh, L. Valizadeh, F. Tadaion (2012) [34]	Iran RNs	√						Content validity was assessed by 14 faculty members of the Department of Nursing and Midwifery, Tabriz University of Medical Sciences. Any modifications suggested by the experts were applied accordingly.	Not reported	Not reported	#♦ Knowledge • Education: Statistical difference between Bachelor's degree (M=13.9; SD=8.1) and Master's degree (M=22.6; SD=8.8) t(598)=5.43, p=0.001 Attitude • Education: Statistical difference between Bachelor's degree (M=32.9; SD=8.1) and Master's degree (M=33.5; SD=7.3) t(598)=-2.5, p=0.04 Skills • Higher skills scores in speciality posts compared to other posts (units) F(6)=2.1, p=0.04
Self-developed EBP measure by Melnyk et al. (2004) (1 study)	B. M. Melnyk, E. Fineout-Overholt, N. Fischbeck Feinstein, H. Li, L. Small, L. Wilcox, R. Kraus (2004) [34]	United States Licensure group not specified						√	Reviewed for content validity by an interdisciplinary group of EBP experts and with 10 practising nurses.	Not reported	Not reported	+ • Nurses' beliefs about the importance of EBP in improving patient outcomes and extent to which practices are evidence-based positively correlated (r=.32, p<.001) • Nurses' beliefs about how much EBP improves clinical care and the extent to which practices are evidence-based positively correlated (r=.40, p<.001) • Nurses with greater EBP knowledge reported greater extent of EBP care (r=.42; p<.0001) • Having greater EBP knowledge positively correlated with EBP initiative involvement (r=.34, p<.001) • Length of time practicing as advanced practice nurse positively correlated with EBP knowledge (r=.37, p<.001) • Higher use of Cochrane Database of Systematic Reviews (r=.43, p<.003) and www.guideline.gov website (r=.41, p<.001) positively correlated with greater EBP practices • Having mentor positively correlated with high levels of EBP knowledge (r=.28, p<.003) • Having mentor who could role model EBP (r=.21, p<.05) positively correlated with more extensive EBP practices
Self-developed measure by Bostrom et al. (2013) (1 study)	A. M. Bostrom, A. Rudman, A. Ehrenberg, J. P. Gustavsson, L. Wallin (2013) [62]	Sweden RNs	√						Content validity assessed by group of RNs with expertise in EBP. Content Validity Indices ranged between 0.8 and 1.0. Professional instrument developers from	Not reported	Not reported	* Logistic regression conducted for each of the six EBP items/activities as dependent variable with individual and organizational factors as independent variables. Overall models were statistically significant. • Formulate questions: x^2=124.7, p<0.001 • Search databases: x^2=63.9, p<0.001 • Search other sources: x^2=103.1, p<0.001 • Compile information: x^2=81.3, p<0.001 • Implement evidence: x^2=145.6, p<0.001

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
									the technical and language laboratory at Statistics Sweden also reviewe items.			• Evaluate practice: x^2=148.9, p<0.001 Significant factors: • EBP capability beliefs was the only significant factor for all six activities (OR ranged from 2.6-7.3). That is, high capability beliefs associated with high extent of EBP activities. • Supportive leadership and high collective efficacy were associated with a high extent of three EBP activities: searching other knowledge sources (OR = 1.5 and OR = 1.4), implementing evidence (OR = 2.0 and OR = 1.7), and evaluating practice (OR = 1.6 and OR = 1.7).
EBP Competency Tool (Melnyk et al., 2018) *provided from expert consultation after online search conducted **(1 study)**	Bernadette Mazurek Melnyk, Lynn Gallagher-Ford, Cindy Zellefrow, Sharon Tucker, Loraine T. Sinnott, Alai Tan (2018) [10]	United States RNs APNs	√						Seven national EBP leaders developed an initial set of competencies for practicing registered nurses and APNs through a consensus building process. Delphi survey was conducted with 80 EBP mentors to determine consensus and clarity around the competencies. (Melnyk et al., 2014)	Not reported	Not reported	+♦* <u>Correlation</u> Significant correlations (p<.001) between EBP competency and: • EBP beliefs (r=.66) • Culture (r=.29) • EBP Knowledge (r=.43) • Mentoring (r=.69) <u>ANOVA</u> Total EBP competency scores associated with: • Age (p<.001) ○ <25 years (M=55.6; SD=12.4) ○ 25-34 (M=54.8; SD=14.2) ○ 35-44 (M=54.0; SD=15.4) ○ 44-54 (M=53.3; SD=16.3) ○ 55+ (M=51.7; SD=18.0) • Education (p<.001) ○ Diploma/associates (M=48.6; SD=15.4) ○ Bachelors (M=51.8; SD=14.8) ○ Masters or higher (M=63.3; SD=15.5) <u>Regression</u> Significant predictors of EBP competency (p<.001): • Master's or doctoral degree • Higher EBP knowledge • Higher EBP beliefs • Higher EBP mentoring
Group 4: One source of validity evidence (n=19 measures)												
EBP-Implementation Scale (EBPI; (35 studies)	N. A. Estrada (2007) [124] N. Estrada (2009) [123]	United States RNs	√						Not reported	Not reported	+ • Principal component analysis resulted in loading on one factor, eigenvalue =9.16, explaining 51% variance.	* <u>Regression analyses</u> Dependent variable: EBP implementation Independent variable: EBP beliefs subscales R^2=0.23, p≤.05 Significant standardized coefficients (p≤.05):

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Knowledge beliefs (0.32) Resource beliefs (0.13) Difficulty/resources beliefs (0.10)
	B. M. Melnyk, E. Fineout-Overholt, M. Z. Mays (2008) [46]	United States Licensure group not specified						√	Items developed from a review of literature on essential components and steps of EBP. Face and content validity of early drafts assessed in convenience samples of practicing staff nurses (N = 15) and EBP subject-matter experts (N = 8) who reviewed the two questionnaires for content and clarity.	Not reported	+ Principal components analysis indicated single factor: • Factor #1: Eigenvalue=10.53; 59% variance • Factor #2: Eigenvalue=1.5; 8% variance • Factor loadings of each item in single factor >0.60	+#♦ <u>Correlations</u> • EBP implementation and EBP beliefs ○ Significantly higher (p=.05) for those who had prior EBP exposure (r=0.51) than those with no EBP exposure (r=0.35) <u>t-test</u> • Prior exposure to EBP (p<.001) *test statistic not reported ○ No EBP exposure (M=8.60; SD=10.74) ○ Prior EBP exposure (M=18.27; SD=16.60) <u>ANOVA</u> F(4, 331) = 7.46, p < .001 • Education ○ Lowest scores associate degree (M=8.37; SD=12.96) ○ Highest scores doctoral degree (M=25.50; SD=21.08) • Nursing role F(3, 226) = 6.97, p < .001 ○ Lowest scores staff nurses (M=10.36; SD=13.54) ○ Highest scores Educator/faculty (M = 20.85, SD = 18.71)
	G. Varnell, B. Haas, G. Duke, K. Hudson (2008) [146]	United States Licensure group not specified	√						Not reported	Not reported	Original findings reported	+# <u>Correlation</u> EBP-I pre-test scores: • Education (rho=0.36; p<.05) • Advanced role (rho=0.48; p<.01) EBP-I post-test scores: Preceptor role (rho=0.29; o<.05) <u>t-test</u> EBP educational intervention (p<.01) • EBP-Implementation score pre-test (M=15.29; SD=13.65) • EBP-Implementation score post-test (M=22.86; SD=11.35) EBP-I pre-test scores (p<.01): • Unfamiliar with EBP (M=10.08; SD=9.25) • Previous exposure to EBP (M=20.95; SD=15.69)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	K. G. Mariano, L. M. Caley, L. Eschberger, A. Woloszyn, P. Volker, M. S. Leonard, Y. Tung (2009) [135]	United States RNs	√						Not reported	Not reported	Not reported	+ Correlation: • EBP beliefs (r=0.39; p=0.092)
	B. M. Melnyk, T. Bullock, J. McGrath, D. Jacobson, S. Kelly, L. Baba (2010) [136]	United States RNs	√						Original findings reported	Not reported	Not reported	No supporting validity evidence
	R. F. Levin, E. Fineout-Overholt, B. M. Melnyk, M. Barnes, M. J. Vetter (2011) [132]	United States RNs				√			Not reported	Not reported	Original findings reported	♦ ANOVA with repeated measures ARCC model program intervention • main effect for experimental group (M=29.52) compared to control group (M=10.44) on EBP implementation (F1,15 = 10.39, p = .006) at times 3 and 4 • significant quadratic effect of time (F1,15 = 12.40, p = .003) such that there was a significant increase in EBP implementation scores from time 1 (M = 12.89) to time 3 (M = 28.14) in the experimental ARCC group.
	Steve Mooney (2012) [83]	United States RNs	√						Not reported	Not reported	Not reported	No supporting validity evidence
	Lynn Gallagher-Ford (2012) [55]	United States RNs	√						Original findings reported	Original findings reported	Original findings reported	+# ♦ * Correlations • EBP beliefs ○ Staff nurses (r=.42; p=.001) ○ Educators (r=.54; p=.001) ○ Leaders (r=.49; p<.001) • Organizational readiness ○ Staff nurses (r=.42; p=.001) ○ Educators (r=.34; p=.03) ○ Leaders (r=.21; p=.07) t-test

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• Certification (p=.001) ○ Certified (M=29) ○ Non-certified (M=17) • Current school enrolment (p=.02) ○ Enrolled (M=25.9) ○ Not enrolled(M=20) <u>ANOVA</u> • Role F(2,266)=60.32; p<.001 Post-hoc analyses: ○ Staff nurses and educators (M_{diff}=-23.29; p<.001) ○ Staff nurses and leaders (M_{diff}=-21.55; p<.001) • Education (F = 14.79, p < .001) ○ Associate degree (M=16.9) ○ Diploma (M=21.8) ○ Master's (M=40.3) ○ Doctorate (M=49.0) <u>Regression analyses</u> Dependent variable: EBP implementation Independent variables: • EBP beliefs F(1,179)=43.38, p<.001, R^2=.19 • EBP beliefs and organizational readiness F(1,178)=10.69, p=.001, R^2=.24
	Susan Hall Lynch (2012) [133]	United States RNs	√						Original findings reported	Not reported	Original findings reported	+♦ <u>Correlation</u> • EBP beliefs (r=.334; p=.0001) <u>ANOVA</u> Higher EBP implementation scores associated with: • Certification (F=13.265, p=000) • Higher education (F=15.100, p=.000) • Higher level on clinical ladder (F=5.529, p=.000)
	Yvette M. Pryse (2012) [138]	United States RNs	√						Original findings reported	Not reported	Not reported	* <u>Regression analyses</u> Dependent variable: EBP implementation Independent variables: education, tenure, Magnet status, beliefs, work environment, leadership Overall multivariate model: (X^2 = 841.021, df = 8, p < .000) Multivariate analysis • EBP beliefs only significant variable (X^2 = 45.261, df = 1, p < .000) Univariate analysis (significant variables) • Leadership (X^2 = 336.839, df = 1, β = .045, p< .000) • Work environment (X^2 = 382.991, df = 1, β = .074, p < .000) • Beliefs (X^2 = 712.881, df = 1, β = .067, p < .000)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	B. M. Melnyk, E. Fineout-Overholt, L. Gallagher-Ford, L. Kaplan (2012) [137]	United States Licensure group not specified	√	√				√	Content validity of the survey was supported by 3 EBP experts	Not reported	Not reported	No supporting validity evidence.
	S. C. Wang, L. L. Lee, W. H. Wang, H. C. Sung, H. K. Chang, M. Y. Hsu, S. C. Chang, C. H. Tai (2012) [148]	Taiwan RNs	√						Back translation to ensure conceptual equivalence of each item. If unsure about content, physician was consulted and discussions took place until consensus reached.	Piloted with an EBP medical centre group (n=9), nursing (n=12) and social work students (n=5) to ensure linguistic appropriateness and utility.	* The NFI (Normed Fit Index) was above 0.70, and the RMSEA (Root Mean Square Error of Approximation) was less than 0.15	+#* <u>ANOVA:</u> • Education (F=5.87; p=.003) ○ Associate (M=0.48) ○ Bachelor (M=0.63) ○ Master or higher (M=1.12) <u>Mann-Whitney U-test</u> • Role ○ Clinical nurses (M=0.56) ○ Nurse researchers (M=1.97) <u>Regression analyses</u> • EBP beliefs, years of conducting research, barriers to research utilization, and ability in literature search predicted EBP implementation (F = 6.84, p = 0.01), accounted for 31.1% of the variance in EBP implementation.
	M. J. Dropkin (2013) [121]	United States Licensure group not specified	√	√				√	Not reported	Not reported	Not reported	+ <u>Correlation</u> • Education (r=.13, p<.01)
	S. Hauck, R. P. Winsett, J. Kuric (2013) [127]	United States RNs	√						Not reported	Not reported	Not reported	♦ • Role: F (2, 882) = 42.5. p < 0.001) with medium effect size (partial eta squared=.088). • Post hoc comparison using Tukey HSD test: ○ Direct Care RNs score (M=0.59; SD=0.61) was significantly different from Indirect Care RNs (M=1.1; SD=0.89) and Director/Leaders (M=1.07; SD=0.77)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	L. Kaplan, E. Zeller, D. Damitio, S. Culbert, K. B. Bayley (2014) [129]	United States RNs LPNs/RPNs APNs	√						Not reported	Not reported	Not reported	♦+ ANOVA • Education: (F = 8.02 , p < .001) Correlation • EBP beliefs: (r = .316, p=.001) • Culture and readiness (r = .198, p = .016)
	K. Stokke, N. R. Olsen, B. Espehaug, M. W. Nortvedt (2014) [143]	Norway RNs	√						Not reported	Not reported	Not reported	+ Correlation • EBP beliefs (r = 0.59, p = 0.001) • EBP beliefs subscales: ○ Attitudes related to knowledge r=0.38 (p < 0.001) ○ Attitudes related to resources r=0.29 (p < 0.001) ○ Attitudes related to the value of EBP r=0.29 (p < 0.001) ○ Attitudes related to difficulty and time r=0.25 (p = 0.001)
	L. H. Eaton, A. R. Meins, P. H. Mitchell, J. Voss, A. Z. Doorenbos (2015) [122]	United States RNs	√						Not reported	Not reported	Not reported	+ • EBP beliefs were associated with nurses' perceived level of EBP implementation (r = 0.36, p = 0.02)
	M. Underhill, K. Roper, M. L. Siefert, J. Boucher, D. Berry (2015) [84]	United States RNs APNs	√						Not reported	Not reported	Not reported	+# Correlation • Education (r = .32; p = .01) Mann-Whitney U Test • Those with formal education have higher EBP implementation scores U=399.0, p=.03 • Those with nurse leader roles have higher EBP implementation scores U=304.5, p=.01
	Carolyn Sweetapple (2015) [144]	United States RNs	√						Original findings reported	Not reported	Original findings reported	+♦ Correlation • EBP beliefs (r=.391, p<.001) ANOVA • Education: F(3,375)=4.565, p<.01 ○ Associates degrees/diploma: M=28.64 ○ Bachelor's: M=30.95 ○ Master's: M=34.86 ○ Doctorate: M=42.45 *Bonferroni adjustment

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												○ Doctorate>associates degree/diploma nurses on EPB implementation scores (p<.05) ○ Doctorate>bachelor's on EPB implementation scores (p=.055) • Role F(5,345)=6.396, p<.001 ○ Directors: M=42.63 ○ Managers: M=36.69 ○ Clinical specialists: M=34.20 ○ Educators: M=31.20 ○ Staff nurses: M=29.52 ○ Assistant nurse managers: M=28.28 *Bonferroni adjustment ○ Directors>staff nurses on EBP implementation scores (p<.001) • Experience: F(3,385)=12.481, p<.001 ○ No experience (M=27.69) ○ Some continuing education (M=29.93) ○ Formal coursework in EBP (M=35.29) ○ Teaching EBP (M=54.00) *Bonferroni adjustment ○ Nurses who teach EBP>nurses with no experience on implementation scores (p<.001) ○ Nurses who teach EBP>nurses with some continuing education on implementation scores (p<.001) ○ Nurses who teach EBP>nurses with some formal coursework on implementation scores (p=.001) ○ Nurses with some formal coursework>nurses with no experience on implementation scores (p<.01) ○ Nurses with some formal coursework>nurses with no some continuing education on implementation scores (p<.01)
	J. Y. Sim, K. S. Jang, N. Y. Kim (2016) [111]	South Korea RNs	√						Not reported	Not reported	Not reported	#♦ t-test EBP educational intervention • Experimental group participation in EBP education program had better EBP implementation compare with control group (t = 3.54, p = .001) ANOVA repeated measures • Effect of educational program on experimental group for EBP implementation maintained despite slight decrease (F = 4.68, p = .006) ○ Experimental group post-test 1 (after 1 week) (M=2.35; SD=0.74) ○ Experimental group post-test 2 (after 4 weeks) (M=2.25; SD=0.85)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												○ Experimental group post-test 3 (after 8 weeks) (M=2.04; SD=0.76)
	S. C. Kim, J. F. Stichler, L. Ecoff, C. E. Brown, A. M. Gallo, J. E. Davidson (2016) [131] S. C. Kim, L. Ecoff, C. E. Brown, A. M. Gallo, J. F. Stichler, J. E. Davidson (2017) [130]	United States RNs, APNs	√						Not reported	Not reported	Not reported	+#* Correlation • EBP beliefs (r=0.47; p<.001) • Job satisfaction (r=0.17; p=.029) • Mentors (r=0.43; p<.001) • Baccalaureate (r=-0.37; p<.001) • Master's (r=0.38; p<.001) • Years of RN experience (r=.16; p<.05) • Clinical nurse (r=-0.28); p<.001) • CNS/nurse educator/NP (r=0.32; p<.001) t-test • Higher scores of EBP implementation for mentors (M=24.2; SD=16.8) versus fellows (M=11.0; SD=10.6) p<.001 • Statistically significant difference between pre-test (M=15.0; SD=12.7) and post-test (M=24.8; SD=13.7) scores p<.001 Regression analyses Step 1: Independent variables: constant demographic variables R^2=0.225, p<.001 Step 2: independent variables: demographics variables, being a mentor (β=0.27, p<.05), and EBP beliefs (β=0.33, p<.001) R^2 Δ=0.075, p<.001
	B. Skela-Savic, K. Pesjak, B. Lobe (2016) [141] B. Skela-Savic, S. Hvalic-Touzery, K. Pesjak (2017) [140]	Slovenia RNs, Other	√						Not reported	Not reported	+ • Two factors explained 68.43% of the total variance with KMO = 0.961 and Barlett P < 0.001. • First factor termed 'Advanced forms of EBP implementation' (64.20%, α = 0.963) • Second factor termed 'Initial forms of EBP implementation' (4.24%, α = 0.92). Factor loadings for factor #1 -0.016-0.996; factor loadings for #2 (-0.070-0.927)	+* Correlations Skela-Savic et al., 2017 *Advanced forms subscale* Significant at p<.05 • Age in years (r=0.094) Significant at p<.01 • Knowledge of research (r=0.326) • Knowledge of EBP (r=0.331) • Job satisfaction (r=0.115)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Initial forms subscale Significant at p<.01 • Age in years (r=0.132) • Length of employment (r=0.114) • Knowledge of research (r=0.291) • Knowledge of EBP (r=0.292) • Job satisfaction (r=0.121) <u>Skela-Savic et al. 2016</u> • Positive beliefs on EBP (EBP beliefs subscale) correlated positively with EBP implementation (r=0.486; p=0.000) • EBP implementation correlated negatively with aversion to EBP (EBP beliefs subscale) (r=-0.361; p=0.000) • Knowledge of research (r=0.347, p<.01) • Knowledge o EBP (r=0.328, p<.01) • Job satisfaction (r=0.182, p<.01) <u>Regression analyses</u> <u>Skela-Savic et al., 2017</u> Dependent variable: Advanced forms of EBP implementation R^2=0.233; p<0.05 Independent variables: Demographic and other respondent characteristics Significant coefficients: • Perceived knowledge of EBP (β=0.148; p=0.028 Dependent variable: Initial forms of EBP implementation R^2=0.200; p<0.05 Independent variables: Demographic and other respondent characteristics Significant coefficients: • Knowledge of research (β=0.161; p<.001 <u>Skela-Savic et al. 2016</u> Dependent variable: EBP implementation R^2=0.205 Independent variables: Demographic and other respondent characteristics Significant coefficients: Perceived knowledge of research (β=0.206; p=0.013) Perceived knowledge of EBP (β=0.166; p=0.039) Perceived job satisfaction (β=0.154; p=0.008)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	J. I. Warren, M. McLaughlin, J. Bardsley, J. Eich, C. A. Esche, L. Kropkowski, S. Risch (2016) [149]	United States RNs	√						Not reported	Not reported	Not reported	♦ ANOVA • Statistically significant difference between Magnet (M=14.88; SD=13.77) and non-Magnet RNs (M=15.36; SD=14.99) F(1, 1,606) = 145.99, p < .001 • Statistically significant different between ages F(3, 756) = 3.88, p = .009 • Post hoc analyses ○ 22-29 years old: (M=12.86; SD=11.14) p<.05 ○ 30-44 years old: (M=16.01; SD=15.21) ○ 45-55 years old: (M=15.17; SD=14.82) ○ 55 and older(M=15.63; SD=15.61) • Significant difference based on years employed as RNs F(4, 505) = 5.12, p < .001. • Significant difference based on education ○ Associated degree: (M=11.93; SD=12.25) ○ Diploma: (M=13.66; SD=15.74) ○ Baccalaureate: (M=14.66; SD=13.76) ○ Master's: (M=22.18; SD=17.36), p<.001 ○ Doctorate: (M=22.22; SD=18), p<.001 • Certified nurses' (M=19.27; SD=16.42; p<.001) EBP implementation were significantly more favourable than nurses with no certification (M=12.78; SD=12.84) • Nursing role F(2, 392) = 29.95, p < .001 ○ Nurses in leadership roles had more EBP implementation compared to clinical nurses F(2, 392) = 29.95, p < .001 ○ Clinical RNs (M=13.06; SD=13.16) mean scores were statistically significantly lower when compared to nurse leaders (M=20.26; SD=15.94) and nurses in support roles (M=19.13; SD=16.5)
	J. I. Warren, K. L. Montgomery, E. Friedmann (2016) [150]	United States RNs	√						Not reported	Not reported	Not reported	♦ ANOVA • EBP implementation differed significantly according to roles (F[1,590] = 48.711, p < .001), but did not differ significantly (F[1,632] = 1.562, p = .212) between the 2 years. Nurse leader EBP implementation scores (2008: M = 21.35, SEM = 1.72; 2012: M = 19.08; SEM = 1.43) were higher than those of clinical RNs (2008: M = 10.38, SEM = .92; 2012: M = 12.12, SEM = .87). The difference between the roles did not depend on year (F[1,590] = 2.439, p = .119).

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Kang Younhee, Yang In-Suk (2016) [128]	Korea Licensure group not specified	√						Not reported	Not reported	Original findings reported	+# ♦ * t-test Higher EBP implementation scores for those with: • Research participation (t=2.409, p=.016) • Positive intention about future research participation (t=2.568, p=.011) • Regularly read research articles (t=4.611, p<.001) ANOVA Higher EBP implementation scores for those with: • High degree of understanding evidence-based nursing practice (F=7.736, p=.001) Correlation • EBP beliefs and EBP implementation (r=.287, p<.001) • Barriers to research utilization – communication (r=-.100, p=.049) Regression analyses • Overall model significantly explained 17.1% of variance in EBNP implementation (F = 5.560, p< .001) Significant coefficients • Regularly read research articles (β=.110, p=.033) • Degree of understanding EBP (β=.113, p=.042) • EBP beliefs (β=.159, p=.004)
	Leonie Rose Bovino, Anne Aquila, Richard Feinn (2016) [120] L. Rose Bovino, A. M. Aquila, S. Bartos, T. McCurry, C. E. Cunningham, T. Lane, N. Rogucki, J. DosSantos, D. Moody, K. Mealia-Ospina, J. Pust-Marcone, J. Quiles (2017) [139]	United States RNs	√						Not reported	Not reported	Not reported	+# Correlation • EBP beliefs (r=.35, p<.001) • Age (r=-.113, p=.045) t-test • Nurses with a baccalaureate or postgraduate degree had higher mean implementation scores (38.2 vs. 31.3; p <.001) than nurses with only an associate degree or a diploma • Bedside nurses had lower mean implementation (32.4 vs. 41.3; p< .001) scores than non-bedside nurses • Nurses who had national certifications had significantly higher implementation scores than those who did not (37.2 vs. 33.1; p = .03).

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Michelle Baxley (2016) [119]	US RNs, LPNs/RPNs			√				Not reported	Not reported	Reported findings for original measure.	+♦* Correlation • EBP beliefs (r=.577, p=.0005) ANOVA • Significant difference between groups for prior EBP training F (1, 57) = 11.18, p=.001) ○ Yes (M=11.50, SD=11.21) ○ No (M=3.47, SD=3.09) • Significant difference between groups for education level F (1, 57) = 5.08, p=.028) ○ LPN, Diploma, & Associate's Degree Nurses (M=6.24; SD=6.93) ○ Bachelor's & Master's Degree Nurses (M=11.95; SD=12.60) Regression analyses Dependent variable: EPB implementation Independent variables: EBP beliefs, EBP training, education level • Significant regression equation, using the three predictors was computed (F (3, 55) = 9.38, p < .0005), with an R^2 of .339. • Significant coefficient: EBP beliefs (β=.651, p=.0005)
	H. Verloo, M. Desmedt, D. Morin (2017) [147]	Switzerland RNs	√						Not reported	Not reported	Not reported	* Regression analyses 13% of the variance in the EBP-I score was explained by the EBP-B score (R^2 = 0.130; P < 0.001)
	M. G. Harper, L. Gallagher-Ford, J. I. Warren, M. Troseth, L. T. Sinnott, B. K. Thomas (2017) [126]	United States RNs	√						Original findings reported	Not reported	Not reported	♦ • Statistically significant difference between organizations with EBP council (M=43.2; SD=16.8) and without EBP (M=38.5; SD=14.6) council status on EBP implementation scores (Cohen's d=0.3, p=.02)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	M. A. Friesen, J. M. Brady, R. Milligan, P. Christensen (2017) [125]	United States RNs	√						Not reported	Not reported	Not reported	# • Change in implementation was significant between preintervention (M=32.9; SD=12.5) and postintervention (M=36.9; SD=17.39) following EBP education mentoring program (t = 1.75, df = 56, p < .05)
	Kim Son Chae, Jaynelle F. Stichler, Laurie Ecoff, Ana-Mari Gallo, Judy E. Davidson (2017) [142]	United States RNs	√						Not reported	Not reported	Not reported	# • Six months after fellowship program completion, statistically significant improvements in EBP implementation (M_{diff}=3.4, p=.013)
	R. Lovelace, M. Noonen, J. F. Bena, A. S. Tang, M. Angie, R. Cwynar, R. Field, J. Rosenberger, D. Ross, D. Walker, N. M. Albert (2017) [102]	United States RNs LPNs/RPNs	√	√					Original findings reported	Not reported	Not reported	+♦ <u>Correlation</u> • Number of educational modules viewed positively associated with higher EBP implementation (rho=0.24, p<.001) • Nurses with less time since receiving their highest college degree positive associated with EBP implementation (rho=0.23, p<.001) <u>ANOVA</u> (significant at p<.001) Factors associated with higher EBP implementation: • Higher education • Certification • More than one certification • Project leader • Past EBP exposure • Registered nurse-led quality project • Registered nurse-led research • Principal investigator
	Lai Ping Atalanta Wan (2017) [115]	United States RNs	√						Not reported	Not reported	Original findings reported	# • Following EBP education intervention, nurses in experimental group had significantly higher EBP implementation scores (p=.025)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Irene Macyk (2017) [134]	United States RNs	√						Not reported	Not reported	Not reported	+*# Correlation • EBP belief (r=0.487; p<0.01) • Staff nurse engagement (r=0.394; p<0.01) • Actual decisional involvement (r=0.312, p<0.01) t-test • Nurses who were members of a shared governance council had higher EBP implementation scores (M=1.07; SD=0.83) than those who were not members (M=0.55; SD=0.66) (t(l27) = 3.96, p<0.001) Cohen's d=0.69 Regression analyses Dependent variables: EBP implementation Independent variables: EBP beliefs, staff nurse engagement, shared governance council membership • overall model was statistically significant (F(3,128) = 21.9, p < 0.001) and the R^2 was 0.345 and adjusted R^2 was 0.329 Significant coefficients: • EBP beliefs (β=0.398, p<0.001) • staff nurse engagement (β=0.241, p<0.01) • shared governance council membership (β=0.168, p<0.05)
	Temple et al. (2014) [145]	Canada Licensure group not specified						√	Not reported	Not reported	Not reported	Prior experience with research and having taken a short course on EBP were found to have the strongest relationship in use of evidence in practice in the practicing nurses. *no data provided in conference abstract
EBP-Beliefs Scale (EBPB) (n=42 studies)	N. A. Estrada (2007) [124] N. Estrada (2009) [123]	United States RNs	√						Not reported	Not reported	+ Exploratory factor analysis with varimax rotation performed and identified adequate loading for four factors: (1) knowledge beliefs (2) value beliefs (3) resource beliefs (4) time and difficulty beliefs.	* Regression analyses Significant coefficients - independent variables of learning organization: **Knowledge:** F=4.71, p≤.01, R^2=0.06 • None **Values:** F=9.26, p≤.01, R^2=0.11 • Connect organization to its environment (β=0.22, p≤.01) **Resources:** F=12.04, p≤.01, R^2=0.14 • None **Time/difficulty:** (not significant) • Connect organization to its environment (β=0.22, p≤.01) Regression Analyses for different organizational types:

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Independent variables: learning organization items Dependent variables: Subscales of EBP-Beliefs scale • Magnet designated ○ Knowledge beliefs ▪ R^2=.17, p=.01 ○ Values beliefs ▪ R^2=.19, p=.01 ○ Resources beliefs ▪ R^2=.12, p=.01 ○ Difficulty/time beliefs ▪ R^2=.12, p=.01 • Non-magnet designated ○ Values beliefs ▪ R^2=.09, p=.01 ○ Resources beliefs ▪ R^2=.13, p=.01 • VA hospital ○ Knowledge beliefs ▪ R^2=.16, p=.01 ○ Values beliefs ▪ R^2=.12, p=.01 ○ Resources beliefs ▪ R^2=.29, p=.01
	B. M. Melnyk, E. Fineout-Overholt, M. Z. Mays (2008) [46]	United States Licensure group not specified						√	Assessed in convenience samples of staff nurses (n=15) and EBP experts (n=8).	Not reported	+ Exploratory Principal Components Analysis: First factor had an eigenvalue of 6.44 and accounted for 40% of the variance in the scale. Three other factors had eigenvalues > 1.0 (1.8, 1.3, and 1.1, respectively). They accounted for 11%, 8%, and 7% of the variance in the scale, respectively. Single-factor solution was most appropriate interpretation.	+ <u>ANOVA:</u> • Education: Significant increase in EBP beliefs with level of education, F(4, 344) = 7.03, p < .001 ○ Associate degree lowest score (M=49.70, SD=19.95) ○ Doctoral degree highest score (M=64.06, SD=9.14) • Nursing roles: Significant increase in EBP beliefs from staff nurses to educator/faculty F(3, 233) = 9.34, p < .001 ○ Staff nurse lowest score (M=48.72, SD=21.63) ○ Educator/faculty highest score (M=61.50, SD=8.51) • Age: Significant increase in EBP beliefs with age: F(4, 337) = 5.60, p < .001 ○ 21 to 30 years lowest score (M=48.35, SD=23.87) ○ 61 to 70 years highest score (M=59.75, SD=4.74)
	G. Varnell, B. Haas, G. Duke, K. Hudson (2008) [146]	United States Licensure group not specified	√						Not reported	Not reported	Not reported	+# <u>Correlations:</u> • Awareness of EBP (learned in nursing school, continuing education, don't know about EBP) associated with higher pre-test scores of EBP beliefs (r_s=0.32, p<0.05) <u>Paired t-test:</u>

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• After EBP champion intervention significant differences found between EBP belief pre-test (M=57.10, SD=5.73) and post-test (M=63.73, SD=4.5) scores (p<0.01)
	K. G. Mariano, L. M. Caley, L. Eschberger, A. Woloszyn, P. Volker, M. S. Leonard, Y. Tung [135]	United States RNs	√						Not reported	Not reported	Not reported	* <u>Regression analyses:</u> Significant coefficients for independent variables of demographics • Age (β=-0.28, p=0.028) • Years of experience (β=0.37, p=0.006)
	B. M. Melnyk, T. Bullock, J. McGrath, D. Jacobson, S. Kelly, L. Baba (2010) [136]	United States RNs	√						Original findings reported	Not reported	Original findings reported	No supporting validity evidence
	R. F. Levin, E. Fineout-Overholt, B. M. Melnyk, M. Barnes, M. J. Vetter (2011) [132]	United States RNs				√			Not reported	Not reported	Original findings reported	♦ Intervention: Advancing Research and Clinical practice (ARCC) model intervention • Significant improvement in ARCC nurses' EBP beliefs at times 3 and 4, compared with control group. Main effect for group (F1,15 = 33.105, p < .001), a quadratic main effect of time (F1,15 = 7.335, p = .016), and a significant interaction between group and time (F3,45 = 16.342, p = .001).
	D. Hagler, M. Z. Mays, S. B. Stillwell, B. Kastenbaum, R. Brooks, E. Fineout-Overholt, K. M. Williamson, J. Jirsak [156]	United States Licensure group not specified	√						Not reported	Not reported	Not reported	# Intervention EBP workshop • Following intervention, significant improvement from pre-test (M=59.0, SD=8.4) and post-test (M=66.4, SD=6.8) EBP belief scores, t(146)=12.61, p<0.001
	B. M. Melnyk, E. Fineout-Overholt, L. Gallagher-Ford, L. Kaplan (2012) [137]	United States Licensure group not specified	√	√				√	Content validity supported by 3 EBP experts.	Not reported	Not reported	+ EBP beliefs item: I am clear about the steps in EBP: • Significantly more Master's degree nurses than non-Master's degree nurses indicated they were clear about the steps in EBP (p<0.001) • Levels of education were positively correlated with being clear about the steps in EBP (r = 0.26; p<0.01)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	H. S. Thorsteinsson (2012) [158] H. S. Thorsteinsson (2013) [159]	Iceland RNs	√						Translated and reviewed by certified translator and bilingual healthcare professional and Master's prepared nurses familiar with EBP. Minor modification on wording and order.	Pilot tested with 12 nurses from university and community hospitals for clarity, acceptability, relevance.	+ <u>Principle component analysis</u> Four factors identified: • Factor #1: Eigenvalue 5.33 (33.3% variance) • Factor #2 (Eigenvalue 1.8) • Factor#3 (Eigenvalue 1.4) • Factor #4 (Eigenvalue 1.1) High factor loadings on first factor indicate unidimensionality.	#♦ Strength of EBP beliefs significantly increased: • With more familiarity of EBP term; F(5, 468) = 44.62, p < 0.001. ○ Participants very familiar with EBP term scored highest (M = 64.96, SD = 6.71), whereas those not at all familiar with EBP scored lowest (M = 54.29, SD = 7.22). • With increased participation (frequency) in EBP-related activities ○ Identified researchable problems F(3, 459) = 25.48, p≤0.001 ○ Evaluated research reports F(3, 455) = 42.56, p≤0.001 ○ Participated in research F(3, 465) = 11.60, p≤0.001 ○ Used research in practice F(3, 455) = 44.28, p≤0.001 • Based on work setting: ○ University hospital nurses scores were higher (M=59.29, SD = 7.29) compared with nurses who worked elsewhere (M=56.85; SD = 6.97; p < 0.001) • Nursing role ○ Cinical RNs scores were 57.59 (SD = 6.91) compared with (M=59.51; SD = 7.59) for administrators or educators (p = 0.012)
	S. C. Wang, L. L. Lee, W. H. Wang, H. C. Sung, H. K. Chang, M. Y. Hsu, S. C. Chang, C. H. Tai (2012) [148]	Taiwan RNs	√						Back translation to ensure conceptual equivalence of each item. If unsure about content, physician was consulted and discussions took place until consensus reached.	Piloted with an EBP medical centre group (n=9), nursing (n=12) and social work students (n=5) to ensure linguistic appropriateness and utility.	* The NFI (Normed Fit Index) was above 0.70, and the RMSEA (Root Mean Square Error of Approximation) was less than 0.15.	♦# EBP beliefs scores increased with: • Education (F=4.58, p<0.011) ○ Associate (M=3.19) ○ Bachelor (M=3.28) ○ Master or higher (M=3.61) • Greater EBP implementation (p<0.001) ○ Implement EBP >1 in previous 8 weeks (M=3.33) ○ Implement EBP<1 in previous 8 weeks (M=3.06) • Nursing role (p≤0.001) ○ Experienced nurse researchers (M=3.92) ○ Clinical nurses (M=3.24)
	Steve Mooney (2012) [83]	United States RNs	√						Not reported	Not reported	Not reported	# Significant difference between pre-test and post-test EBP belief scores after EBP educational intervention (p=0.000) • Pre-test (M=53.8; SD=5.53) • Post-test (56.4; SD=4.62)
	Lynn Gallagher-Ford (2012) [55]	United States RNs	√						Original findings reported	Original findings reported	Original findings reported	+♦# <u>ANOVA</u> Significant EBP belief differences: • Nurse groups (F = 6.72, p = .001):

