

SOCIAL NETWORKS AND EVIDENCE-INFORMED PUBLIC HEALTH

Ph.D. Thesis- R. Yousefi Nooraie
McMaster University- Clinical Epidemiology and Biostatistics

**A SERIES OF STUDIES ON USING SOCIAL NETWORKS TO INFORM AND
SUPPORT EVIDENCE-INFORMED PUBLIC HEALTH PRACTICE IN
CANADA:
INVESTIGATING ORGANIZATIONAL SOCIAL NETWORKS**

By: REZA YOUSEFI NOORAIE, M.D., M.Sc.

**A Thesis
Submitted to the School of Graduate Studies
In Partial Fulfillment of the Requirements for the Degree
Doctorate of Philosophy**

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DOCTORATE OF PHILOSOPHY (2015) McMaster University

Health Research Methodology Program Hamilton, Ontario CANADA

TITLE:

A Series of Studies on Using Social Networks to Inform and Support Evidence-Informed
Public Health Practice in Canada: Investigating Organizational Social Networks

AUTHOR: Reza Yousefi Nooraie, M.D. (Tehran University of Medical Sciences), M.Sc.
(McMaster University)

SUPERVISOR: Prof. Maureen Dobbins

NUMBER OF PAGES: xiv, 278

LAY ABSTRACT

In three public health departments in Ontario, where we offered an intervention to a group of staff on how to use more research evidence in practice, I studied how the pattern of communication among staff influenced their use of evidence, how those communications changed over time, and how the staff themselves viewed those changes. In the department that largely promoted staff engagement in the intervention, the staff who were engaged became more popular over time. In all departments, already popular staff became more popular. The staff who sought information from popular people engaged in the intervention, and those popular people who communicated with each other used more research evidence over time. Network analysis helped reveal the social structure and identify popular staff and could be used to inform similar interventions. It also showed how selecting and training a group of staff can change the way people communicate in health departments.

THESIS ABSTRACT

Introduction: In a mixed-methods study I assessed the role of social networks as predictors and outcomes of the implementation of an intervention to promote evidence-informed decision-making (EIDM) in three public health departments in Ontario, Canada. The quantitative strand included the analysis of the role of staff's position in networks on the adoption of EIDM, the longitudinal evolution of networks, and the association between the name generators' position in surveys and respondents' motivation to answer survey questions. The qualitative strand aimed to explain and contextualize the quantitative findings.

Methods: A tailored intervention was implemented in the public health departments, including the mentoring of staff through the EIDM process by a knowledge broker. The staff participated in three online surveys before and after the 22-month intervention, providing the names of peers to whom they turned to seek information, whom they considered as experts, and their friends. I assessed the dynamic evolution of social networks, and the role of local opinion leaders (OL) in promoting the adoption of EIDM. I interviewed key network actors about their interpretation and experience regarding the quantitative findings.

Results: Overall, there was no statistically significant impact on EIDM behavior and skill in health departments. However, the analysis of the role of OLs in behaviour change showed that non-engaged staff who were connected to highly engaged OLs, and those OLs who communicated with each other improved their EIDM behavior. Social networks became more centralized around already popular

staff due to selective training of recognized experts. Highly engaged staff tended to connect to each other, and to limit their connections within organizational divisions over time. In the department where multiple activities were being implemented to support EIDM, the highly engaged staff became more popular due to department-wise presentations and informal information spread. I also found that when name generator questions are asked later in surveys then respondents are more likely to refuse, indicate they do not know anyone, or provide fewer names than when these questions are asked earlier *Conclusion:* Social network analysis showed the structure of information-seeking relations, the impact of opinion leaders on the EIDM behavior of their peers, and underlying social changes through implementing an EIDM intervention. These findings can inform the design and tailoring of EIDM interventions in public health organizations.

ACKNOWLEDGMENTS:

I would like to express my sincerest gratitude to my supervisor Professor Maureen Dobbins who enthusiastically encouraged my research ideas, and patiently walked me through my Master's and PhD studies. Her deep insights, encouragements, and advice have added a pronounced value to the quality of this study, and were a great inspiration to me. I am also greatly indebted to my supervisory committee Professor Robert Hanneman (whose book introduced me to the realm of social network analysis and whose continuous support during the last ten years guided me in exploring new fields), Dr Lynne Lohfeld (who was always available to help me professionally and personally, and from her I learned a lot about qualitative research) and Dr Alexandra Marin (whose course revolutionized my understanding about social network theorizing, and her frank expert advice and constructive feedback were pivotal in the development of this thesis). I am very lucky to have this exceptional combination of expertise and passion on my side. I am also thankful to the PHSI team, especially Ms. Robyn Traynor and Ms. Kara Decorby, whose assistance was extremely valuable during data collection and analysis. Vanier Canada doctoral scholarship came when I needed it, and provided me with a peace of mind through my journey to complete my PhD.

I dedicate this thesis to my wife Soroush and my son Alborz whose unconditional love and support kept me afloat throughout this long and sometimes turbulent voyage.

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LIST OF ABBREVIATIONS AND SYMBOLS

(A)MOH	(Associate) Medical Officer of Health
CoP	Community of Practice
DOI	Diffusion of innovations
EBP	Evidence-Based Practice
EIDM	Evidence-Informed Decision Making
GEE	Generalized Estimating Equation
KB	Knowledge Broker
KT	Knowledge Translation
OL	Opinion Leader
PHSI	Partnership for Health Systems Improvement
SNA	Social Network Analysis

PREFACE

This is a sandwich thesis consisting of three separate manuscripts submitted to peer-reviewed journals and a report of an explanatory qualitative study done to better understand the quantitative data. All of the papers included in this document were part of the student's thesis research program on investigating the role of social networks in the implementation process of knowledge translation (KT) interventions.

The studies were prepared in collaboration with Professor Maureen Dobbins (thesis supervisor) and all members of the thesis committee: Professor Robert Hanneman, Dr. Alexandra Marin, and Dr. Lynne Lohfeld. Professor Dobbins was pivotal in the mentorship and guidance during the development, execution and write-up of this thesis. Committee members contributed to both methodological and theoretical aspects of study design and data analysis, as well as reviewed and provided feedback on the study proposal and manuscripts.

The author of this doctoral thesis led all components of the research projects, including the development of objectives and aims, data collection and analysis, interpretation of results, and manuscript preparation and revisions. He is the main contributor and the first author of all studies.

CHAPTER 1-Introduction

1-1 OVERVIEW

There is a widely recognized gap in the translation of research evidence into practice in various clinical and public health contexts (Kiefer et al. 2005; Cochrane et al. 2007). Recent developments have shifted our understanding of knowledge translation (KT) towards a multi-dimensional construct that is influenced by contextual and organizational factors (Sudsawad 2007). KT-promoting interventions should be adopted and endorsed by health practitioners to be effective and sustainable. The process of endorsement is affected by several contextual and social factors including interpersonal relationships, social influence (Fattore et al. 2009), access to resources (Szreter and Woolcock 2003), and the way interventions are diffused within social networks (Rogers 2003). Therefore, in order to understand the behaviour of people within organizations, not only their individual characteristics but also their relationships should be studied.

Social Network Analysis (SNA) captures the interactions and links among people (Cross, Parker, and Borgatti 2002). One important application of SNA is understanding the patterns of knowledge-sharing and diffusion of innovation in organizations (West et al. 1999; Coleman, Katz, and Menzel 1966; Creswick and Westbrook 2010).

In a mixed-methods study I assessed the role of social networks as predictors and outcomes of the implementation of a tailored intervention to promote evidence-informed decision-making (EIDM) in three public health departments in Ontario, Canada, which is presented in this sandwich thesis.