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												○ Staff nurses (M=58.3) ○ Educators (M=64.4) ○ Leaders (M=61.0) *Post-hoc analysis ○ Significant difference between staff nurses and educators (p=.003) • Education (F = 7.48, p < .001) ○ Doctorate degrees (M=68.0) ○ Master's degree (M=66.9) ○ Bachelor's degree (M=59.4) ○ Associate degree (M=57.7) ○ Diploma degree (M=57.0) Correlations • EBP Implementation ○ Staff nurses (r=0.42, p=.001) ○ Educators (r=0.54, p=.001) ○ Leaders (r=0.49, p<.001) T-test • Certification (p=.009) ○ Certified nurses (M=62) ○ Non-certified (M=58)
	Susan Hall Lynch (2012) [133]	United States RNs	√						Original findings reported	Not reported	Original findings reported	+♦ Correlations • Age (r=-.120, p=.044) • EBP implementation (r=.334, p=.0001) ANOVA • Higher education levels (F=2.829, p=.025)
	Yvette M. Pryse (2012) [138]	United States RNs	√						Original findings reported	Original findings reported	Not reported	Established +#♦ ANOVA • Significant difference found among education levels (ASN, BSN, or MSN/NP/DNS/PhD) F(2,418) = 3.042, p = .049 T-test • Significant difference found among Magnet (M=60.47; SD=7.48) and non-Magnet nurses (M=57.98; SD=8.51); t (419) = 3.183, p =.002 Correlation • Perceptions of nursing leadership support (r=.430, p<.000) • Perceptions of work environment (r=.486, p<.000)
	M. J. Dropkin (2013) [121]	United States Licensure group not specified	√					√	Not reported	Not reported	Not reported	No supporting validity evidence

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	S. Hauck, R. P. Winsett, J. Kuric (2013) [127]	United States RNs	√						Not reported	Not reported	Not reported	♦ Intervention: facilitating strategies for evidence-based practice enculturation • Significant difference between baseline (M=3.67; SD=0.58) and final (M=3.94; SD=0.58) EBP belief scores F(1,899)=52.2, p<0.001 • Significant main effect of time, F (1, 881) = 21.4, p < 0.001 and job role, F (2, 881) = 51.0, p < 0.001 with moderate effect size (partial eta squared = 0.104 on EBP beliefs
	Dawna L. Cato (2013) [155]	United States RNs	√						Not reported	Not reported	Original findings reported	No supporting validity evidence
	K. Stokke, N. R. Olsen, B. Espehaug, M. W. Nortvedt (2014) [143]	Norway RNs	√						Not reported	Not reported	Not reported	+* <u>Correlation</u> • Overall EBP beliefs score and EBP implementation (r = 0.59, p = 0.001) • EBP implementation and EBP beliefs subscales (significant at p≤0.001): ○ Knowledge attitudes (r=0.38) ○ Resource attitudes (r=0.29) ○ Value of EBP (r=0.29) ○ Difficulty and time (r=0.25) <u>Regression analyses</u> Significant coefficients • RN Bachelor's degree (β=-0.31, p=0.04) • Learned about EBP (β=0.15, p=0.04) • Participation in EBP working group (β=0.15, p=0.05)
	L. Kaplan, E. Zeller, D. Damitio, S. Culbert, K. B. Bayley (2014) [129]	United States RNs, APNs, LPNs/RPNs						√	Not reported	Not reported	Original findings reported	+ <u>Correlation</u> • Organizational culture and readiness (r = .623, p<.001 • EBP implementation (r = .316, p<.001)
	H. S. Thorsteinsson, H. Sveinsdottir (2014) [160]	Iceland RNs	√						Not reported	Not reported	Not reported	* <u>Regression analyses</u> F (8,283) = 23.919, p < 0.001, R^2=0.384 Significant coefficients • EBP skills (β=0.280, p<0.001) • EBP discussions at work (β=0.291, p<0.001) • Familiarity with EBP (β=0.145, p=0.037)
	Natasha Laibhen-Parkes (2014) [45]	United States RNs	√						Not reported	Not reported	Not reported	♦ Web-based EBP education module • Significant difference in post-intervention EBP belief scores between control (M=54.6; SD=5.1)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												and education intervention group (M=60.1; SD=5.1) F=6.44; p=0.005
	L. H. Eaton, A. R. Meins, P. H. Mitchell, J. Voss, A. Z. Doorenbos [122]	United States RNs	√						Not reported	Not reported	Not reported	+ Correlation • Innovativeness (r=0.48, p=0.002) • EBP implementation (r=0.36, p=0.02)
	M. Underhill, K. Roper, M. L. Siefert, J. Boucher, D. Berry (2015) [84]	United States RNs, APNs	√						Not reported	Not reported	Not reported	+# Correlation • Level of nursing education (r = .25; p = .03) Mann-Whitney U Test • Formal EBP education – yes/no (U=525.0; p<.01) • Nursing role -direct care/nurse leader (U=554.5, p=.03)
	Debra Hain, Mary Haras (2015) [161]	United States RNs, APNs						√	Not reported	Not reported	Original findings reported	# EBP educational pre-conference intervention t-test Significant difference between pre- and post- EBP belief scores for: • Combined session #1 and #2: Pre- (M=3.52, SD=0.44) and Post- (M=4.02, SD=0.43); t(51)=8.60, p=0.000 • RN: Pre- (M=3.50, SD=0.45) and Post- (M=3.99, SD=0.42); t(46)=7.92, p=0.000 • APN: Pre- (M=3.71, SD=0.27) and Post- (M=4.29, SD=0.45); t(4)=3.31, p=0.030 • ADN/Diploma: Pre- (M=3.39, SD=0.46) and Post- (M=3.89, SD=0.39); t(12)=7.76, p=0.000 • BSN: Pre- (M=3.48, SD=0.46) and Post- (M=4.02, SD=0.43); t(22)=6.03, p=0.000 • MSN: Pre- (M=3.65, SD=0.33) and Post- (M=4.03, SD=0.42); t(13)=2.69, p=0.018
	Carolyn Sweetapple (2015) [144]	United States RNs	√						Not reported	Not reported	Not reported	+♦ ANOVA • Significant differences based on education levels F(3, 373)=3.276, p<.05 ○ Associate degree/diploma: (M=59.2) ○ Bachelor's: (M=61.3) ○ Master's: (M=63.0) ○ Doctorate: (M=64.9) *Bonferroni adjustment: Master's prepared nurses > beliefs vs. associate degree/diploma nurse (p<.05) • Significant differences based on EBP experience F(3,382)=11.428, p<.001 ○ No experience (M=57.4)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												○ Some continuing education (M=60.8) ○ Formal coursework in EBP (M=63.4) ○ Teaching EBP (M=69.8) *Bonferroni adjustment: Significant differences: • Nurses who teach EBP > beliefs than nurses with no experience (p<.001) and nurses with some continuing education (p<.01) • Nurses with formal coursework > beliefs than those with no experience (p<.001) and those with some continuing education (p<.05) <u>Correlation</u> • EBP Implementation (r=.391, p<.001)
	J. Y. Sim, K. S. Jang, N. Y. Kim (2016) [111]	South Korea RNs	√						Not reported	Not reported	Not reported	# EBP education intervention • Significant difference in post-test belief scores between experimental (M=3.76; SD=0.41) and control group (M=3.32, SD=0.53), t=3.61, p=.001
	S. C. Kim, J. F. Stichler, L. Ecoff, C. E. Brown, A. M. Gallo, J. E. Davidson (2016) [131] S. C. Kim, L. Ecoff, C. E. Brown, A. M. Gallo, J. F. Stichler, J. E. Davidson (2017) [130]	United States RNs, APNs	√						Not reported	Not reported	Not reported	+# Regional EBP fellowship program intervention <u>t-tests</u> • Significant difference between pretest (M=61.7; SD=7.12) and posttest (M=67.3; SD=6.01) scores (p<.001) • Role (p<.001) ○ Mentor (M=66.6; SD=6.91) ○ Fellows (M=59.3; SD=6.38) <u>Correlation</u> • Job satisfaction (r=.27; p=.003) • Mentor role (r=0.48; p<.001) • Diploma/associate (r=-0.19; p<.05) • Baccalaureate (r=-0.43; p<.001) • Master/doctorate (r=0.51; p<.001) • Clinical nurse (r=-0.33; p<.001) • CNS/nurse educator/NP (r=0.34; p<.001) • EBP implementation (r=0.47; p<.001)
	B. Skela-Savic, K. Pesjak, B. Lobe (2016) [141] B. Skela-Savic, S. Hvalic-Touzery, K. Pesjak (2017) [140]	Slovenia RNs "Other"	√						Not reported	Not reported	+ Skela-Savic et al. (2016) Yielded three factors explaining 57.88% of total variance: 1. Factor #1: Positive beliefs on EBP (44.36%) 2. Factor #2: Aversion to EBP (8.57%) 3. Factor #3 (4.93%) Skela-Savic et al. (2017) Yielded three factors explaining 58.29% of total variance:	+* Skela-Savic et al. (2016) <u>Correlations</u> Factor #1: Positive beliefs on EBP • EBP implementation (r=0.486, p=0.000) • Factor #2 Aversion to EBP (r=-0.361, p=0.000) • Length of employment (r=0.120, p=0<.05) • Knowledge of research (r=0.452, p<0.01) • Knowledge of EBP (r=0.448, p<0.01) • Job satisfaction (r=0.314, p<0.01) Factor #2 Aversion to EBP • EBP implementation (r=-0.361, p=0.000)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
											1. Factor #1: Knowledge and Skills on EBP (45.21%) 2. Factor #2: Effects of EBP on clinical practice (8.67%) 3. Factor #3 (4.41%)	• Age (r=--0.176, p<0.01) • Length of employment (r=-0.166, p=0<0.01) • Knowledge of research (r=-0.286, p<0.01) • Knowledge of EBP (r=-0.417, p<0.01) • Job satisfaction (r=-0.234, p<0.01) <u>Regression analyses</u> Dependent variable Factor #1: Positive beliefs on EBP, R^2=0.311 Significant coefficients • Perceived knowledge of research (β=0.240; p=0.007) • Perceived job satisfaction (β=0.236; p=0.000) • Length of nursing employment (β=0.159; p=0.008) Dependent variable Factor #2: Aversion to EBP, R^2=0.222 Significant coefficients • Perceived knowledge of research (β=-0.333; p=0.000) • Training and education in EBP in nursing (β=0.191; p=0.022) Skela-Savic et al. (2017) <u>Correlations</u> Factor #1 Knowledge and Skills on EBP: Significant at p<.05 • Educational achievement (r=0.103) Significant at p<.01 • Age (r=0.124) • Length of employment (r=0.122) • Knowledge of research (r=0.464) • Knowledge of EBP (r=0.477) • Job satisfaction (r=0.256) Factor #2 Effects of EBP on clinical practice Significant at p<.01 • Training and education in research (r=0.213) • Training and education in EBP (r=0.291) <u>Regression analyses</u> Dependent variable: Factor #2 Effects of EBP on clinical practice; R^2=0.289, p<.05 *Demographic and respondent characteristics* Significant coefficients: • Training and education in EBP (β=0.165, p=.004)
	J. I. Warren, M. McLaughlin, J. Bardsley, J. Eich, C. A. Esche, L.	United States RNs	√						Not reported	Not reported	Not reported	♦ <u>ANOVA</u> • Age F(3, 750) = 4.37, p = .005 ○ 22-29 years (M=59.22; SD=8.33) p<.05 ○ 30-44 years (M=58.58; SD=8.55)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Kropkowski, S. Risch (2016) [149]											○ 45-54 years (M=57.18; SD=8.71) ○ 55 and older (M=57.28; SD=9.4) • Years employed as RN F(4, 513) = 5.20, p < .001 • Education *no F-statistic provided but states statistically significant difference ○ Diploma (M=55.23; SD=9.43) ○ Associate degree (M=56.21; SD=8.68) ○ Baccalaureate (M=58.02; SD=8.75) ○ Master's (M=61.64; SD=7.56) p<.001 ○ Doctorate (M=65.89; SD=8.62) p<.001 • Certification F(1, 1137) = 18.78, p < .001 ○ Certified (M=59.21; SD=8.73) p < .001 ○ Not certified (M=57.2; SD=8.7) • Nursing role F(2, 446) = 21.42, p < .001 ○ Leadership (M=60.71; SD=8.71) p < .001 ○ Support service RN (M=59.53; SD=8.18) p < .001 ○ Clinical RN (M=57.04; SD=8.8)
	J. I. Warren, K. L. Montgomery, E. Friedmann (2016) [150]	United States RNs	√						Not reported	Not reported	Not reported	♣ Linear mixed model • EBP beliefs depended on both year and nurses' roles (F[1,576] = 4.435, p = .036, interaction effect) • Nurse leader scores were significantly higher than clinical RN scores for both years, but the difference was greater in 2008 (nurse leader: M = 61.15, SEM = 1.23; clinical RN: M = 53.85, SEM = 0.65) than in 2012 (nurse leader: M = 60.60., SEM = 0.96; clinical RN: M = 57.07, SEM = 0.58)
	Kang Younhee, Yang In-Suk (2016) [128]	Korea Licensure group not specified	√						Not reported	Not reported	Not reported	+ • EBP beliefs and EBP implementation were significantly positively correlated (r = .287, p<.001)
	Leonie Rose Bovino, Anne Aquila, Richard Feinn (2016) [120] L. Rose Bovino, A. M. Aquila, S. Bartos, T. McCurry, C. E. Cunningham, T. Lane, N. Rogucki, J. DosSantos, D. Moody, K. Mealia-Ospina,	United States RNs	√						Not reported	Not reported	Not reported	+# t-test • Direct care nurses had significantly lower beliefs scores than non-direct care nurses (60.1 vs. 65.7; p<.001) • Nurses with a baccalaureate or postgraduate degree had higher beliefs scores than did those with an associate degree or a diploma (63.6 vs. 59.2; p<.001 Correlation • Beliefs correlated positively with implementation (r = .35, p < .001)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	J. Pust-Marcone, J. Quiles (2017) [139]											
	Michelle Baxley (2016) [119]	United States RNs, LPNs/RPNs			√				Not reported	Not reported	Original findings reported	+ Correlation • EBP implementation (n = 59, r = .57, p = .0005)
	Sherri L. Smith-Keys (2016) [157]	United States RNs	√						Not reported	Not reported	Not reported	No supporting validity evidence
	R. Lovelace, M. Noonen, J. F. Bena, A. S. Tang, M. Angie, R. Cwynar, R. Field, J. Rosenberger, D. Ross, D. Walker, N. M. Albert (2017) [102]	United States RNs, LPNs/RPNs	√						Original findings reported	Not reported	Not reported	+♦ Correlation • Number of educational models viewed: (rho=0.12, p<.001) • Nurses with less time since receiving their highest college degree were more likely to have positive beliefs about the value of EBP (rho = 0.20; p < .001) ANOVA *No F-statistic, means or SD reported Significant at p<.001 • Higher education • Certification • Project leader • Past exposure EBP • RN nurse-led quality project • Principal investigator • Literature review completed Significant at p=.042 • Higher clinical ladder level
	H. Verloo, M. Desmedt, D. Morin (2017) [147]	Switzerland RNs	√						Not reported	Not reported	Not reported	* • 13% of the variance in the EBP-I score was explained by the EBP-B score (R^2 = 0.130; P < 0.001)
	M. G. Harper, L. Gallagher-Ford, J. I. Warren, M. Troseth, L. T. Sinnott, B. K. Thomas (2017) [126]	United States RNs	√						Original findings reported	Not reported	Not reported	+ • Organizations with EBP councils had statistically significant higher levels of EBP beliefs (p = .03)
	M. A. Friesen, J. M. Brady, R.	United States RNs	√						Not reported	Not reported	Not reported	No supporting validity evidence

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Milligan, P. Christensen (2017) [125]											
	Kim Son Chae, Jaynelle F. Stichler, Laurie Ecoff, Ana-Mari Gallo, Judy E. Davidson (2017) [142]	United States RNs	√						Not reported	Not reported	Not reported	+#* t-test Fellowship program intervention • Statistically significant improvements in EBP beliefs 6-months post-intervention (mean difference=6.6; p<.001 Correlation • EBP adoption at 6 months post-intervention (r = 0.35, p = .001) Regression • EBP beliefs emerged as a positive predictor of EBP adoption (OR=1.12; 95% confidence interval, 1.02-1.22; p = .017)
	Lai Ping Atalanta Wan (2017) [115]	United States RNs	√						Not reported	Not reported	Original findings reported	# EBP educational intervention • Significant increase between pre-test and post-test scores in experimental group (p=.046)
	Irene Macyk (2017) [134]	United States RNs	√						Not reported	Not reported	Not reported	+* Correlation • Actual decisional involvement (r=0.260; p<0.01) • EBP implementation (r=0.487; p<0.01) • Staff nurse engagement (r=0.235; p<0.05) Regression analyses Dependent variable: EBP Implementation Independent variables: EBP beliefs, nurse engagement, shared governance council participation ($F(3,128) = 21.9$, $p < 0.001$), $R^2=0.345$ • EBP beliefs predicative factor (β=0.398; p<0.001)
	Temple et al. (2014) [145]	Canada Licensure group not specified						√	Not reported	Not reported	Not reported	• Prior experience with research and having taken a short course on EBP were found to have the strongest relationship in a more positive belief about use of evidence. *no data provided in conference abstract
Evidence-Based Practice Questionnaire (EBPQ)	D. Upton, P. Upton (2006) [30]	Wales Does not specify licensure group	√						Initial pool of items generated from literature review and discussions with healthcare professionals	Piloted 3 times: initial pool with 33 senior healthcare professionals; after revisions draft piloted in two rounds with initial group of healthcare professionals in addition to a steering group of	Principal component factor analysis yielded three factors, each with an eigenvalue >1 (61.77% explained in total): 1) Practice of EBP (33.08%) 2) Attitude towards EBP (17.07%) 3) Knowledge/skills associated with EBP (11.63%) Each of the items of the subscales loaded onto separate factors. Items were considered as contributing to a subscale if they had a factor loading of at least 0.4 on that factor.	+# Correlation coefficients between subscale scores and awareness of EBP ranged from 0.3-0.4 (p<0.001) indicating positive but moderate relationship. Those with knowledge of local EBP initiative compared to those without knowledge had better attitude (t=2.5; d.f.=332; p<0.01), more frequent EBP practice (t=3.2; d.f.=360; p<0.02) and better EBP knowledge (t=5.2; d.f.=360; p<0.001)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
										experts in the field of health and social care policy		
	M. L. Koehn, K. Lehman (2008) [101]	United States RNs	√						Not reported	Not reported	Not reported	♦ Statistically significant differences found among four educational levels (diploma, ADN, BSN, MSN) on EBP practice, attitude, knowledge/skills subscale scores Wilk's Λ=0.93, F=3.16 (p=0.001) Use of EBP: • Diploma (M=4.98; SD=1.23) • ADN (M=5.01; SD=1.41) • Baccalaureate (M=4.92; SD=1.35) • Master's (M=5.65; SD=0.76) Knowledge/Skills of EBP: • Diploma (M=4.56; SD=0.95) • ADN (M=4.60; SD=1.00) • Baccalaureate (M=4.66; SD=1.01) • Master's (M=5.15; SD=0.68) Attitudes towards EBP: • Diploma (M=5.03; SD=1.06) • ADN (M=4.90; SD=1.12) • Baccalaureate (M=5.34; SD=1.08) • Master's (M=5.59; SD=0.86) ANOVA conducted as f/u to MANOVA. ANOVA on attitude scores was statistically significant, F(3, 403)=6.01, p=0.001. Post-hoc analyses determined BSN group had statistically significant higher attitude scores compared to ADN group (p<0.003).
	C. E. Brown, M. A. Wickline, L. Ecoff, D. Glaser (2009) [93]	United States Does not specify licensure group	√						Not reported	Not reported	Not reported	+ Correlation between "Characteristics of the Communication" (i.e., perceive research difficult to find and understand) subscale of BARRIERS scale and "Knowledge/Skill of EBP" subscale (r=-0.216, p<0.05). Correlation between "Characteristics of the Organization" subscale of BARRIERS scale and "Knowledge/Skills of EBP" subscale (r=-0.179, p=0.004).
	C. E. Brown, L. Ecoff, S. C. Kim, M. A. Wickline, B. Rose, K. Klimpel, D. Glaser (2010) [92]	United States RNs	√						Not reported	Not reported	Not reported	+* <u>Bivariate correlations with EBPQ subscales:</u> Significant (p≤0.05) **Practice of EBP:** • Nurse manager role (0.13) **Attitudes towards EBP:** • CNS Nurse Educator (0.10) • Organization BARRIERS subscale (-0.09)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• Innovation BARRIERS subscale (-0.08) **Knowledge/skills of EBP:** • years of RN experience (0.08) • Nurse manager (0.13) Significant (p≤0.01) **Practice of EBP:** • Age (0.10) • Years of RN experience (0.10) • Master's degree (0.11) • Staff nurse (-0.20) • Communication BARRIERS subscale (-0.13) **Attitudes towards EBP:** • Master's degree (0.11) • Staff nurse (-0.18) • Adopter BARRIERS subscale (-0.12) • Communication BARRIERS subscale (-0.15) **Knowledge/skills of EBP:** • Baccalaureate degree (-0.15) • Master's (0.20) • Doctoral (0.18) • Staff nurse (-0.19) • Adopter BARRIERS subscale (-0.16) • Organization BARRIERS subscale (-0.16) • Communication BARRIERS subscale (-0.20) <u>Regression analyses</u> Significant coefficients **Practice of EBP** Regression model; R^2=2.7%, p≤0.001) *Demographic variables* • Years of RN experience (β =0.07, p≤0.05) • Staff nurse (β=-0.09; p≤0.01) • Master's degree (β =0.07, p≤0.05) *BARRIERS subscales* • Adopter (β=-0.10; p≤0.05) • Innovation (β=0.14; p≤0.001) • Communication (β=-0.16; p≤0.001) **Attitude towards EBP** Regression model; R^2=2.4%, p≤0.001) *Demographic variables* • Staff nurse (β=-0.09; p≤0.05) • Master's degree (β =0.08, p≤0.05) *BARRIERS subscales* • Adopter (β=-0.12; p≤0.01) • Communication (β=-0.11; p≤0.001)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Knowledge/Skills associated with EBP Regression model; R^2=4.5%, p≤0.001) *Demographic variables* • Doctoral degree (β=-0.17; p≤0.001) • Master's degree (β =0.18, p≤0.001) *BARRIERS subscales* • Adopter (β=-0.12; p≤0.01) • Innovation (β=0.11; p≤0.01) • Communication (β=-0.15; p≤0.001) **Note for BARRIERS subscales:* **Adopter:** nurses' values and awareness of research **Organization:** nurses' perception about limitations/barriers at work **Innovation:** nurses' perception about quality of research **Communication:** nurses' perceptions about presentation and accessibility of research
	P. Prior, J. Wilkinson, S. Neville (2010) [107]	New Zealand RNs		√					Not reported	Not reported	Not reported	+ **Practice of EBP:** • Level of registration preparation (r_s=0.306; p=0.026) • Frequency of reading journals (r_s=0.303; p=0.028) • Length of time practicing as a registered nurse (r_s=-0.288; p=0.038) • Length of time practicing in primary health care (r_s=-0.312; p=0.024) **EBP Knowledge/Skills:** • Practice of EBP (r_s=0.744; p=0.00) • Attitudes towards EBP (r_s=0.532; p=0.000) • Length of time practicing in primary health care (r_s=-0.412; p=0.004) • Level of registration preparation (education) (r_s=0.528; p=0.000) • Tertiary qualification (post-registration) (r_s=0.351; p=0.016) **Attitudes Towards EBP:** • Practice of EBP (r_s=0.516; p=0.00)
	S. Gonzalez-Torrente, J. Pericas-Beltran, M. Bennasar-Veny, R. Adrover-Barcelo, J. M. Morales-	Spain Does not specify licensure group		√					Not reported	Not reported	Not reported	◆* <u>ANOVA; no test statistics reported</u> **EBPQ Total:** Group differences based on years of professional experience (p=0.018) • 0 to 2 years (M=127.3) • 2 to 10 years (M=115.6) • 10 to 20 years (M=112.5) • >20 years (M=110.3)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Asencio, J. De Pedro-Gomez (2012) [96]											**Knowledge/Skills of EBP:** Group differences based on years of professional experience (p=0.023) • 0 to 2 years (M=72.3) • 2 to 10 years (M=66.1) • 10 to 20 years (M=63.9) • >20 years (M=62.4) **Attitudes toward EBP:** Nurses with management functions > clinical nurses (p=0.008) <u>Regression analyses</u> Dependent variable: EBPQ Independent variables: Nurse work index, gender, professional category (e.g., management-supervision/coordination), years of practice Significant coefficients: Years of practice: (B=-0.733; p=0.004)
	M. J. Linton, M. A. Prasun (2013) [50]	United States Does not specify licensure group	√						Not reported	Not reported	Not reported	+ <u>Correlations (p<0.05)</u> Age and: • Ability to identify gaps in your professional practice (r=0.285) • Knowledge of how to retrieve evidence (r=0.203) • Ability to critically analyze evidence (r=0.236) • Ability to apply information to individual cases (r=0.307) • Evaluate outcomes of your practice (r=0.179) Education and: • Ability to identify gaps in your professional practice (r=0.377) • Knowledge of how to retrieve evidence (r=0.368) • Ability to critically analyze evidence (r=0.379) • Ability to apply information to individual cases (r=0.323) • Evaluate outcomes of your practice (r=0.257)
	White-Williams, P. Patrician, P. Fazeli, M. A. Degges, S. Graham, M. Andison, A. Shedlarski, L. Harris,McCaleb (2013) [116]	United States RNs	√						Not reported	Not reported	Not reported	+♦ <u>Correlations:</u> **EBPQ total:** • Education (r=0.23; p<0.01) • Certification (r=0.12; p<0.01) • Job title (r=0.18; p<0.01) • Attended any EBP research or PD workshops offered by Centre for Nursing Excellence (r=-0.16; p<0.01) *1=yes, 2=no **Practice of EBP:** • Education (r=0.12; p<0.01) • Job title (r=0.17; p<0.01)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• Attended any EBP research or PD workshops offered by Centre for Nursing Excellence (r=-0.19; p<0.01) *1=yes, 2=no • EBPQ total (r=0.75; p<0.01) **Attitudes towards EBP:** • Education (r=0.26; p<0.01) • Employment status (r=-0.11; p<0.05) • Job title (r=0.18; p<0.01) • Attended EBP and Research Council (r=-0.15; p<0.01) • Attended any EBP research or PD workshops offered by Centre for Nursing Excellence (r=-0.20; p<0.01) • EBPQ total (r=0.61; p<0.01) • EBP Practice (r=0.40; p<0.01) **Knowledge/Skills towards EBP:** • Education (r=0.21; p<0.01) • Certification (r=0.12; p<0.01) • Job title (r=0.16; p<0.01) • Attended any EBP research or PD workshops offered by Centre for Nursing Excellence (r=-0.12; p<0.01) • EBPQ total (r=0.95; p<0.01) • EBPQ total (r=0.95; p<0.01) • Practice of EBP (r=0.55; p<0.01) • Attitudes towards EBP (r=0.44; p<0.01) <u>MANCOVA:</u> Dependent variables: EBPQ total and three subscales 4. Independent variable: EBP and Research Council attendance • Significant multivariate main effect Wilk's λ = 0.982, F(3, 471) = 2.88, p = .035 • Univariate tests: Attitudes subscale significantly higher for those with EBP attendance (M=5.75) vs. those with no EBP attendance (M=5.23) p<0.05 2. Independent variable: attendance at any EBP education class/workshop • Significant multivariate main effect Wilk's λ = 0.965, F(3, 471) = 5.725, p = 0.001 • Univariate tests showed significant higher scores for those who attended vs. no attendance (p<0.01) for: • EBPQ total: M=4.74 vs. M=4.51 • Practice: M=3.65 vs. M=3.29 • Attitudes: M=5.78 vs. M=5.49

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	B. M. Toole, J. F. Stichler, L. Ecoff, L. Kath (2013) [114]	United States RNs	√						Not reported	Not reported	Not reported	+# Significant differences between pretest and post-test EBPQ practice scores for: • Computer-based learning EBP education: (M [pre-test]=3.74; SD=1.41; M [post-test]=4.41; SD=1.13; p=0.002) • In-class EBP education: (M [pre-test]=3.63; SD=1.36; M [post-test]=4.10; SD=1.24; p=0.006) <u>Correlations:</u> **EBPQ practice:** Significant at p<0.01 • # formal EBP classes/in-service (r=0.205) • # of own readings in EBP (r=0.308) • # EBP computer-based education (r=0.220) • # EBP conferences (r=0.273) • EBP knowledge/skills (r=0.613) • EBP attitudes (r=0.281) Significant at p<0.05 • Age (r=0.108) **Attitudes toward EBP:** Significant at p<0.01 • # of own readings in EBP (r=0.213) • EBP knowledge/skills (r=0.410) **Knowledge/Skills of EBP:** Significant at p<0.01 • # formal EBP classes/in-service (r=0.215) • # of own readings in EBP (r=0.352) • # EBP computer-based education (r=0.237) Significant at p<0.05 • # EBP conferences (r=0.147)
	Son Chae Kim, Caroline E. Brown, Laurie Ecoff, Judy E. Davidson, Ana-Maria Gallo, Kathy Klimpel, Mary A. Wickline (2013) [100]	United States RNs	√						Not reported	Not reported	Not reported	+#* <u>Paired t-tests</u> Following EBP Fellowship intervention: **Practice of EBP** • Overall: Significant difference in pre-test (M=4.52) and post-test (M=5.33) scores; t=5.91, p<0.001 • Fellows: Significant difference in pre-test (M=4.14) and post-test (M=5.09) scores; t=4.46, p<0.001 • Mentors: Significant difference in pre-test (M=4.95) and post-test (M=5.60) scores; t=3.95, p<0.001 **Knowledge/skills of EBP**

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• Overall: Significant difference in pre-test (M=4.64) and post-test (M=5.24) scores; t=9.06, p<0.001 • Fellows: Significant difference in pre-test (M=4.13) and post-test (M=5.11) scores; t=7.36, p<0.001 • Mentors: Significant difference in pre-test (M=4.82) and post-test (M=5.38) scores; t=5.68, p<0.001 <u>Bivariate correlations at post-test:</u> **Practice of EBP:** Significant at p<0.05 • Mentor (r=0.24) • Baccalaureate (r=-0.22) • Staff nurse position (r=-0.28) • CNS/nurse educator/NP (r=0.25) • Communication BARRIERS subscale (r=-0.22) Significant at p<0.01 • Organization BARRIERS subscale (r=-0.25) **Attitude towards EBP:** Significant at p<0.05 • Baccalaureate (r=-0.19) • Staff nurse position (r=-0.21) • CNS/nurse educator/NP (r=0.25) • Innovation BARRIERS subscale (r=-0.19) Significant at p<0.01 • Organization BARRIERS subscale (r=-0.27) **Knowledge/skills of EBP:** Significant at p<0.05 • Mentor (r=0.22) • CNS/nurse educator/NP (r=0.20) Significant at p<0.01 • Baccalaureate (r=-0.31) • Master's/doctoral (r=0.32) • Staff nurse (r=-0.26) • Organization BARRIERS subscale (r=-0.26) • Innovation BARRIERS subscale (r=-0.28) • Communication BARRIERS subscale (r=-0.32) <u>Regression analyses</u> **Practice of EBP** *Demographic variables* Regression model; R^2=9.7%, p<0.05 *Barriers variables* Regression model; R^2=6.8%, p<0.05 • No predictor variables reached statistical significance **Attitudes toward EBP** *Demographic variables* Regression model; R^2=7.6%, p<0.01