In chapter 1 I provided a rationale for the network analysis of the EIDM implementation. I reviewed the social aspects of the KT process, reviewed the capabilities

of a SNA perspective, and the advantages of a mixed methods study in expanding and deepening our understanding about the role of networks in the KT process. I overviewed the setting of this study (characteristics of the three health departments and how the KT intervention was tailored to meet the needs and expectations of each health department), the overarching mixed methods design and questions, and the propositions that informed the quantitative and qualitative strands of the study.

The quantitative strand of the study included an analysis of the longitudinal evolution of networks through the implementation process (chapter 2), and the role of staff's position in information-seeking networks on the adoption of EIDM (chapter 3). I also used the collected information to answer a methodological question regarding the association between the position of name generator questions in surveys and the motivation of respondents to answer them (chapter 4).

The qualitative strand of the study is a case study with embedded units aimed to understand and contextualize the quantitative findings by presenting the process of knowledge flow, implementation of the KT intervention, and the evolution of social networks from the viewpoints of influential staff in the three health departments (chapter 5). The concluding chapter integrates the quantitative and qualitative findings and provides implications on how SNA informs KT research and practice (chapter 6).

1-2 BACKGROUND

1-2-1 Knowledge Translation (KT) in Canadian Public Health System:

There is a growing expectation for public health decisions to be informed by the best available evidence (Kiefer et al. 2005). This requires that public health decision-makers find and apply relevant high-quality evidence in a timely manner (Kiefer et al. 2005). However, despite gradually increasing interest in this topic (Lavis et al. 2003), the translation of best research evidence into practice is slow and far less than optimal (Graham et al. 2006). Evidence-informed public health decision-making (EIDM) is a complex process because, in part, public health evidence is very inclusive and context-dependent, and decisions to address emerging public health crises such as SARS and H1N1 require collaboration among multiple stakeholders (e.g. researchers, policy makers, public health system, public) (Rosella et al. 2013). In addition, there is the reality of the trade-off between different evidentiary and political factors, which is further complicated by the complexity of executive, legislative and bureaucratic structures of public health systems (Frank, Di Ruggiero, and Moloughney 2003; Rosella et al. 2013).

The Canadian public health system operates at federal, provincial, regional, and local levels, and is formed by the collaboration of various governmental, non-governmental and community organizations. Public health programs are delivered regionally in all provinces in Canada except in Ontario and provincially in the territories. In Ontario services are delivered locally through 36 local boards of health, each responsible for administering all public health programs to the population within its geographic borders (Ministry of Health and Long-term Care 2010). Local boards of health govern public health departments that vary considerably in terms of the size of the population covered, budget and full-time equivalent staff. Public health departments also

differ considerably in terms of their commitment and policies related to EIDM. The political independence and structural, cultural, and demographic diversity of health departments in Ontario provide a unique opportunity to study the organizational and social factors affecting public health decision-making.

There are very few studies on the use of research evidence in the Canadian public health system, and the impact of public health structures on the decision-making process. In order to assess the extent of use of systematic reviews in public health decisions, Dobbins, et al. (2001) surveyed decision-makers of 41 Ontario public health departments in 1999. About one-third of the respondents had not used systematic reviews when making public health decisions over the two years prior to the study. The authors highlighted the role of organizational characteristics as an important predictor of the use of systematic reviews in decision-making. In another study, Dobbins et al. surveyed the members of technical review groups that updated the Ontario Mandatory Programs and Services guidelines for public health about the extent to which systematic reviews influenced the new guidelines (Dobbins et al. 2004). The public health decision-makers in this more recent study showed positive perceptions towards the usefulness of systematic reviews in practice, although the ‘evidence-informed guidelines’ that they produced were never adopted by policy-makers.

There are many barriers to EIDM in the Canadian public health system (Dobbins, DeCorby, and Twiddy 2004; Bowen et al. 2009), including limited access to evidence, limited ability and capacity to appraise research evidence and translate it into practice, and lack of motivation to change practice (LaPelle et al. 2006; Ciliska et al. 1999).

Resolution of these barriers requires organizational and system-level changes (Dobbins et al. 2009a).

1-2-2 Social and Organizational Aspects of KT

KT is a solution to fill the knowledge-to-action gap. However, given the varied theoretical perspectives, professional backgrounds, and methodological preference of KT scholars, the KT construct encompasses a myriad of frameworks, theories, and interventions. In fact there is no consensus on the definition and nomenclature associated with KT; and the KT literature includes more than 100 indexing terms (McKibbin et al. 2010).

Since the emergence of KT in the health sector in the past 15 years, applicable models and interventions have been evolving. Traditionally, most efforts to promote the translation of research evidence into practice have focused on the production and dissemination of high-quality research. However, the validity of research evidence does not necessarily ensure that it will be accepted by end-users and will improve the quality of clinical practice (Nuckols et al. 2008; Fertig et al. 1993). Given the complex nature of public health systems and decisions, several factors apart from the development and provision of high-quality research influence public health decisions, such as community views, social and political pressures, and organizational constraints (Armstrong et al. 2011). Unfortunately, much less effort has been placed on capacity development and use of evidence in policy and program decision-making, than on the production of high-quality evidence (Best et al. 2009).

Traditional thinking has tended to view KT as a linear and unidirectional activity starting with knowledge developers and ending with intended users (Kitson 2009).

Traditional models of KT assumed that researchers produce knowledge and then disseminate it to users who then use it in practice, and that there is a linear association between the quality of evidence and subsequent behaviour change by end-users. This represents a fairly passive strategy that ignores the complexity of decision-making in health care and the systems in which interventions are applied.

A more contemporary conceptualization of KT considers it as a large multi-dimensional construct that engages all parts of the research cycle, from research production to practice and even the conception of subsequent research (Sudsawad 2007). Acknowledging the complex and multi-dimensional nature of the process, the Canadian Institutes of Health Research (CIHR) defines KT as “a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system” (Canadian Institutes of Health Research 2014).

The association between social structure and KT interventions is intricate and bi-directional. On the one hand, several social factors may impede or facilitate the implementation and adoption of KT interventions. On the other hand, similar to other social and organizational interventions KT interventions may have social consequences and affect the way that individuals interact with each other. In the following sections, I will provide an overview of the social considerations associated with the steps of the KT process.

1-2-2-1 Social Barriers/Facilitators of KT

Individuals are surrounded by their social context, which provides them with opportunities to access resources and constrains and shapes their beliefs and behaviours. Social networks are an important aspect of the social context. Human interactions in a social structure shape the norms, interpersonal trust, and social organization, which are various aspects of the social context (Coleman, 1988). Consequently, a crucial step in designing KT interventions is determining the contextual capacities and barriers, which may facilitate or impede the adoption and implementation of knowledge translation. Consequently, identifying barriers to adoption of KT is a step considered in many KT process models such as the Knowledge To Action (KTA) framework (Graham et al. 2006) and Advancing Research and Clinical Practice Through Close Collaboration (ARCC) model (Melnik and Fineout-Overholt 2002).

From a broader perspective, the role of contextual and environmental factors is highlighted in most KT frameworks. Ward, et al. (2009), in a thematic analysis of 28 KT models, found that 20 of these models considered the role of context as part of the KT process. The Ottawa Model of Research Use, for example, defines the “practice environment”, including cultural/social and structural factors, as an important component that can hinder or support the process of KT (Graham and Logan 2004). Kitson et al. (1998) proposed the PARIHS framework (Promoting Action on Research Implementation in Health Services). They developed the schematic equation of $SU = f(E,C,F)$, in which SU (successful utilization) is a non-linear function of E (evidence), C (context), and F

(facilitation). Context includes the physical environment, pattern of power, and organizational culture.

Barriers may be experienced at the personal, community, or system levels and can affect the knowledge, attitudes, and behaviours of practitioners (Légaré et al. 2008).