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Barriers variables Regression model; R^2=8.9%, p<0.01 • Organization BARRIERS subscale (β =-0.35, p≤0.01) **Knowledge/Skills of EBP** *Demographic variables* Regression model; R^2=10%, p<0.001 *Barriers variables* Regression model; R^2=13.9%, p<0.001 • Innovation BARRIERS subscale (β =-0.21, p≤0.05)
	Sese-Abad, J. De Pedro-Gomez, M. Bennasar-Veny, P. Sastre, J. C. Fernandez-Dominguez, J. M. Morales-Asencio (2014) [109]	Spain RNs		√					Not reported	Not reported	<u>Confirmatory Factor Analysis:</u> Inadequate fit for 24-item model vs. 19-item model in four subsamples Goodness of fit indexes: **Subsample 1** (staff in large hospitals n=415): *24-item model* x^2=1720.32, df= 249, p < .0001 x^2/df=6.91 RMSEA=.12 90% CI=[.11, .12] p (RMSEA) > .05 <.0001 SRMR=.08 *19-item model* x^2=301.31, df= 149, p < .0001 x^2/df=2.02 RMSEA=.05 90% CI=[.05, .06] p (RMSEA) > .05 =.16 SRMR=.04 *Model comparison* x^2=1419.01, df=100, p<.0001 **Subsample 2** (staff in medium-sized hospitals n=611): *24-item model* x^2=2566.73, df= 249, p < .0001 x^2/df=10.31 RMSEA=.12 90% CI=[.12, .13] p (RMSEA) > .05 <.0001 SRMR=.08 *19-item model* x^2=366.98, df= 149, p < .0001 x^2/df=2.46 RMSEA=.05 90% CI=[.05, .06] p (RMSEA) > .05 =.19 SRMR=.04 *Model comparison* x^2=2199.75, df=100, p<.0001 **Subsample 3:** (staff in small hospital centres n=270) *24-item model* x^2=1367.95, df= 249, p < .0001 x^2/df=5.49 RMSEA=.13 90% CI=[.12, .14] p (RMSEA) > .05 <.0001 SRMR=.09 *19-item model* x^2=263.96, df= 149, p < .0001 x^2/df=1.77 RMSEA=.06 90% CI=[.05, .07] p (RMSEA) > .05 =.06 SRMR=.05 *Model comparison* x^2=1103.99, df=100, p<.0001	+ <u>Correlations:</u> **EBP Practice:** • Attitudes toward EBP (r=0.57; p<0.0001) • Knowledge/skills EBP (r=0.62, p<0.0001) **Attitudes Toward EBP:** • Knowledge (r=0.36, p<0.0001)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
											Subsample 4: (primary care n=377) *24-item model* x^2=1818.74, df= 249, p < .0001 x^2/df=7.30 RMSEA=.13 90% CI=[.12, .14] p (RMSEA) > .05 <.0001 SRMR=.09 *19-item model* x^2=329.27, df= 149, p < .0001 x^2/df=2.21 RMSEA=.06 90% CI=[.05, .07] p (RMSEA) > .05 =.01 SRMR=.05 *Model comparison* x^2=1489.47, df=100, p<.0001	
	M. A. Perez-Campos, I. Sanchez-Garcia, P. L. Pancorbo-Hidalgo (2014) [105]	Spain, Latin America RNs	√	√			√		Not reported	Not reported	Not reported	+♦ <u>Correlations</u> EBPQ total: • Academic level (rho=0.303, p≤0.01) • Professional category (rho=0.221, p≤0.01) • More favourable evaluation of environment (rho=0.147, p≤0.05) <u>ANOVA</u> **EBP Practice:** • Professional category: F=5.22, p=0.002 ○ Registered Nurse (M=4.59; SD=1.53) ○ Clinical nurse specialist (M=5.35; SD=1.26) ○ Ward manager (M=5.04; SD=1.55) ○ Direction (M=4.69; SD=1.79) • Academic level: F=11.06, p<0.001 ○ Diploma (M=4.49; SD=1.48) ○ Bachelor degree (M=5.26; SD=1.45) ○ Master degree/PhD (M=5.27; SD=1.39) **EBP Attitudes:** • Practice environment: F=5.99, p=0.003 ○ Unfavourable (M=5.08; SD=1.26) ○ Mixed (M=5.58; SD=1.04) ○ Favourable (M=5.53; SD=1.09) • Academic level: F=7.66, p=0.001 ○ Diploma (M=5.51; SD=1.05) ○ Bachelor degree (M=5.73; SD=1.16) ○ Master degree/PhD (M=5.56; SD=1.15) **EBP Knowledge:** • Professional category: F=8.41, p<0.001 ○ Registered Nurse (M=4.56; SD=1.15) ○ Clinical nurse specialist (M=5.26; SD=1.14)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												○ Ward manager (M=5.04; SD=1.11) ○ Direction (M=5.20; SD=1.18) • Practice environment: F=4.89, p=0.008 ○ Unfavourable (M=4.63; SD=1.24) ○ Mixed (M=4.97; SD=1.03) ○ Favourable (M=5.12; SD=1.12) • Academic level: F=16.20, p<0.001 ○ Diploma (M=4.54; SD=1.04) ○ Bachelor degree (M=5.23; SD=1.14) ○ Master degree/PhD (M=5.25; SD=1.11) **EBPQ total** • Professional category: F=5.46, p=0.001 ○ Registered Nurse (M=4.81; SD=1.09) ○ Clinical nurse specialist (M=5.39; SD=1.00) ○ Ward manager (M=5.17; SD=1.20) ○ Direction (M=4.96; SD=1.36) • Academic level: F=15.46, p<0.001 ○ Diploma (M=4.72; SD=0.98) ○ Bachelor degree (M=5.41; SD=1.11) ○ Master degree/PhD (M=5.36; SD=1.06)
	E. Shafiei, A. Baratimarnani, S. Goharinezhad, R. Kalhor, M. Azmal (2014) [110]	Iran Does not specify licensure groups	√						Content validity was established using a peer review method	Not reported	Not reported	+ Correlations: **EBP Practice:** • Attitude toward EBP (r=0.222; p=0.004) • Knowledge/skills of EBP (r=0.734; p<0.001) **Attitude toward EBP:** Knowledge/skills of EBP (r=0.443; p<0.001)
	A. Ammouri, A. A. Raddaha, P. Dsouza, R. Geethakrishnan, J. A. Noronha, A. A. Obeidat, L. Shakman (2014) [91]	Oman RNs	√						Not reported	Not reported	Not reported	*+ Correlations: **EBP Practice** • Years of experience (r=0.160, p<0.001) **Attitudes toward EBP** • Years of experience (r=0.202, p<0.001) • Years of last academic qualification (r=-0.091, p<0.05) **Knowledge/skills of EBP** • Academic qualification (r=0.076, p<0.05) • Years of last academic qualification (r=-0.101, p<0.05) Regression analyses:

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Significant coefficients: **EBP Practice:** F (4, 409) = 3.79, p<0.01, R^2=0.036 • Years of experience (β =0.170, p<0.01) • Barriers to finding/reviewing research (β=−0.242; p <0.001) **Attitudes toward EBP:** F (4, 409) = 3.45, p<0.01, R^2=0.042 • Years of experience (β =0.197, p<0.001) • Barriers to finding/reviewing research (β=−0.280; p <0.001) **Knowledge/skills of EBP** F (4, 409) = 2.82, p<0.05, R^2=0.017 • Years of last academic qualification (β =-0.109, p<0.05) • Barriers to finding/reviewing research (β=−0.306; p <0.001) *years of last academic qualification (nurses needed to report if last qualification was after 2005)
	Y. J. Son, Y. Song, S. Y. Park, J. I. Kim (2014) [112]	Korea RNs	√						Not reported	Piloted with the nurses to ensure that its cultural and linguistic adaptations were appropriate. No reported problems in understanding the scale, nor was cultural rewording necessary	+* <u>Exploratory factor analysis</u> EFA yielded three factors (64.4% variance explained in total): 1. Practice of EBP (7.597%) 2. Attitude towards EBP (6.277%) 3. Knowledge/skills associated with EBP (50.495%) *one item moved from attitude to practice <u>Confirmatory factor analysis</u> Model 1 (original factor structure): x^2=5.79 (p < 0.001), SRMR=0.08, NFI=0.81, CFI=0.84 Model 2 (revised factor structure): x^2=5.59 (p < −0.001), SRMR=0.06, NFI=0.85, CFI=0.85 Model 2 identified better fit.	+ <u>Correlations (p<0.001)</u> Critical thinking disposition: • EBP Knowledge/skills (r=0.398) • EBP Practice (r=0.318) • EBP Attitude (r=0.212)
	J. B. Carlone, O. Igbirieh (2014) [94]	Qatar RNs	√						Not reported	Not reported	Not reported	+#♦ <u>Spearman's rank correlations (p<0.001)</u> **EBP Practice** • Attitude (r_s=0.321) • Knowledge/skills (r_s=0.471) • Level of education (identified as significant but no data provided) **EBP Attitudes** • Knowledge/skills (r_s=0.299) • Age (identified as significant but no data provided) <u>Kruskal-Wallis H Test</u> • Significant difference between total score and clinical speciality (H= 26.588, p=0.014) • Significant difference between EBP Practice score and clinical speciality (H= 30.214, p=0.004)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Mann-Whitney U Test • Urology (M=161) differed significantly in its total score when compared to the rest of the sample (M=124) (U=41.5, p=0.041) Urology (M=42, U=24, p<0.001) and Emergency/Trauma (M=32.5) U=629, p=0.041 differed significantly when compared to rest of sample
	Jed Duff, Margaret Butler, Menna Davies, Robyn Williams, Jannelle Carlile (2014) [95]	Australia RNs	√						Reported findings for original measure.	Not reported	Not reported	No support validity evidence
	Susanne Tacaraya Fehr (2014) [56]	United States RNs	√						Not reported	Researcher conducted paper-pencil pilot with sample of 5 medical-surgical nurses.	Not reported	+♦* Correlations: **EBPQ total score:** • Nursing informatics competency (r=0.548, p<0.01) • Self-efficacy (r=0.248, p<0.01) ANOVA: **EBPQ total score:** • Nursing degree (F=3.10, p=0.17) ○ Diploma (M= 4.16; SD=.827) ○ Associates (M=5.13; SD=.829) ○ Bachelors, traditional (M=5.06; SD=.867) ○ Bachelors, 2nd degree (M=5.27; SD=.822) ○ MSN (M=5.55; SD=.666) Regression analyses: Significant coefficients **EBPQ total score:** F=7.34, p<0.001, R^2=0.43 • Nursing informatics competency (B =0.63, p=0.000) • Self-efficacy (B =0.22, p=0.006) • Age (under 35 years vs >50 years) (B =0.56, p=0.002)
	H. T. Xie, Z. Y. Zhou, C. Q. Xu, S. Ong, A. Govindasamy (2015) [118]	Singapore Does not specify licensure group						√	Not reported	Not reported	Not reported	No supporting validity evidence

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Nicole Allen, Barbara G. Lubejko, Julie Thompson, Barbara S. Turner (2015) [90]	United States Does not specify licensure group	√	√				(does not specify 'other')	Not reported	Not reported	Not reported	No supporting validity evidence
	Aliyu Adamu, Joanne Rachel Naidoo (2015) [60]	Nigeria RNs	√						An expert in nursing research, to evaluate the content of the questionnaire.	Not reported	Not reported	+# Correlations: **EBP Attitude:** • Age (r_s=0.137, p<0.05) • Knowledge (r_s=0.137, p<0.01) Independent t-test Significant difference in knowledge between junior and senior nurses; t(14)=2.526, p<0.05 (no mean scores provided)
	R. P. Pereira, A. C. Guerra, M. J. Cardoso, A. T. dos Santos, C. de Figueiredo Mdo, A. C. Carneiro (2015) [104]	Portugal Does not specify licensure group	√						Not reported	Not reported	* Revised 20 item structure underwent confirmatory factor analysis: New model was tested and goodness of fit was obtained: χ2 (167) = 520.009; p = 0.0001; χ2df = 3.114; CFI = 0.908; GFI = 0.865; PCFI = 0.798; PGFI = 0.678; RMSEA = 0.077 (CI 90%=0.07-0.08).	No supporting validity evidence
	J. I. Hwang, H. A. Park (2015) [99]	Korea Does not specify licensure group	√						Not reported	Not reported	Indicates that a principal components factor analysis using the varimax rotation method was performed to test the validity of the EBPQ. However, no findings regarding this are presented.	+* **EBPQ total scores:** Significant differences between groups related to: • Age (F=7.92; p<0.001) ○ 20-30 (M=4.0; SD=0.7) ○ 31-40 (M=4.2; SD=0.8) ○ 41-60 (M=4.4; SD=0.9) • Education (F=13.84; p<0.001) ○ 3-year diploma (M=3.9; SD=0.7) ○ 4-year baccalaureate (M=4.1; SD=0.7) ○ Master or higher (M=4.5; SD=0.9) • Years in Nursing (F=4.84; p=0.003) ○ <3 (M=3.9; SD=0.7) ○ 3-<5 (M=4.0; SD=0.7) ○ 5-<10 (M=4.1; SD=0.7) ○ 10 or more (M=4.3; SD=0.9) • Job position (t=4.16; p<0.001) ○ Manager (M=4.5; SD=0.9) ○ Staff (M=4.1; SD=0.7) Regression analyses:

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• Higher age and education significantly associated with EBPQ total scores (F=10.98; p<0.001) ○ Age (β =0.01, p=0.029) ○ Master degree or higher (β =0.43, p<0.001) <u>Correlations:</u> Identifies positive moderate correlation between EBPQ and quality improvement scores, and between individual EBPQ subscales and total score, however does not identify which are statistically significant.
	C. Phillips (2015) [106]	United States Does not specify licensure group	√						Not reported	Not reported	Not reported	+ <u>Correlations:</u> **Practice of EBP** • Attitudes (r=0.813, p=0.000) • Knowledge (r=0.844, p=0.000) • Total EBPQ (r=0.936, p=0.000) **Attitudes towards EBP** • Knowledge (r=0.848, p=0.000) • Total EBPQ (r=0.907, p=0.000) **Knowledge of EBP** Total EBPQ (r=0.973, p=0.000)
	A. J. Ramos-Morcillo, S. Fernandez-Salazar, M. Ruzafa-Martinez, R. Del-Pino-Casado (2015) [108]	Spain RNs	√						Not reported	Not reported	+ Exploratory factor analysis with principal axis factors and Varimax rotation showed the previous three dimensions, which accounted for 72.5% of the variance.	♦ Between-subjects effects (EBP intervention) EBP Knowledge and skills F(1)=6.6, p=0.01
	K. M. Williamson, M. Almaskari, Z. Lester, D. Maguire (2015) [117]	United States RNs	√						Not reported	Not reported	Not reported	# <u>Mann-Whitney U test</u> Significant differences between staff nurses and management for: • EBP knowledge/skills (U = 1153, p = .001) • EBP attitude (U = 1072, p = .000) EBP practice (U = 1123, p = .001)
	J. R. Duffy, S. Culp, C. Yarberry, L. Stroupe, K. Sand-Jecklin, A. Sparks Coburn (2015) [48]	United States RNs	√						Not reported	Not reported	Not reported	+# <u>Correlations:</u> EBP attitudes with individual EBP Practice items of: • Participating in implementing research knowledge in practice (r_s=0.299, p=0.011) EBP confidence with individual EBP Practice items of: • Formulate questions (r_s=0.424, p<0.001) • Seek out relevant knowledge using databases (r_s=0.544, p<0.001)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	J. R. Duffy, S. Culp, K. Sand-Jecklin, L. Stroupe, N. Lucke-Wold (2016) [49]											• Seek out relevant knowledge using other information sources (r_s=0.558, p<0.001) • Critically appraise and compile best knowledge (r_s=0.538, p<0.001) • Participate in implementing research knowledge (r_s=0.265, p=0.022) EBP knowledge with individual EBP Practice items of: • Formulate questions (r_s=0.460, p<0.001) • Seek out relevant knowledge using databases (r_s=0.298, p=0.011) • Seek out relevant knowledge using other information sources (r_s=0.314, p=0.007) • Critically appraise and compile best knowledge (r_s=0.346, p=0.003)
	Donna Agnew (2016) [89]	United States Does not specify licensure group	√						Not reported	Not reported	Not reported	#♦ **EBPQ total score** • Certified nurses had higher scores (t=1.996, p=0.047) • Managers/directors and advanced practice nurses had higher scores (F=8.905, p<0.001) than staff nurses **EBP Knowledge/Skills** • Managers/directors and advanced practice nurses had higher scores (F=9.6, p<0.001) than staff nurses **EBP Attitudes** • Managers/directors had higher scores (F=4.498, p=0.012) compared to staff nurses **EBP Practice** Managers/directors had higher scores (F=6.567, p=0.002) compared to staff nurses
	J. Y. Sim, K. S. Jang, N. Y. Kim (2016) [111]	South Korea RNs	√						Not reported	Not reported	Not reported	# <u>T-tests for post-test scores</u> Following EBP educational intervention: • **Knowledge/skill of EBP:** Significant difference between experimental (M=5.04) and control (M=4.31) groups, t=3.08, p=0.003 • **Attitude toward EBP:** Significant difference between experimental (M=5.47) and control (M=4.55) groups, t=4.10, p<0.001
	R. Lovelace, M. Noonen, J. F. Bena, A. S. Tang, M. Angie, R. Cwynar, R. Field, J.	United States RNs LPNs/RPNs	√	√					Reported findings for original measure.	Not reported	Reported findings for original measure.	+♦ **EBP attitude** • Number of EBP educational modules viewed positively associated with higher EBP attitudes (*rho*=0.082; p=0.009)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Rosenberger, D. Ross, D. Walker, N. M. Albert (2017) [102]											• Less time since receiving their highest college degree have higher EBP attitudes (*rho*=0.17; p<0.001) Factors associated with higher EBP attitudes *only p-values reported for following associations: Significant at p<0.001 • Higher education • Certification (yes) • More than one certification • Project leader (yes) • Past exposure to EBP • Registered nurse-led quality project (yes) • Principal investigator (yes) • Literature review completed ≤6 months (yes) Significant at p=0.039 Work full-time (vs. part-time)
	A. Hagedorn Wonder, A. M. McNelis, D. Spurlock, P. M. Ironside, S. Lancaster, C. R. Davis, M. Gainey, N. Verwers (2017) [97]	United States RNs	√						Not reported	Not reported	Not reported	+ <u>Correlations:</u> **EBP Practice** • EBP attitudes (r=0.350, p<0.01) • EBP knowledge/skills (r=0.595, p<0.01) • Age (r=0.202, p<0.05) • Years of RN experience (r=0.168, p<0.05) • "I am sure I can deliver evidence-based care" (r=0.294, p<0.01) **EBP Attitudes** • EBP knowledge/skills (r=0.398, p<0.01) • "I am sure I can deliver evidence-based care" (r=0.228, p<0.01) **EBP Knowledge/Skills** • "I am sure I can deliver evidence-based care" (r=0.413, p<0.01)
	D. C. Stavor, J. Zedreck-Gonzalez, R. L. Hoffmann (2017)	United States RNs	√						Not reported	Not reported	Not reported	No supporting validity evidence
	M. O. A. Hasheesh, M. E. AbuRuz (2017) [113]	Saudi Arabia RNs	√						Not reported	Not reported	Not reported	+* <u>Correlations:</u> **Practice of EBP:** • Age (r=-0.18, p<0.01) • Qualification (r=0.23, p<0.01) • Years of experience (r=-0.12, p<0.05) • EBP training (r=0.11, p<0.05) • Research involvement (r=0.20, p<0.01) **EBP Attitudes:** • Qualification (r=0.2, p<0.01) **EBP Knowledge/skills:**

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• Qualification (r=0.12, p<0.05) Regression analyses: Significant coefficients identified for demographic variables *p-values not stated **Practice of EBP** R^2 = 0.12; F(6,296) = 7.07, P<0.001 • Education (β =0.25) **EBP Attitudes** R^2 = 0.049; F(6,296) = 3.53, P<0.05 • Education (β =0.20) **EBP Knowledge/Skills** R^2 = 0.038; F(6,296) = 2.69, P<0.05 • Education (β =0.16)
	Lora Moore (2017) [103]	United States RNs	√						Not reported	Not reported	Reported findings for original measure.	No supporting validity evidence
	Mohannad Eid AbuRuz, Haneen Abu Hayeah, Ghadeer Al-Dweik, Hekmat Yousef Al-Akash (2017) [88]	Jordan RNs	√						Not reported	Not reported	Not reported	+* Correlations: **EBP Practice:** • Educational level (0.066, p<0.1) **EBP Attitudes:** • Educational level (0.101, p<0.05) • Participation in research (0.142, p<0.01) • Data base access (0.146, p<0.01) **EBP Knowledge/skills:** • Educational level (0.116, p<0.01) • Participation in research (0.201, p<0.01) • Data base access (0.235, p<0.01) Regression analyses: Significant coefficients with demographic variables **EBP Practice** R^2=0.061; F(4,495)=9.11, p<0.001 • Participation in research (β =-0.11, p<0.05) • Data base access (β =-0.171, p<0.001) **EBP Attitudes** R^2=0.054; F(4,495)=7.12, p<0.001 • Educational level (β =0.093, p<0.05) • Data base access (β =0.121, p<0.01) **EBP Knowledge/skills** R^2=0.074; F(4,495)=10.89, p<0.001 • Educational level (β =0.1, p<0.05) • Participation in research (β =0.1, p<0.05) • Data base access (β =0.206, p<0.001)
	Lai Ping Atalanta Wan	United States	√						Not reported	Not reported	Not reported	# Wilcoxon signed-rank text **EBP Knowledge/Skills**

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	(2017) [115]	RNs										Statistically significant difference between pre-test (M=9.39) and post-test (M=10.83) scores after EBP educational intervention (p=0.34) in experimental group
Developing Evidence-based practice questionnaire (Gerrish et al., 2007; 6 studies)	K. Gerrish, P. Ashworth, A. Lacey, J. Bailey, J. Cooke, S. Kendall, E. McNeilly (2007) [63]	England *Does not specify licensure group	√	√	√				Content validity of the questionnaire was considered by a panel of four experts in community health nursing and minor modifications made to the questionnaire	Not reported	+ Exploratory factor analysis identified ten factors (variance %): • Factor 1. Skill in finding, reviewing and using different sources of evidence (10.622%) • Factor 2. Barriers to, or facilitators of, personal efficacy in the context of the organization, including team culture and personal authority (10.622%) • Factor 3. Published information as a source of knowledge used in practice. (10.622%) • Factor 4. Focal concern or interest in the effective use of research. (10.622%) • Factor 5. The availability of formal information (research and organizational information), and disposable time to implement the recommendations. (10.622%) • Factor 6. Knowledge gleaned from training, conferences, and local and national reports and audits. (10.622%) • Factor 7. Personal experience. (10.622%) • Factor 8. Informal information gleaned in the course of daily work, including interprofessional conversations. (10.622%) • Factor 9. The facilitating or hindering effect of colleagues in changing practice. (10.622%) Factor 10. Client /patient contact and the nurse's personal knowledge and experience. (10.622%)	+ • Significant positive associations between skills in finding and reviewing evidence and facilitation and support in changing practice (r=0.197; p<0.01)
	K. Gerrish, P. Ashworth, A. Lacey, J. Bailey (2008) [151]	England RNs	√						Not reported	Not reported	Original findings reported	No supporting validity evidence

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	J. Mills, J. Field, R. Cant (2009) [152]	Australia RNs, LPNs/RPNs		√					Not reported	Not reported	Not reported	+ • Significant association between younger age of nurses and perceptions of skills in use of the library to locate information (r=−.140; p<.01) and skills in using the Internet (r=−.243; p<.01) • Significant association (p<.01) between level of nursing qualification and: ○ Using internet to search for information (r=.209) ○ Using library to locate information (r=.215) ○ Using organizational information to change practice (r=.177) ○ Reviewing organizational information (r=.203) ○ Finding organizational information (r=.180) ○ Using research evidence to change practice (r=.143) ○ Finding research evidence (r=.201) Reviewing research evidence (r=.242)
	Kate Gerrish, Jo Cooke (2013) [8]	England *Does not specify licensure group			√	√			Not reported	Not reported	Not reported	No supporting validity evidence
	L. M. Baird, T. Miller (2015) [153]	Canada RNs, APNs		√	√	√			Not reported	Not reported	Not reported	♦ Significant differences: • Education and skills: F(2 ,60)=7.349, p=0.001 (eta squared 0.20) ○ Diploma (M=2.3; SD=0.48) ○ Bachelor (M=2.0; SD=0.56) ○ Master (M=1.2; SD=0.38) Post-hoc analyses: Significant difference between those with highest education (Master's) and other two groups.
	J. I. Shin, E. Lee (2017) [154]	South Korea RNs	√						Not reported	Not reported	Not reported	+♦* <u>Correlation</u> Significant associations (p<.05) between skills in finding and reviewing evidence and: • Barriers to finding and reviewing evidence (r=-.46) • Barriers to changing practice (r=-.23) • Facilitators and support to changing practice (r=.27) <u>ANOVA</u> • Nurses with higher social capital (social dimensions of the nursing environment) scores showed higher scores (F= 7.513, p = .001)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Regression analyses • Social capital explained 11% of the variance in Skills Appraisal in Finding and Reviewing Evidence (F = 2.37, p < .001)
Modified Evidence-Based Nursing Education Questionnaire (EBEQ) (1 study)	S. Hellier, T. Cline (2016) [38]	United States APNs	√						Not reported	Not reported	Not reported	+♦# Correlation Age with: • Overall EBEQ scores (r=-.113, p=.029) • Knowledge of EBP (r=-.168, p<.001) • Changing practice based on evidence (r=-.112, p=.017) Number of years practicing as NP: • negatively correlated with knowledge of EBP scores (r = −.195, p < .001) ANOVA Education with: • Overall EBEQ score F=7.369, p=.000 • Knowledge score F=5.510, p=.000 • Finding evidence score F=5.960, p=.000 • Changing practice based on evidence score F=3.338, p=.010 • Judging evidence score F=12.979, p=.000 Post-hoc tests: • DNPs scored significantly higher than Master's prepared NPs, on: ○ overall EBEQ score (mean difference=9.28, p<.001) ○ finding evidence factor (mean difference=1.96, p=.002) ○ judging evidence factor (mean difference=3.50, p<.001) • DNPs scored significantly higher than bachelor degree holders on knowledge of EBP (mean difference = 6.69, p = .004) t-test • Participants who are employed at Magnet-designated facilities reported marginally higher scores (M = 21.42, SD = 2.99) than did non-Magnet participants (M = 20.27, SD = 3.89); t(431)=2.61; p=.01
Self-developed measure by Barako et al. (2012; 1 study)	Talaso D. Barako, Margaret Chege, Sabina Wakasiaka, Lilian Omondi (2012) [40]	Kenya Licensure group not specified	√						Not reported	Not reported	Not reported	#* t-test • Nurses who fully practised EBP had more positive attitude (M= 4.41) compared to those who do not fully practice EBP (M= 3.76), t =3.34, p =0.001. Regression analyses Dependent variable: EBP application

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Independent variables: demographic characteristics Significant factors associated with EBP application: • Nursing education (p=0.029) ○ Certificate (OR=1.00) ○ Diploma (OR=0.31) ○ Bachelor's (OR=6.00) • Ability to critically review EBP literature (p=0.021) ○ Confident (OR=1.00) ○ Fairly confident (OR=0.75) ○ Poorly confident (OR=0.06) Attitudes towards EBP (OR=0.49; p=0.007): Nurses with negative EBP attitudes less likely to practice EBP
Self-developed measure by Gerrish et al. (2011) (1 study)	K. Gerrish, L. Guillaume, M. Kirshbaum, A. McDonnell, A. Tod, M. Nolan (2011) [43]	England APNs	√	√					Not reported	Not reported	Not reported	♠ Chi-squared tests indicated statistically significant differences (P < 0.001) between nurses with Master's qualifications and above and those with a bachelor degree or below. APNs with Master's qualifications were more likely to view themselves as competent/expert in all the identified skills associated with evidence-based practice: • Obtaining sources of evidence via WWW x^2= 29.817 • Undertaking literature searches x^2= 40.425 • Evaluating research reports x^2= 38.266 • Adapting national guidelines for local implementation x^2= 28.673 • Setting evidence-based standards x^2= 30.977 • Undertaking clinical audit x^2= 24.488 • Undertaking benchmarking x^2= 39.615 • Identifying need for change based on evidence x^2= 28.254 • Implementing changes in practice x^2= 30.285 • Evaluating effects of changes made in practice x^2= 21.489 • Undertaking research x^2= 38.881
Adapted Fresno Test (1 study)	Natasha Laibhen-Parkes (2014) [45]	United States RNs	√						Not reported	Not reported	Not reported	# <u>t-test</u> • Intervention group (EBP education) had statistically higher test scores (M=94.1; SD=32.4) compared to control group (M=80.3; SD=24.3); t=1.31, p=0.20 • Hedge's g=0.47
Self-developed measure by Kim et al. (2013) (1 study)	Son Chae Kim, Caroline E. Brown, Laurie Ecoff, Judy E. Davidson, Ana-Maria Gallo,	United States RNs	√						Not reported	Not reported	Not reported	# Significant differences (p<.001) between pre- and post-test scores of perceived abilities to implement EBP steps following EBP fellowship intervention: • Formulate a key clinical question: M_{diff}=0.86; t=10.04 • Search databases: M_{diff}=0.61; t=7.54

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
	Kathy Klimpel, Mary A. Wickline (2013) [100]											• Find best clinical evidence: M_{diff}=0.82; t=9.53 • Understand research articles: M_{diff}=0.61; t=7.61 • Appraise articles critically: M_{diff}=0.73; t=8.78 • Synthesize research articles: M_{diff}=0.73; t=9.07 • Apply evidence to patient care: M_{diff}=0.73; t=8.22
Evidence-Based Practice Confidence Scale (EPIC) (1 study)	J. R. Duffy, S. Culp, C. Yarberry, L. Stroupe, K. Sand-Jecklin, A. Sparks Coburn (2015) [48] J. R. Duffy, S. Culp, K. Sand-Jecklin, L. Stroupe, N. Lucke-Wold (2016) [49]	United States RNs	√						Not reported	Not reported	Not reported	+#♦ <u>Correlation</u> EBP confidence and: • EBP use (r = 0.538, p<.001) • Formulate questions to search for research- based knowledge (ρ=0.424; p<.001) • Seek out relevant knowledge using databases (ρ=0.544, p<.001) • Seek out relevant knowledge using other information sources (ρ=0.558, p<.001) • Critically appraise and compile best knowledge (ρ=0.538, <.001) • Participate in implementing research knowledge in practice (ρ=0.265, p=.022) <u>t-test</u> • Statistically significant difference in EBP confidence between those who had professional certification (M=64.2%; SD=14.7%) and those who did not (M=55.2%; SD=18.8), p= .025) <u>Kruskal-Wall's</u> Statistically significant difference in EBP confidence by education level (p=.013): • Diploma/associate degree M=49.8%; SD=14.8% • Bachelor's degree M=58.5%; SD=18.0% Graduate coursework/degree M=67.8%; SD=13.8%
Information literacy tool (1 study)	J. Y. Sim, K. S. Jang, N. Y. Kim (2016) [111]	South Korea RNs	√						Not reported	Not reported	Not reported	# Information search ability post-test scores were higher for intervention group (M=3.88; SD=0.67) versus control (M=2.82; SD=0.69) following EBP education program t=6.22; p<.001
Modified Korean EBM questionnaire (1 study)	J. W. Park, J. A. Ahn, M. M. Park (2015) [47]	Korea RNs	√						Not reported	Not reported	Not reported	#♦ <u>t-test and ANOVA</u> **Perception of EBP** Significant differences found based on: • Work experience (t = −2.494, P = 0.013) ○ ≤10 years (M=2.79; SD=0.26) ○ >10 years (M=2.86; SD=0.26) • Education level (F=9.769, p<0.001) ○ 3-year college (M=2.76; SD=0.28) ○ Bachelor (M=2.82; SD=0.22) ○ Master and PhD (M=2.94; SD=0.31) • Previous EBP education (t=2.454, p=0.015) ○ Yes (M=2.86; SD=0.25) ○ No (M=2.80; SD=0.26)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												Attitudes towards EBP Significant differences found based on: • Work experience (t = −2.360, P = 0.019) ○ ≤10 years (M=2.72; SD=0.31) ○ >10 years (M=2.80; SD=0.33) • Education level (F=15.236, p<0.001) ○ 3-year college (M=2.65; SD=0.27) ○ Bachelor (M=2.76; SD=0.32) ○ Master and PhD (M=2.92; SD=0.36) • Previous EBP education (t=1.972, p=0.049) ○ Yes (M=2.80; SD=0.31) ○ No (M=2.73; SD=0.33)
Evidence-Based Practice Attitudes Scale (EBPAS) (1 study)	J. R. Duffy, S. Culp, K. Sand-Jecklin, L. Stroupe, N. Lucke-Wold (2016) [49] J. R. Duffy, S. Culp, C. Yarberry, L. Stroupe, K. Sand-Jecklin, A. Sparks Coburn (2015) [48]	United States RNs	√						Not reported	Not reported	Not reported	+# <u>Correlation</u> • Positive association between EBP use item (Participate in implementing research knowledge in practice) and EBP attitudes (ρ=0.299, p=.011) <u>Mann-Whitney U test</u> • Statistically significant difference in EBP attitudes by position type (p=.016): ○ Nurse leaders (M=50.4, SD=5.5) ○ Staff (M=46.4, SD=5.9)
Attitudes to Evidence-Based Practice Questionnaire (1 study)	M. J. Linton, M. A. Prasun (2013) [50]	United States Licensure group not specified	√						Original findings reported	Not reported	Not reported	+ Significant positive correlations between individual 'attitudes' items and age and/or education: • Confidence in my ability to evaluate quality of research ○ Education (r=0.208, p=0.000) • Available research is not relevant ○ Age (r=0.155; p=0.004) • Hard to influence changes in clinical practice ○ Age (0.153; p=0.005) • Research findings are often not easily transferable ○ Age (r=0.182; p=0.001)
Nurses' Attitudes Toward EBP Scale (NATES) (1 study)	Linda Thiel, Yashowanto Ghosh (2008) [53]	United States RNs	√						Not reported	Not reported	Original findings reported	+ Significant positive associations between NATES scores and: • Education (rho = 0.248, p < 0.01) • Years in nursing (rho = 0.236, p < 0.01) • Age (rho = 0.210, p < 0.05) • Unit culture (rho = 0.626, p < 0.01)

Measure	Study	Country, Licensure Group	Setting						Source of Validity Evidence			
			Acute	Primary	Public Health	Home Health	Long-term	Other/ NA	Content	Response Process	Internal Structure	Relationships to Other Variables
												• EBP knowledge (rho = 0.379, p < 0.01)
Single item measure for EBP knowledge (1 study)	B. Skela-Savic, S. Hvalic-Touzery, K. Pesjak (2017) [140]	Slovenia RNs	√						Not reported	Not reported	Not reported	+ Significant positive associations between EBP knowledge and: • EBP beliefs (knowledge and skills on EBP) r=0.477; p<0.01) • EBP implementation (advanced forms of EBP implementation) r=0.331, p<0.01 • EBP implementation (initial forms of EBP implementation) r=0.292, p<0.01
Evidence-Based Practice Knowledge Assessment in Nursing (EKAN) (1 study)	A. Hagedorn Wonder, A. M. McNelis, D. Spurlock, P. M. Ironside, S. Lancaster, C. R. Davis, M. Gainey, N. Verwers (2017) [97]	United States RNs	√						Not reported	Not reported	Not reported	* • Educational level was a statistically significant predictor of EKAN scores F(1,149) = 30.43, p<.001, R^2 = .170)
Knowledge Assessment Test (KAT) (1 study)	H. T. Xie, Z. Y. Zhou, C. Q. Xu, S. Ong, A. Govindasamy (2015) [118]	Singapore Licensure group not specified						√	Not reported	Not reported	Not reported	#♦ <u>t-test</u> Significant difference in KAT scores based on prior EBP involvement t(58) = 2.41, p = 0.02 <u>ANOVA</u> Nurses with degrees (M=15.15, SD=3.88) had better knowledge than nurses with diplomas (M=12.00; SD=2.81) F(3,58) = 3.28, p = 0.03
Core Knowledge Questionnaire (1 study)	B. M. Toole, J. F. Stichler, L. Ecoff, L. Kath (2013) [114]	United States RNs	√						Not reported	Not reported	Not reported	+ Significant correlations between core knowledge and: • EBPQ skills (r=.158, p<.01) • EBPQ attitude (r=.148, p<.01) • EBPQ practice (.090, p<.05)

Chapter 5:

Development and Content Validation of a Measure to Assess Evidence-Informed Decision-Making Competence in Public Health Nursing

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Abstract

Introduction: There are professional expectations for public health nurses to develop competencies in evidence-informed decision-making (EIDM) due to its potential for improved client and community outcomes.