Mitton et al. (2007), in a review of the KT literature on health care policy, classified barriers and facilitators as those factors that have an impact at the individual level, those impacting the organization, as well as the factors relevant to communication. A few examples of facilitators are “building trust” and “ongoing collaboration” at the individual level; the “authority to implement changes” and “staff stability” at the organizational level; and “face-to-face exchanges” and the role of “knowledge brokers” and “opinion leaders or champions” at the communication level.

The role of social context in determining the capacity to change is not limited to direct effects. Many other barriers and facilitators cited by Mitton et al. (2007) are influenced by social relations. Examples include human interactions in social groups and the influence people have on each other’s beliefs and attitudes, which result in the formation of shared understanding and agreements, and subsequently shape social norms and cultures (Friedkin and Johnsen 1999; Friedkin 2001). The role of social relations in the development of norms and cultures and the tendency of individuals to adopt new innovations is sometimes more important than individual attributes (Plsek and Wilson 2001; Lapinski and Rimal 2005). Mitton et al. (2007) identified several barriers relevant to social norms, including negative attitudes towards change and unsupportive culture.

From another viewpoint, Cochrane et al. (2007), in a systematic review of the literature on barriers to optimal practice, classified the barriers as “cognitive/behavioral”, “attitudinal/rational-emotive”, and barriers related to the “evidence”, “health care professionals”, “patients”, “support/resource”, and “system/process”. Again, social context can influence many of the identified barriers ranging from direct effect (e.g. peer influence, support, and team structure) to more subtle and indirect effects (e.g. perceived competence, authority, and the culture of inertia).

As described above, even though KT models and frameworks have recognized the importance of social context and interpersonal communication in the process of KT, they have not been explicit about the mechanisms by which social relations may influence the impact of KT interventions either directly (i.e. communicative barriers), or indirectly (i.e. the role of social structure in the formation of personal and organizational barriers).

1-2-2-2 Social Considerations in Designing KT Interventions

A KT intervention should be chosen based on the objectives of KT, the evidence on the effectiveness of interventions, and the feasibility and applicability of the intervention. It should be tailored to address identified barriers and be theory-based (Wensing et al. 2005).

KT interventions seek to facilitate and improve the link between research and action. Lavis et al. (2006) proposed four approaches to KT efforts. “Push efforts” focus on the dissemination of knowledge. They include the development and publication of evidence and support the uptake and reach of evidence (Nutley, et al., 2007). They are especially suitable in situations where the lack of knowledge about the evidence is the

main barrier (Lavis et al. 2006). “Pull efforts” are focused on the target users seeking research evidence to address practice- or policy-based issues/questions. These efforts include facilitation of access and use of research through technical, financial, organizational and emotional support, training and skill development, social influence (relying on influential members), and incentives and reinforcements (Nutley, Walter, and Davies 2007; Lavis et al. 2006). “Exchange efforts” target the interaction between researchers and users and include network establishment, partnership strategies, and the use of knowledge brokers (Lavis et al. 2006). The fourth approach involves “integrated efforts” which uses elements of pull, push, and exchange strategies.

Given their diverse nature, KT interventions include a large variety of strategies focusing on heterogeneous groups, working through different mechanisms and targeting various outcomes. A number of studies have shown that more interactive strategies that involve users in the decision-making process are more likely to change the behaviour of practitioners (Oxman et al. 1995; Dobbins et al. 2005). Baker et al. (2010), in a systematic review of 12 randomized controlled trials, concluded that interventions tailored to address the barriers to change have a statistically significant pooled effect on changing the behaviour of health practitioners, with a pooled Odds Ratio of 1.54 (95% CI of 1.16 to 2.01). However they were not able to provide any conclusion on what barriers were more important, and the optimal way to address the barriers in a tailored intervention. In addition, increasing the number of components of a KT intervention did not seem to increase effectiveness in a linear fashion. Grimshaw et al. (2006) found that given the

complexity of health systems and human behaviour, the effectiveness of KT interventions does not increase incrementally by adding components of multifaceted interventions.

The effect of KT interventions on improving public health practice is controversial and context dependent. LaRocca et al. (2012) conducted a systematic review of experimental studies on effectiveness of KT strategies in public health. They found five studies of moderate quality, which were synthesized narratively, due to the heterogeneity of study characteristics. They found that passive strategies (such as access to online resources) tended to be less effective than active interventions (such as audit and feedback). They concluded that the effect of KT interventions could not be determined without considering the impact of context and suggested using mixed methods studies to capture the complex dimensions of the effects. Similarly, in a randomized controlled trial of 141 Canadian health departments, Dobbins et al. (2009a) reported that tailored, targeted messages are an effective strategy to promote EIDM, but its extent of usefulness might be moderated by organizational culture.

Among various types of KT interventions, few explicitly have incorporated social relationships as a component of the intervention, of which the use of ‘local opinion leaders’ has been tested most frequently in experimental studies. Flodgren et al. (2011) conducted an update on a previously published Cochrane review on the effect of opinion leaders. They found 18 randomized controlled trials that compared interventions led by opinion leaders, alone or in combination with other interventions, in improving the behaviour of health care professionals and patient outcomes. The studies had moderate to high methodological quality but were very heterogeneous in terms of the methodology

used to identify opinion leaders, define the interventions, and measure outcomes. Most of the studies were conducted in hospital settings, mostly with physicians, but varied in terms of clinical discipline they studied. Flodgren et al. (2011) found that engagement of opinion leaders alone or in combination with other interventions may successfully promote evidence-based practice. The authors concluded that the effect of opinion leaders in promoting KT is comparable to other known interventions such as distributing educational materials, audit and feedback, and multifaceted interventions involving educational outreach in terms of their ability to increase compliance with the behavior change. However, due to the heterogeneous nature of the studies, the authors were not able to suggest the best way to identify opinion leaders or design interventions that included them.

In summary, social relationships are considered to be a component of social context to which KT interventions should be tailored. They are also incorporated as a component of some KT interventions. However, more research is required to understand optimal tailoring strategies and effective methods of incorporating social interactions in designing KT interventions.

1-2-2-3 Social Consequences of KT Interventions

The implementation of KT interventions has social consequences. On the one hand, individuals tend to connect to others who share characteristics and values with them. On the other hand, individuals tend to turn to peers who recognize and value their expertise and accessibility. The change in organizational norms may affect the way individuals seek information from peers, the frequency by which they turn to peers as an

information source, and whom they consider to be useful sources of information. These changes in social structure may subsequently affect the quality of health care decisions.

The final consideration in the KT process is ensuring sustainability of change in practice and/or policy over time. Even when the initial implementation is successful, the resulting behaviour and process change may not last very long, or evolve to forms not originally intended due to broader environmental forces and contextual factors (Stirman et al. 2012). Despite its importance, assessing sustainability of KT interventions is not common in the KT literature and generally most implementation studies focus on outcomes measured in the short-term rather than the long-term (Tricco et al. 2013).

Stirman et al. (2012), in a systematic review of studies reporting on the long-term consequences of implementing health interventions, classified factors affecting sustainability into the following characteristics: the intervention, context, capacity, and involved processes and interactions. The characteristics of the intervention include its fit to the context, modifiability/adaptability, apparent benefits, and the ability to maintain integrity over time. Context denoted the climate, culture, and structure of the organization, support from leadership, and supportive policies. Capacity included the role of opinion leaders, support from community, and availability of funding, resources, and workforce. Processes and interactions refer to the formation of partnerships and collaboration, shared decision-making among stakeholders, and ongoing support, feedback, evaluation, planning, and monitoring of competing demands.

In summary, interactions among individuals, teams and organizations are fundamental aspects of the KT process. They affect the beliefs and norms to which the

interventions should be adapted. They may impede and facilitate the implementation process, work as a channel through which knowledge is diffused, and affect the sustainability of changes. Consequently, a useful perspective to deepen our understanding of KT implementation is to study the role of social networks as determinants, processes, and outcomes of KT interventions.