Purpose: The purpose of this research study is to develop and validate the content of a measure to assess EIDM competence among public health nurses.

Methods: A four-stage process, based on measure development principles and the Standards for Educational and Psychological Testing, was used to develop and refine items for a new EIDM competence measure: a) content coverage assessment of existing measures; b) identification of existing measures for use and development of items; c) validity assessment based on content; d) validity assessment based on response process.

Results/Findings: The content coverage assessment of existing EIDM measures demonstrated that content was focused more on the 'search' and 'appraise' steps of EIDM and less on the steps of 'synthesize' and 'adapt'. Based on strengths and limitations identified from the content coverage assessment, conceptual literature on EIDM and existing measures (Evidence-Based Practice Competency Tool and Evidence-Based Practice Beliefs Scale) were used to develop a new EIDM Competence Measurement Tool. Item content validity index ratings ranged from 0.64-1.00. Qualitative themes from validity assessment based on content and response process included word changes to improve clarity, reducing item redundancy, separating multi-component items, and ensuring items reflect nursing role expectations.

Linking Evidence to Action: Upon determining its reliability and validity, there is potential for the EIDM competence measure to be used in: public health nursing practice to identify competence gaps and strengths to facilitate professional development activities; in research to

support development of strategies to build EIDM capacity; and for curriculum planning and development across nursing education programs.

Keywords: Evidence-informed decision-making, evidence-based practice, competence, measurement, tool development

Introduction

Evidence-informed decision-making (EIDM) is important to the delivery of effective and cost-efficient public health services [1]. EIDM is the integration of the best available research evidence along with consideration of local context, community and political preferences, professional expertise, and resources in public health decision-making [2]. The process of EIDM consists of seven steps: 1) define (clearly defining a public health practice question); 2) search (searching for research evidence); 3) appraise (critically appraising research evidence); 4) synthesize (interpreting and forming practice recommendations based on literature); 5) adapt (adapting research to local context); 6) implement (planning how to implement adapted evidence); and 7) evaluate (evaluating implementation) [2]. Because of its impact on public health outcomes and resources, public health nurses are expected to support EIDM implementation in their practice. For example, EIDM expectations are articulated in community health nursing standards [3], in standards for mandatory public health programs and services [4], and in national public health core competency documents [5].

With EIDM expectations established, the assessment of nurses' competence in EIDM requires attention. Competence is defined as the quality of a nurse's ability to use the four attributes of knowledge, skills, attitudes/beliefs, and behaviours in performing a nursing role to an expected standard [6-10]. In the context of EIDM, knowledge is defined as an understanding of the theoretical and practical principles or steps of EIDM [11-13]. EIDM skills are defined as applying knowledge in the performance of EIDM tasks in a practical setting (e.g., clinical case scenario) [12-14]. While, EIDM attitudes and beliefs represent perceptions or beliefs about and importance of EIDM [13, 14]. And EIDM behaviours consist of enacting EIDM steps in real-world health care settings [13-15]. Competence assessment in nursing practice is a critical

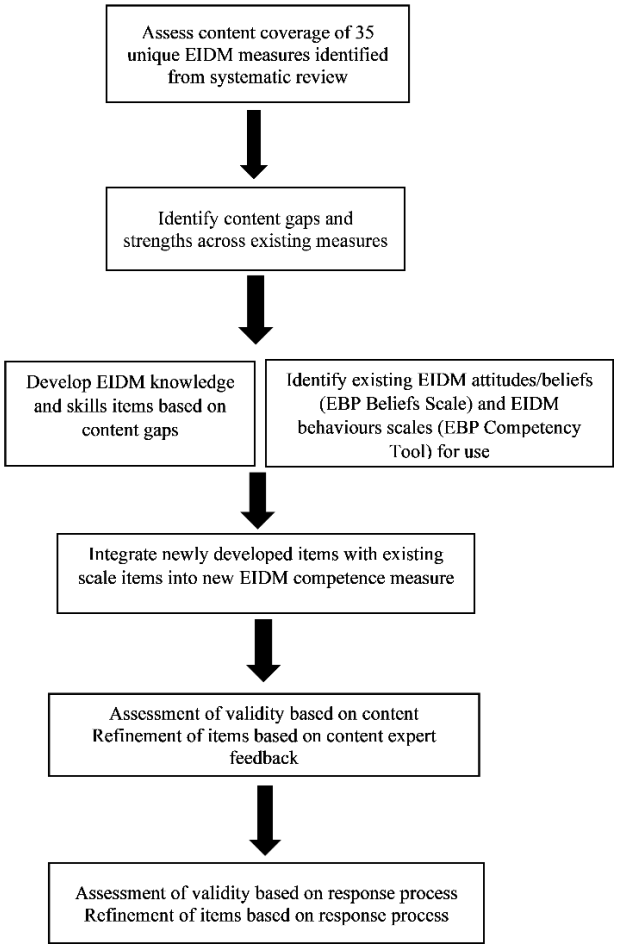
endeavour because it supports workforce development by identifying professional development needs which can then be addressed through capacity development [16]. This highlights the importance of conceptually sound and robust tools to support competence assessment. However, there are limitations among existing measures that assess EIDM competence attributes.

A systematic review of 35 EIDM competence attribute measures (i.e., knowledge, skills, attitudes/beliefs, and behaviours), determined that the majority of measures assessed only one competence attribute, with only three measures assessing all four attributes [17]. These three measures include the Evidence-Based Practice Questionnaire (EBPQ) [18], the School Nursing Evidence-Based Practice Questionnaire [19], and a self-developed measure by Chiu et al. [20]. While these three measures address all four competence attributes, there are limitations among them. Most importantly, the measures are based on an incomplete conceptualization of EIDM competence. Instead of assessing the quality of attributes, a critical component of competence [7], in some instances, there is a focus on rating items based on agreement or frequency of completing EIDM activities. This makes it challenging to distinguish the 'quality' of EIDM knowledge, skill, or behaviours of nurses. As well, for two of these measures [19, 20], behaviour items are narrowly focused on use of online databases, and do not capture the breadth of all EIDM steps. Lastly, in one measure, knowledge and skills attributes are combined into one subscale, when literature identifies them as conceptually different [13]. Given conceptual limitations of existing EIDM measures that do not satisfy a comprehensive understanding of competence (i.e., measuring quality of attributes) there was a need for development of a comprehensive EIDM competence measure.

Methods for Tool Development

A four-stage process, based on measure development principles [21] and the Standards for Educational and Psychological Testing [22], was used to develop and refine items for a new EIDM competence measure: a) content coverage assessment; b) identification of existing scales for use and development of items; c) validity assessment based on content; d) validity assessment based on response process. See Figure 1 for an overview of the development and refinement process.

Figure 1. Development process of EIDM competence measure



Content Coverage Assessment

A content coverage assessment was conducted using 35 unique measures of EIDM competence attributes (i.e., knowledge, skills, attitudes/beliefs, behaviours) identified from a recent systematic review [17]. Assessing content coverage using a matrix determines how representative items are across content domains for a concept under measure [21]. To assess content coverage of existing measures, data regarding EIDM steps addressed by each measure were extracted by one reviewer and checked for accuracy by a second reviewer. Individual items were extracted, where available, from each measure and categorized according to each of the seven steps of EIDM. Data on response type was also extracted for each measure to determine how items were assessed. Measures were categorized according to objective (multiple choice, short answer/open text) or self-report (agreement level, frequency, or quality rating) response type. To assess content coverage of measures assessing EIDM attitudes/beliefs, items were extracted, where available, from each measure and categorized according to three primary domains identified from the literature: organizational, personal characteristics, and general beliefs about EIDM [13, 23, 24]. For all attributes, the total number of measures addressing each of the EIDM steps or domains were reported.

Identification of Existing Scales for Use and Development of Items

The content coverage assessment identified conceptual gaps among EIDM knowledge and skills measures. To address these gaps, EIDM knowledge and skill items were developed guided by existing EIDM literature [2, 13, 25-28]. Among the EIDM attitudes and behaviour measures, two measures, the EBP Beliefs Scale [29] and the EBP Competency Tool [30] demonstrated content comprehensiveness; that is, all EIDM content domains were addressed and items had sufficient/specific detail. Permission was obtained from the original developer (Dr.

Bernadette Melnyk) for the use and integration of selected existing EIDM scales and in addition, if item modifications were needed, permission was subsequently received to make the proposed changes. Newly developed EIDM knowledge and skills items and existing EIDM attitudes and behaviour scale items from the EBP Beliefs Scale [29] and the EBP Competency tool [30] were integrated into a new EIDM competence measure and assessed for validity based on content and response process.

Validity Assessment Based on Content

Recruitment and sample.

Assessment of validity based on content is defined as "an analysis of the relationship between the content of a test and the construct it is intended to measure" [22]. A purposive sample of international experts in public health and/or EIDM were recruited to participate in the study via email. A list of 17 EIDM experts was generated through knowledge of co-investigators, knowledge of those cited frequently in the related literature, and from the participant list of an EIDM public health conference (2018 FUSE International Conference on Knowledge Exchange in Public Health). This sample size exceeds the minimum recommendation of five experts to assess content validity of a measure [31]. Experts who confirmed interest in participating via email were each sent a unique link to an online consent form (see Appendix L) and anonymous survey via the platform LimeSurvey.

Data collection.

Data were collected at one time point in May 2019. In an online survey consisting of 63 items across the competence attribute subscales of EIDM knowledge, skills, attitudes/beliefs, and behaviours, content experts were asked to rate the relevance of each item to the competence attribute under which it was categorized according to a 4-point scale: 1 – not relevant, 2 – unable

to assess relevance without item revision or item is in need of revision, 3 – relevant but needs minor alterations, 4 – very relevant and succinct [32]. Experts were also provided an opportunity to write open-text comments for each proposed item.

Data analysis.

A content validity index (CVI) was calculated at the item (i.e. I-CVI) and scale level from content experts' relevance ratings [33]. The item CVI is the proportion of experts rating each item as a "3" or "4" [32]. The scale CVI (i.e. S-CVI/Ave) is calculated as the average proportion of items rated a ''3' or "4" across all judges [33]. Qualitative comments were analyzed using thematic analysis [34].

Item refinement.

Results were discussed among co-investigators and consensus was used to make decisions regarding item deletions, modifications, and additions with the following guiding principles: a) CVI minimum guideline of ≥0.78 for acceptability [32]; b) recommendations from qualitative comments; c) applicability of use in a public health practice setting.

Validity Assessment Based on Response Process

Sample and recruitment.

Response process involves an understanding about the thought processes used in responding to scale items and its consistency with the construct being studied [22]. Pilot test interviews of new instruments are recommended until saturation is reached (i.e., no new concerns are identified), which commonly occurs with a minimum of eight participants [21]. A convenience sample of nine Public Health Nurses (PHNs) were recruited across two public health units. A primary contact at each public health unit disseminated an email to nurses working in any position or role across the health unit to determine interest in study participation.

Data collection.

Individual semi-structured interviews were conducted with participants via telephone, to test the refined EIDM competence measure following validity assessment based on content [21]. Participants received an email with a web link to a consent form (see Appendix M) and anonymous online survey with items from the new measure. Upon participants providing consent, phone interviews were recorded via Skype. After answering 1-3 items at a time, participants were asked semi-structured questions to explore comprehension and ease or difficulty after answering each item [35]. Detailed interview notes were also taken to supplement audio recordings.

Data analysis.

The 'interviewer text summary' model of analysis was used to analyze data, consisting of a "description of dominant themes, conclusions, and problems that are evidenced within a set of aggregated interviewer notes" [36]. Detailed interview notes and digitally recorded interviews were reviewed to identify common themes across participant data. Items were refined based on identified themes and through consensus in discussions among co-investigators.

This research study was granted ethics approval from the Hamilton Integrated Research Ethics Board (HiREB), project #5238 (see Appendix K).

Results

Content Coverage Assessment

Across 35 measures, items for 28 of them were obtained. Overall, across EIDM knowledge, skill, and behaviour measures, there was a large content emphasis on the 'search' and 'appraise' steps of EIDM and much less emphasis on the steps of 'synthesize' and 'adapt' (see Table 1). Across measures, certain individual items were vague, lacking specificity (e.g., I

know how to find evidence for practice) [37], or broad in nature (e.g., My knowledge of the application of EBP principles is sufficient) [20]. None of the EIDM knowledge or skills measures assessed all EIDM steps. While, only one EIDM behaviour measure, the EBP Competency Tool [30] addressed all EIDM steps (see S1 Table). As well, some measures included response scales that were based on agreement (EIDM knowledge measures n=5; EIDM skills n=3) or frequency of completing a task (EIDM behaviour measures n=8), rather than assessing quality of the competence attribute (see S2 Table). Across EIDM attitudes/beliefs measures, content focused more on general beliefs about EIDM (e.g., I value EBP) [38] as compared to individual/personal or organizational factors. Only one measure, the EBP Beliefs Scale [29] comprehensively addressed all three domains (see S3 Table). All EIDM attitude/belief measures included agreement level response scales (e.g., strongly disagree to strongly agree).

Based on identified content gaps, lack of specificity, and vagueness in existing items, new self-report items were generated for EIDM knowledge (19 items) and EIDM skills (15 items) subscales. Accompanying response scales assessing quality of EIDM knowledge and skill acquisition were also developed using psychometric principles [21] and conceptual literature on competence [7]. New items were integrated with items from the EBP Competency Tool (n=13) [30] and EBP Beliefs Scale (n=16) [29], which comprehensively addressed EIDM behaviours and attitudes/beliefs respectively. In total, 63 items were proposed to assess EIDM competence through assessment of knowledge, skills, attitudes/beliefs, and behaviours.

Table 1. Overall EIDM content coverage chart

EIDM competence attribute addressed	**Number of measures addressing EIDM steps**							
	General	**Define**	**Search**	**Appraise**	**Synthesize**	**Adapt**	**Implement**	**Evaluate**
Knowledge (n=19 measures)	11	5	7	6	2	0	3	1

Skills (n=15 measures)	2	6	10	9	1	2	5	4
Behaviours (n=13 measures)	4	8	11	10	5	5	8	7
Attitudes (n=17 measures)	**Number of measures addressing EIDM attitudes/beliefs steps**							
	General beliefs about EIDM			**Individual/personal factors**			**Organizational factors**	
	14			6			5	

Note: Measures in each category identified in S1 Table.

Assessment of Validity Evidence Based on Content

Of the 17 international EIDM experts that were contacted, 11 (65%) participated in the online survey (5 from Europe, 2 from the United States, 4 from Canada) to assess validity based on content of the new measure (63 items). Across the entire measure, item CVIs ranged from 0.64-1.00. Ranges of I-CVIs were similar across subscales: EIDM knowledge (0.72-1.00); EIDM skills (0.72-1.00); EIDM attitudes/beliefs (0.64-0.91); and EIDM behaviours (0.72-0.91) (see S4 Table for CVIs of individual items). Scale-CVIs varied across subscales: knowledge (0.88); skills (0.88); attitudes/beliefs (0.79); and behaviours (0.87). Across subscales, qualitative comments centred on four main themes. First, content experts recommended specific word changes to items to increase clarity:

"The 6S hierarchy is a very specific item – are all PHNs trained on this particular (i.e., Haynes') version? – would it be sufficient (or more appropriate) to talk about an evidence pyramid/hierarchy (i.e., mention the concept of the hierarchy rather than a specific representation of it)?" (feedback for EIDM knowledge item)

Second, experts also identified points of redundancy across items:

"Dissemination of best practice is likely to be part of the implementation step mentioned in item 10. I would reduce this overlap and false dichotomy by using item 10 instead." (feedback for EIDM behaviours item)

Third, qualitative data in some instances, suggested combining certain items or separating double-barrelled items (i.e., items that ask two or more questions simultaneously):

"Other sections want respondent to specify/respond to this question about critical appraisal according to different designs (multiple questions) how consistent is it to lump them all into one question here (though maybe that would be a better strategy for the earlier sections, to combine into a general question)" (feedback for EIDM behaviour item)

"These steps are complex processes. Do you want questions for each one?" (feedback for EIDM knowledge item)

And fourth, comments conveyed that some items were not reflective of EIDM expectations for nurses:

"This is borderline to conducting research… questionable as whether part of EBP/EIDM – will every practitioner be able to do this?" (feedback on EIDM behaviour item)

After considering CVIs, qualitative feedback, and feasibility for use in public health practice settings across the whole measure, 28 items were deleted, 23 were modified, 5 items were added, and 12 were kept in their original form. See Table 2 for data according to each subscale. After these revisions, a total of 40 items were proposed with varying numbers across subscales: EIDM knowledge (11 items); EIDM skills (10 items); EIDM attitudes/beliefs (7 items); and EIDM behaviours (12 items). These modified items then underwent an assessment of validity based on response process in the next phase of measure development.

Table 2. Deleted and Modified Items Following Content Validity Assessment

Subscale	Number of original items	Number of deleted items	Number of modified items	Number of new items added	Number of items kept in original form	Total # after revisions
Knowledge	19	8	4	0	**7**	**11**

Skills	15	7	5	2	3	**10**
Attitude/Beliefs	16	9	5	0	2	**7**
Behaviours	13	4	9	3	0	**12**

Assessment of Validity Based on Response Process

Nine registered nurses in frontline or supervisory roles from two public health units, participated in the assessment of validity based on response process. No items were deleted or added following this assessment. Modifications were made to 8 items across all subscales of knowledge (n=3 items), skills (n=1 item), attitudes/beliefs (n=3 items), and behaviours (n=1 item). Across all modified items, minor revisions followed three main categories to increase clarity: removing words; adding examples; or re-ordering words.

One theme that emerged specific to the knowledge items was that while participants generally felt items were clear and straightforward, some items included terms that required further explanation (e.g., knowledge of what is involved in the 'search' step of EIDM). Participants identified a need for information to help clarify terms that denoted specific steps in EIDM. Three participants suggested use of an information box that hovers over and provides brief definitions of broad EIDM terms (e.g., synthesize, adapt).

With respect to the behaviour items, the majority of participants felt that the stem of each item needed further clarity by adding "I" to the beginning of the statement (i.e., 'participates in the formulation of public health practice questions' versus 'I participate in the formulation of public health practice questions). As well, the response scale for behaviour items was changed from a 4-point to a 7-point Likert scale, based on participant feedback to improve scale consistency, since the other subscales consisted of a 7-point response scale.

Discussion

This study reports the process and results from the development and first phase of validation for a self-report EIDM competence measure. The first step used in developing an initial item pool was content coverage assessment. This was done to determine conceptual strengths and gaps among existing measures identified from a systematic review that assessed EIDM knowledge, skills, attitudes/beliefs, and behaviours. To our knowledge, assessing content coverage is a unique aspect of our study, which has not been used in the development processes of other measures also assessing EIDM knowledge, skills, attitudes/beliefs, and behaviours. In developing the self-report EBPQ, items were generated from a literature review of primary factors influencing EIDM, in addition to engagement of health and social service professionals [18]. Similarly, for the School Nursing Evidence-Based Practice Questionnaire, a review of EIDM literature and existing EIDM measurement tools helped to develop self-report items specific to public health school nursing [19]. However, the development processes for these two measures did not specify if an in-depth process was used, such as thematic analysis from the literature review or strategically developing items to address conceptual gaps in the existing literature, which was conducted in our study. Perhaps the lack of content assessment of existing EIDM measures prior to development of new ones, highlights an important issue that if continued to be left unaddressed, perpetuates conceptual gaps in forthcoming EIDM measures.

As well, results from this content coverage assessment showed notable trends. Items across measures more frequently addressed the EIDM steps of ‘search’ and ‘appraise’. Steps that appear later in the EIDM process (i.e., synthesize, adapt) were less often addressed across measures. This emphasis on searching for, retrieving, and critically appraising research evidence was also demonstrated in a systematic review of 104 EIDM measures used by physicians and

trainees [15]. Shaneyfelt and colleagues [15] reported that measures assessing EIDM skills focused heavily on appraising quality of research evidence and searching specific online databases. These results also reflect a trend across current educational interventions that aim to develop EIDM knowledge, skills, and behaviours. In a systematic review of educational interventions that promoted learning of EIDM among nurses, learning content was analyzed, showing a primary sub-theme of searching for and evaluating evidence [39]. With a concentration on the initial steps of the EIDM process, there is a need to expand the breadth of EIDM competence assessment and content in educational interventions to support a holistic development of EIDM competence. A unique contribution of our proposed EIDM competence measure is that it encompasses items that specifically assess all steps in the EIDM process across knowledge, skills, and behaviour subscales.

Content coverage assessment also determined that existing self-report EIDM measures which assess knowledge, skills, attitudes/beliefs, and behaviours have response scales that do not assess the quality of a competence attribute, but rather use agreement or frequency scales [18-20]. A conceptual limitation of this approach is that it reduces EIDM to completion of tasks, rather than focusing on knowledge level, and how well a skill or behaviour is being performed [9]. Integrated in this new EIDM competence measure are response scales (e.g., beginner to expert; poor to excellent) that reflect quality or one's ability to perform an EIDM task, a critical component of ongoing competence assessment for workforce development [7, 10].

With respect to validity based on content for our measure, item level content validity indices (CVI) were computed [33]. While the use of CVI in nursing studies is commonplace, CVI appears to be used less frequently in EIDM nursing measurement literature. As reported in a systematic review of 35 EIDM measures [17], CVIs were used to confirm validity based on

content for only four measures: the Quick VIK (Values, Implementation, Knowledge) survey [38]; the Knowledge and Skills in Evidence-Based Nursing Tool [40]; Modified Stevens EBP Readiness Inventory [41]; and a self-developed tool by Bostrom et al. [42]. Developers of the remaining 31 measures provided only general information on number and demographics of experts who assessed content validity or did not report on content validity at all. For the four measures with computed CVIs identified above, the majority of original items had CVIs between 0.80 – 1.0, indicating acceptable content validity. In comparison, CVIs for initial items in our proposed EIDM competence measure ranged from 0.64 – 1.0. Most of the low CVI values were linked to items in the attitudes/beliefs subscale, an attribute covered in only one of the four existing EIDM measures reporting CVIs [38]. Less agreement in relevance ratings of EIDM attitudes/beliefs items may be attributed to the subjective nature of this domain compared to greater objectivity surrounding competence indicators for knowledge, skills, and behaviours.

Supplemental to CVI results, qualitative results played a critical role in revisions to the measure. Expert feedback informed, deletions and wording modifications to remove technical terms and simplify multicomponent items. This feedback and measure changes are supported by Streiner and colleagues' [21] recommendations when selecting or devising items. To improve interpretability of items, Streiner and colleagues stress the importance of pre-testing prior to the use of jargon terms. As well, to decrease cognitive load, it is suggested to separate double-barrelled questions into multiple items instead [21]. Another major qualitative theme that surfaced was ensuring items were congruent with realistic EIDM expectations for nurses. This is a valid consideration given there are differences with respect to varying degrees of exposure to EIDM, differing levels of EIDM knowledge and skills, and receptiveness to the EIDM process across disciplines [11].

Validity based on response process was assessed by conducting interviews with nine nurses, in frontline and supervisory roles. Having these two perspectives was beneficial, given that both represent the public health end users for this measure. In comparison, for two measures, the School Nursing Evidence-Based Practice Questionnaire [19] and the Evidence-Based Practice Questionnaire [18], pilot testing of questionnaires was limited to either frontline nurses only or senior health care professionals, potentially omitting critical perspectives of other principal users in practice. A strength of our study is that response process assessment demonstrated participants had strong comprehension of the items, with minor word changes suggested to improve clarity on eight items. This validates the extensive work done prior to modify, delete, and develop new items based on results from the assessment of validity based on content.

While this study makes a unique contribution to the EIDM measurement nursing literature, there are limitations to note. First, for some of the measures assessed for content coverage, specific items could not be retrieved despite efforts to contact original developers. However, given that items for only seven of 35 measures could not be obtained, it is unlikely that such a small number would substantially impact results. Even across the 28 measures of which content coverage was assessed, prominent and consistent themes emerged. Second, a convenience sample was used for the response process assessment with potential to bias results. Those who agreed to participate in this stage of the study may already have a strong interest in EIDM, which could skew their comprehension or feedback about the measure's items. However, in selecting the two public health units from which this sample was obtained, we selected one health unit that was immersed in EIDM work for many years along with a second health unit which was in the beginning stages of conducting EIDM work. This was strategically done to

capture diverse perspectives of individuals with differing exposure to EIDM and varied levels of EIDM knowledge, skills, attitudes/beliefs, and behaviours.

Conclusions

A rigorous process was used to develop and validate the content of a proposed EIDM competence measure for use among public health nurses. Validity evidence with respect to content and response process was assessed and results were used to modify, delete, and add new items to ensure content relevance and clarity. To further assess the psychometric properties of the proposed measure, a larger pilot test is in progress with 16 Ontario public health units. Through this, acceptability, validity evidence based on internal structure and relationships to other variables, along with internal consistency reliability will be assessed.

This new EIDM competence measure has great potential to impact nursing practice, education, and research. Specific EIDM competence indicators can be integrated into performance review processes to support public health nurses in identifying learning needs and developing tailored learning plans related to EIDM. Organizations may also use these indicators for workforce planning and management by articulating EIDM roles and responsibilities for public health nurses [16, 43]. In nursing research, having a standardized EIDM competence measure to help identify workforce gaps is a critical first step in developing targeted interventions to address specific EIDM competencies or overall EIDM competence. There is also great potential to apply this understanding about EIDM competence to curriculum planning and development in undergraduate and graduate nursing programs. Methods for assessing EIDM competence can be integrated into nursing curricula with subsequent use of tailored educational strategies based on competence assessment results.

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S1 Table. Detailed content coverage chart per measure.

Tool	EIDM Content Coverage							
	General	Define	Search	Appraise	Synthesize	Adapt	Implement	Evaluate
Knowledge (n=19 measures total; n=15 measures with retrieved items)								
Evidence-Based Practice Questionnaire (EBPQ) [18]			√					
School Nursing Evidence-Based Practice Questionnaire (SN-EBP) [19]	√		√				√	
Self-developed measure by Chiu et al. (2010)	√							
Johns Hopkins Nursing EBP Assessment Survey [44]	√							
Persian translated EBP measure [45]	*Unable to retrieve items.							
Self-developed measure by Yip, Mordiffi (46)		√						
Self-developed measure by Chew, Sim (47)	*Unable to retrieve items.							
Self-developed EBP measure by Melnyk, Fineout-Overholt (48)	√							
Modified Evidence-Based Nursing Education Questionnaire (EBEQ) [37]	√		√	√				
Quick EBP VIK (Values, Implementation, Knowledge) Survey [38, 49]	√	√	√	√	√			
Modified Stevens EBP Readiness Inventory (ERI) (Finnish ERI) [41]	*Unable to retrieve items.							
Self-developed measure by Gerrish, Guillaume (50)	√							
Knowledge and Skills in Evidence-Based Nursing (KS-EBN) [40]			√	√				

Tool	EIDM Content Coverage							
	General	**Define**	**Search**	**Appraise**	**Synthesize**	**Adapt**	**Implement**	**Evaluate**
Adapted Fresno Test [51]		√	√	√				
Single item measure for EBP knowledge by Skela-Savic, Hvalic-Touzery (52)	√							
Perceived EBP Knowledge Measure [53]	√							
Evidence-Based Practice Knowledge Assessment in Nursing (EKAN) [54]	√	√	√	√	√		√	
Knowledge Assessment Test (KAT) [55]	*Unable to retrieve items.							
Core Knowledge Questionnaire [56]	√	√		√			√	√
Total # measures addressing each EIDM knowledge domain	**11**	**5**	**7**	**6**	**2**	**0**	**3**	**1**
Skills (n=15 measures; n=12 measures with items retrieved)								
EBPQ [18]		√	√	√				
SN-EBP [19]			√	√				√
Self-developed measure by Chiu, Weng (20)	√							
Johns Hopkins Nursing EBP Assessment Survey [44]		√	√	√				
Persian translated EBP measure [45]	*Unable to retrieve items.							
Self-developed measure by Yip, Mordiffi (46)		√	√	√		√	√	√
Self-developed measure by Chew, Sim (47)	*Unable to retrieve items.							
EBP measure developed by Majid et al. (2011) [57, 58]		√	√	√			√	√

Tool	EIDM Content Coverage							
	General	**Define**	**Search**	**Appraise**	**Synthesize**	**Adapt**	**Implement**	**Evaluate**
Modified Stevens EBP Readiness Inventory (ERI) (Finnish ERI) [41]	*Unable to retrieve items.							
Self-developed measure by Gerrish et al. (2011)	√		√	√	√	√	√	√
Knowledge and Skills in Evidence-Based Nursing (KS-EBN) [40]		√ .						
Adapted Fresno Test [51]		√	√	√				
Self-developed measure by Gerrish and Clayton (59)			√	√			√	
DEBPQ [60]			√	√			√	
Information literacy tool [61]			√					
Total # measures addressing each EIDM skills domain	**2**	**6**	**10**	**9**	**1**	**2**	**5**	**4**
Behaviours (n=13 measures total and with retrieved items)								
EBPQ [18]		√	√	√		√		√
SN-EBP [19]			√			√		
Self-developed measure by Chiu et al. (2010)			√					
Johns Hopkins Nursing EBP Assessment Survey [44]		√	√	√	√	√	√	√
Self-developed EBP measure by Melnyk et al. (2004)	√							
Modified Evidence-Based Nursing Education Questionnaire (EBEQ) [37]			√	√	√		√	

Tool	EIDM Content Coverage							
	General	Define	Search	Appraise	Synthesize	Adapt	Implement	Evaluate
Quick EBP VIK (Values, Implementation, Knowledge) Survey [38, 49]	√	√	√	√			√	√
Self-developed measure by Barako, Chege (62)	√			√				
EBP Implementation Scale [29]	√	√	√	√			√	√
Self-developed measure by Bostrom, Rudman (42)		√	√	√			√	√
Self-developed measure by [63]		√	√	√	√		√	
Evidence-Based Practice Confidence Scale (EPIC) [64, 65]		√	√	√	√	√	√	√
EBP Competency Tool [30]		√	√	√	√	√	√	√
Total # measures addressing each EIDM behaviours domain	**4**	**8**	**11**	**10**	**5**	**5**	**8**	**7**

S2 Table. Response scales of measures.

Tool	Objective		Self-report			
	Multiple choice	**Open text/Short answer**	**Agreement level** (e.g., strongly disagree to strongly agree)	**Quality rating** (e.g. poor to best; not competent to highly competence)	**Frequency** (e.g., never to frequently)	**Confidence level** (e.g., I feel confident I can)
Knowledge (n=19 measures total; n=16 measures with retrieved response type)						
Evidence-Based Practice Questionnaire (EBPQ) [18]				√		
School Nursing Evidence-Based Practice Questionnaire (SN-EBP) [19]			√			
Self-developed measure by Chiu, Weng (20)			√			
Johns Hopkins Nursing EBP Assessment Survey [44]			√			√
Persian translated EBP measure [45]	*Unable to retrieve response type.					
Self-developed measure by Yip et al. [46]				√		
Self-developed measure by Chew, Sim (47)	*Unable to retrieve response type.					
Self-developed EBP measure by Melnyk, Fineout-Overholt (48)				√		
Modified Evidence-Based Nursing Education Questionnaire (EBEQ) [37]			√			
Quick EBP VIK (Values, Implementation, Knowledge) Survey [38, 49]				√		
Modified Stevens EBP Readiness Inventory (ERI) (Finnish ERI) [41]	√					
Self-developed measure by Gerrish, Guillaume (50)		√				
Knowledge and Skills in Evidence-Based Nursing (KS-EBN) [40]	√	√				
Adapted Fresno Test [51]		√				
Single item measure for EBP knowledge by Skela-Savic, Hvalic-Touzery (52)				√		

Tool	Objective		Self-report			
	Multiple choice	**Open text/Short answer**	**Agreement level** (e.g., strongly disagree to strongly agree)	**Quality rating** (e.g. poor to best; not competent to highly competence)	**Frequency** (e.g., never to frequently)	**Confidence level** (e.g., I feel confident I can)
Perceived EBP Knowledge Measure [53]			√			
Evidence-Based Practice Knowledge Assessment in Nursing (EKAN) [54]	√					
Knowledge Assessment Test (KAT) [55]	*Unable to retrieve response type.					
Core Knowledge Questionnaire [56]	√					
Total # knowledge measures for each response type	**4**	**3**	**5**	**5**	**0**	**1**
Skills (n=15 measures; n=12 measures with retrieved response type)						
EBPQ [18]				√		
SN-EBP [19]			√			
Self-developed measure by Chiu, Weng (20)			√			
Johns Hopkins Nursing EBP Assessment Survey [44]			√			√
Persian translated EBP measure [45]	*Unable to retrieve response type.					
Self-developed measure by Yip, Mordiffi (46)				√		
Self-developed measure by Chew, Sim (47)	*Unable to retrieve response type.					
EBP measure developed by Majid et al. (2011) [57, 58]				√		
Modified Stevens EBP Readiness Inventory (ERI) (Finnish ERI) [41]						√
Self-developed measure by Gerrish, Guillaume (50)				√		
Knowledge and Skills in Evidence-Based Nursing (KS-EBN) [40]	√	√				
Adapted Fresno Test [51]		√				
Self-developed measure by Gerrish and Clayton (59)				√		

Tool	Objective		Self-report			
	Multiple choice	**Open text/Short answer**	**Agreement level** (e.g., strongly disagree to strongly agree)	**Quality rating** (e.g. poor to best; not competent to highly competence)	**Frequency** (e.g., never to frequently)	**Confidence level** (e.g., I feel confident I can)
DEBPQ [60]				√		
Information literacy tool [61]	*Unable to retrieve response type.					
Total # skills measures for each response type	**1**	**2**	**3**	**6**	**0**	**2**
Behaviours (n=13 measures total and with retrieved response type)						
EBPQ [18]					√	
SN-EBP [19]					√	
Self-developed measure by Chiu, Weng (20)					√	
Johns Hopkins Nursing EBP Assessment Survey [44]			√			√
Self-developed EBP measure by Melnyk, Fineout-Overholt (48)					√	
Modified Evidence-Based Nursing Education Questionnaire (EBEQ) [37]			√			
Quick EBP VIK (Values, Implementation, Knowledge) Survey [38, 49]					√	
Self-developed measure by Barako, Chege (62)					√	
EBP Implementation Scale [29]					√	
Self-developed measure by Bostrom, Rudman (42)					√	
Self-developed measure by [63]				√		
Evidence-Based Practice Confidence Scale (EPIC) [64, 65]						√
EBP Competency Tool [30]				√		
Total # behaviour measures addressing each EIDM behaviours domain	**0**	**0**	**2**	**2**	**8**	**2**

S3 Table. Detailed content coverage chart per EIDM attitudes/beliefs measure.