1-2-3 Social Network Analysis

Individuals live in social networks in which they constantly interact with other members. A social network is a set of social entities (e.g. individuals, institutions, countries) that are connected by social relations (e.g. friendship, information exchange, money transaction). In a relational system of thinking, elements and realities are not detachable from their transactions and relations and “the very terms or units involved in a transaction derive their meaning, significance, and identity from the (changing) functional roles they play within that transaction” (Emirbayer 1997). In other words, all social entities and concepts (e.g. power, freedom, and society) are redefined as the functions of dynamic relationships. Even individuals, at a micro level, gain their identity and personality from the recognition and name-giving process through interaction with other agents. Consequently, from a social network perspective causation is located in social structures rather than individual attributes (Marin and Wellman 2011).

Social network analysis (SNA) is a well-established perspective that focuses on the patterns of relationships between individuals and social groups (Cross, Parker, and Borgatti 2002; Fattore et al. 2009). SNA examines individuals and their connecting links with each other rather than treating individuals as separate units. In analyzing the relation

between individuals, SNA also takes into account the broader pattern of connections beyond pair-wise connections to understand the linkage between the components and the overall structure of a network (Luke and Harris 2007). Because of its unique perspective, SNA captures information that is generally missed by conventional research methodologies. Consequently, it has become a pivotal perspective in understanding organizational and social relationships.

Although it has been recognized as a valuable perspective in the social sciences for a long time, SNA is only slowly becoming more often used in health services research as researchers acknowledge the complexity of health systems and the importance of networks in the translation of knowledge into policy and practice (McAneney et al. 2010). SNA can provide a resourceful perspective to KT research given the widely recognized importance of social context in the KT process and our limited knowledge of the underlying mechanisms of the influence of social and relational factors in the impact of KT interventions.

1-2-3-1 Network Analysis to Understand the Context

One important perspective useful to the study of the social and relational aspects of KT is analyzing the effect of social networks as contextual factors influencing the implementation of KT interventions. From a structural perspective, we can assume that networks are part of a social context, providing opportunities for individuals and constraining individual and collective beliefs and behaviours. Human interactions in a social structure shape the norms, interpersonal trust, and social organization, which are various aspects of the social context (Coleman, 1988). Consequently, studying the

patterns of human interactions by analyzing social networks is a pivotal perspective in understanding social contexts and their impact on human behaviour.

From a *social capital* perspective, individuals may use their network positions as opportunities to gain access to resources, such as becoming connected to influential individuals or making other individuals feel morally obliged to return their favours in the future (Borgatti & Halgin, 2011). In the context of KT, the benefit could be gaining access to novel information such as a newly disseminated clinical guidelines or high-quality evidence.

On the other hand, interpersonal interactions influence and constrain human beliefs, attitudes, and behaviours (Borgatti & Foster, 2003). Human interactions in social groups and the influence people have on each other's beliefs and attitudes result in the formation of shared understanding and agreements, and subsequently shape social norms (Friedkin & Johnsen, 1999). Sustainable behaviour change depends on successfully altering underlying social norms, which is a burdensome and time-consuming task. If accomplished successfully, this results in the formation of new norms, which are self-sustaining. Network theories of *social influence* deal with how interactions in social networks affect the attitudes, beliefs and behaviours of individuals. In other words, a person's behavior is modified by the actions of other people due to several mechanisms, including authority, identification, expertise, and competition (Marsden and Friedkin 1993). SNA can expand our understanding of KT processes by exploring the role of *social influence* in the formation of supportive or inhibitory norms towards EIDM, such

as how social norms toward the use of evidence are formed, and how close network ties affect the process of norm formation.

The classic study by Coleman, Katz, & Menzel (1966) on the adoption of antibiotics by physicians was one of the earliest studies of the effect of social influence on the behaviour of health practitioners. In that work the authors aimed to learn why some physicians start prescribing a new antibiotic as soon as it is available but others wait until the majority of their colleagues prescribe the drug. They found that the more socially integrated doctors were, the more likely they were to both hear about the new antibiotic from peers and adopt the new innovation under the influence of peers. The findings of this study supported the hypothesis of social contagion of medical innovations and different roles of people as early adopters versus laggards, as described by Rogers (Rogers 2003). In a recent replication study, Iyengar, Van den Bulte, & Valente (2011) performed a network analysis of the network factors affecting the prescribing of a new antiviral drug by American physicians. They found that even after controlling for various contextual and marketing factors, there is still evidence of the effect of social contagion on the prescribing behaviors of physicians.

1-2-3-2 Network Analysis to Study the Process of Change

New knowledge diffuses through communities by means of social contagion. The pace and breadth of contagion depends on several factors, including the characteristics of the knowledge, current norms, early adopters, and overall network structure involved. Socially powerful peers are influential in changing the beliefs and behaviours of their peers, and hence diffusing interventions. For example, if opinion leaders are the early

adopters of innovation, they enhance the diffusion process due to their social connectedness and influence (Valente & Davis, 1999).

SNA provides a framework to analyze the impact of the characteristics and positions of early adopters of KT interventions, the overall patterns of the network structure that may enhance or impede the contagion of new knowledge in a target population, and the required threshold for individual change in the context of health care decision-making. Even though several KT models include social relationships as a contributing factor, they usually categorize them as part of the contextual component and not as an explicit vehicle of knowledge through the translation process. In addition, the majority of empirical studies investigating the role of networks on the diffusion of innovations are not in the health care field. The limited studies in this field are mainly focused on the change in prescription patterns for new drugs after they have been introduced to the market (West et al. 1999; Coleman, Katz, and Menzel 1966; Zheng et al. 2010; Creswick and Westbrook 2010; Creswick, Westbrook, and Braithwaite 2009; Jippes et al. 2010; Keating et al. 2007). The need for formal SNA analyses to advance current understanding in the field of KT has been stated by several authors (Rogers and Martin 2009; Estabrooks et al. 2006; Bentley, Browman, and Poole 2010).

Diffusion of innovations (DOI) theories can explain how the process of social influence and interpersonal communication lead to the spread of new ideas within social networks. According to Rogers (2003), the four elements of the DOI theory are:

- the innovation, which is defined by Rogers as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption"

- communication channel, which is the means by which the innovation or the knowledge about it is transferred between individuals in the organization
- time, which is the length of time provided for the process of diffusion
- social system, which is defined as "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal"

Rogers (2003) classified the actors involved in the diffusion process into the following categories: innovators, early adopters, early majority, late majority, and laggards. The pattern of communication of these actors throughout the diffusion process shapes the communication channel. The network position of early adopters, the majority, and laggards influence the spread pattern. Different network structures may affect the spread pattern. The degree of cohesiveness, disparity or similarity of actors, hierarchy, and segmentation of the network also affect the process, depending on the type of innovation, characteristics of actors, and underlying social norms (Zappa 2011). For example, hierarchical networks are more useful for disseminating authoritative decisions, whereas horizontal networks are more effective in diffusing peer influence and dynamic communication (West et al. 1999). Moreover, empirical studies on the DOI theory have shown that when the norm of the organization favours change, key or central people and community leaders are better candidates for early adoption of the innovation than peripheral and isolate individuals (McGrath and Krackhardt 2003; Menzel 1960). These people can diffuse the innovation more easily through channels of *social influence*. Conversely, when an organization is resistant to change, peripheral and less-connected actors are better candidates for early adopters because they are less bound to

organizational norms and more willing to change their current position than central actors (McGrath and Krackhardt 2003; Menzel 1960).

Studying the effect of local opinion leaders and their use of power to enhance the diffusion of organization-wide interventions is an important application of DOI theories in KT. Opinion leadership is the degree to which someone is able to informally affect others' attitudes and behaviours in a desired way (Rogers 2003). Opinion leaders are individuals nominated by their peers as influential because they are well known, and trusted (Majumdar, Tsuyuki, and McAlister 2007). This position is not part of the formal role of people in an organization, but is earned as a result of people's competence, accessibility, trustworthiness, and conformity to social norms. In ambiguous situations individuals compare themselves with socially powerful individuals in order to reduce social conflicts (Erickson 1988; Friedkin and Johnsen 1990). The power of opinion leaders mainly lies in their referent and expert power, which subsequently results in the formation of legitimate power, according to French and Raven's (1959) classification.

Opinion leaders are not always the early adopters of the innovation, because if they change their behaviour too quickly and without scrutiny followers may doubt their judgment (Rogers 2003). Opinion leaders monitor the climate, and advocate change when the advantages of the innovations are apparent or the change in norms is inevitable (Valente and Pumpuang 2007). Consequently, innovators can take an active role, identify and convince opinion leaders and use them as agents of change to facilitate and promote the diffusion process.

There are various methods for identifying opinion leaders, which may involve different individuals, depending on how opinion leadership is defined and who identifies the opinion leader. Valente and Pumpuang (2007) comprehensively reviewed 10 techniques to identify opinion leaders, including identification of celebrities (well-known individuals), self-identification (through surveys), judge's rating (asking knowledgeable members of the community), positional approach (identifying individuals who formally hold leadership positions), and sociometric (identifying opinion leaders based on the frequency of nomination by all members of the community). Different methods are rooted in various theoretical definitions of the qualities of opinion leaders, and each places different emphasis on the leader's values, expertise, and social position. The sociometric approach involves running a SNA of the community and identifying the most central actors. This technique is popular in experimental studies due to its reliance on the judgments of a larger population rather than an elite minority of the community. However, its superiority to other techniques has not been tested in methodologically sound studies.

1-2-3-3 Network Analysis to Study the Outcomes of KT Interventions

In parallel to *social influence* theories, which deal with how networks shape individuals' beliefs and behaviour, we can examine how social networks are shaped, what the trajectories of their change are over time, and how networks are affected by external factors such as organization-wide interventions. In the context of KT, networks may be the outcomes of a behaviour change intervention in health practitioners or health care users.

The longitudinal changes of networks and behaviours can be interpreted as the result of a *social selection* process, or the formation of social ties based on the characteristics of the actors (Robins et al. 2001). It is distinct from the *social influence* process in which networks influence the attributes of the actors. For example, both processes can explain the simultaneous change in behaviour and social ties of an individual (i.e. Jack) through time. Jack might have become friends with John first and then changed his behaviour under John's influence (social influence). Alternatively, Jack might have changed his behaviour before choosing John as friend who had the same behavioral trait (social selection). Research has shown that the role of social selection sometimes is more significant than social influence in explaining longitudinal changes (Mason et al. 2007; McPherson et al. 2001).

In information-seeking networks, social selection theories can explain how individuals choose their sources of information to deal with professional problems. Information-seeking networks represent the pattern of connections by which people share information and ideas, and seek guidance and information (Smith and Peterson 2007). Selecting an information source results from various competing and interlacing mechanisms and may differ based on various factors including the nature of the problem, the type of information being transferred, the social network structure, and shared norms and values between individuals. Borgatti and Cross (2003) suggested that information-seeking behaviour in organizations is a function of: 1) the extent to which an information-seeker recognizes and values another person's knowledge and skill in certain areas, 2) the potential cost of information-seeking, and 3) accessibility of that person.

People usually need to seek advice from experts (Borgatti and Cross 2003). So in directed advice networks, less experienced people tend to seek advice from more experienced peers. According to social exchange theory (Blau 1964), information exchange in organizations can be explained by economic principles: receiving information from someone obliges the seeker to pay back the person in some way. People recognize the informant's superiority (in terms of knowledge and expertise) in exchange for the information they receive (Lazega et al. 2012). However, people may be hesitant to play the status recognition game by deferring to prestigious figures because it highlights their own lower status and lack of knowledge, and exposes them to the judgment of superiors. Instead they look for alternative connections for information in order to reduce the likelihood of such negative effects. People may rely on peers for information with whom they have pre-existing informal connections to minimize the cost of advice (Lazega et al. 2012) such as friendship because people with similar problems understand each other's concerns more easily (Cheshire 2007).

Accessibility of the information source is another factor contributing to the choosing an information source. In addition to technical barriers to access (e.g. geographical distance) the issue of access could be defined by more subtle relational mechanisms. For example, timeliness of the advice (i.e. who is able to provide help in a time frame in which the seeker needs advice) and the level of engagement the advice seeker expects (i.e. who can spare enough time and resources to get sufficiently engaged in the seeker's problem) are also important determinants of accessibility of information source (Borgatti and Cross 2003).

The implementation of KT interventions has social consequences, which include the formation and restructuring of social networks. KT interventions may influence various components of the social selection process. Changes in knowledge, attitude, and behaviour regarding EIDM may alter the pattern of information seeking from experts. More practitioners may recognize and turn to knowledgeable peers. Alternatively, training may change the distribution of power in the organization. It may also increase the confidence and autonomy of the practitioners, and they may rely less on peers as the information source.

Moreover, the participatory and communicative nature of the KT intervention may affect the formation of connections among segregated clusters. Health practitioners have a tendency to limit their formal and informal networks geographically or professionally (West and Barron 2005; West et al. 1999; Coleman, Katz, and Menzel 1966). This may be the result of a tendency for health professionals to shape circles of trust by turning to easily accessible peers with values and concerns similar to their own for getting information and discussing work-related issues (homophily) (Lazega et al. 2012).

This tendency towards segregating social networks based on formal structural boundaries may cause entrapment of the information within social clusters and formation of information silos. Organizations with more non-routine tasks and uncertainty in workflow require a more dynamic social structure with less complex hierarchy, less segmented networks, and more reciprocated connections than organizations with routine chain of command work style (Flap, Bulder, and Beate 1998). Consequently, organizational segregation seems to be a barrier to optimal decision-making in public

health organizations, particularly when dealing with unprecedented and uncertain issues. Accordingly, Canadian health decision-makers have identified this structural tendency as a potential barrier to EIDM (Bowen et al. 2009). Participatory KT interventions may facilitate the formation of inter-divisional connections. As a result, more frequent contacts between the staff from various organizational divisions through co-participation in training programs may facilitate the formation of sustainable ties among segregated divisions and institutions.

1-2-4 Mixed Methods Studies on Social Networks:

Mixed methods research is an increasingly popular approach in the social and behavioral sciences. Its main principle is that by combining qualitative and quantitative methods a richer and deeper understanding of a problem can be gained (Creswell and Plano Clark 2007), and offset the strengths and weaknesses of each approach. Mixed methods research is more than merely conducting relevant quantitative and qualitative studies. Instead it entails explicit strategies for integrating qualitative and quantitative data. Since the development of early forms of mixed methods studies during the 1950s (Campbell and Fiske 1959), the philosophical underpinnings and the methodologies of mixed methods studies have evolved considerably. Creswell et al. (2007) categorized the history of the development of mixed methods studies into the following stages:

- the formative period from the 1950s to 1980s, during which time some researchers, mainly in psychology, combined multiple quantitative methods (Campbell and Fiske 1959), and some discussions initiated about the idea of triangulation and mixing quantitative and qualitative designs

- Paradigm debate period (1970s-1980s) during which there were heated debates on the concept of mixing qualitative and quantitative studies. The idea of combining qualitative and quantitative paradigms was criticized mainly by qualitative researchers (e.g. J. Smith, 1983); some researchers (so-called purists) were against the combination due to the mutually exclusive differences in the philosophical assumptions of quantitative and qualitative research (Rossman and Wilson 1985), whereas others (situationalists) focused on methods rather than epistemological and ontological assumptions. They stated that each method had its own value with some methods more appropriate for specific situations; however they did not favor integration of different methods in a single study (Rossman and Wilson 1985). In contrast, the pragmatists supported the integration of different methods in a single study. Pragmatism is called the best philosophical foundation for mixed methods studies by some of the pioneers of the field. According to this perspective different paradigms and methods can be combined as long as each is honored and elaborated (Creswell and Plano Clark 2007).
- Procedural development period (1980s) when advocates of mixed methods studies wrote about data collection, analysis, and designs.
- Advocacy and expansion period (1990s forward) when several authors advocated the use of mixed methods studies and recognized them as a separate research design.