Tool	EIDM Content Coverage		
n=17 measures total; n=15 measures with retrieved items	**General Beliefs about EIDM**	**Individual Factors**	**Organizational Factors**
EBPQ [18]	√	√	√
SN-EBP [19]	√	√	
Self-developed measure by Chiu et al. (2010)	√		
Persian translated EBP measure [45]	*Unable to retrieve items.		
Self-developed measure by Yip, Mordiffi (46)	√	√	
Self-developed measure by Chew, Sim (47)	*Unable to retrieve items.		
Self-developed EBP measure by Melnyk et al. (2004)	√		
Modified Evidence-Based Nursing Education Questionnaire (EBEQ) [37]	√		
Quick EBP VIK (Values, Implementation, Knowledge) Survey [38, 49]	√		√
Self-developed measure by Barako, Chege (62)	√		
EBP measure developed by by Majid et al. (2011) [57, 58]	√	√	
Evidence-based Practice Beliefs Scale [29]	√	√	√
Modified Korean Evidence-Based Medicine questionnaire [66]	√		
Evidence-Based Practice Attitudes Scale (EBPAS) [64, 65]	√		
Attitudes to Evidence-Based Practice Questionnaire [67]		√	√
Evidence-Based Nursing Attitude Questionnaire (EBNAQ) [68, 69]	√		
Nurses' Attitudes Toward EBP Scale (NATES) [53]	√		√
Total # measures addressing each EIDM attitudes/beliefs domain	**14**	**6**	**5**

S4 Table. Item content validity indexes (CVI).

Original Items – EIDM Knowledge	Item CVI
1. Knowledge of what is involved in the 'define' step of EIDM.	1.00
2. Knowledge of what is involved in the 'search' step of EIDM.	1.00
3. Knowledge of what is involved in the 'appraise' step of EIDM.	1.00
4. Knowledge of what is involved in the 'synthesize' step of EIDM.	1.00
5. Knowledge of what is involved in the 'adapt' step of EIDM.	1.00
6. Knowledge of what is involved in the 'implement' step of EIDM.	1.00
7. Knowledge of what is involved in the 'evaluate' step of EIDM.	1.00
8. Knowledge about the 6S hierarchy of research evidence	0.82
9. Knowledge of online databases that house pre-appraised, synthesized research evidence (e.g., Health Evidence, ACCESSSS)	0.82
10. Knowledge of online databases that house individual research studies (e.g., Medline)	0.91
11. Knowledge of critical appraisal tools for summaries of research evidence (e.g. clinical practice guidelines)	0.91
12. Knowledge of critical appraisal tools for systematic reviews	0.91
13. Knowledge of critical appraisal tools for qualitative research studies	0.82
14. Knowledge of critical appraisal tools for randomized controlled trials	0.91
15. Knowledge of critical appraisal tools for observational studies	0.82
16. Knowledge about the definition of knowledge translation	0.73
17. Knowledge of **all** the steps of developing a knowledge translation plan (conduct stakeholder analysis, assess barriers/facilitators, select appropriate knowledge translation strategies)	0.82
18. Knowledge about how to develop outcome indicators to evaluate practice change.	0.72
19. Knowledge about how to develop process indicators to evaluate practice change.	0.72
Original Items – EIDM Skills	**Item CVI**
1. Ability to develop an answerable public health practice question using the PICO (P=population; I=intervention; C=comparison; O=outcome) format for quantitative research questions.	1.00
2. Ability to develop an answerable public health practice question using the PS (P=patient/population; S=situation) format for qualitative research questions.	0.91
3. Ability to develop a comprehensive strategy to search for research evidence.	0.91
4. Ability to use online databases that house pre-appraised, synthesized research evidence (e.g., Health Evidence).	0.91
5. Ability to use online databases that house individual research studies reports (e.g., CINAHL)	0.91
6. Ability to use critical appraisal tools to appraise pre-appraised, synthesized research evidence such as best practice guidelines.	0.91

Original Items – EIDM Knowledge	Item CVI
7. Ability to use critical appraisal tools to appraise systematic reviews	0.82
8. Ability to use critical appraisal tools to appraise qualitative research studies	0.82
9. Ability to use critical appraisal tools to appraise randomized controlled trials	0.91
10. Ability to use critical appraisal tools to appraise observational studies	0.82
11. Ability to assess the applicability of research evidence to the local public health context.	1.0
12. Ability to develop a knowledge translation plan for implementing a new change in practice.	0.91
13. Ability to develop a knowledge translation plan for de-implementing a current practice.	0.91
14. Ability to develop outcome indicators to evaluate practice change.	0.72
15. Ability to develop process indicators to evaluate practice change.	0.72
Original Items – EIDM Attitudes/Beliefs [29]	**Item CVI**
1. I am sure that I can implement EBP in a time efficient way.	0.82
2. I am sure that I can implement EBP.	0.72
3. I believe that I can search for the best evidence to answer clinical questions in a time efficient way.	0.91
4. I am confident about my ability to implement EBP where I work.	0.72
5. I believe that I can overcome barriers in implementing EBP.	0.91
6. I am sure about how to measure the outcomes of clinical care.	0.91
7. I know how to implement EBP sufficiently enough to make practice changes.	0.72
8. I am sure that I can access the best resources in order to implement EBP.	0.82
9. I am sure that implementing EBP will improve the care that I deliver to my patients.	0.82
10. I believe that critically appraising evidence is an important step in the process.	0.91
11. I am clear about the steps of EBP.	0.64
12. I am sure that evidence-based guidelines can improve clinical care.	0.82
13. I believe that EBP results in the best clinical care for patients.	0.64
14. I believe the care that I deliver is evidence-based.	0.72
15. I believe EBP is difficult. (reverse scored)	0.82
16. I believe that EBP takes too much time. (reverse scored)	0.72
Original Items – EIDM Behaviours [70]	**Item CVI**
1. Questions clinical practices for the purpose of improving the quality of care.	0.91
2. Describes clinical problems using internal evidence* (internal evidence* = evidence generated internally within a clinical setting, such as patient assessment data, outcomes management, and quality improvement data).	0.91
3. Participates in the formulation of clinical questions using PICOT* format. (*PICOT = patient; population; intervention or area of interest; comparison intervention or group; outcome; time).	0.91

	Item CVI
4. Searches for external evidence* to answer focused clinical questions. (external evidence* = evidence generated from research).	0.91
5. Participates in critical appraisal of pre-appraised evidence (such as clinical practice guidelines, evidence-based policies and procedures, and evidence syntheses).	0.82
6. Participates in the critical appraisal of published research studies to determine their strength and applicability to clinical practice.	0.91
7. Participates in the evaluation and synthesis of a body of evidence gathered to determine its' strength and applicability to clinical practice.	0.91
8. Collects practice data (e.g., individual patient data, quality improvement data) systematically as internal evidence for clinical decision making in the care of individuals, groups and populations.	0.72
9. Integrates evidence gathered from external and internal sources in order to plan evidence-based practice changes.	0.91
10. Implements practice changes based on evidence and clinical expertise and patient preferences to improve care processes and patient outcomes.	0.82
11. Evaluates outcomes of evidence-based decisions and practice changes for individuals, groups and populations to determine best practices.	0.91
12. Disseminates best practices supported by evidence to improve quality of care and patient outcomes.	0.82
13. Participates in strategies to sustain an evidence-based practice culture.	0.91

Chapter 6:

Validation, Reliability, and Acceptability of the Evidence-Informed Decision-Making (EIDM) Competence Measure

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Abstract

Introduction: Valid, reliable, and acceptable tools for assessing self-reported competence in evidence-informed decision-making (EIDM) are required to provide insight into the current status of EIDM knowledge, skills, attitudes/beliefs, and behaviours for registered nurses working in public health.

Purpose: The purpose of this research study was to assess the validity, internal reliability, and acceptability of the EIDM Competence Measure.

Methods: A psychometric study design was employed guided by the Standards for Educational and Psychological Testing and general measurement development principles. All registered nurses working across 16 health units in Ontario, Canada were invited to complete the EIDM Competence Measure via an online survey. The EIDM Competence Measure consists of four EIDM subscales: 1) knowledge; 2) skills; 3) attitudes/beliefs; and 4) behaviours. The internal structure of the tool was first assessed by analyzing item-subscale total and item-item correlations within subscales to assess the potential for item reduction of the original 40-item tool. Following item reduction which resulted in a revised 27-item EIDM Competence Measure, a principal component analysis using an oblique rotation (allowing correlated factors) was performed. Validity evidence based on relationships to other variables was assessed by exploring associations between EIDM competence attributes and individual factors (e.g., years of nursing experience, education, role, EIDM training) and organizational factors (e.g., resource allocation, EIDM champions). Internal reliability was analyzed using Cronbach's alphas. Acceptability was measured by calculating completion time and percentage of missing data of the original 40-item tool.

Results/Findings: Across 16 participating public health units, 201 nurses completed the EIDM Competence Measure. Extraction of a four-factor model based on the 27-item version of the scale showed substantial factor loadings (>0.4) that aligned with the four EIDM subscales of knowledge, skills, attitudes/beliefs, and behaviours. Significant relationships between EIDM competence subscale scores and education, EIDM training, EIDM project involvement, and supportive organizational culture were observed and in accordance with expectations. Cronbach's alphas exceeded minimum standards for all subscales: knowledge (α=0.96); skills (α=0.93); attitudes/beliefs (α=0.80); and behaviours (α=0.94). Overall missing data was minimal as 93% of participants completed the entire original 40-item tool (i.e., no missing data), meaning only 7% of participants had at least one item with missing data. As well, only one participant (0.5%) had >10% of missing data (i.e., more than 4 out of 40 items with data missing). Mean completion time was 7 minutes and 20 seconds for the entire 40-item tool.

Keywords: evidence-informed decision-making, public health nursing, self-reported competence assessment, community health nursing, evidence-based nursing, instrument development

Introduction

The crucial need for implementing evidence-informed public health interventions that are cost-efficient and effective has been increasingly demonstrated amid emerging communicable diseases, sustained rates of chronic conditions, climate change, and other public health threats to populations, communities, and individuals [1]. The concept of basing public health decision making on diverse forms of high quality, available evidence is recognized as evidence-informed decision-making (EIDM) [2]. EIDM involves the identification, appraisal, and application of evidence related to research, along with professional expertise, local context, and client and community characteristics, needs, and preferences in public health practice [2-4].

Across the functions of public health preparedness, prevention, protection, and promotion [5], there is considerable evidence of high-quality, effective and cost-efficient interventions [6, 7]. Despite this evidence base, there is a persistent gap in which research evidence is not consistently used by public health professionals to inform decision-making in practice [8, 9]. Findings across multiple studies highlight this research-to-practice gap among the public health workforce, of which nurses remain the largest professional discipline [10]. In two studies exploring EIDM capacity building among public health professionals, participants reported that between 58%-72% of public health programs offered by their state and local organizations were based on research evidence [11, 12]. Furthermore, in a systematized review of 33 studies exploring public health professionals' information needs for evidence-informed decision-making, Barr-Walker [13] reported that colleagues served as a primary information source more often than online databases. In another study investigating public health decision-making among local governments in Australia, [14] published literature such as journal articles or reports by

academic institutions were reported as the least influential and least useful resources in decision-making.

Findings from international studies centred specifically on nurses in public health further validate this research-to-practice gap. Authors of studies in Canada [15] and Norway [16] have reported that nurses frequently used knowledge from clients, other clinical experts, and professional development trainings to inform their professional practice, and in fewer instances relied on evidence from published research.

Deficits in EIDM public health practice relate largely to low levels of confidence, knowledge, and skills sets in performing EIDM related tasks [17, 18], along with a lack of organizational support such as work cultures resistant to change, insufficient resource allocation, or lack of protected time for EIDM work [17, 19]. Strategies to encourage sustained organization-wide EIDM uptake include supportive nursing leadership and mentorship, a focus on competence development at the individual practitioner level through professional development opportunities [17, 20], integration of EIDM as a strategic priority in organizational missions or visions, and explicit indicators of EIDM responsibilities and expectations for practitioners and health care leaders [20-22]. Regarding the latter, the articulation of EIDM expectations provides organizations and health care professionals with shared and consistent language around standards that can be integrated into competence assessment measures for use in real-world practice.

While many tools exist to measure EIDM, there are only a few that specifically seek to assess EIDM competence among different health care professionals. The Evidence Based Practice Evaluation Competence Questionnaire (EBP-COQ) is a 25-item tool with demonstrated internal reliability, construct and discriminant validity which assesses self-reported competence

in EIDM among undergraduate nursing students [23]. Developers of this instrument defined competence as the ability to choose and use knowledge, skills and attitudes with the intention of performing a task in a specific context [23]. The Fresno test has also been labelled by its developers as a competence assessment measure for EIDM knowledge and skills [24]. This objective measure has been tested among family practice residents, EIDM educators [24] and an adapted version used among pediatric nurses [25]. The Fresno test requires responses to short answer questions based on hypothetical clinical scenarios. Inter-rater reliability, internal consistency, and content, and construct validity have all been established through its psychometric testing [24]. While the original developers do not explicitly discuss their established conceptual definition of competence [24], the author of the adapted Fresno test discusses the conceptual meaning of competence as related to knowledge and skill acquisition [25].

Missing from the conceptual definitions of competence used in these existing measures is inclusion of all attributes that comprise competence, which includes knowledge, skills, attitudes/values, and behaviours [26-28]. Competence has been defined as the integration of these four attributes with a focus on the quality of task performance related to a specific standard [26, 28, 29]. Specifically, in relation to competence in EIDM, these four attributes are well described across the literature (see Table 1).

Table 1. EIDM competence attribute definitions

Knowledge	Skill/functional	Attitudes/values	Behavioural
Awareness and understanding about principles, steps, and practical aspects of EIDM [30-33]	Applying knowledge of EIDM steps, principles in a practical setting (e.g., clinical case scenario) [30, 31, 33, 34]	Views, perceptions, beliefs, thoughts, intentions about agreement, acceptance related to EIDM overall or its aspects [30, 32, 33]	Performance of EIDM tasks in a real-world setting (e.g., searching databases for evidence based real life clinical problem) [30, 33, 34]

This conceptual underrepresentation among EIDM competence attribute measures has also been confirmed in a recent systematic review of 35 measures assessing EIDM knowledge, skills, attitudes, and/or behaviours in which authors reported that only three measures assessed all four competence attributes [35]. In addition, there were limitations among these three measures, including a lack of assessment in the quality of the competence attributes, a critical component of competence, particularly with respect to EIDM behaviours [35].

To address these conceptual gaps among EIDM measures, this study aimed to develop and psychometrically test a comprehensive self-report EIDM competence measure assessing the quality of knowledge, skills, attitudes/beliefs, and behaviours among nurses in public health. The first phase of this study, described elsewhere [36], focused on the process of item development, content validation, and response process assessment of the new EIDM Competence Measure. The purpose of this paper is to describe the second phase of this study; to assess validity evidence based on internal structure, relationships to other variables, internal consistency reliability, and acceptability of the EIDM Competence Measure to practicing public health nurses.

Methods

Design

A psychometric study design was employed for this study, guided by the Standards for Educational and Psychological Testing [37] and general measure development principles [38].

Sample and Recruitment

Recruitment occurred from November 2019 to March 2020. A convenience sample of public health units in Ontario was employed based on this project being a pilot study. Existing relationships with Medical Officers of Health in Ontario were used to identify organizations for

this convenience sample. Thirty-two Ontario health units were invited to participate through an email sent to each Medical Officer of Health informing them about and requesting support for the study. Sixteen Medical Officers of Health agreed to support the study, permitting recruitment of registered nurses at their health units. Champions in each health unit (e.g., Chief Nursing Officers, nursing managers) were identified by Medical Officers of Health and were responsible for sending out emails to all registered nurses working in their respective health units, inviting them to voluntarily participate in the study. Invitation emails included a study introductory letter with a link to the participant consent form (see Appendix N) and anonymous online survey.

All registered nurses within the health units agreeing to participate in the study were invited to participate. The target sample size was 400 participants based on a 10:1 respondent to item ratio for factor analysis based on an original EIDM competence tool consisting of 40 items [39]. Inclusion criteria were: 1) licensure as a registered nurse; 2) employment in an Ontario public health unit; and 3) working in any nursing or non-nursing role within the health unit. Those who participated in the first phase of the study (response process testing) were not eligible to participate, as they would have had familiarity with the measure, with potential to skew results [36].

Data Collection

Data collection occurred from December 2019 to March 2020. Upon confirming written consent via an online form, participants completed a one-time anonymous online survey via the LimeSurvey platform. The self-report survey consisted of three sections: 1) demographics; 2) organizational factors; and 3) the 40-item self-report EIDM Competence Measure (see Appendix O). Demographic information collected included: number of years worked as a registered nurse and in public health; gender; current role; primary area of work specialization; highest earned

degree; completion of formal EIDM training; and involvement in EIDM projects/work. Regarding organizational factors, 12 out of 19 items relevant to a public health setting, from the Organizational Culture and Readiness for System-Wide Implementation of EBP (OCR-SIEP) scale [40] were used with participants responding to items on a 5-point Likert scale (1=not at all to 5=very much). Since the OCR-SIEP employed a summative score, this same scoring process was applied to the subset of 12 selected items, with higher scores denoting greater organizational readiness for EIDM. Permission for use of scale items was granted by the original developer, Dr. Bernadette Melnyk [41]. The original 40-item self-report EIDM Competence Measure, which was assessed for content and response process validity in the first phase of the study [36] consisted of four subscales: knowledge (11 items), skills (10 items), attitudes/beliefs (7 items), and behaviours (12 items). Participants responded to each subscale on a 7-point Likert scale: knowledge (1=poor to 7=excellent); skills (1=beginner to 7=expert); attitudes/beliefs (1=strongly disagree to 7=strongly agree); and behaviours (1=not competent to 7=highly competent). Given the multi-dimensional nature of the instrument, an overall total score was not computed. Instead, a total for each of the four subscales was computed. Reverse coding was conducted for only one item in the EIDM attitudes/beliefs subscale (i.e., "I believe EIDM is difficult"). Higher total subscale scores denoted higher competence for that EIDM competence attribute.

Data Analysis

Validity evidence based on internal structure.

Validity evidence based on internal structure is defined as the "degree to which the relationships among test items and test components conform to the construct on which the proposed test score interpretations are based" [37 p. 36]. Internal structure was assessed by performing the following analyses using SAS 9.4 statistical software: 1) item-subscale total

polychoric correlations, representing the correlation of individual items with subscale totals [38]; 2) item-item polychoric correlations within each subscale [42]; and 3) exploratory factor analysis using principal components analysis (PCA) using an oblique rotation which allowed for correlated factors, a common method used to extract potential latent variables/factors in the assessment of dimensionality and to reduce item components into more meaningful data [42-44]. Polychoric correlations were computed given that response scales of all items included in the tool consisted of ordinal data (i.e., 7-point Likert scales) [45, 46]. The use of polychoric correlations in the factor analysis of ordinal data, compared to Pearson correlations which are to be used with at least interval-level data, yields results that demonstrate less error and better alignment with originally proposed theoretical models [45].

Conceptual literature was considered alongside statistical criteria in decision-making related to item deletions or item combinations [47]. Items in which item-subscale correlations were low (<0.3) were deleted [38]. Item-item correlations within subscales were analyzed and those with low correlations <0.30 were flagged for possible deletion [38]. High item-item correlations within subscales of >0.80 may signal redundancy [42] and as such, were flagged for possible item deletion or item combination. Potential item deletions and combinations were discussed and finalized with consideration of conceptual literature [42] among co-investigators given the team's expertise in EIDM and public health nursing. After these revisions, subscale-subscale correlations were computed to explore relationships between EIDM competence attributes.

Prior to conducting PCA on the revised EIDM competence tool, the Kaiser-Meyer-Olkin (KMO) test was performed to determine sampling adequacy [42, 43] with a value above 0.5 being used to determine adequacy [39, 48]. PCA was performed using an oblique rotation, given

that items were assumed to be interrelated [42]. A four factor model solution was extracted in the PCA analysis, consistent with the design of the tool which was based on a priori conceptual literature [49] that EIDM competence is comprised of four key attributes of knowledge, skills, attitudes/beliefs, and behaviours. Items were assessed as loading onto a factor if loadings were a minimum of ≥ 0.4 [42], with strong loadings indicated by values of ≥ 0.5 [49, 50].

Validity evidence based on relations to other variables.

This source of validity evidence involves the testing of relationships between instrument sub-scale scores and socio-demographic and organizational factors to determine their consistency with the construct under measurement [37]. Correlations, t-tests, and ANOVA analyses were performed using IBM SPSS version 26 with level of significance set at alpha=0.05 (2-sided) to explore variable relationships. The following relationships were hypothesized: 1) years of experience as a registered nurse would be positively correlated with EIDM knowledge, skills, attitudes, and behaviours [51]; 2) those working in a supervisory or management role would have higher EIDM knowledge, skills, attitudes/beliefs, behaviours compared to frontline staff [52, 53]; 3) those with a higher education level would have higher EIDM knowledge, skills, attitudes/beliefs, behaviour scores [52, 54]; 4) those who completed EIDM training or have had involvement in EIDM projects/work would have higher EIDM knowledge, skills, attitudes/beliefs, behaviour scores [54]; and 5) those who self-reported higher organizational support for EIDM would have higher EIDM knowledge, skills, attitudes/beliefs, behaviour scores compared to those with lower organizational support [17, 55].

Acceptability.

Acceptability is associated with the practicality of a measure and was operationalized by the amount of time respondents were required to complete the tool and the extent to which there

was difficulty with completion as it related to missing data [56]. Mean completion times were analyzed for the entire original 40-item tool and each EIDM subscale. Acceptable completion time was identified as < 10 minutes [57, 58] for the entire original 40-item tool. Missing data were analyzed through: 1) percentage of participants who completed the entire 40-item tool (i.e., no missing data) [59]; 2) percentage of participants who had data missing for at least one item [51]; and 3) percentage of participants who had >10% of missing data [60] across the entire 40-item tool (i.e., more than 4 out of 40 items with missing data).

Reliability.

Reliability was assessed by examining the measure's internal consistency, which determines how well scale items are correlated with one another in order to yield similar scores [38, 61]. Cronbach's alphas were computed for each individual subscale [38]. This is the most frequently used statistic for examining reliability in psychometric testing, can be determined with one administration, and is recommended for use with items that have more than two response options [38, 61]. Acceptable internal consistency for each sub-scale was determined as a Cronbach's alpha (α) of ≥ 0.70 [62].

Results

Demographics

Across the 16 participating public health units, 562 registered nurses opened the online survey. Of these 201 respondents (35.8%) completed and submitted the survey. Participants were largely female (98.5%), primarily employed as a frontline public health nurse (87.2%), Bachelor's degree prepared (73.1%), and worked across diverse specializations, with the majority having completed EIDM training (66.8%). See Table 2 for detailed demographics.

Table 2. Participant demographics

Demographic variable	
Number of years worked (N=201)	**Mean (Standard Deviation)**
As a registered nurse (RN)	18.1 (10.7)
In public health	13.6 (8.5)
Gender (N=200)	**n (%)**
Female	197 (98.5)
Male	2 (1)
Other	1 (0.5)
Current Role (N=196)	
Public health nurse	171 (87.2)
Health promoter	3 (1.5)
Supervisory/manager	12 (6.1)
Director	2 (1)
Other	8 (4.1)
Highest earned degree (N=201)	
Bachelor's degree	147 (73.1)
Master's degree	54 (26.9)
Area of work specialization (N=201)	
Reproductive/infant health/healthy babies/children	61 (30.3)
School years	23 (11.4)
Chronic disease prevention/injury prevention and safety	16 (8)
Communicable diseases/sexually transmitted diseases	60 (29.8)
Emergency preparedness	3 (1.5)
Mental health	1 (0.5)
Substance use	13 (6.5)
Other	24 (11.9)
Completed EIDM training (N=199)	
No	66 (33.2)
Yes	133 (66.8)
Involvement in EIDM work/projects (N=201)	
No	102 (50.7)
Yes	99 (49.3)

Validity Evidence

Validity based on internal structure.

Item-subscale total correlations for the original 40 items all met the minimum criteria of 0.3 (see Table 3). Ranges of *item-item correlations* varied across subscales: knowledge (0.810-0.936); skills (0.805-0.923); attitudes/beliefs (0.038-0.867); and behaviours (0.801-0.901). Some *item-item correlations* fell below the minimum of 0.3 indicating weak relationships while others exceeded 0.8 indicating potential redundancy (see S1 Table for low and high item-item

correlations). Based on low or high item-item correlations, along with consideration of conceptual literature, item deletions and item combinations were made within each EIDM subscale: 1) knowledge (deleted items #3, 4, 5, 7 based on redundancy); 2) skills (deleted items #2, 7, 8, 9 and combined items #3 and 4 based on redundancy); 3) attitudes (deleted item #7 due to irrelevance and combined items #4 and 6 due to redundancy); and 4) behaviours (deleted #5 and 6 due to redundancy).

Table 3. Item-subscale total correlations (40 items)

Item	Item-subscale correlation
Knowledge	
K1. Knowledge of what is involved in the 'define' step of EIDM	0.832
K2. Knowledge of what is involved in the 'search' step of EIDM	0.864
K3. Knowledge about different levels of evidence when searching for research evidence (e.g., single studies, systematic reviews, summaries)	0.867
K4. Knowledge that online databases exist which house publications of individual research studies (e.g., PubMed, CINAHL)	0.819
K5. Knowledge that online databases exist which house pre-appraised, synthesized research evidence (e.g., Health Evidence, ACCESSSS)	0.854
K6. Knowledge of what is involved in the 'appraise' step of EIDM	0.935
K7. Knowledge that critical appraisal tools exist to assess the quality of research evidence (e.g., AGREE II tool, CASP)	0.850
K8. Knowledge of what is involved in the 'synthesize' step of EIDM	0.936
K9. Knowledge of what is involved in the 'adapt' step of EIDM	0.932
K10. Knowledge of what is involved in the 'implement' step of EIDM	0.894
K11. Knowledge of what is involved in the 'evaluate' step of EIDM	0.873
Skills	
S1. Ability to develop an answerable practice question.	0.893
S2. Ability to develop an appropriate strategy to search for research evidence	0.928
S3. Ability to use online databases that house publications of individual research studies (e.g., CINAHL)	0.853
S4. Ability to use online databases that house pre-appraised, synthesized research evidence (e.g., Health Evidence)	0.899
S5. Ability to use critical appraisal tools to appraise the quality of research evidence (e.g., AGREE II tool, CASP)	0.881
S6. Ability to assess applicability of research evidence to the local public health context.	0.939
S7. Ability to conduct an assessment of barriers and facilitators (related to resources, organization, evidence/guideline, clients' preferences/values) when implementing a practice change.	0.922
S8. Ability to conduct a stakeholder analysis (i.e., collecting and analyzing information on stakeholders' importance and influence) when implementing a practice change.	0.921

S9. Ability to develop an action plan to implement an evidence-informed practice change.	0.920
S10. Ability to participate in the development of evaluation indicators to assess outcomes of evidence-informed decision or practice changes.	0.913
Attitudes	
A1. I believe that I can implement EIDM in a time efficient way.	0.780
A2. I believe I can engage others in implementing strategies to address barriers (e.g., personal, organizational, community) when implementing EIDM	0.746
A3. I believe that evaluating outcomes of an evidence-informed decision or practice change is an important component of EIDM.	0.829
A4. I believe that implementing EIDM can improve the services and programs delivered to clients (e.g., communities, individuals, families).	0.825
A5. I believe that critically appraising evidence is an important step in the EIDM process.	0.770
A6. I believe that the use of high-quality evidence-informed guidelines (e.g., clinical practice guidelines) can improve public health practice and policy.	0.731
A7. I believe EIDM is difficult.	0.516
Behaviours	
B1. I question public health practices for the purpose of improving the quality of care/service delivery.	0.692
B2. I describe public health practice issues using client assessment data (i.e., community, individuals, families, populations).	0.732
B3. I participate in the formulation of public health practice questions.	0.838
B4. I search for research evidence to answer public health practice questions.	0.703
B5. I participate in the critical appraisal of individual research studies to determine their strength and applicability to public health practice.	0.868
B6. I participate in the critical appraisal of synthesized evidence (such as clinical practice guidelines, evidence-based policies and procedures, and evidence syntheses).	0.841
B7. I participate in the synthesis and interpretation of a body of research evidence gathered to formulate recommendations for public health practice.	0.895
B8. I integrate evidence gathered from public health expertise, client or community preferences, and local context with research evidence to plan evidence-informed practice changes.	0.901
B9. I participate in the assessment of barriers and facilitators (related to resources, organization, evidence/guidelines, clients' preferences/values) when implementing a practice change.	0.844
B10. I participate in the process of stakeholder analyses (i.e., collecting and analyzing information on stakeholders' importance and influence) when implementing a practice change.	0.872
B11. I participate in the development of an action plan to implement a practice change.	0.841
B12. I participate in evaluating outcomes of evidence-informed decisions or practice changes.	0.852

Following the item reduction process, a revised EIDM competence measure was proposed consisting of 27 items. Regarding *subscale-subscale correlations,* findings demonstrated significant positive associations between all EIDM subscales (see Table 4).

Table 4. Subscale-subscale Pearson correlations (r)

	EIDM Knowledge	EIDM Skills	EIDM Attitudes	EIDM Behaviours
EIDM Knowledge	1	.783**	.630**	.684**
EIDM Skills	.783**	1	.585**	.755**
EIDM Attitudes	.630**	.585**	1	.581**
EIDM Behaviours	.684**	.755**	.581**	1

** Correlation is significant at the 0.01 level (2-tailed).

A PCA with oblique rotation was then performed on the revised 27-item self-report Competence Measure. The Kaiser-Meyer-Olkin test verified sampling adequacy with a value of 0.8597. A four-factor model was extracted with all components accounting for 90.00 % of the variance. Primary factor loadings were substantial across components and ranged from 0.463 to 0.924. Items primarily loaded onto factors that aligned with the established conceptual framework of EIDM behaviours (Factor 1), knowledge (Factor 2), skills (Factor 3), and attitudes/beliefs (Factor 4). However, there were three cases where significant cross-loading with other domains were observed: 1) attitude item #1 loaded onto Factor 3 (skills, factor loading = 0.54432); 2) attitude item #2 loaded onto Factor #1 (behaviours, factor loading = 0.46275); and 3) skills item #5 loaded onto Factor #1 (behaviours) with a value of 0.58381, while also cross loading to Factor #3 (skills) with a lower but acceptable value of 0.50309 (see Table 5 for factor loadings). After reviewing these factor loadings, along with consideration of acceptable item-subscale total correlations (see Table 6) and conceptual literature, these three items were retained in the competence attribute under which they were originally categorized. The final proposed 27-item EIDM competence measure consists of a varied number of items per subscale: knowledge (7 items); skills (5 items); attitudes (5 items); behaviours (10 items).

Table 5. Factor loadings for 27-item EIDM competence measure

	Behaviours	Knowledge	Skills	Attitudes
B9 participate in development of action plan	**0.83330**	0.36131	0.05844	0.06041
B7 participate in assessment of barriers/facilitators	**0.82986**	0.33910	0.15039	0.06866

	Behaviours	Knowledge	Skills	Attitudes
B10 participate in evaluating outcomes	**0.82784**	0.34701	0.10771	0.08060
B8 participate in stakeholder analysis	**0.80123**	0.30334	0.24328	0.00585
B6 integrate evidence from expert/preferences/context	**0.78667**	0.28615	0.30018	0.10554
B3 participate in formulating public health practice questions	**0.67181**	0.22779	0.40243	0.16308
B5 participate in synthesis and interpretation of evidence	**0.64193**	0.27840	0.49000	0.09156
B2 describe public health practice issues using client data	**0.59533**	0.18411	0.33834	0.24173
S5 ability to develop evaluation indicators	**0.58381**	0.43891	0.50309	0.07669
B1 question public health practices	**0.55902**	0.13263	0.34727	0.23593
B4 search for research evidence	**0.52637**	0.04308	0.35800	0.39682
A2 engage others to address EIDM barriers	**0.46275**	0.33608	0.42824	0.24907
K9 knowledge of adapt step	0.31157	**0.83284**	0.29666	0.11174
K6 knowledge of implement step	0.41174	**0.82480**	0.15738	0.14134
K4 knowledge of synthesize step	0.23683	**0.81492**	0.41201	0.12885
K1 knowledge of define step	0.24588	**0.77078**	0.17705	0.18103
K3 knowledge of appraise step	0.22579	**0.76328**	0.41405	0.18797
K7 knowledge of evaluate step	0.42076	**0.74304**	0.22450	0.21527
K2 knowledge of search step	0.32665	**0.69623**	0.28058	0.26116
S2 ability to use online databases	0.24328	0.49033	**0.70429**	0.08607
S3 ability to use critical appraisal tools	0.31968	0.42968	**0.68642**	0.02147
S1 ability to develop answerable public health question	0.36784	0.50188	**0.63732**	0.06734
S4 ability to assess applicability of research to local context	0.48977	0.46223	**0.62686**	0.05395
A1 believe can implement EIDM efficiently	0.39696	0.42874	**0.54432**	0.25960
A4 implementing EIDM improves services, programs, policies	0.08183	0.12448	0.05876	**0.92402**
A3 believe evaluation important	0.09869	0.18529	0.07449	**0.85666**
A5 believe critical appraisal is important	0.13401	0.18702	0.06388	**0.83702**

Note: A=attitude item; B=behaviour item; K=knowledge item; S=skills item

Table 6. Item-subscale total correlations for 27-item EIDM competence measure

Item	Item-subscale correlation
Knowledge	
1. Knowledge of what is involved in the 'define' step of EIDM	0.864
2. Knowledge of what is involved in the 'search' step of EIDM	0.881
3. Knowledge of what is involved in the 'appraise' step of EIDM	0.919
4. Knowledge of what is involved in the 'synthesize' step of EIDM	0.946
5. Knowledge of what is involved in the 'adapt' step of EIDM	0.957
6. Knowledge of what is involved in the 'implement' step of EIDM	0.938

7. Knowledge of what is involved in the 'evaluate' step of EIDM	0.907
Skills	
1. Ability to develop an answerable practice question.	0.916
2. Ability to use online databases that house research evidence (combined original skills item #3 and #4).	0.901
3. Ability to use critical appraisal tools to appraise the quality of research evidence (e.g., AGREE II tool, CASP)	0.914
4. Ability to assess applicability of research evidence to the local public health context.	0.943
5. Ability to participate in the development of evaluation indicators to assess outcomes of evidence-informed decision or practice changes.	0.903
Attitudes	
1. I believe that I can implement EIDM in a time efficient way.	0.836
2. I believe I can engage others in implementing strategies to address barriers (e.g., personal, organizational, community) when implementing EIDM	0.812
3. I believe that evaluating outcomes of an evidence-informed decision or practice change is an important component of EIDM.	0.836
4. I believe that implementing EIDM can improve public health services, programs, and policies (combined original attitudes items #4 and #6).	0.777
5. I believe that critically appraising evidence is an important step in the EIDM process.	0.788
Behaviours	
1. I question public health practices for the purpose of improving the quality of care/service delivery.	0.713
2. I describe public health practice issues using client assessment data (i.e., community, individuals, families, populations).	0.751
3. I participate in the formulation of public health practice questions.	0.850
4. I search for research evidence to answer public health practice questions.	0.701
5. I participate in the synthesis and interpretation of a body of research evidence gathered to formulate recommendations for public health practice.	0.860
6. I integrate evidence gathered from public health expertise, client or community preferences, and local context with research evidence to plan evidence-informed practice changes.	0.909
7. I participate in the assessment of barriers and facilitators (related to resources, organization, evidence/guidelines, clients' preferences/values) when implementing a practice change.	0.902
8. I participate in the process of stakeholder analyses (i.e., collecting and analyzing information on stakeholders' importance and influence) when implementing a practice change.	0.888
9. I participate in the development of an action plan to implement a practice change.	0.868
10. I participate in evaluating outcomes of evidence-informed decisions or practice changes.	0.877

Validity based on relationships to other variables.