Quantitative and qualitative studies can be integrated in various ways (Creswell and Plano Clark 2007). In studies using the *triangulation design*, the main purpose is to

merge different models obtained from simultaneous qualitative and quantitative studies in order to best understand the problem. In the *embedded design*, one type of data is embedded in the other to provide complementary clarification. The *explanatory design* is a two-phase study in which the qualitative study is generally performed after quantitative analysis with the aim of further explanation. In an *exploratory design*, the qualitative study helps develop and inform the subsequent quantitative study.

The study of social networks is also an appropriate field for mixed methods research (Bazeley 2009; Edwards 2010). Although quantitative network analysis provides important information regarding the patterns and shapes of social networks and the roles of influential people, it may not be in-depth enough to uncover the subtle mechanisms through which social networks shape, emerge and influence social and organizational processes. The limitation of quantitative network analysis in providing comprehensive insight on underlying social and organizational processes has also been noted by different researchers (Dubini and Aldrich 1991; Neergaard, Shaw, and Carter 2005). Moreover, some authors argue that mixing qualitative and quantitative approaches to analyze social network data is particularly desirable because network analysis is interested in both the forms of social relationships (i.e. an outsider's view of the structure of networks) and the interactional processes underlying these social relations (i.e. an insider's view) (Edwards 2010).

However, despite the fact that qualitative approaches have been used in the context of network analysis as independent studies, combining two methods of qualitative and quantitative network analysis, in the form of a mixed-method design, is a fairly new

and underexplored field, especially in the health care context (Frechtling and Sharp 1997). Martínez et al. (2003) proposed using a mixed methods approach to analyze social network data as a more efficient design than pure qualitative analysis, because the quantitative SNA findings are able to highlight critical issues and appropriate directions of subsequent qualitative enquiry. Quantitative and qualitative methods also inform each other and consequently can help researchers gain more in-depth insight into social networks by gaining both outsider and insider views of the social networks of interest (Edwards 2010).

In addition, mixed-method approaches are particularly well suited to help us understand the process of change over time because researchers are able to map and model the process of evolution using quantitative methods while also exploring the underlying reasons in more depth by utilizing qualitative analysis. For instance, Bidart & Lavenu (2005) performed a longitudinal network survey in three triennial waves on 66 French youths to understand the trajectories of the evolution of personal networks and the role of important life events on the journey towards adulthood. They complemented the quantitative network analysis with a qualitative study to give more depth to the findings. They concluded that mixing quantitative and qualitative approaches is needed in network studies because enumerating the quantity of ties alone is not enough to understand the process and fails to capture influential ties which are “less numerous but qualitatively richer in forceful ideas”.

Chiu & West (2007) used SNA to understand how neighborhood and personal networks affect health interventions implemented by community health educators (CHE)

in the UK, and to what extent they are aware of their embeddedness in personal networks and consciously use their knowledge to promote their professional activities. The researchers used both a network survey and focus group discussions. The integration of quantitative and qualitative findings led them to cross-reference the results and produce richer conclusions about the perception of neighborhood and its role in CHEs' practices.

1-3 STUDY SETTING:

This study is a continuation of my Master's thesis (Yousefi-Nooraie et al. 2012) and part of the Partnership for Health Systems Improvement (PHSI) study (Dobbins et al. 2009b). For this project I investigated the pattern of information-seeking networks among the staff of three public health departments in Ontario over a two-year period, during which time an organizational KT intervention was implemented to facilitate the process of EIDM.

The staff of three public health departments in Ontario participated in the PHSI study through which a multi-faceted and tailored intervention was applied in each department to promote EIDM. These health departments varied in size, complexity, and their commitment and types of policies for implementing EIDM. Departments "A" and "B" serve primarily large urban populations, whereas Department "C" serves a smaller mixed urban-rural community, with "urban" defined as areas with a population of at least 1,000 people and a density of 400 or more people per square kilometer, and "rural" as any territory outside an urban area (Statistics Canada 2011). Department "A" developed a 10-year strategic plan to achieve EIDM, has a specific budget line for individual capacity

development activities, and several project specialists (N=40) assigned to practice-based teams with responsibility for conducting literature reviews to address practice issues. Department “B” has health promotion consultants (N=100) attached to specific teams to conduct literature reviews to address practice issues. However this department does not have a strategic plan in place specifically for EIDM, although it has dedicated some resources for capacity development. In contrast, in Department “C” responsibility for synthesizing evidence for practice issues rests with program managers and key front line staff (N=30). In addition, this department has made “advancing Research and Knowledge Exchange” one of its four strategic directions and supports this through a central resource Centre and professional development activities.

The KT intervention was tailored to meet the needs and expectations of each health department. Trainees included a group of staff chosen by management to become engaged in EIDM activities led and facilitated by a Knowledge Broker (KB). In Department A, the majority of the KB’s time was dedicated to mentoring teams through a rapid evidence review process including: question definition; finding, appraising, interpreting research evidence; and assessing the applicability of the evidence to a particular practice decision. The KB, who was provided a defined office space in the health unit, facilitated a monthly critical appraisal club with staff, provided workshops on EIDM, and responded to questions posed by staff related to EIDM. The KB also attended and presented information at meetings with senior management and other health department staff, which included an introduction to EIDM, interpreting statistics, and

searching for and critically appraising public health practice guidelines. A total of 51 staff (8% of the workforce) were mentored, either individually or in small groups, by the KB.

In Department B the KB was mainly involved in building capacity for EIDM among staff who were responsible for incorporating research evidence into practice decisions (mostly health promotion consultants) and conducting introductory EIDM workshops with other staff. The KB guided a group of staff to conduct rapid evidence reviews to answer practice-based questions. The KB was also involved in attending and presenting at meetings with the senior management team and other health department staff. A total of 12 staff (less than 1% of workforce) were mentored, either individually or in small groups, by the KB in this department.

In Department C, the KB mentored teams through a rapid evidence review process, ran introductory EIDM workshops, worked with the Research and Knowledge Exchange (RKE) committee to develop policies, procedures, and a guidebook for EIDM ,and presented at senior management meetings and department-wide symposia. A total of 17 staff (2% of workforce) were mentored, either individually or in small groups, by the KB.

1-4 STUDY DESIGN:

This is a sequential explanatory mixed-methods study, according to Creswell and Plano Clark's (2011) typology, consisting of a series of quantitative studies on the association between the network structure and implementation of EIDM that are followed by an explanatory qualitative study. The quantitative phase includes a longitudinal analysis of the information-seeking networks and EIDM behavior of the staff before and

after the KT intervention. The longitudinal network analysis captured the dynamic evolution of the networks in three different contexts allowing me to test hypotheses about the effect of a KT intervention on social structure and relational factors affecting the implementation of the KT intervention (chapter 2). In the analysis of the effect of network position and connections on the behaviour change of staff towards EIDM (chapter 3) I assessed the social influence of local opinion leaders on the behaviour change. I also used the social network data that was gathered via name generator questions to assess hypotheses about the effect of the position of network questions in surveys on people's motivation to answer, assessing the likelihood of refusal and different satisficing techniques among respondents (chapter 4).