While some non-significant relationships between EIDM competence attributes and other variables were revealed, there were also statistically significant findings that confirmed many of the hypothesized relationships to establish validity evidence of the EIDM competence measure. Regarding number of years worked as a registered nurse, a statistically significant positive correlation was found with EIDM behaviours, indicating a weak relationship (r = 0.17; p = 0.008), although no significant relationships were found related to EIDM knowledge, skills, and attitudes (see Table 7). Similarly, statistically significant differences in mean scores were found only for EIDM behaviours between professional role groups of public health nurse (M = 42.69; SD = 11.79), health promoter (M = 47.00; SD = 7.00), supervisor/manager (M = 49.75; SD = 8.87), director (M = 53.50; SD = 13.44), and other (e.g., practice lead, advanced practice nurse) (M = 53.57; SD = 12.63); F(4, 187) = 1.08; p = 0.027 (see Table 8). However, a follow-up post-hoc Tukey's test was performed for EIDM behaviour scores to attempt to pinpoint specific group differences, and no statistically significant relationships were identified.

Table 7. Correlation between EIDM subscale totals and years worked as RN

Subscale	Mean (Standard Deviation)	Pearson correlation coefficient (r)	*p*
EIDM knowledge	31.20(9.14)	0.00	0.499
EIDM skills	20.11(7.19)	0.07	0.357
EIDM attitudes/beliefs	27.08(4.34)	-0.04	0.623
EIDM behaviours	43.99(11.97)	0.17	0.008

Table 8. One-Way ANOVA of EIDM subscale scores as a function of professional role

Subscale	Source	*SS*	*df*	*MS*	*F*	*p*
EIDM knowledge	Between groups	357.77	4	89.44	1.08	0.369
	Within groups	15439.23	186	83.01		
EIDM skills	Between groups	446.29	4	111.57	2.25	0.065
	Within groups	9322.50	188	49.59		
EIDM attitudes	Between groups	65.44	4	16.36	0.88	0.477
	Within groups	3514.43	189	18.60		
EIDM behaviours	Between groups	1517.30	4	379.32	2.80	0.027
	Within groups	25310.37	187	135.35		

Higher scores in EIDM knowledge, skills, attitudes/beliefs, and behaviours were found among nurses with master's degree preparation compared to those with a bachelor's degree (p<0.0001; see Table 9 for mean scores). Differences between education groups were statistically significant for all EIDM subscales (p<0.0001).

Table 9. Mean EIDM competence scores based on education

Subscale	Education Level	N	Mean	Standard Deviation
EIDM Knowledge	bachelor's degree	143	29.39	8.49
	master's degree	53	36.08	9.13
	Total	196	31.20	9.14
EIDM Skills	bachelor's degree	145	18.33	6.61
	master's degree	53	25.00	6.43
	Total	198	20.11	7.19
EIDM Attitudes	bachelor's degree	145	26.27	4.31
	master's degree	54	29.26	3.61
	Total	199	27.08	4.34
EIDM Behaviours	bachelor's degree	144	41.33	11.33
	master's degree	53	51.21	10.71
	Total	197	43.99	11.97

Higher scores across all EIDM subscales were also found among nurses who completed training compared to those who did not (p<0.0001), as well as those with involvement in EIDM related work or projects (p<0.0001) compared to those with no EIDM experience. Statistically significant positive correlations were found between total organizational factor scores and EIDM knowledge (r = 0.29; p<0.000), skills (r = 0.27; p = 0.001), attitudes/beliefs (r = 0.26; p = 0.00), and behaviours (r = 0.22; p = 0.005).

Internal Consistency Reliability

All EIDM subscales met the minimum Cronbach's alpha (α) of ≥0.70: knowledge (α=0.96); skills (α=0.93); attitudes/beliefs (α=0.80); and behaviours (α=0.94).

Acceptability

Completion time.

The average completion times for each EIDM competence subscale were similar in length: knowledge (1 minute and 37 seconds); skills (2 minutes and 11 seconds); attitudes/beliefs (1 minute and 18 seconds); and behaviours (2 minutes and 14 seconds). The mean completion time for the entire original 40-item EIDM Competence Measure was 7 minutes and 20 seconds.

Missing data.

The percentage of nurses fully completing the original 40-item EIDM measure (i.e., no missing data) was 93% (n=187), with 7% of participants who had data missing for at least one item across the entire 40-item tool. As well, only one participant (0.5%) had >10% of missing data (i.e., more than 4 out of 40 items with data missing).

Discussion

Validity Evidence

Findings from this study establish strong validity evidence related to internal structure and relationships to other variables of the self-report EIDM Competence Measure for public health nursing. Factor analysis results for the EIDM competence measure support a four-factor model that aligned with the conceptual understanding that EIDM competence is comprised of four attributes of knowledge, skills, attitudes/beliefs, and behaviours. In comparison, factor analysis results from the psychometric assessment of another self-report measure [63] addressing these same competence attributes yielded to some extent, different factor compositions. Principal component analysis of the 24-item Evidence Based Practice Questionnaire (EBPQ) produced a three-factor model for the measure: practice of evidence-based practice (related to behaviour frequency); attitudes towards evidence-based practice; and knowledge/skills associated with

evidence-based practice [63]. EIDM behaviours and attitudes emerged as separate entities in the EBPQ, a similar finding in our EIDM competence measure. As well, in the EBPQ, knowledge and skills items appeared to be highly related, loading together to comprise one factor [63]. In our self-report EIDM Competence Measure, the knowledge and skills subscales were also highly correlated with one another, however, in the factor analysis process, knowledge emerged as a distinct factor independent of others. This difference in terms of knowledge surfacing as a distinct factor may have been attributed to the broad nature in which knowledge items were articulated compared to the specificity used to formulate items in the other subscales of skills, attitudes, and behaviours in the EIDM Competence Measure. While, in the EBPQ, both the knowledge and skills items were worded and phrased similarly, possibly contributing to their emergence as one factor [63]. In our study, there were also two instances in which attitude items loaded onto factors representing EIDM behaviour or skills. Looking at the phrasing of these two attitudes items, since they relate to beliefs/perceptions about personal engagement in EIDM overall and in ability to address EIDM barriers, it seems reasonable that statistically, they might cluster together with items that are phrased similarly to assess ability, participation in or performance of EIDM tasks. However, regardless of factor loadings, conceptually, these items are better represented under the 'attitudes' attribute given these are defined as the values, perceptions, beliefs or intentions related to EIDM. This may include acceptance of, motivation for or self-efficacy in overall EIDM engagement [30, 33], as compared to categorization under EIDM skills (application of knowledge to perform discrete EIDM tasks in a practical setting) [30, 33, 34] or EIDM behaviours (EIDM performance in real-world practice) [30, 33, 34].

Results in this study also showed evidence to support validity based on relationships with other variables for the EIDM competence measures. In our study, there were statistically

significant associations between all EIDM competence attributes and education level, EIDM training, and EIDM work experience. These findings are consistent with other literature indicating that EIDM engagement is heavily influenced by personal and professional characteristics such as having advanced level formal education [54], exposure to multifaceted EIDM educational interventions [64, 65], and opportunities to participate in or lead EIDM projects in real-world practice [54, 66]. Our study findings also align with existing literature that consistently demonstrates organizational context as a strong predictor of EIDM uptake. Similar to other studies, EIDM knowledge, skills, attitudes/beliefs and behaviours were all significantly related to work environments in which: EIDM priorities were integrated into strategic plans [17, 67], there were identified EIDM champions [68, 69], and critical resources necessary to carrying out EIDM activities were provided [70, 71].

There were however some findings in which the relationships we hypothesized were not validated. Our findings did not show a significant positive correlation between years of experience as a registered nurse and EIDM competence attributes. While many studies have determined that a longer duration of work experience is associated with more developed EIDM competence attributes [72-74], literature has emerged showing conflicting evidence; that there is either no existing relationship between these variables [52] or that those with less nursing experience actually display higher EIDM competence attribute scores [75]. Regarding the influence of professional role, our study findings demonstrated only a significant relationship between role (e.g., public health nurse, supervisor/manager) and EIDM behaviours specifically, but this relationship was not found regarding knowledge, skills, or attitudes. This is in contrast to other studies with reported findings that showed higher level professional roles (e.g., management, advanced practice nurse) were associated with greater scores on EIDM knowledge,

skills, attitudes, and behaviours [71, 75, 76]. However, an important note is that these existing studies pertain to an acute care setting where discussions of advanced roles were focused on clinical distinctions (i.e., frontline staff nurse versus educator or nurse practitioner). In comparison, our study, set in a public health context in which these clinical roles are less prominent, explored roles in relation to public health nurses, health promoters, and management, which may have contributed to differences in findings.

Reliability

The EIDM Competence Measure also exhibited strong internal reliability with Cronbach's alphas for all subscales exceeding the minimum of 0.70 for new measures [62]. Cronbach's alphas surpassed 0.90 for the behaviours, knowledge, and skills subscales. Given these high alphas, which may be indicative of further redundancy [38], there is opportunity for possible refinement of the tool in further psychometric testing with other populations and contexts. Similarly, original psychometric testing of the EBPQ also yielded high alphas for the EBP practice (behaviour) subscale (α=0.85) and the combined knowledge/skills subscale (α=0.91). Assessment of the Quick Evidence-Based Practice (EBP) Values, Implementation and Knowledge (VIK) survey, a 25-item self-report tool addressing EIDM knowledge, attitudes/beliefs, and behaviours, also demonstrated comparable internal consistency with its subscale of knowledge (α=0.93), although had a lower alpha (0.76) for its implementation subscale (frequency of EIDM behaviours) [77]. This latter discrepancy may be attributed to item content differences in which behavioural items of the Quick-EBP-VIK survey are less specific and have less coverage of all the EIDM steps compared to our EIDM competence measure or the EBPQ. What remains consistent across the psychometric literature are reported alpha values for

EIDM attitude/beliefs subscales across multi-dimensional measures: our EIDM competence measure (α=0.80); EBPQ (α=0.79) [63]; and the Quick-EBP-VIK survey (α=0.79) [77].

Acceptability

Minimal missing data and the short completion time observed in this study suggest that our EIDM Competence Measure is 'acceptable', signifying it is not highly burdensome or challenging to complete [78]. The overall low percentage of missing data for the EIDM competence measure (7%) resembles rates of other EIDM measures that have been used or tested among public health nurses including the EBP Implementation Scale (6.3%) [79] and the School Nurse Evidence-Based Practice Questionnaire (5.2%) [51]. As well, the original 40-item EIDM Competence Measure appears to have a similar completion time to other EIDM measures of shorter length which assess only one competence attribute: 16-item EBP Beliefs Scale (~5-7 minutes) [80, 81]; 18-item EBP Implementation Scale (~6-8 minutes) [80, 81].

Limitations

While this study provides supporting evidence of the validity, reliability, and acceptability of a new EIDM competence measure that can be used in public health practice, there are limitations that require consideration. While the proposed study sample size was 400, only 50% (n=201) of this projected sample was achieved. As such, given the original EIDM competence measure had 40 items, the frequently suggested ratio of 10:1 (subjects to items) in calculating sample size for factor analysis was not met [42]. Given that the principal components analysis was run on the reduced 27-item tool, using the 10:1 subject to items ratio, an acceptable sample size would be 270, which still was not met with the sample size of 201 participants. However, in other literature, a case to variable ratio of 5:1 has also been deemed sufficient to conduct factor analysis [82], indicating that a sufficient sample size was reached. Comrey as

cited in Taherdoost et al. [48] identifies 200 as a ‘fair’ sample, compared to increasing samples of 300 classified as ‘good’ and 500 respondents as ‘very good’. As well, the Kaiser-Meyer-Olkin test determined that there was acceptable sampling adequacy to conduct factor analysis in this study. It is important to note that this study is considered exploratory in nature, with an understanding that findings are to be interpreted with some caution. In the future, such psychometric testing will be replicated with a larger sample size, with plans to extend sample recruitment to a national cohort. A larger sample would allow for a next step of validation using confirmatory factor analysis with a split sample approach, which was not feasible to perform in this pilot study given the small sample [83].

Over the course of this study, particularly throughout the study recruitment period, there were pivotal public health events that had substantial bearing on the ability to recruit the proposed sample size. First, the provincial government of Ontario announced public health modernization plans which proposed a critical restructuring of the public health system, reducing the number of operating health units in Ontario from 36 to 10. Second, the beginning stages of the COVID-19 coronavirus pandemic had emerged during this time, with health units dedicating staff resources toward the pandemic response. These two events impacted study participation at both the public health unit and individual staff level and illustrates some of the challenges of conducting research in a health sector that regularly responds to emerging crises. The changing nature of public health illuminates the need to embed strategies that will mitigate the impact of unforeseen and unavoidable circumstances within the research design.

Conclusions

The 27-item EIDM competence measure provides a comprehensive self-assessment of EIDM knowledge, skills, attitudes/beliefs, and behaviours for use among nurses in public health

practice. This instrument has demonstrated strong validity evidence based on internal structure and relations to other variables, as well as exhibits strong internal reliability. Given its ease of use and short completion time, there is great potential for its use in real-world public health practice for individual nurses, supervisors/managers, and organizations to provide insight into the status of EIDM competence among public health nurses. This sets the stage well for improving clarity around EIDM nursing expectations and in strategic planning of resources and professional development interventions to facilitate improved EIDM engagement. Given the nature of this study as a pilot, there is opportunity to expand on the psychometric testing conducted, which would include confirmatory factor analysis/split sample approach using a national sample of nurses across health units in Canada. Further testing will add to the reliability and validity evidence of the EIDM Competence Measure, as well as explore its acceptability across a diverse sample.

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S1 Table. Low and high item-item correlations (40 items)

Item	Item	Correlation
Knowledge		
1. Knowledge about 'define' step	2. Knowledge about 'search' step	0.845
3. Knowledge of evidence levels	5. Knowledge of databases (pre-appraised evidence)	0.812
3. Knowledge of evidence levels	6. Knowledge about 'appraise' step	0.815
6. Knowledge about 'appraise' step	7. Knowledge of critical appraisal tools	0.834
6. Knowledge about 'appraise' step	9. Knowledge about 'adapt' step	0.878
7. Knowledge of critical appraisal tools	8. Knowledge about 'synthesize' step	0.811
8. Knowledge about 'synthesize' step	9. Knowledge about 'adapt' step	0.936
8. Knowledge about 'synthesize' step	10. Knowledge about 'implement' step	0.829
8. Knowledge about 'synthesize' step	11. Knowledge about 'evaluate' step	0.810
9. Knowledge about 'adapt' step	10. Knowledge about 'implement' step	0.913
9. Knowledge about 'adapt' step	11. Knowledge about 'evaluate' step	0.810
10. Knowledge about 'implement' step	11. Knowledge about 'evaluate' step	0.884
Skills		
1. Develop answerable question	2. Develop search strategy	0.906
1. Develop answerable question	6. Assess applicability of evidence to local context	0.826
2. Develop search strategy	3. Use online databases (individual research studies)	0.836
2. Develop search strategy	4. Use online databases (synthesized research)	0.862
2. Develop search strategy	6. Assess applicability of evidence to local context	0.839
2. Develop search strategy	7. Conduct barrier/facilitator assessment	0.824
3. Use online databases (individual research studies)	4. Use online databases (synthesized research)	0.888
4. Use online databases (synthesized research)	6. Assess applicability of evidence to local context	0.805
5. Use critical appraisal tools	6. Assess applicability of evidence to local context	0.812
6. Assess applicability of evidence to local context	7. Conduct barrier/facilitator assessment	0.909
6. Assess applicability of evidence to local context	8. Conduct stakeholder analysis	0.833
6. Assess applicability of evidence to local context	9. Develop action plan	0.853
7. Conduct barrier/facilitator assessment	8. Conduct stakeholder analysis	0.890
7. Conduct barrier/facilitator assessment	9. Develop action plan	0.900
8. Conduct stakeholder analysis	9. Develop action plan	0.923
Attitudes		
1. Can implement EIDM in efficient way	A6 - believe use of guidelines improves practice/policy	0.262
1. Can implement EIDM in efficient way	A7 - EIDM is difficult	0.272
2. Can engage others in addressing barriers	6. Believe use of guidelines improves practice/policy	0.290
2. Can engage others in addressing barriers	7. EIDM is difficult	0.234
3. Believe evaluating outcomes important	7. EIDM is difficult	0.174
5. Believe critical appraisal important	7. EIDM is difficult	0.099
6. Believe use of guidelines improves practice/policy	7. EIDM is difficult	0.038

3. Believe evaluating outcomes important	4. Believe EIDM improves services or programs	0.824
4. Believe EIDM improves services or programs	5. Believe critical appraisal important	0.810
4. Believe EIDM improves services or programs	6. Believe use of guidelines improves practice/policy	0.867
5. Believe critical appraisal important	6. Believe use of guidelines improves practice/policy	0.807
Behaviours		
5. Critical appraisal of individual studies	6. Critical appraisal of synthesized evidence	0.901
5. Critical appraisal of individual studies	7. Synthesis and interpretation of evidence/form recommendations	0.853
6. Critical appraisal of synthesized evidence	7. Synthesis and interpretation of evidence/form recommendations	0.886
7. Synthesis and interpretation of evidence/form recommendations	8. Integrate evidence from expertise, preferences, context	0.801
8. Integrate evidence from expertise, preferences, context	9. Assessment of barriers/facilitators	0.866
9. Assessment of barriers/facilitators	10. Participate in stakeholder analyses	0.820
9. Assessment of barriers/facilitators	11. Action planning	0.823
10. Participate in stakeholder analyses	11. Action planning	0.810
11. Action planning	12. Evaluating outcomes	0.857

Note: ≤0.30 = low; ≥0.80 = high

Chapter 7

Discussion and Implications

This chapter first presents a high-level summary of the completed stages of this study, its findings, and the strengths and limitations of each stage. This is followed by a discussion of implications for nursing research, practice, and education, along with broader study strengths and limitations.

Summary of Study and Overall Findings

The overall purpose of this study was to develop and psychometrically evaluate a new self-report Evidence-informed Decision-making (EIDM) Competence Measure for public health nursing. For the purposes of this study, EIDM was defined as "the process of distilling and disseminating the best available evidence from research, context, and experience, and using that evidence to inform and improve public health practice and policy" (National Collaborating Centre for Methods and Tools, 2020a, p. 1). EIDM consists of a multi-step process: 1) clearly define a public health question or problem; 2) search efficiently for research evidence; 3) appraise research sources; 4) synthesize the research evidence by interpreting and forming recommendations based on literature; 5) adapt information to the local context; 6) implement the adapted evidence; and 7) evaluate the implementation (National Collaborating Centre for Methods and Tools, 2020a). While many expectations regarding EIDM implementation have been established in public health through the development of general competencies for public health nurses (Community Health Nurses of Canada, 2019; Public Health Agency of Canada, 2008), as well as in standards guiding mandatory public health programs and services (Ontario Ministry of Health and Long-Term Care, 2018), there has been limited research to comprehensively assess EIDM competence in a public health context. As such, the development

of a psychometrically and conceptually robust self-report EIDM competence measure with specific indicators can support reflective practice, life-long learning, and professional development planning among public health nurses. To meet this need, a multi-stage study was conducted reflecting the overall study's purpose which included: Stage 1) a systematic review of EIDM measures assessing competence attributes of knowledge, skills, attitudes/beliefs, and behaviours; Stage 2) development of a new self-report EIDM Competence Measure comprised of four subscales of EIDM knowledge, skills, attitudes/beliefs, and behaviours; and Stage 3) psychometric testing of a new self-report EIDM Competence Measure.

Stage one: systematic review.

The objectives of this study's systematic review were to identify existing measures of EIDM knowledge, skills, attitudes/beliefs, and behaviours used among nurses in diverse health care settings and to determine the psychometric properties of such measures. Chapter 3 presents the rigorous methodology of the systematic review through a published protocol (Belita et al., 2018). A strength of the review's methodology is that it was guided by a comprehensive conceptualization of competence, defined as comprising four attributes of knowledge, skills, attitudes/beliefs, and behaviours; this comprehensive conceptualization has been largely missing from existing systematic reviews of EIDM measures across nursing and other health care disciplines. Although a limitation of this review was that it did not include a quality assessment of included primary studies, a strong rationale for not doing so was that existing quality assessment tools for psychometric studies are guided by a traditional approach of assessing construct, content, and criterion validity separately, which does not align with the contemporary perspective of validity used in this study, wherein validity is understood as a unified construct

(American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014).

In Chapter 4, the published results from this systematic review identified limitations across existing EIDM knowledge, skills, attitudes/beliefs, and behaviour instruments (Belita et al., 2020). First, across these measures, there has been a lack of thorough testing conducted by nursing researchers and instrument developers in relation to validity, reliability, and acceptability. This signals a critical need to improve psychometric evaluation efforts to facilitate production and selection of high-quality EIDM competence attribute measures for nursing practice. Second, reported findings also reflect that the majority of existing EIDM measures assess only one of the four competence attributes, underscoring a lack of comprehensive assessment of EIDM competence and need for the use of a more fulsome conceptualization of competence to guide measure development.

Stage two: development of the EIDM Competence Measure.

Chapter 5, a manuscript submitted for publication, describes the process used to develop items of the self-report EIDM Competence Measure, which included a content coverage assessment of existing EIDM competence attribute measures and item validation based on test content and response process. A strength of this study stage is the rigorous content analysis of 35 existing EIDM knowledge, skills, attitudes/beliefs, and behaviours instruments identified from stage one's systematic review. This content coverage assessment allowed for identification of conceptual gaps and strengths among existing EIDM measures, which served as the foundation from which content of the new EIDM Competence Measure was strategically developed. Another strength of this stage was the integration of diverse perspectives into the content validation and response process assessment, which included academic experts in EIDM and

public health, as well as nurses in frontline and supervisory public health roles. Also, both quantitative (content validity indices) and qualitative feedback were collected and analyzed to support content validation, providing strong rationale to support decisions for item modifications, deletions, or retaining original items. A limitation in the response process phase included the use of a convenience sample of nurses drawn from two health units. This had the potential to introduce bias into results, given participants may have had existing interest in or experience with EIDM that could largely influence how they comprehended or valued certain items. To mitigate this, health units were strategically selected such that one organization had a long-standing history in engaging in EIDM work, while the other health unit was in the infancy stages of EIDM activities, which would have varied the amount of organizational exposure participants had to EIDM and thereby offered diverse perspectives.

Results identified in Chapter 5, specifically emerging from the content coverage assessment, indicated that existing EIDM measures are largely focused on assessing competence attributes related to the earlier steps of the EIDM process (search and appraise) in comparison to later steps such as ‘synthesize’ or ‘adapt’. Other limitations of existing measures included ambiguity and vagueness of items, thus failing to capture the nuances or discrete aspects of EIDM steps, in addition to response scales not reflecting assessment of the ‘quality’ of an attribute, a critical aspect of competence. Items and response scales of the EIDM Competence Measure were developed to specifically address these limitations. Item reduction was then conducted and guided by content validity indices and informed by qualitative data from EIDM/public health experts resulting in modifications to increase clarity, reduce redundancy, and ensure items reflected EIDM expectations relevant for the nursing role. Following these modifications, qualitative results from response process interviews further validated the content

of the 40-item self-report EIDM Competence Measure, with only minor suggestions for re-wording or re-phrasing to improve clarity.

Stage three: psychometric testing of the EIDM Competence Measure.

The last stage of this study, described in Chapter 6, was the psychometric testing of the EIDM Competence Measure. The comprehensive psychometric testing, particularly with respect to validity assessment and acceptability, constitutes a primary strength of this stage of the study. Relationships between all EIDM competence attributes and multiple socio-demographic and organizational factors were analyzed and established in congruence with a priori literature, contributing to strong validity evidence of the EIDM Competence Measure. In addition, acceptability, a property of instruments which has been historically neglected in psychometric assessments of EIDM instruments, was explored in relation to completion time and missing data. Limitations of this stage of the study related primarily to recruitment and sample size. Active recruitment of participants occurred during the time when the COVID-19 coronavirus pandemic was emerging as a critical issue for health units, resulting in redeployment of most of the public health workforce toward these efforts. This resulted in some health units retracting their initial agreement to participate in the study, and likely influenced the availability and interest of individual nurses to participate, considering their workload priorities. Despite this however, considering this was an exploratory study, the sample size achieved (n=201), is still deemed a 'fair' sample for conducting factor analysis (Taherdoost, Sahibuddin, & Jalaliyoon, 2014).

In Chapter 6, psychometric evaluation results for the EIDM Competence Measure presented validity evidence based on internal structure and relationships to other variables, internal consistency, and acceptability. Strong validity evidence was established for the EIDM Competence Measure as demonstrated through the performance of a principal component

analysis in which a four-factor model was extracted aligning with the established conceptualization of EIDM competence as being comprised of the four attributes of knowledge, skills, attitudes/beliefs, and behaviours. As well, significant relationships between EIDM competence attributes and socio-demographic (e.g., education level, professional role) and organizational factors were confirmed according to hypothesized relationships, providing further validity evidence. Strong internal consistency was also determined for the EIDM Competence Measure as evidenced by all four subscales of knowledge, skills, attitudes/beliefs, and behaviours meeting a minimum $\alpha \geq 0.80$. Ease of completion was reflected through short completion time and low missing data rates demonstrating acceptability by end users who engaged in this pilot testing.

Together, this multi-stage study has important implications to inform nursing research, practice, and education.

Nursing Research Implications

Need for enhanced psychometric assessment of EIDM measures in nursing.

EIDM is an important first step in achieving optimal health services and subsequently positive health outcomes. Nurses must be competent in EIDM for the intended impacts of EIDM to be realized. Psychometrically robust EIDM measures are therefore critical in evaluating whether nurses are competent in EIDM. However, nursing research related to EIDM instrument development and testing requires improvement due to limitations across psychometric assessment processes. Results from this study's systematic review highlight a persistent gap among existing EIDM measures in nursing; that is, a lack of comprehensive psychometric testing that encompasses assessment of reliability, validity, and acceptability (Belita et al., 2020). Similar findings have been found in other systematic reviews across nursing (Leung, Trevena, &

Waters, 2014; Squires et al., 2011) and allied health care (Buchanan, Siegfried, & Jelsma, 2016) as it relates to EIDM assessment, and generally across psychometric studies in other fields of research such as education, sociology, and psychology (Hogan & Agnello, 2004). Deficiencies in psychometric testing are seen not only in the development of original measures, but also when adaptations to original measures are made and used in different contexts. Leung et al. (2014), in their systematic review of 24 instruments assessing research utilization and EIDM knowledge, skills and attitudes among nurses and midwives, identified that a common issue across the literature was a lack of re-validation in cases of instrument replication, particularly with respect to construct and criterion validity. This lack of psychometric assessment was similarly found in a systematic review by Squires and colleagues (2011) who analyzed 60 self-report research utilization measures used among health care providers (nurses, physicians, allied health professionals) and decision-makers. Findings demonstrated that only 13 of the 60 measures had established reliability, while 12 measures had no reported validity evidence (Squires et al., 2011). Squires and colleagues (2011) also highlighted that a limitation across studies was an overreliance on the original psychometric evaluation in subsequent uses of a measure, and lack of re-assessment even with adaptations made and/or testing in a new population or practice setting. As well, in a systematic review of 35 studies and 34 EIDM measures used among occupational therapists, findings revealed that only nine of the reviewed instruments had at least one component of validity and reliability assessed (Buchanan et al., 2016). Buchanan et al. (2016) also found that several of the studies included adapted versions of original instruments with failure to conduct re-assessment of psychometric properties.

According to Froman and Schmitt (2003) psychometric re-assessment of instruments in nursing research is especially critical given that scales with long-standing histories and use can

'age' amidst the production of similar measures assessing the same construct, advancements in measurement techniques and programming, and the growing diversity of populations under study. As well, reliability and validity evidence for measures is cumulative across multiple studies performed, and thus nurse researchers and consumers of research, such as clinicians and decision-makers, require comprehensive and updated psychometric information to support informed decision-making when selecting measures that produce results impacting nursing practice (Waltz, Strickland, & Lenz, 2017).

Findings from this study's systematic review (Chapter 4) also showed that reliability was reported more frequently across EIDM measures as compared to validity evidence. This is in alignment with an earlier review of 696 studies pertaining to measures across psychology, education, and sociology in which authors reported that 94% of the studies reported on reliability, while only 52.3% reported on at least one source of validity evidence (Hogan & Agnello, 2004). More frequent and detailed reporting and investigation of reliability evidence compared to validity is problematic (Hogan & Agnello, 2004), given that validation is the most fundamental component in the development and psychometric testing of measures (American Educational Research Association et al., 2014). That is, all other psychometric properties associated with a measure are meaningless if it has not been shown that an instrument accurately assesses the construct under measure (Hogan & Agnello, 2004). This discrepancy in frequency and depth of reliability and validity testing is often attributed to the ease of reliability assessment compared to more complex validation processes (Cizek, 2020). Cizek (2020) notes that measurement experts have focused more effort on developing abstract principles of validity theory, with limited attention afforded to providing information on how to apply these theoretical principles in a real-world setting for tool developers.

Further compounding this issue is that even in instances in which efforts to assess validity are undertaken, they are often not comprehensive, and include assessment of only one or two of the four sources of validity evidence. Systematic review results reported in Chapter 4 also revealed that over half of existing EIDM measures reviewed reported only one source of validity evidence, largely based on test content and relationships to other variables. This was comparable to results reported by Leung et al. (2014) in their review of 24 EIDM and research utilization measures used among nurses and midwives, in which they reported that two sources of validity evidence were the most frequently identified – content and construct validation. Likewise, Squires et al. (2011), in their systematic review of research utilization measures used among health care professionals (inclusive of nurses), reported that of 48 measures which had established validity evidence, the majority of them (n=26) had only one out of four sources of validity evidence reported.

In addition, acceptability was explored to an even lesser extent than reliability and validity. Of the 35 measures reviewed in this study's systematic review as discussed in Chapter 4, completion time was reported for only five tools, and missing data reported for 10 (Belita et al., 2020). Similarly, Squires et al. (2011) also reported that acceptability, characterized by completion time and missing data, was not explored at all in any of the 97 studies or 60 research utilization measures included in their systematic review. In other psychometric systematic reviews of EIDM measures used among allied health care professionals, completion times were reported for only 1 out of 15 (Glegg & Holsti, 2010) and 2 out of 34 (Buchanan et al., 2016) measures when assessing clinical utility. While time to complete and missing data rates have been widely acknowledged as indicators of acceptability for measures (Fitzpatrick, Davey, Buxton, & Jones, 2007), qualitative methods can also be employed to supplement these

quantitative statistics. In doing so, acceptability can be assessed through open-ended or structured individual interviews to explore participant views on task difficulty in overall completion of an instrument or determine if specific items were found to be distressing or challenging to answer (Ambagtsheer, Archibald, Lawless, Kitson, & Beilby, 2020; Fitzpatrick et al., 2007; Supino et al., 2009). Since instrument length (number of items), and instrument features such as layout and appearance influence acceptability, these factors can also be assessed through qualitative interviews (Fitzpatrick et al., 2007). There is great opportunity to expand beyond traditional acceptability assessments of only completion time and missing data scores in psychometric replication studies or development of original EIDM competence measures in nursing, thereby contributing to a richer understanding of acceptability. Given this, advanced acceptability testing of the EIDM Competence Measure can be explored in future studies by incorporating qualitative methods that inquire about difficulty of individual item completion, instrument length and aesthetics (e.g., layout, format).

Given that psychometrically robust EIDM measures are crucial in determining the extent to which nurses are competently practicing EIDM and several limitations among developed ones exist, improvements in the way in which the development of EIDM instruments are approached through research is warranted. To ensure the quality of existing and future measures, a standardized approach following sound psychometric principles in the development and evaluation of EIDM measures must be championed across nursing. This can include investment in inclusion of content and experiences related to instrument development and testing within academic preparation of nurse scientists. In addition, as it pertains to nursing scholarship, within peer review processes and editorial policies, editorial boards of journals can set quality standards for psychometric evaluation related to reliability, validity, and acceptability (Hogan & Agnello,

2004). This can help establish consistent messaging and expectations around psychometric evaluation in both novel and adapted measures (Hogan & Agnello, 2004).

Conceptual considerations in the development of EIDM measures.

The development phase of the EIDM Competence Measure (Chapter 5) highlighted key gaps in the psychometric literature with respect to conceptual underpinnings. During the item development phase, the content coverage assessment of existing EIDM measures revealed a substantial emphasis on the first three steps of the EIDM process: define, search, and appraise. These results were similarly reported in a discussion paper by Saunders and Vehviläinen-Julkunen (2018) and a systematic review by Shaneyfelt et al. (2006), which both focused on EIDM assessment among different health care disciplines. These authors found that the majority of reviewed EIDM instruments centred on the 'appraise' step of EIDM (i.e., assessing critical appraisal knowledge, skills, or behaviours). As well, in a systematic review of 42 measures assessing EIDM behaviours, Oude Rengerink et al. (2013) described that almost 40% of the instruments they reviewed assessed only one EIDM step, with a major focus on 'searching' for research evidence.

This narrow assessment of EIDM competence may be based in misconceptions surrounding the definition of EIDM and how it has been traditionally defined and operationalized. Misconceptions and criticisms about EIDM persist, in that by taking a narrow view some associate EIDM solely as the application of research evidence, excluding consideration of other forms of evidence such as local context, client preferences/values or resources (Falk-Rafael, 2000; Nevo & Slonim-Nevo, 2011). This more limited view of EIDM may perpetuate a focus on the beginning stages of the EIDM process, associated primarily with identifying, reviewing, and appraising research evidence. As well, the way in which instrument

developers articulate the multi-step process of EIDM can also influence the specificity of item development and comprehensiveness of EIDM competence assessment. Seminal work about EIDM has traditionally defined it as a 5-step process including the steps of ask, search, appraise, apply, and evaluate (Sackett, Richardson, Rosenberg, & Haynes, 1997; Straus, Glasziou, Richardson, & Haynes, 2011). This 5-step process has frequently served as a guiding framework for a multitude of EIDM measures (Leung et al., 2014; Shaneyfelt et al., 2006). In contrast, items within the EIDM Competence Measure are based on the 7-step process established by the National Collaborating Centre for Methods and Tools (NCCMT): define, search, appraise, synthesize, adapt, implement, and evaluate (National Collaborating Centre for Methods and Tools, 2020a). In using the NCCMT EIDM process, the separation of what has traditionally been identified as the 'apply' step into three distinct steps of synthesize, adapt, and implement, guided explicit expectations and indicators in the EIDM Competence Measure to align with these last EIDM steps, which are largely missing from existing measures.