In the subsequent qualitative study, which was informed and directed by the findings of the quantitative studies, I explained the numerical findings, connected them to real life experiences of the staff, and provided complementary information regarding the organizational processes influencing the observed patterns (chapter 5). This provided a more in-depth understanding about the effects of the tailored KT interventions on the evolution of formal and informal networks, and the role of influential staff and network clusters at each of the study sites.

A mixed-methods study should create insight and knowledge that is more than the sum of its quantitative and qualitative strands. Integration is the main indicator of this extra insight, or “yield”, according to O’Cathain et al. (2007) terminology. As explained in chapters 5 and 6, the quantitative and qualitative phases of this study were integrated at multiple points including: sampling, data collection, analysis, and interpretation stages.

The quantitative findings informed the sampling frame of the qualitative case study and development of the interview guide (Ivankova, Creswell, and Stick 2006). A diagram of the study process and interface points between the quantitative and qualitative phases is provided in Figure 1.

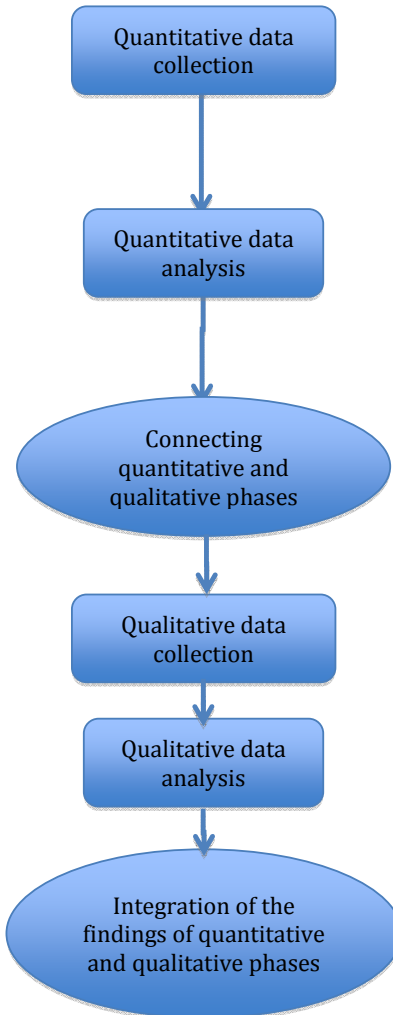
I chose to conduct a sequential explanatory mixed-methods study because this design was best to address the research questions I posed. According to Johnson, et al. (2007), mixed-methods research expands the depth and breadth of understanding by combining elements of the qualitative and quantitative approaches. The limitations of each approach are offset by the strengths of the other. Combining them provides a deeper understanding of the problem, than either approach alone (Creswell and Plano Clark 2011). A sequential explanatory mixed-methods design is especially useful for situations in which the research questions are quantitatively oriented, but for which qualitative inquiry will help explain the quantitative results (Creswell and Plano Clark 2011; Ivankova, Creswell, and Stick 2006). Accordingly, in this study the role of the qualitative strand was to explain the macro/micro social processes that happened through the implementation of the organizational KT intervention in three health departments, and resulted in the observed associations between the structure of information seeking networks and EIDM behavior of the staff.

A key element in a qualitative or mixed-methods study is the worldview or research paradigm underlying the design and research methods used. Creswell and Plano Clark (2011) postulate that more than one worldview can be used in a mixed- methods study, with the researcher selecting the paradigms based on the study design rather than

how the researcher knows the world. This study began with a quantitative analysis of social networks and behaviour, which lies within the post-positivist worldview. Post-positivism is founded upon the belief in the existence of a partially comprehensible reality that can be explained by a systematic and objective process of theory development, and then tested and verified in other contexts using statistical means to obtain high quality answers to research questions. According to the tenets of this paradigm, research findings are contextually bound and not necessarily generalizable to all other contexts and situations (Carpiano and Daley 2006).

The quantitative phase was followed by a qualitative single case study with embedded units. Consequently, the guiding worldview shifted towards constructivism, which stresses the subjective nature of meanings, pluralism and relativism. It also emphasizes the close collaboration between the researcher and the study participants in order to gain a deeper understanding of the subjective meaning of concepts (Guba and Lincoln 1994). A case study is a qualitative research design used to explain an existing phenomenon within a real life context that is too complex for assessment using a survey or experimental design, which is important when the context and the phenomenon of interest cannot be separated (Yin 2008).

Figure 1: The visual model for the sequential explanatory design

Phase	Procedure	Product
 <p>Quantitative data collection</p>	<p>An online survey of social networks before and after KT intervention in three health departments An online questionnaire of the Evidence-Based Practice (EBP) implementation</p>	<p>List of personal network members An EBP implementation score</p>
<p>Quantitative data analysis</p>	<p>Descriptive network analysis A longitudinal analysis of the evolution of social networks and EIDM behavior</p>	<p>Social network matrices and maps The list of central staff Overall characteristics of networks A statistical analysis on factors predicting the formation of ties and change in behaviour over time</p>
<p>Connecting quantitative and qualitative phases</p>	<p>Purposeful criterion sampling based on the network analysis findings Development of interview guide based on the overall objectives and the SNA results</p>	<p>The list of interviewees Interview guide</p>
<p>Qualitative data collection</p>	<p>Focused interviews Organizational structure documents KT intervention documentation</p>	<p>Transcripts Supplementary information</p>
<p>Qualitative data analysis</p>	<p>Coding and thematic analysis Cross-unit analysis</p>	<p>Codes, themes Theme categories and frameworks</p>
<p>Integration of the findings of quantitative and qualitative phases</p>	<p>Integrative analysis of two strands Interpretation and explanation of quantitative and qualitative findings</p>	<p>Discussion Implications</p>

1-5 STUDY QUESTIONS

1-5-1 Quantitative Strand Question

The quantitative strand of this study was a longitudinal analysis of social networks and EIDM behaviour carried out to answer the following question:

How do the structure of information-seeking networks and the EIDM behaviour of staff evolve over time (i.e. before and after the implementation of an organizational KT intervention) in three public health departments in Ontario, Canada?

1-5-2 Qualitative Strand Question

The qualitative strand was a single case study with embedded units, with the purpose of exploring the processes of information-seeking and its association with EIDM behaviour to answer the following question:

How do influential staff engaged in the KT intervention in three public health departments of Ontario, Canada, describe the composition of social networks, the implementation of the KT intervention, and its interaction with communication patterns?

1-5-3 Mixed Methods Question

The overarching mixed-methods research question was:

How do the qualitative interviews with influential staff engaged in the KT intervention in three public health departments help to explain quantitatively identified changes in the information-seeking social networks and EIDM behaviour during the implementation of an organizational KT intervention?

1-6 PROPOSITIONS:

1-6-1 The Effect of a KT Intervention on the Directionality of Information-Seeking Connections

The KT intervention implemented in three health departments was a multi-faceted tailored intervention that included knowledge broker (KB) mentoring of small groups through the EIDM process to answer a practice-relevant question; workshops (both for these small groups and for more staff in the health departments); one-on-one consultation and support by the KB; presentations and meetings by the KB for senior management; and advice on creating policies and procedures for the health department related to EIDM. Dobbins and colleagues (2009) identified the activities of the KB in the promotion of EIDM as follows: needs assessments, horizon scans,; knowledge management,; KT, network development, maintenance, and facilitation, facilitation of individual capacity development in EIDM,; and facilitation of and support for organizational change.