In the development of future measures, the use of NCCMT's 7-step process (National Collaborating Centre for Methods and Tools, 2020a) can allow for more comprehensive and optimal assessment of the different competencies required to fully implement EIDM. This may also broaden nurses' and other health care leaders' perceptions about the nuanced steps of EIDM and direct more attention toward less assessed EIDM competencies such as those included in the later steps (e.g., adapt, synthesize, implement). Greater attention toward these later EIDM steps is warranted, as Leeman et al. (2017) note that in particular, there is limited capacity in the adoption, adaptation, and implementation of evidence-informed interventions, contributing in part, to their underutilization across diverse practice areas. The use of a holistic conceptualization of EIDM is a critical requirement in competence assessment as using an

incomplete conceptualization may lead to false depictions of EIDM being fully implemented in nursing practice (Hagedorn Wonder et al., 2017).

In addition, the comprehensive conceptual nature of the EIDM Competence Measure may also lend itself to intervention research. The lack of EIDM engagement, identified barriers, and gaps in meeting EIDM competencies have led to the development and testing of different interventions to increase EIDM knowledge, attitudes, skills, and behaviours among nurses (Haggman-Laitila, Mattila, & Melender, 2016; Hines, Ramsbotham, & Coyer, 2015; Middlebrooks, Carter-Templeton, & Mund, 2016). Limitations in content and conceptual deficiencies among existing EIDM measures are echoed in existing interventions meant to develop EIDM knowledge, skills, and behaviours among nurses. Across these educational and capacity-building interventions, content has largely been focused on the beginning steps of EIDM with emphasis on searching for and critically appraising research evidence (Haggman-Laitila et al., 2016; Middlebrooks et al., 2016; Phillips et al., 2014). Although, there is emerging literature in public health around strategies to support capacity building of practitioners in the use of evidence-informed interventions (Leeman et al., 2017). Such strategies include training, tools, and technical assistance aimed at developing behaviours related to community assessment, identification of evidence-informed options, action planning and evaluation (Leeman et al., 2015), which align with the later steps of EIDM (i.e., adapt, implement, evaluate). The use of a comprehensive assessment tool such as the EIDM Competence Measure can help guide content development of interventions to ensure balanced focus on all EIDM steps and not only those which have traditionally received attention. There is potential for the EIDM Competence Measure to then be used in testing of such interventions to determine those most effective in developing specific competencies and guide future use of targeted interventions.

A multi-method approach to EIDM competence assessment.

This study sheds light on the multi-faceted nature of assessing EIDM competence attributes. Results from this study's systematic review (Chapter 4) and content coverage assessment (Chapter 5), along with existing EIDM psychometric literature across other health care disciplines (Shaneyfelt et al., 2006) demonstrate that EIDM assessment particularly of knowledge, skills, and behaviours can encompass self-report or objective methods (i.e., achievement tests, observational tools). A multi-method approach to assessing EIDM competence may lead to a more in-depth understanding of this complex construct. From a psychometric perspective, Waltz et al. (2017) support this approach by indicating that reliability and validity of an evaluation process is enhanced when diverse measures are used to address a particular research question.

As one aspect of competence assessment, the EIDM Competence Measure presented in Chapter 6 is a self-report instrument that has been developed to strategically address conceptual and psychometric limitations among existing EIDM measures. The importance of self-reported competence in nursing has been underscored through the development of other valid and reliable self-assessment competence measures for general clinical nursing practice (Cowan, Jenifer Wilson-Barnett, Norman, & Murrells, 2008; Flinkman et al., 2017; Meretoja, Isoaho, & Leino-Kilpi, 2004). Frequent use of self-perceived competence measures stems from benefits of low cost and resource requirements, practicality in a real-world setting, and short completion times (Campbell & Mackay, 2001; Cowan et al., 2008). While certain limitations of competence self-assessments have been highlighted, namely, lack of objectivity (Watson, Stimpson, Topping, & Porock, 2002) and the influence of social desirability (Takase, Yamamoto, & Sato; Waltz et al., 2017), it is still acknowledged as a crucial part of maintaining continuing nursing competence

(Campbell & Mackay, 2001; Waddell, 2001). Self-assessment engages nurses in ongoing critical reflection, a foundational component of professional accountability (Cowan et al., 2008; Waddell, 2001). Self-assessment also fosters independence and self-directedness in identifying professional development needs and planning for targeted strategies to address them within the context of a nurse's role and practice (Campbell & Mackay, 2001; Waddell, 2001). Consistent self-reflection is particularly important as it pertains to EIDM, since EIDM is understood as a process associated with lifelong learning and continuous improvement (Rousseau & Gunia, 2016; Sackett et al., 1997). As such, since self-assessment is regarded as an integral part of a multi-method strategy in measuring general nursing competence (Watson et al., 2002), such understanding can also be extended to the realm of EIDM competence measurement (Melnyk, Fineout-Overholt, & Mays, 2008; Melnyk, Gallagher-Ford, Long, & Fineout-Overholt, 2014; Tilson et al., 2011).

Another method to complement self-assessment of EIDM competence is the use of objective measures such as achievement tests (Saunders & Vehviläinen-Julkunen, 2018; Tilson et al., 2011). Waltz, Strickland, and Lenz (2010) characterize achievement tests as including short answer/essay questions or multiple-choice items to assess meeting established knowledge and/or skills standards. One such instrument is the online EIDM Skills Assessment tool, which is a 20-item multiple choice test developed using the same 7-step EIDM process established by the National Collaborating Centre for Methods and Tools (Dobbins, Ciliska, Mackintosh, Kyabaggu, & Howarth, 2016; National Collaborating Centre for Methods and Tools, 2020b). Given this conceptual alignment, there is opportunity in future studies to analyze the relationship between scores of the self-report EIDM Competence Measure and an objective EIDM measure as part of ongoing validity assessment. If determinations of high correlation are found, this could

contribute stronger validity evidence for both measures, based on the validity source of relationships to other variables (American Educational Research Association et al., 2014), in addition to supporting their use from a psychometric perspective in both research and practice. Such comparative studies could include testing the simultaneous use of the self-report EIDM Competence Measure and an objective EIDM measure in intervention studies that aim to increase EIDM knowledge, attitudes, skills, and behaviours among nurses or in a real-world practice setting to ascertain competence gaps and strengths of nurses.

The use of diverse EIDM behavioural tools has also been discussed as part of a broader EIDM competence assessment approach (Oude Rengerink et al., 2013). Two systematic reviews which included an analysis and synthesis of EIDM behavioural tools used among health care professionals (e.g., physicians, nurses, allied health) identified primary assessment methods as including self-report or objective measures (Oude Rengerink et al., 2013; Shaneyfelt et al., 2006). Such self-report tools commonly consisted of retrospective questionnaires evaluating the frequency with which EIDM behaviours were performed (Oude Rengerink et al., 2013; Shaneyfelt et al., 2006). While evaluating the frequency with which an EIDM behaviour is performed does not independently capture the established conceptualization of competence which includes identifying the ‘quality’ or how well a behaviour is performed, these data can still contribute to enhanced understanding of EIDM behavioural competence. Having an index of EIDM behaviour frequency, as a supplement to the EIDM Competence Measure which assesses quality of EIDM behaviours, may provide indications about organizational opportunities to engage in EIDM work or the influence of role functions on EIDM engagement. Objective assessment methods discussed included use of learning portfolios to document specific EIDM behaviours (e.g., question developing, searching) and direct observation of health care

professionals in practice (e.g., capturing databases consulted or searches performed in real time) (Oude Rengerink et al., 2013; Shaneyfelt et al., 2006). Once again however, across most measures, validity and reliability evidence were lacking, demonstrating a need for further exploration about psychometric properties of diverse EIDM behavioural measures.

While there is great potential for use of a multi-method approach to EIDM competence assessment, further exploration is still needed to assess its psychometrics and feasibility. Such approach may include the computation of a composite score derived from the self-report EIDM Competence Measure, an achievement test, items pertaining to frequency of EIDM behaviours and direct observation, to capture a fulsome picture of EIDM competence.

Access to psychometric literature for knowledge advancement.

In Chapter 6 which describes the development process for the EIDM Competence Measure, it was indicated that items from two existing tools, the Evidence-Based Practice (EBP) Beliefs Tool (Melnyk et al., 2008) and the EBP Competency Tool (Melnyk et al., 2018) were used when generating items. The use of these items was made possible not only through their availability in published literature, but also through permission granted by their original developer, Dr. Bernadette Melnyk, to conduct further psychometric testing in a different population and subsequently to perform modifications. Accessibility of instruments and an openness by original developers to share their work and encourage continued testing and evolution of an original tool is critical to advancing knowledge in the area of psychometric research in nursing. Norbeck (1985) comments that the use of several avenues to communicate research on an instrument such as conferences, manuscripts, and publication of abstracts is an important part of establishing collaborations among the nursing research community to collectively build continued validity evidence for an instrument. Norbeck (1985) also notes that

continued work with instruments whether psychometrically based or not, should be communicated back to the original developer to expand knowledge about how the instrument functions in different contexts and populations. Roberts and Stone (2003) agree and remark that in some instances nurse researchers may establish agreements in sharing or combining data with instrument developers in exchange for the use of an instrument, in the spirit of academic collaboration and allowing for advancement of knowledge and dissemination. In keeping with this, when negotiating the use of the EPB Beliefs Tool and EBP Competency Tool with Dr. Melnyk, an agreement was made to share findings from this study (Chapters 5 and 6) to add to her repertoire of psychometric evidence for her tools. In this vein, publications have been submitted for peer review and others will be developed based on future testing to increase visibility and accessibility of the EIDM Competence Measure among the nursing research and practice community and with an openness to share data and collaborate on further psychometric testing.

Nursing Practice Implications

Purposeful engagement of experts in EIDM and public health, along with end users in item development for the EIDM Competence Measure ensured conceptual rigor, relevance, and clarity of the developed competence indicators. Acceptability as it pertains to low missing data and completion times shows potential for use of this measure in a practical public health nursing setting. Existing literature has highlighted the essential need for explicit EIDM expectations to facilitate engagement in EIDM; such expectations can be communicated through integration into performance appraisal or annual review processes for health care professionals (Dobbins et al., 2019; Melnyk et al., 2014; Peirson, Ciliska, Dobbins, & Mowat, 2012). However, guidance from national organizations regarding EIDM expectations comes in the form of general and non-

specific EIDM competencies developed for community health nurses (Community Health Nurses of Canada, 2019) and public health professionals (Public Health Agency of Canada, 2008). Challenges persist with the use of these competencies, limited by a failure to fully integrate and evaluate them within public health systems (Canadian Public Health Association (CPHA), 2019).

The discrete indicators in the EIDM Competence Measure have potential to advance the current national understanding of EIDM role expectations by providing more clarity and direction for nurses in public health settings. At the local or regional public health unit level, the EIDM Competence Measure can be integrated into public health nurse performance reviews and used by managers, supervisors, and frontline staff to monitor progressive changes in overall EIDM competence or in its specific domains throughout one's professional career. This supports ongoing professional development by helping public health nurses to determine EIDM learning needs and subsequently develop learning plans to optimize performance as public health nurses and strengthen contributions to one's organization and the community or clients served (Hamilton et al., 2007). In addition, delineation of measurable competencies and competence recognition motivate healthcare professionals to initiate and sustain engagement in EIDM skills and behaviours (Lai & Teng, 2011). At the organizational level, EIDM competence standards can support human resources management by establishing clear EIDM role expectations for prospective, newly hired or employed public health nurses (Allen et al., 2018; Cross et al., 2006). Using aggregate data from EIDM competence assessments can also help management identify trends in staff competency gaps. This would support organizations to plan and implement tailored EIDM professional development opportunities for public health nurses.

Nursing Education Implications

Professional expectations that public health nurses engage in EIDM as part of their practice necessitates quality educational preparation in EIDM across undergraduate nursing programs. As such, the Canadian Association of Schools of Nursing have identified core expectations for nursing programs related to EIDM in their National Education Framework aligning with entry-to-practice competencies (Canadian Association of Schools of Nursing, 2015). These core expectations are articulated as general guiding principles and student outcome indicators (e.g., demonstrates knowledge and skills to access, appraise, critically examine, synthesize and judiciously use theory and empirical evidence from a variety of sources) under the domain of Research, Methodologies, Critical Inquiry, and Evidence (Canadian Association of Schools of Nursing, 2015). Despite guiding frameworks for nursing programs such as the above, there are gaps across nursing education which require attention to support EIDM competence among students. For example, traditionally, there has been a focus on teaching students about the conduct of primary research (e.g., research methods and design), rather than the application of evidence to nursing practice in the role of critical consumer (Rojjanasrirat & Rice, 2017). This may have led to students developing misconceptions about what EIDM entails (Fineout-Overholt, Melnyk, & Schultz, 2005), and difficulties in distinguishing conceptual and practice differences between primary research activities and EIDM, resulting in an inability to accurately identify specific EIDM competencies (Lam & Schubert, 2019). Moreover, while nursing faculty generally have positive attitudes toward EIDM, a lack of knowledge, skills, and time required to integrate and teach EIDM in the curriculum may contribute to limited EIDM curricular content (Orta et al., 2016; Stichler, Fields, Kim, & Brown, 2011). Also, with respect to student evaluation as it relates to EIDM, there remains a lack of valid and reliable tools to measure

EIDM competence that have been tested and used among nursing students across existing literature (Fiset, Graham, & Davies, 2017).

Given this, there is great potential to use the EIDM Competence Measure to address in part, some of the limitations in current nursing curriculum as it pertains to EIDM. While the EIDM knowledge, skills, attitudes/beliefs, and behavioural indicators have only been tested so far among practising public health nurses, there is opportunity to test their validity, reliability, and acceptability among nursing students across various levels and nursing faculty. These competence indicators may then serve as a foundation from which nursing curriculum can be assessed to determine existing content coverage or gaps that need to be addressed. In this case, the indicators can be used as a mapping resource to plan curricular content to ensure comprehensive integration of EIDM concepts, principles, and frameworks, across course objectives, individual and group learning activities, and evaluation measures. Further research would be required to explore how EIDM competence indicators need to be scaled across progressive levels of undergraduate and graduate nursing education (Blackman & Giles, 2017; Melnyk et al., 2018; Scurlock-Evans, Upton, Rouse, & Upton, 2017). Additionally, if reliability, validity, and acceptability evidence are determined for the EIDM Competence Measure within this educational context, it can be used as an evaluation instrument in both didactic and clinical learning environments to assess learning outcomes for students and provide opportunities for discrete feedback and development of learning goals related to EIDM using self-reflection.

Strengths and Limitations

There are both strengths and limitations to be considered for this study. First, a comprehensive literature review was conducted to establish conceptualizations of EIDM and competence. These definitions were used consistently throughout all phases of this study to

ground both the systematic review and instrument development process in conceptual literature. Across existing EIDM psychometric literature, instrument developers frequently do not establish EIDM constructs under measurement (Fernandez-Dominguez et al., 2014) or do not employ a fulsome conceptualization of competence (Belita et al., 2020). Second, to inform the instrument development stage, a methodologically rigorous systematic review was conducted in order to identify existing strengths and limitations among existing EIDM competence attribute measures and justify the need for a new EIDM competence measure that was unique, relevant, and addressed critical gaps. Third, in the development and evaluation of the EIDM Competence Measure, a rigorous process was used based on well established psychometric principles (Streiner, Norman, & Cairney, 2015) and the Standards for Educational and Psychological Testing (American Educational Research Association et al., 2014). In this study, the psychometric evaluation of reliability, acceptability and all four sources of validity evidence demonstrates a fulsome assessment approach that is often lacking across both newly developed and modified EIDM instruments (Buchanan et al., 2016; Glegg & Holsti, 2010).

One study limitation includes sample recruitment which was limited to Ontario. As such, the results may not necessarily be generalizable beyond the population of nurses working in the Ontario public health system. To contribute to validity evidence of the EIDM Competence Measure and to investigate potential use beyond one province, a next stage for this study is to test this measure in a national sample of public health nurses. Additionally, to broaden the scope of use for this measure, there are plans to psychometrically assess the tool across other professional groups aside from nurses in the public health workforce (e.g., public health inspectors, health promoters). This would address a need identified by a few of the Medical Officers of Health during the recruitment phase of the validation study. Extending beyond the

public health workforce, there is also opportunity to test the EIDM Competence Measure among nurses in other practice settings. In the context of nursing education, there is also potential for the EIDM Competence Measure to be tested across different levels of nursing students and among nursing faculty.

A second limitation relates to the recruitment method used in this study. Due to the large number and geographic dispersion of public health units across Ontario, email and telephone methods were used to recruit participants at both the organization and individual level. Other strategies consisting of a more personalized approach may have enhanced the recruitment process and contributed to greater participation, such as the use of video conferencing or personalized health unit visits to discuss study purpose and process and answer questions from potential participants for relationship building.

Conclusions

This study makes several unique contributions to the existing EIDM literature. The systematic review synthesizing data for 35 EIDM competence attribute measures can be used as a resource for organizations, nurses, and nursing leaders who are seeking valid, reliable, and acceptable instruments for their specific practice setting. As well, a consistent, and rigorous approach to the development and psychometric evaluation of measures assessing EIDM knowledge, skills, attitudes/beliefs, and behaviours is needed in order to produce high quality, conceptually sound, and practical tools among different nursing populations. The newly developed EIDM Competence Measure has demonstrated strong evidence of internal reliability, validity, and acceptability among Ontario nurses working in public health. Given this, there is great potential to expand the use of such tool across a national sample of nurses and other public

health professionals across Canada, as well as for nurses entering the public health workforce to facilitate continued self-reflection and professional development planning related to EIDM.

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Appendix A

EIDM Competencies and Standards in Canada and Ontario

Standard/Competency Document	Applicable EIDM Requirement or Competency Statement
Canadian Community Health Nursing Standards of Practice (Community Health Nurses of Canada [CHNC], 2019)	**Standard 7: Evidence Informed Practice** Community health nurses use best evidence to guide nursing practice and support clients in making informed decisions. **The community health nurse:** a. Uses professional expertise in considering best available research evidence, and other factors such as client context and preferences and available resources, to determine nursing actions. b. Seeks out reliable sources of available evidence from nursing and other relevant disciplines. c. Understands and uses critical appraisal skills to determine quality of research evidence. d. Understands and uses knowledge translations strategies to integrate high quality research into clinical practice, education, and research. e. Uses quality evidence to inform policy advocacy, development, and implementation. f. Uses a variety of information sources including acknowledging diverse perspectives and Indigenous ways of knowing.
Core Competencies for Public Health in Canada Release 1.0 (Public Health Agency of Canada [PHAC], 2008)	**Competency #1: Public Health Sciences** **1.4** Use evidence and research to inform health policies and programs. **Competency #3: Policy and Program Planning, Implementation and Evaluation** **3.3** Develop a plan to implement a course of action taking into account relevant evidence, legislation, emergency planning procedures, regulations and policies **Note:** Evidence is defined as "information such as analyzed data, published research findings, results of evaluations, prior experience, expert opinions, any or all of which may be used to reach conclusions on which decisions are based"
Standards for Public Health Programs and Services Consultation Document (Ontario Ministry of Health	**Policy Framework for Public Health Programs and Services** One of the goals for Programs and Services: • To increase the use of current and emerging evidence to support effective public health practice **Principle #2: Impact**

Standard/Competency Document	Applicable EIDM Requirement or Competency Statement
and Long-Term Care, 2018)	• Boards of health shall assess, plan, deliver, and manage their programs and services by considering evidence, effectiveness of the intervention, barriers to achieving maximum health potential, relevant performance measures, and unintended consequences. **Foundational Standard #3: Effective Public Health Practice** • Program Planning, Evaluation, and Evidence-informed Decision-Making ○ **Requirements:** 1. The board of health shall develop, implement and make available to the public an annual service plan and budget which: • a) demonstrates the use of a systematic process to plan public health programs and services to address the needs of the community by integrating the best available research and evaluation evidence with contextual factors and available resources • b) describes the public health programs and services planned for implementation and the information which informed it 5. The board of health shall ensure all programs and services are informed by evidence. **Note:** Foundational Standard: specific requirements that underlie all support all Program Standards.

Appendix B

EBP/EIDM Decision-making Models

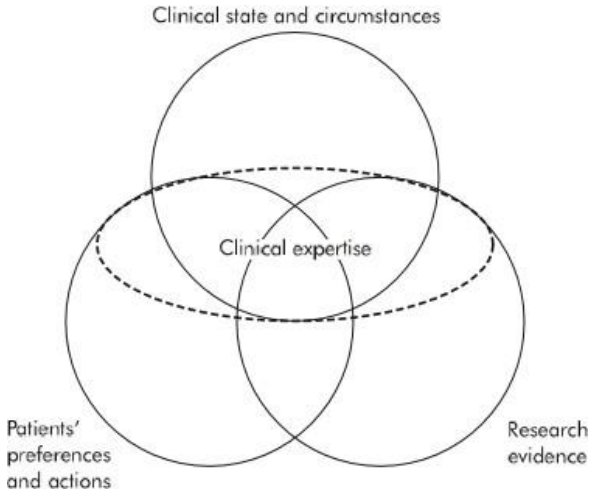


Figure B1. Model for evidence-based clinical decisions. Reprinted from "Clinical expertise in the era of evidence-based medicine and patient choice," by R.B. Haynes, P.J. Devereaux, and G. Guyatt, 2002, *Evidence Based Medicine, 7*(2), p. 37. Copyright 2002 by BMJ.

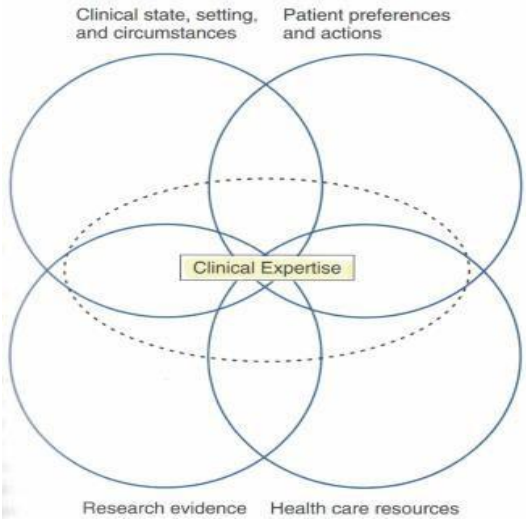


Figure B2. Adapted model for evidence-based clinical decisions. Reprinted from "Evidence-based nursing a guide to clinical practice," by A. DiCenso, G. Guyatt, and D. Ciliska, 2005, p. 5. Copyright 2005 by Mosby, Inc.

Figure B3. Evidence-Based Behavioral Practice. Reprinted from "Definition and competencies for evidence-based behavioral practice (EBBP)," by Spring et al., 2008, p. 4. Copyright 2008 by Council for Training in Evidence-Based Behavioral Practice.

Figure B4. A model for evidence-informed decision making in public health. Reprinted from "A model for evidence-informed decision-making in public health," by National Collaborating Centre for Methods and Tools (NCCMT), 2018, p. 1. Copyright 2018 by NCCMT.

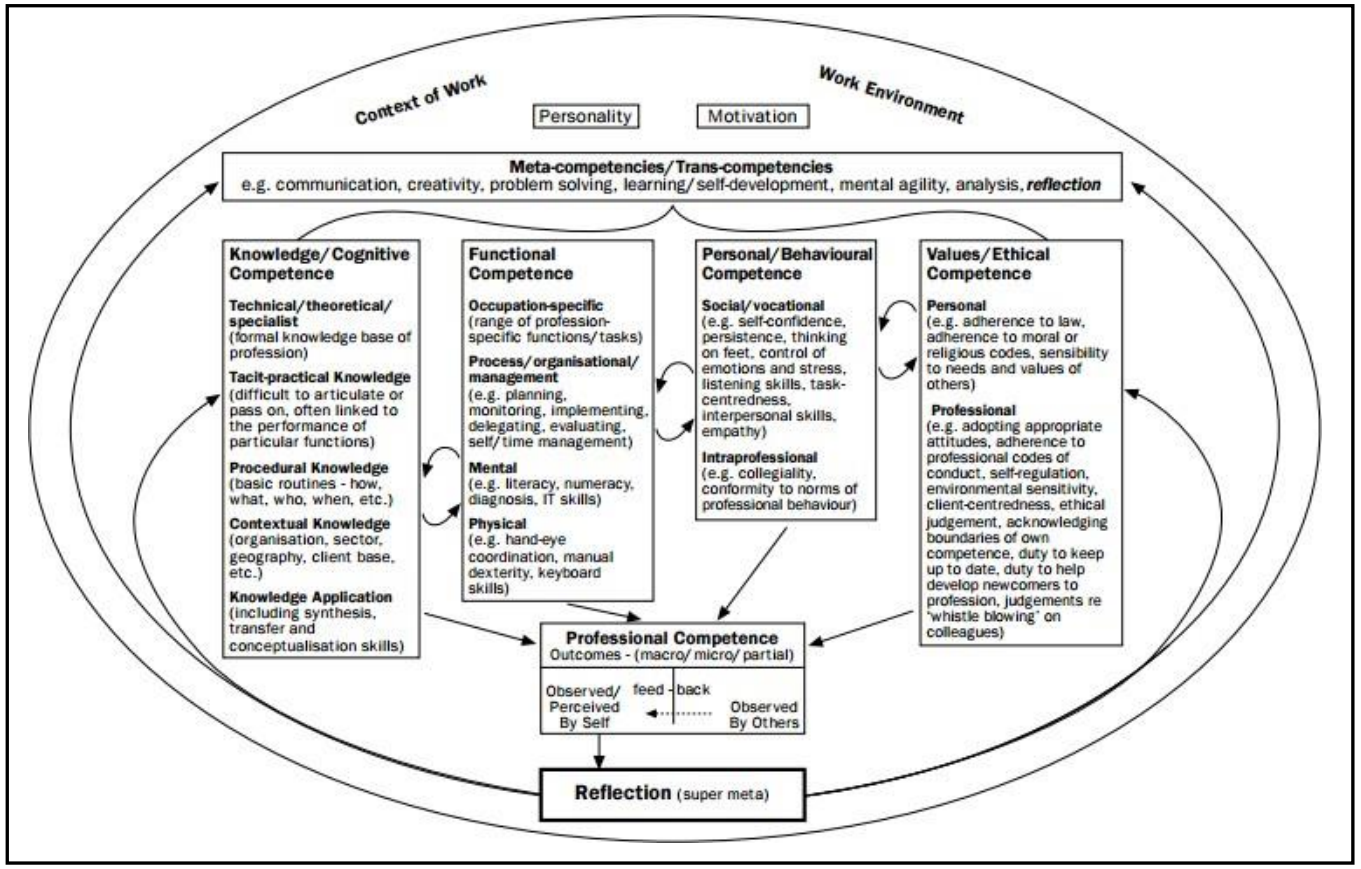
Appendix C

EBP/EIDM Stepwise Process Frameworks

Clinical/ Medicine	**Public Health**	
Sackett et al. (1997)	**Brownson et al. (1999)**	**NCCMT (2020)**
1. Ask - Form answerable clinical question	1. Develop an initial, concise, operational statement of the issue	1. Define - Clearly define the question or problem
2. Search - Search for best evidence (e.g. clinical examination, research evidence or other sources) with maximum efficiency	2. Determine what is known through the scientific literature 3. Quantify the issue using existing sources of data	2. Search - Efficiently search for research evidence
3. Appraise - Critically appraise evidence for validity (closeness to truth) and usefulness (clinical applicability)		3. Appraise - Critically and efficiently appraise the research sources.
4. Apply - Apply evidence in clinical practice	4. Develop program or policy options	4. Synthesize -Interpret/form recommendations for practice based on literature.
	5. Develop an action plan for the program or policy	5. Adapt - Adapt the information to the local context.
		6. Implement - Decide whether and plan how to implement adapted evidence into practice or policy.
5. Evaluate EBM performance	6. Evaluate the program and policy	7. Evaluate - Evaluate the effectiveness of implementation efforts (process and outcomes

Appendix D

Holistic Model of Professional Competence



Reprinted from "The reflective (and competent) practitioner: a model of professional competence which seeks to harmonise the reflective practitioner and competence-based approaches" by G. Cheetham and G. Chivers, 1998, *Journal of European Industrial Training, 22*(7), p. 275. Copyright 1998 by Emerald Publishing.

Appendix E

Definitions of EIDM Competence Attributes Across the Literature

Source of Definitions	Knowledge	Skill/functional	Attitudes/beliefs	Behavioural
Holistic model of professional competence (Cheetham & Chivers, 1998)	Possession of work-related knowledge and ability to put into use	Ability to perform work-based tasks effectively to produce specific outcome; possession of discrete skills	Possession of personal and professional values and ability to make judgments based on these in work-related situations	Ability to adopt appropriate, observable behaviours in work-related situation
CREATE (Classification Rubric for EBP Assessment Tools in Education) Framework from Sicily Statement (Tilson et al., 2011)	Retention of facts and concepts about EIDM (e.g. defining EIDM concepts, list basic principles of EIDM, describe levels of evidence)	Application of knowledge, ideally in practical setting; complete EIDM tasks; may assess different dimensions of skills (e.g. thoroughness of process, efficiency, correct application)	Values ascribed by learner to importance and usefulness of EIDM	What is done in practice; includes processes that clinician would use in application of EIDM (assess patient circumstances, values, preferences, goals, identify own clinical competence)
Leung et al. (2014)	Theoretical and practical understanding of evidence-based nursing practice	Nurse's ability to apply his/her knowledge using the 5 steps	Hypothetical construct that represents an individual's thought about the concepts of EIDM	n/a
Glegg & Holsti (2010)	Awareness of evidence sources and understanding about evidence itself; awareness and understanding of EIDM principles or steps	Application of knowledge to carry out EIDM tasks	n/a	n/a
Shaneyfelt et al. (2006)	Knowledge about EIDM	Participants applying knowledge; performance of EIDM steps in clinical scenarios (written case, OSCE)	Attitudes toward EIDM	Actual performance of EIDM in practice (enacting EIDM steps, performing evidence-based clinical maneuvers, affecting patient outcomes)
Buchanan et al. (2016)	Awareness of facts, data, information, ideas or principles accessed through study, research observation, experience or intuition	Performing EIDM steps in clinical scenario	Include views, perceptions, beliefs, and intentions relating to EIDM	Actual performance of EIDM in practice

Appendix F

Summary Details of Systematic Reviews

Review	Number of Studies	Number of Unique Measures	Population of Focus	Settings	Competence Attributes Measured			
					Knowledge	Skills	Attitudes/Values	Behaviour
Buchanan et al. (2016)	35	34	Qualified occupational therapists (OT), graduate or undergraduate OT students	Not described	✓	✓	✓	✓
Fernandez-Dominguez et al. (2014)	24	24	Physiotherapists	Not described	✓	✓	✓	✓
Glegg & Holsti (2010)	15	15	Practising OTs	Not described	✓	✓		
Leung et al. (2014)	59	24	Nurses/Midwives	Not described	✓	✓	✓	
Shaneyfelt et al. (2006)	115	104	Physicians, residents, medical students	Primary care, hospital	✓	✓	✓	✓

Appendix G

AMSTAR Ratings Across Systematic Reviews

AMSTAR criteria	**Buchanan et al. (2016)**	**Fernandez-Dominguez et al. (2014)**	**Glegg & Holsti (2010)**	**Leung et al. (2014)**	**Shaneyfelt et al. (2006)**
A priori protocol	Can't tell	Can't tell	Can't tell	Can't tell	Can't tell
Duplicate study selection	Yes	Yes	No	Yes	Yes
Duplicate data extraction	No	Yes	Can't tell	Yes	Yes
Comprehensive search	Yes	Yes	Yes	Yes	Yes
Status of publication inclusion	No	No	Can't tell	Yes	No/Can't tell
List of included studies	Yes	Yes	Yes	No (only limited selection)	No (only limited selection)
List of excluded studies	No	No	No	No	No
Characteristics of studies provided	Yes	Yes (lacking)	No (only outcome)	No (only limited selection)	No (only limited selection)
Scientific quality assessed and documented	Yes	Yes (requires improvement; has focus on psychometric properties)	Yes (ratings require clarity)	Yes (only focus on psychometric properties of instruments)	Yes (developed own criteria)
Scientific quality included in conclusions	Yes	Yes	Yes	Yes	Yes
Methods used for pooling correct	N/A	N/A	N/A	N/A	N/A
Publication bias assessed	No	No	No	No	No
Conflict of interest included	No	No	No	No	No
AMSTAR SCORE	4/11	5/11	3/11	5/11	4/11

Appendix H

Definitions of EIDM Competence Attributes Across Systematic Reviews

Review	Knowledge	Skill/functional	Attitudes/beliefs	Behavioural
Buchanan et al. (2016)	Awareness of facts, data, information, ideas or principles accessed through study, research observation, experience or intuition	Performing EIDM steps in clinical scenario such as standardized patient, clinical examination, direct observation	Include views, perceptions, beliefs, and intentions relating to EIDM. May include agreement/acceptance of evidence, motivation, self-efficacy to adopt EIDM	Actual performance of EIDM in practice (e.g. searching databases for evidence, accessing information sources and using evidence to select an intervention in the actual practice setting)
Fernandez-Dominguez et al. (2014)	*Does not define			
Glegg & Holsti (2010)	Awareness of evidence sources and understanding about evidence itself; awareness and understanding of EIDM principles or steps	Application of knowledge to carry out EIDM tasks	n/a	n/a
Leung et al. (2014)	Theoretical and practical understanding of evidence-based nursing practice	Nurse's ability to apply his/her knowledge using the 5 steps	Hypothetical construct that represents an individual's thought about the concepts of EIDM	n/a
Shaneyfelt et al. (2006)	Knowledge about EIDM	Participants applying knowledge; performance of EIDM steps in clinical scenarios (written case, OSCE)	Attitudes toward EIDM	Actual performance of EIDM in practice (enacting EIDM steps, performing evidence-based clinical maneuvers, affecting patient outcomes)

Appendix I

EIDM Competence Assessment Measures Recommended From Systematic Reviews

Review	Instrument and Individual Study	Competence Attributes Measured				Format			Reliability				Validity Evidence Based On				Type	
		Knowledge	Skills	Attitude	Behaviour	Self-assessment	Achievement test	External assessment	Alternate form	Test re-test	Internal consistency	Inter-rater	Test Content	Response Processes	Internal Structure	Relations to Other Variables	RU	EIDM
Buchanan et al. (2010)																		
	Knowledge, Attitudes and Practices of Research [KAP] Survey (Van Mullem et al., 1999)	x		x	x	x				✓ 0.77-0.83	✓ 0.93-0.97		✓ 0.85 (CVI)				x	
	Barriers to Research Utilization Scale (Funk et al., 1991)			x		x				✓ 0.68-0.83	✓ 0.72-0.80 (first three factors); 0.65 (last factor)				✓ Factor Analysis: 4 factor		x	
	Barriers and Attitudes to Research in the Therapies [BART] (Metcalfe et al., 2001)			x		x					✓ 0.63 (importance of research); 0.78 (perceived barrier)				✓ Factor Analysis: 8 factor; 2 sub-scales		x	
	Edmonton Research Orientation Survey [EROS] (Pain et al., 1996)	x			x	x					✓ 0.93				✓ Factor Analysis: 4 factor	✓ Scores correlated with research /training	x	

Review	Instrument and Individual Study	Competence Attributes Measured				Format			Reliability				Validity Evidence Based On				Type	
		Knowledge	Skills	Attitudes	Behaviours	Self-assessment	Achievement	External assessment	Alternate form	Test re-test	Internal consistency	Inter-rater	Test Content	Response Processes	Internal Structure	Relations to Other Variables	RU	EIDM
	Philibert et al. (2003)			x	x	x					✓ 0.89 (attitudes); 0.78 (research use)						x	
	Modified Knowledge, Attitude and Behaviour [KAB] Questionnaire (Stronge & Cahill, 2012)	x		x	x	x					✓ 0.71-0.88				✓ Factor Analysis: 4 factor	✓ Scores correlated with other EIDM measures		x
	Evidence-Based Practice Questionnaire (EBPQ) (Upton & Lewis, 1998)	x	x	x	x	x				✓ 0.80-0.92	✓ 0.74-0.88		✓					x
	Revised EBPQ (Upton & Upton, 2006)	x	x	x	x	x					✓ 0.79-0.85 (subscales) 0.87 (overall)		✓		Factor analysis: 3 factor	knowledge of local EIDM initiative = ↑ EIDM attitude, knowledge, behaviour		x

Review	Instrument and Individual Study	Competence Attributes Measured				Format			Reliability				Validity Evidence Based On				Type	
		Knowledge	Skills	Attitudes	Behaviours	Self-assessment	Achievement test	External assessment	Alternate form	Test-re-test	Internal consistency	Inter-rater	Test Content	Response Processes	Internal Structure	Relations to Other Variables	RU	EIDM
Glegg & Holsti, 2010	Adapted Fresno Test of Competence in EBP [AFT] (McCluskey & Bishop, 2009; McCluskey & Lovarini, 2005)	x	x				x				✓ 0.74	✓ ICC 0.91-0.96						x
	EBP Survey (McCluskey & Lovarini, 2005)	x	x	x		x	x				✓ 0.74-0.84	✓ 0.20-0.92	✓					x
	Revised EBPQ (Upton & Upton, 2006)	*Duplicate. See above under Buchanan et al. review for data.																
Leung et al., 2014	Revised EBPQ (Upton & Upton, 2006)	*Duplicate. See above under Buchanan et al. review for data.																
	Revised EBPQ (Koehn & Lehman, 2008)	x	x	x	x	x					✓ 0.72-0.95 (subscale); overall 0.94								x

Review	Instrument and Individual Study	Competence Attributes Measured				Format			Reliability				Validity Evidence Based On				Type	
		Knowledge	Skills	Attitudes	Behaviours	Self-assessment	Achievement test	External assessment	Alternate form	Test-re-test	Internal consistency	Inter-rater	Test Content	Response Processes	Internal Structure	Relations to Other Variables	RU	EIDM
Shaneyfelt et al., 2006	Fresno Test (Ramos et al., 2003)	x	x				x				✓ 0.88	✓ 0.98	✓			✓ higher scores (experts); lower scores (novices)		x
	Berlin Questionnaire (Fritsche et al., 2002)	x	x				x				✓ 0.75-0.82					✓ Different scores between expertise groups.		x

Note: RU = research utilization; EIDM = evidence-informed decision-making

Appendix J

Criteria Used in Systematic Reviews for Critical Appraisal of Individual Studies

Review	Name of Criteria	Description of Criteria	Criteria used to determine highest quality tools for recommendation
Buchanan et al. (2016) p. 62	Adapted from COSMIN criteria (Terwee et al., 2012)	• Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) • Criteria include: internal consistency, reliability, content validity, structural validity, hypothesis testing, cross-cultural validity, clinical utility • Each criteria rated on 4-point scale (excellent, good, fair, poor)	• If a measure received at least 3 'excellent' scores (out of 5 possible criteria)
Fernandez-Dominguez et al. (2014) p. 775	Adapted criteria from Terwee et al. (2007)	• Criteria: content validity, criteria validity, construct validity, reproducibility, internal consistency, responsiveness, theoretical ground, floor/ceiling effect • Ratings: positive, negative, uncertain, absent	*No recommendations made
Glegg & Holsti (2010) p. 224	Adapted criteria from CanChild Outcomes Measures Rating Form and Guidelines (Law, 2004)	• Focus: primary purpose, population, evaluation context (no rating) • Scale construction: quality of item selection, weight and type of scale used (excellent, adequate, poor) • Reliability: excellent, adequate, poor • Validity (no rating) *although in original criteria by Law (2004), rating scale was developed • Overall utility: Consideration of each of the previous factors (excellent, adequate, poor)	• If overall utility had a score of "adequate" which was achieved by gaining adequate-excellent ratings for scale construction and reliability
Leung et al. (2014)	Psychometric Grading Framework [PGF] (Leung et al., 2012)	• Rates the strength of validity of measurement tools • Assessment criteria: content validity, construct validity, criterion validity, internal consistency, test-retest reliability, inter-rater reliability based on strength of measures	• The measure scored at least an 'adequate' for overall strength based on an algorithm from PGF
Shaneyfelt et al. (2006)	Developed own criteria	• Identified 3 levels of instruments: **Level 1** • Individual trainee formative or summative EIDM evaluation	• Included in Level I

Review	Name of Criteria	Description of Criteria	Criteria used to determine highest quality tools for recommendation
		• Most robust psychometric properties • Ability to distinguish between participants of different levels of EIDM experience or expertise. • Establish inter-rater reliability • Objective outcome measures • Multiple ≥ 3 types of established validity (including discriminative validity) **Level 2** • Programmatic EIDM curriculum evaluation • Establish inter-rater reliability • Objective outcomes • "Strong evidence of response validity" from RCTs or pre-post controlled studies **Level 3** • Evaluation of EIDM behaviours • Objective outcomes	

Appendix K

HiREB Ethics Approval Letter

HiREB

Hamilton Integrated Research Ethics Board

Mar-29-2019

Project Number: 5238

Project Title: Psychometric Evaluation of a Measure to Assess Evidence-Informed Decision-Making (EIDM) Competence in Public Health Nursing

Principal Investigator: Dr. Maureen Dobbins

This will acknowledge receipt of your letters dated February 24 2019 and March 26, 2019 which enclosed revised copies of the Information/Consent Form and the Application Form along with a response to the additional queries of the Board for the above-named study. These issues were raised by the Hamilton Integrated Research Ethics Board at their meeting held on February 19, 2019. Based on this additional information, we wish to advise your study had been given ***final*** approval from the full HiREB.

The following documents have been approved on both ethical and scientific grounds:

Document Name	Document Date	Document Version
Permission to use EBP Competency Tool - Version 1	Jan-09-2019	Version 1
Permission to use EBP-Beliefs Scale - Version 1	Jan-09-2019	Version 1
Permission to use organization factor items Version 1	Jan-12-2019	Version 1
Phase 1 Assessment of Content Validity - Participant Consent Form - Version 2 CLEAN	Feb-24-2019	Version 2
Phase 1 Assessment of Content Validity Email Correspondence with Content Experts - Version 1	Jan-05-2019	Version 1
Phase 1 Content Validity Assessment - Participant Tracking Sheet Version 1	Jan-07-2019	Version 1
Phase 1 Questionnaire for assessment of validity based on content Version 1	Jan-10-2019	Version 1
Phase 2 Pilot Testing - Participant Consent Form Version 2 CLEAN	Feb-24-2019	Version 2
Phase 2 Pilot Testing - Participant Tracking Sheet Version 1	Jan-07-2019	Version 1
Phase 2 Pilot Testing Email correspondence with Health Unit Contact - Recruitment_Introduction Letter Version 1	Jan-08-2019	Version 1
Phase 2 Pilot Testing Email correspondence with Pilot Test Participant - Version 1	Jan-08-2019	Version 1
Phase 2 Pilot Testing Interview Guide - Version 1	Jan-08-2019	Version 1
Phase 2 Pilot Testing Questionnaire - Version 1	Jan-08-2019	Version 1
Phase 3 Psychometric Testing - Participant Consent Form - Version 3 CLEAN	Mar-26-2019	3
Phase 3 Psychometric Testing Email correspondence with Health Unit Contact - Recruitment_Introduction Letter Version 2 CLEAN	Feb-24-2019	Version 2
Phase 3 Questionnaire for psychometric testing Version 1	Jan-10-2019	Version 1
Protocol for EIDM Competence Study January 9 2018 - Version 1	Jan-09-2019	Version 1

Document Name	Document Date	Document Version
M. Dobbins CITI completion report march 2018; Certificate # 26918214	Mar-02-2019	Version 2
Halton Region Letter of Support for EIDM Competences Study January 2019	Jan-11-2019	Version 1
McMaster_EIDM_OPH_Letter_Support_Dec2018	Dec-12-2018	Version 1
Peel Public Health EIDM Study Letter of Support Dec 2018	Dec-11-2018	Version 1
tcps2-eptc2-certificate E.Belita	Nov-06-2016	Version 1
Waterloo EIDM Study Letter of Support Part 1 Dec 2018	Dec-11-2018	Version 1
Waterloo EIDM Study Letter of Support Part 2 Dec 2018	Dec-11-2018	Version 1
Waterloo EIDM Study Letter of Support Part 3 Dec 2018	Dec-12-2018	Version 1
WDGPH Letter of Support to Hamilton Integrated Research Ethics Board re EIDM - January 18, 2019	Jan-18-2019	Version 1

Please Note: All consent forms and recruitment materials used in this study must be copies of the above referenced documents.

We are pleased to issue final approval for the above-named study for a period of 12 months from the date of the HiREB meeting on February 19, 2019. Continuation beyond that date will require further review and renewal of HiREB approval. Any changes or revisions to the original submission must be submitted on a HiREB amendment form for review and approval by the Hamilton Integrated Research Ethics Board.

PLEASE QUOTE THE ABOVE REFERENCED PROJECT NUMBER ON ALL FUTURE CORRESPONDENCE

Sincerely,

Dr. Mark Inman, MD, PhD
Chair, Hamilton Integrated Research Ethics Board

The Hamilton Integrated Research Ethics Board (HiREB) represents the institutions of Hamilton Health Sciences, St. Joseph's Healthcare Hamilton, Research St. Joseph's-Hamilton, and the Faculty of Health Sciences at McMaster University and operates in compliance with and is constituted in accordance with the requirements of: The Tri-Council Policy Statement on Ethical Conduct of Research Involving Humans; The International Conference on Harmonization of Good Clinical Practices; Part C Division 5 of the Food and Drug Regulations of Health Canada, and the provisions of the Ontario Personal Health Information Protection Act 2004 and its applicable Regulations; For studies conducted at St. Joseph's Healthcare Hamilton, HiREB complies with the Health Ethics Guide of the Catholic Alliance of Canada

Appendix L

Consent Form – Content Validation

McMaster University

Faculty of Health Sciences
School of Nursing

1200 Main Street West
Hamilton, Ontario, Canada
L8N 3Z5

Phone 905.525.9140
Fax 905.524.5228
http://www.fhs.mcmaster.ca/nursing

LETTER OF INFORMATION / CONSENT

Measuring Evidence-informed Decision-Making Competence in Public Health Nursing

This is a student research project conducted under the supervision of Dr. Maureen Dobbins. This study will help the student learn more about the topic area and develop skills in research design, collection and analysis of data, and writing a research paper.

Investigators:

Local Principal Investigator:

Dr. Maureen Dobbins
School of Nursing, McMaster University
175 Longwood Rd South, Suite 210a
Hamilton, Ontario, Canada
(905) 525-9140 ext. 20455
E-mail: dobbinsm@mcmaster.ca

Student Investigator:

Emily Belita
School of Nursing, McMaster University
175 Longwood Rd South, Suite 210a
Hamilton, Ontario, Canada
E-mail: belitae@mcmaster.ca

What is the purpose of the study?

You are being invited to take part in a study which will help develop a tool to assess competence in evidence informed decision making (EIDM) for public health nurses (PHNs).

Evidence-informed decision making (EIDM) is an important part of the public health nurse's role. EIDM is defined as the use of research knowledge, public health expertise, client/community preferences and values, and understanding of public health resources to help make health care decisions. EIDM implementation is linked to improved health outcomes for clients and communities, increased job satisfaction for nurses, and efficient use of health care resources. Expectations in applying EIDM in practice for PHNs are outlined in provincial mandates and broad national competencies. While PHNs are expected to practice EIDM, there

are no clear and specific competencies that help to assess how well they are practicing it. Through this study, we hope to develop and test a tool that can be used in practice to help PHNs, Supervisors/Managers assess EIDM competence. This will encourage self-reflection about EIDM competencies and support professional development related to it.

What will happen during the study?

If you volunteer to participate in this study, you will be asked to:

- Read and complete a consent form
- Complete a one-time anonymous electronic survey that will take approximately 30 minutes to complete. The survey will ask that you rate the level of relevance of each proposed item to the EIDM competence attribute under which it has been categorized. There will also be text boxes provided in which you can make additional comments to supplement the relevance rating of each item or provide general comments overall about the proposed measure.

Are there any risks to doing this study?

There are no anticipated risks to participating in this study.

How many people will be involved in the study?

Approximately six individuals will be recruited to participate as content experts in this phase of the study.

Are there any benefits to doing this study?

We cannot promise any personal benefits to you from your participation in this study. However participating in this study may provide you with the benefit of contributing to the development of a practical tool that can be used to advance EIDM in public health nursing, with applicability to other professions in public health.

What information will be kept private?

You are participating in this study anonymously. No personal identifying information will be linked to your completed survey data. Collected data will be maintained on a password protected computer on a secure network. All study data will be destroyed after 10 years.

For the purposes of ensuring the proper monitoring of the research study, it is possible that a member of the Hamilton Integrated Research Ethics Board and/or another institutional member may consult your research data. However, no records which identify you by name or initials will be allowed to leave the research office. By signing this consent form, you authorize such access.

What if I change my mind about being in the study?

Your participation in this study is voluntary. It is your choice to be part of the study or not. Your decision to participate or not will not affect you in a professional or personal capacity. If you decide to be part of the study, you can decide to stop (withdraw), at any time, even after signing the consent form or part-way through the study. If you decide to withdraw, there will be no consequences to you professionally or personally. Should you wish to withdraw from the study, contact the Student Investigator (Emily Belita) by email (belitae@mcmaster.ca). You may also refuse to answer any questions you do not want to answer and still remain in the study.

If I have any questions or problems, whom can I call?

If you have questions or need more information about the study itself, please contact the Student Investigator (Emily Belita) at belitae@mcmaster.ca.

If you have any questions regarding your rights as a research participant, you may contact the Office of the Chair of the Hamilton Integrated Research Ethics Board at 905-521-2100 x42013.

CONSENT

I have read the information presented in the information letter about a study being conducted by Dr. Maureen Dobbins and Ms. Emily Belita of McMaster University.

- ⎦ Yes
- ⎦ No

I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested.

- ⎦ Yes
- ⎦ No

I understand that if I agree to participate in this study, I may withdraw from the study at any time.

- ⎦ Yes
- ⎦ No

I agree to participate in the study.

- ⎦ Yes, I agree to participate in this study.
- ⎦ No, I do not wish to participate in this study.

*The survey will follow if participants click on “Yes, I agree to participate in this study.”

Appendix M

Consent Form – Response Process

Faculty of Health Sciences
School of Nursing
1200 Main Street West
Hamilton, Ontario, Canada
L8N 3Z5
Phone 905.525.9140
Fax 905.524.5228
http://www.fhs.mcmaster.ca/nursing

LETTER OF INFORMATION / CONSENT

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This is a student research project conducted under the supervision of Dr. Maureen Dobbins. This study will help the student learn more about the topic area and develop skills in research design, collection and analysis of data, and writing a research paper.

Investigators:

Local Principal Investigator:

Dr. Maureen Dobbins
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175 Longwood Rd South, Suite 210a
Hamilton, Ontario, Canada
(905) 525-9140 ext. 20455
E-mail: dobbinsm@mcmaster.ca

Student Investigator:

Emily Belita
School of Nursing, McMaster University
175 Longwood Rd South, Suite 210a
Hamilton, Ontario, Canada
E-mail: belitae@mcmaster.ca

What is the purpose of the study?

You are being invited to take part in a study which will help develop a tool to assess competence in evidence informed decision making (EIDM) for public health nurses (PHNs).

Evidence-informed decision making (EIDM) is an important part of the public health nurse's role. EIDM is defined as the use of research knowledge, public health expertise, client/community preferences and values, and understanding of public health resources to help make health care decisions. EIDM implementation is linked to improved health outcomes for clients and communities, increased job satisfaction for nurses, and efficient use of health care resources. Expectations in applying EIDM in practice for PHNs are outlined in provincial mandates and broad national competencies. While PHNs are expected to practice EIDM, there are no clear and specific competencies that help to assess how well they are practicing it. Through this study, we hope to develop and test a tool that can be used in practice to help PHNs, Supervisors/Managers assess EIDM competence. This will encourage self-reflection about EIDM competencies and support professional development related to it.

What will happen during the study?

If you volunteer to participate in this study, you will be asked to:

- Read and complete a consent form
- Participate in a one-to-one, in person or telephone interview (approximately 20-30 minutes) with the student investigator that will be audio taped.
- Answer questions rating your knowledge, skills, attitudes/beliefs, and behaviours related to EIDM.
- Answer additional questions about how well you understood these questions or how difficult or easy it was to answer them.

How many people will be involved in the study?

Approximately eight individuals will be recruited to participate in this phase of the study.

Are there any risks to doing this study?

The risks involved in participating in this study are minimal. You may worry that your self-assessment scores may be viewed by a Supervisor/Manager. However, your responses will be kept confidential, with no identifying information attached to them. Additionally, only members of the research team will have access to the collected data which is on a password protected database and computer. Described below are the steps we will take to protect your privacy and maintain confidentiality.

Are there any benefits to doing this study?

We cannot promise any personal benefits to you from your participation in this study. However, participating in the study may increase your knowledge or understanding about EIDM and encourage self-reflection about your strengths and areas for development with respect to EIDM.

What information will be kept private?

You are participating in this study confidentially. All personal information, such as your name, will be removed from the data and will be replaced with a number. No one but me (or other members of the research team) know whether you participated unless you choose to tell them. Audio tapes will be kept in a locked drawer in a research office or audio files will be saved on a secure McMaster University network. Electronic files of interview responses will be maintained on a password protected computer on a secure network. If the results of the study are published, no information that discloses your identity will be released or published without your consent to the disclosure. All study data will be destroyed after 10 years.

For the purposes of ensuring the proper monitoring of the research study, it is possible that a member of the Hamilton Integrated Research Ethics Board and/or another institutional member may consult your research data. However, no records which identify you by name or initials will be allowed to leave the research office. By signing this consent form, you authorize such access.

What if I change my mind about being in the study?

Your participation in this study is voluntary. It is your choice to be part of the study or not. Your decision to participate or not will not affect you in a professional or personal capacity. If you decide to be part of the study, you can decide to stop (withdraw), at any time, even after signing the consent form or part-way through the interview. If you decide to withdraw, there will be no consequences to you professionally or personally. You may also refuse to answer any questions you do not want to answer and still remain in the study.

If I have any questions or problems, whom can I call?

If you have questions or need more information about the study itself, please contact the Student Investigator (Emily Belita) at belitae@mcmaster.ca.

If you have any questions regarding your rights as a research participant, you may contact the Office of the Chair of the Hamilton Integrated Research Ethics Board at 905-521-2100 x42013.

CONSENT

I have read the information presented in the information letter about a study being conducted by Dr. Maureen Dobbins and Ms. Emily Belita of McMaster University.

- ⎦ Yes
- ⎦ No

I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested.

- ⎦ Yes
- ⎦ No

I understand that if I agree to participate in this study, I may withdraw from the study at any time.

- ⎦ Yes
- ⎦ No

I agree to participate in the study.

- ⎦ Yes, I agree to participate in this study.
- ⎦ No, I do not wish to participate in this study.

*The survey will follow if participants click on “Yes, I agree to participate in this study.”

Appendix N

Consent Form – Psychometric Testing

McMaster University

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L8N 3Z5

Phone 905.525.9140
Fax 905.524.5228
http://www.fhs.mcmaster.ca/nursing

LETTER OF INFORMATION / CONSENT

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Investigators:

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Dr. Maureen Dobbins
School of Nursing, McMaster University
175 Longwood Rd South, Suite 210a
Hamilton, Ontario, Canada
(905) 525-9140 ext. 20455
E-mail: dobbinsm@mcmaster.ca

Student Investigator:

Emily Belita
School of Nursing, McMaster University
175 Longwood Rd South, Suite 210a
Hamilton, Ontario, Canada
E-mail: belitae@mcmaster.ca

This study has been approved by the Ottawa Public Health Research Ethics Board.

What is the purpose of the study?

You are being invited to take part in a study which will help develop a tool to assess competence in evidence informed decision making (EIDM) for public health nurses (PHNs).

Evidence-informed decision making (EIDM) is an important part of the public health nurse's role. EIDM is defined as the use of research knowledge, public health expertise, client/community preferences and values, and understanding of public health resources to help make health care decisions. EIDM implementation is linked to improved health outcomes for clients and communities, increased job satisfaction for nurses, and efficient use of health care resources. Expectations in applying EIDM in practice for PHNs are outlined in provincial mandates and broad national competencies. While PHNs are expected to practice EIDM, there are no clear and specific competencies that help to assess how well they are practicing it. Through this study, we hope to develop and test a tool that can be used in practice to help PHNs, Supervisors/Managers assess EIDM competence. This will encourage self-reflection about EIDM competencies and support professional development related to it.

What will happen during the study?

If you volunteer to participate in this study, you will be asked to:

- Read and complete a consent form
- Complete a one-time anonymous electronic survey that will take approximately 20 minutes to complete. The survey will begin by asking some demographic questions. The remaining questions will ask you to assess your knowledge, skills, attitudes/beliefs, and behaviours as related to EIDM using a rating scale.

Are there any risks to doing this study?

The risks involved in participating in this study are minimal. You may worry that your self-assessment scores may be viewed by a Supervisor/Manager. However, your responses will be anonymous, with no identifying information linked to them. Additionally, only members of the research team will have access to the collected data which is on a password protected database and computer. Described below are the steps we will take to protect your privacy and maintain anonymity.

How many people will be involved in the study?

Approximately 400 individuals will be recruited to participate in this study.

Are there any benefits to doing this study?

We cannot promise any personal benefits to you from your participation in this study. However, it is our hope that the research team, PHNs, and PHN Supervisors/Managers will have a clearer understanding of what EIDM competence looks like and how it can be assessed in practice. Participating in the study may increase your knowledge or understanding about EIDM and encourage self-reflection about your strengths and areas for development with respect to EIDM.

What information will be kept private?

You are participating in this study anonymously. No personal identifying information will be linked to your completed survey data. Collected data will be maintained on a password protected computer on a secure network. All study data will be destroyed after 10 years.

For the purposes of ensuring the proper monitoring of the research study, it is possible that a member of the Hamilton Integrated Research Ethics Board and/or another institutional member may consult your research data. However, no records which identify you by name or initials will be allowed to leave the research office. By signing this consent form, you authorize such access.

What if I change my mind about being in the study?

Your participation in this study is voluntary. It is your choice to be part of the study or not. Your decision to participate or not will not affect you in a professional or personal capacity. If you decide to be part of the study, you can decide to stop (withdraw), at any time, even after signing the consent form or part-way through the study. If you decide to withdraw, there will be no consequences to you professionally or personally. Should you wish to withdraw from the study, contact the Student Investigator (Emily Belita) by email (belitae@mcmaster.ca). If you decide to withdraw from the study and your data has already been submitted, your data cannot be removed due to the anonymity of the data. You may also refuse to answer any questions you do not want to answer and still remain in the study.

If I have any questions or problems, whom can I call?

If you have questions or need more information about the study itself, please contact the Student Investigator (Emily Belita) at belitae@mcmaster.ca.

If you have any questions regarding your rights as a research participant, you may contact the Office of the Chair of the Hamilton Integrated Research Ethics Board at 905-521-2100 x42013.

CONSENT

I have read the information presented in the information letter about a study being conducted by Dr. Maureen Dobbins and Ms. Emily Belita of McMaster University.

⎦ Yes
⎦ No

I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested.

⎦ Yes
⎦ No

I understand that if I agree to participate in this study, I may withdraw from the study at any time.

⎦ Yes
⎦ No

I agree to participate in the study.

⎦ Yes, I agree to participate in this study.
⎦ No, I do not wish to participate in this study.

*The survey link will follow if participates click on “Yes, I agree to participate in this study.”

Appendix O

Participant Survey – Psychometric Testing

Registered nurses from public health departments throughout Ontario are being invited to complete this survey as part of the study "Measuring Evidence-Informed Decision-Making Competence in Public Health Nursing".

Please complete this survey if you are a registered nurse working in any role across any division in your health unit.

The survey will take approximately 20 minutes to complete. Your responses to the survey are anonymous. You will not be identified in the reporting of the results.

Demographics

1. Number of years worked as a Registered Nurse: _____

2. Number of years worked in Public Health: _____

3. Role:

   - ⎦ Frontline Public Health Nurse
   - ⎦ Health Promoter
   - ⎦ Policy Analyst
   - ⎦ Supervisor/Manager
   - ⎦ Director
   - ⎦ Other. Please specify:

4. Gender
   - ⎦ Male
   - ⎦ Female
   - ⎦ Other

5. Area of work specialization. Choose only ONE/PRIMARY area of work.
   - ⎦ Reproductive/infant health
   - ⎦ Healthy Babies/Healthy Children (HBHC)
   - ⎦ Pre-school
   - ⎦ School years
   - ⎦ Chronic disease prevention (e.g., nutrition, physical activity)
   - ⎦ Communicable and infectious diseases (e.g., rabies, tuberculosis, vaccine preventable diseases)
   - ⎦ Dental/oral health
   - ⎦ Emergency preparedness

- ⎦ Environmental health (e.g., food and water safety, health hazard prevention)
- ⎦ Injury prevention/safety
- ⎦ Mental health
- ⎦ Sexual health / sexually transmitted infections-STIs
- ⎦ Social determinants of health
- ⎦ Substance use / misuse / addiction
- ⎦ Other. Please specify ONE/PRIMARY area of specialization: _____

6. Highest earned degree in Nursing:

   - ⎦ Diploma
   - ⎦ Bachelor's degree
   - ⎦ Master's degree
   - ⎦ Doctoral degree

7. Have you completed training in evidence-based practice (EBP)/evidence-informed decision making (EIDM) (e.g., webinar, in-person course):

   - ⎦ No
   - ⎦ Yes

8. Have you ever (currently or in the past) been involved in any EIDM-related activities/projects at work (e.g., participating/leading a rapid review, training other individuals in EIDM, participation in a journal club):
   - ⎦ No
   - ⎦ Yes

9. Have you been involved in program planning? *For Halton Region Health Department only (at their request)
   - ⎦ No
   - ⎦ Yes
     - o If yes, which one:
       - o Pilot
       - o Cohort 1 and 2

Organizational Factors

Reference: Fineout-Overholt E, Melnyk BM. Organizational Culture and Readiness for System Wide Implementation of EBP (OCRSIEP) Scale. ARCC llc Publishing; Gilbert, AZ: 2006.

Item	None at all	A Little	Somewhat	Moderately	Very Much
1. To what extent is EIDM clearly described as central to the mission and philosophy of your institution?	1	2	3	4	5

2. To what extent is the nursing staff with whom you work committed to EIDM?	1	2	3	4	5
3. To what extent are there administrators within your organization committed to EIDM (i.e., have planned resources and support [e.g., time] to initiate EIDM)?	1	2	3	4	5
4. In your organization, to what extent is there a critical mass of nurses who have strong EIDM knowledge and skills?	1	2	3	4	5
5. To what extent do practitioners model EIDM in their clinical setting?	1	2	3	4	5
6. To what extent do staff nurses have access to quality computers and access to electronic databases for searching for best evidence?	1	2	3	4	5
7. To what extent are fiscal resources used to support EIDM (e.g. education-attending EIDM conferences/workshops, computers, paid time for the EIDM process, mentors)	1	2	3	4	5
8. To what extent are there EIDM champions (i.e., those who will go the extra mile to advance EIDM) in the environment among: ⌋ Administrators ⌋ Physicians ⌋ Nurse Educators ⌋ Advance Nurse Practitioners ⌋ Staff Nurses	1	2	3	4	5

EIDM Competence Attributes: Knowledge, Skills, Attitudes/Beliefs, Behaviours

In the following questions, you will be asked to assess your own knowledge, skills, attitudes/beliefs and behaviours in EIDM.

Definitions:

Evidence-informed decision-making (EIDM): "the process of distilling and disseminating the best available evidence from research, context and experience, and using that evidence to inform and improve public health practice and policy" (The National Collaborating Centre for Methods and Tools, 2018). According to the National Collaborating Centre for Methods and Tools (2018), there are seven steps that define EIDM:

1. **Define:** Clearly define the question or problem.
2. **Search:** Efficiently search for research evidence.
3. **Appraise:** Critically and efficiently appraise the research sources.
4. **Synthesize**: Interpret/form recommendations for practice based on the literature found.
5. **Adapt:** Adapt the information to a local context.
6. **Implement:** Decide whether (and plan how) to implement the adapted evidence into practice or policy.
7. **Evaluate:** Evaluate the effectiveness of implementation efforts.

Competence: "the ability to perform the tasks and roles required to the expected standard" (Eraut, 1998, p. 129) in a specific domain. It encompasses four attributes of knowledge, skills, attitudes/values, and behaviours (Cheetham & Chivers, 1998).

EIDM Knowledge: Understanding the defining theoretical, practical concepts and principles of EIDM and the different levels of evidence

Please rate your level of knowledge for each of the items on a scale from **(1) Poor to (7) Excellent**

1. Knowledge of what is involved in the 'define' step of EIDM.	1 □ Poor	2 □	3 □	4 □	5 □	6 □	7 □ Excellent
2. Knowledge of what is involved in the 'search' step of EIDM.	1 □ Poor	2 □	3 □	4 □	5 □	6 □	7 □ Excellent
3. Knowledge about the different levels of evidence when searching for research evidence (e.g., single studies, systematic reviews, summaries)	1 □ Poor	2 □	3 □	4 □	5 □	6 □	7 □ Excellent
4. Knowledge that online databases exist which house publications of individual research studies (e.g., PubMed, CINAHL)	1 □ Poor	2 □	3 □	4 □	5 □	6 □	7 □ Excellent
5. Knowledge that online databases exist which house pre-appraised,	1	2	3	4	5	6	7

synthesized research evidence (e.g., Health Evidence, ACCESSSS)	⌋ □ □ □ □ □ □ Poor Excellent
6. Knowledge of what is involved in the 'appraise' step of EIDM.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Poor Excellent
7. Knowledge that critical appraisal tools exist to assess the quality of research evidence (e.g., AGREE II tool, CASP).	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Poor Excellent
8. Knowledge of what is involved in the 'synthesize' step of EIDM.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Poor Excellent
9. Knowledge of what is involved in the 'adapt' step of EIDM.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Poor Excellent
10. Knowledge of what is involved in the 'implement' step of EIDM.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Poor Excellent
11. Knowledge of what is involved in the 'evaluate' step of EIDM.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Poor Excellent

EIDM Skills: The application of EIDM knowledge to perform tasks related to EIDM in a practical setting

Please rate your level of skill for each of the items from **(1) Beginner to (7) Expert**

1. Ability to develop an answerable practice question.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
2. Ability to develop an appropriate strategy to search for research evidence.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
3. Ability to use online databases that house publications of individual research studies (e.g., CINAHL)	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
4. Ability to use online databases that house pre-appraised, synthesized research evidence (e.g., Health Evidence).	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert

5. Ability to use critical appraisal tools to appraise the quality of research evidence (e.g., AGREE II tool, CASP)	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
6. Ability to assess the applicability of research evidence to the local public health context.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
7. Ability to conduct an assessment of barriers and facilitators (related to resources, organization, evidence/guideline, clients' preferences/values) when implementing a practice change.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
8. Ability to conduct a stakeholder analysis (i.e. collecting and analyzing information on stakeholders' importance and influence) when implementing a practice change.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
9. Ability to develop an action plan to implement an evidence-informed practice change.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert
10. Ability to participate in the development of evaluation indicators to assess outcomes of evidence-informed decisions or practice changes.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Beginner Expert

EIDM Attitudes/Beliefs: Perceptions, personal beliefs about, and the importance assigned to EIDM

Reference: Melnyk, B. M., Fineout-Overholt, E., & Mays, M. Z. (2008). The evidence-based practice beliefs and implementation scales: Psychometric properties of two new instruments. *Worldviews on Evidence-Based Nursing*, *5*(4), 208-216. doi:10.1111/j.1741-6787.2008.00126.x

Please rate your level of agreement with the following items **Strongly disagree (1) to Strongly agree (7)**.

1. 17. I believe that I can implement EIDM in a time efficient way.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Strongly disagree Strongly agree
2. 18. I believe that I can engage others in implementing strategies to address barriers (e.g., personal, organizational, community) when implementing EIDM.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Strongly disagree Strongly agree

3.	19. I believe that evaluating outcomes of an evidence-informed decision/practice change is an important component of EIDM.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Strongly disagree Strongly agree
4.	20. I believe that implementing EIDM can improve the services and programs delivered to clients (e.g., communities, individuals, families).	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Strongly disagree Strongly agree
5.	21. I believe that critically appraising evidence is an important step in the EIDM process.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Strongly disagree Strongly agree
6.	22. I believe that the use of high-quality evidence-informed guidelines (e.g., clinical practice guidelines) can improve public health practice and policy.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Strongly disagree Strongly agree
7.	23. I believe EIDM is difficult. (reverse scored)	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Strongly disagree Strongly agree

EIDM Behaviours: The enactment of EIDM steps in a real-life health care setting

Reference: Melnyk, B. M., Gallagher-Ford, L., Zellefrow, C., Tucker, S., Thomas, B., Sinnott, L. T., & Tan, A. (2018). The first U.S. study on nurses' evidence-based practice competencies indicates major deficits that threaten healthcare quality, safety, and patient outcomes. *Worldviews on Evidence-Based Nursing, 15*(1), 16-25.

Please rate your level of competence for the following items from **(1) Not competent to (4) Highly competent**

1. I question public health practices for the purpose of improving the quality of care/service delivery.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
2. I describe public health practice issues using client assessment data (i.e., community, individuals, families, populations).	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent

3. I participate in the formulation of public health practice questions.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
4. I search for research evidence to answer public health practice questions.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
5. I participate in the critical appraisal of individual research studies to determine their strength and applicability to public health practice.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
6. I participate in the critical appraisal of synthesized evidence (such as clinical practice guidelines, evidence-based policies and procedures, and evidence syntheses).	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
7. I participate in the synthesis and interpretation of a body of research evidence gathered to formulate recommendations for public health practice.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
8. I integrate evidence gathered from public health expertise, client/community preferences, and local context with research evidence to plan evidence-informed practice changes.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
9. I participate in the assessment of barriers and facilitators (related to resources, organization, evidence/guidelines, clients' preferences/values) when implementing a practice change.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
10. I participate in the process of stakeholder analyses (i.e., collecting and analyzing information on stakeholders' importance and influence) when implementing a practice change.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent

11. I participate in the development of an action plan to implement a practice change.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent
12. I participate in evaluating outcomes of evidence-informed decisions or practice changes.	1 2 3 4 5 6 7 □ □ □ □ □ □ □ Not competent Highly competent

Thank you for participating in our survey!

Please click **'submit'** below to ensure your answers are submitted.

To support your ongoing development of competence in evidence-informed decision-making (EIDM), the National Collaborating Centre for Methods and Tools provides numerous learning resources and supports including: online learning modules, webinars, assessment tools, videos, workshops and events.