As explained in section 1-2-3-3, organizational interventions may affect the way people interact with each other, and choose their information sources. The KT intervention would affect the distribution of knowledge in health departments in two alternative ways. Because the multi-dimensional and communicative nature of the intervention was designed to increase the knowledge and expertise of staff undergoing training, I expected it would affect the structure of information-seeking networks in the health departments, leading to an increase in their expertise and confidence when dealing with research evidence and applying it into practice. This might lead to a decrease in the exclusivity of the “experts” as the only gatekeepers of the evidence. As a result, trained

staff might help inform each other in their practice in a more dynamic and bi-directional (reciprocal) way, because people would feel a moral or social obligation to return favors granted them, especially when the network is small and dense (Gould 2002; Coleman 1988). Alternatively, training only a selective group of experts might result in an ever-increasing disparity in the popularity of staff, with some experts gaining even more popularity, leading to a more centralized pattern, and a decrease in tendency towards reciprocation. Consequently I hypothesized that:

Proposition 1: the reciprocity of information-seeking connections will increase after the intervention.

1-6-2 The Effect of KT Intervention on the Distribution of knowledge

In the three health departments, there are staff specially trained to assist their colleagues to find, appraise and apply research evidence into their practice. Different professional groups, such as health promotion consultants, project specialists, epidemiologists, and supervisors, may take on these roles. According to formal job definitions, professional consultants fill the role of experts and professional advisors in the department. They provide advice on the development and implementation of programs and policies, conduct research, interpret and analyze information, and prepare specialized reports. They are responsible for developing and maintaining cooperative, collaborative relationships with internal and external partners. According to the findings of the baseline assessment of the social network in one health department, these professional roles were mostly consistent with the central position of the professional consultants in the information-seeking networks (Yousefi-Nooraie et al. 2012).

As explained earlier, one important criterion for choosing an information source is the knowledge and expertise (Borgatti and Cross 2003). Given that the KT intervention involved various educational strategies to train staff on how to find and apply research evidence as a part of their daily decisions, I expected that after the intervention expertise would be distributed more evenly in the social network. Consequently, information-seeking networks would become less centralized because more staff would be competent in EIDM, and as such would not need to refer to professional consultants to the same extent as before the KT intervention. I hypothesized that:

Proposition 2: The information-seeking network will become less centralized/polarized after the KT intervention.

1-6-3 The Effect of a KT Intervention on the Connectivity of Organizational Divisions

As explained in section 12-3-3, information exchange in organizations is an economic transaction through which receiving information from a source obliges the seeker to recognize the source's superiority (Blau 1964; Lazega et al. 2012). Many people are not comfortable with revealing their lack of knowledge and exposing themselves to others' judgment. In order to reduce this cost, people may prefer to seek information from peers to whom they have closer bonds and more similar values and characteristics (Lazega et al. 2012; Cheshire 2007). Another contributing factor is the accessibility of the information source, which could be due to geographical distance or more subtle relational mechanisms (Borgatti and Cross 2003). For example, timeliness and the level of

engagement the information seeker expects are also important determinants of accessibility of information source.

So it seems that, people prefer to turn to socially close peers who are geographically accessible, and have more common interests and assignments, which is confirmed by the empirical evidence in various contexts that showed that health practitioners tend to form small local circles based on overlap in professional duties (West and Barron 2005; West et al. 1999; Coleman, Katz, and Menzel 1966; Lazega et al. 2012). One important finding in the baseline assessment of the health department I studied in my Masters study was the scarcity of interdivisional connections. There were almost no interdivisional information-seeking connections, other than referral to the central supervisory/administrative division (Yousefi-Nooraie et al. 2012). This tendency towards segregation of social networks based on formal structural boundaries may trap the information within social clusters and shape information silos (Flap, Bulder, and Beate 1998). Consequently, organizational segregation seems to be a barrier to optimal decision-making in public health organizations, particularly in dealing with unprecedented and uncertain issues (Bowen et al. 2009).

The KT intervention in this study would affect inter-divisional communications in two ways. The KT intervention at these health departments consisted of several small and large group workshops and journal club meetings, which might have resulted in more frequent interactions among the staff from different divisions. More frequent contact between staff members from various organizational divisions through co-participation in training programs might facilitate the formation of sustainable ties among segregated

divisions. On the other hand, the staff's tendency to seek information from peers in their own division would increase after the intervention because the training might enable more local experts to help their peers in a timely manner, reducing the need to seek information from external elite experts. Consequently, I tested the following hypothesis:

Proposition 3: Inter-divisional connections will increase after intervention.

1-6-4 The Effect of a KT Intervention on the Network Position of Early Adopters

In each public health department, a small group of staff were intensively involved in the KT intervention while the majority of staff either had no contact with the intervention or participated in only one large group workshop. The staff who were highly engaged in the KT intervention were the “early adopters” of the intervention in Rogers’ terminology (Rogers 2003). The early adopter (trained) group was supposed to apply expertise gained through their training during the KT training to assist other staff to find, appraise, and apply research evidence in their practice. People turn to peers who are known experts, when they want to acquire high quality information (Borgatti and Cross 2003). So less experienced people tend to seek advice from more experienced peers. Consequently, I expected that the highly engaged group would take a more central position in the social network. This led me to hypothesize:

Proposition 4: The early adopters of information will take more central positions in the information-seeking networks over time.

1-6-5 The Social Influence of Experts

I assessed the impact of early adopters in the longitudinal behavior change in other staff in the health departments. These people could be considered as early adopters of the intervention (Rogers 2003). The lead users of innovations are usually known as risk-takers and innovators who serve as role models for others (Schreier, Oberhauser, and Prugl 2007; Perry-Smith and Shalley 2003). So I expected that the early adopters would have a significant effect on the behavior of other staff. Consequently, I hypothesized that:

Proposition 5: The staff are more likely to change their behaviour towards adopting EIDM if they directly seek information from early adopters.

1-6-6 Social Influence through Informal Ties

As explained in section 1-2-3-2, solidarity of relations is an important foundation of social influence. People learn by observing the behavior of and non-verbal communication of their trusted peers (Bandura 1977), and are influenced by the behavior of their friends and peers who share similar values and interests (Marsden and Friedkin 1993; Bandura 1977). I hypothesized that the early adopters would exert more influence on their peers who were also their friends:

Proposition 6: The staff are more likely to change their behavior towards adopting EIDM if they are friends with early adopters.

1-6-7 Social Influence of Opinion Leaders

Opinion leaders (OLs) influence the attitudes, beliefs, and behaviors of their peers, because of their widely recognized competence, accessibility, and trustworthiness (Valente and Pumpuang 2007; Majumdar, Tsuyuki, and McAlister 2007). The baseline network analysis of health departments in this study provided a sociometric framework for identification of opinion-leaders. With this data I assessed the effect of opinion leadership on the effectiveness of early adopters of the KT intervention on influencing the behaviour of their peers. I hypothesized that:

Proposition 7: Staff are more likely to change their behaviour towards EIDM if they are connected to early adopters who hold more central positions in networks.

1-7 OVERVIEW OF QUANTITATIVE AND QUALITATIVE DESIGNS

The following chapters of this thesis each report on a separate study designed to address the above propositions. In this overview, I will provide a brief summary of the methods used in each study. The detailed explanations of the theoretical frameworks, methods, findings, and implications are provided in the corresponding chapters.

1-7-1 Network Evolution Manuscript (Chapter 2)

In this study I assessed the evolution of information-seeking networks over a two-year period through which the organizational KT intervention was implemented in the three public health departments. I analyzed whether engagement of staff in the intervention and their EIDM behaviour over time was associated with being chosen as an

information source, and how the trend of inter-divisional communications and the dominance of experts evolved over time. This study addressed propositions #1 (the evolution of reciprocity in social networks), #2 (the evolution of centralization in social networks), #3 (the formation of inter-divisional connections over time), and #4 (the tendency of the staff who were highly engaged in the intervention to migrate towards the center of networks).

The staff were invited to respond to three anonymous online surveys (at baseline and two annual follow ups) including name generator questions eliciting a list of names of staff they would turn to for help integrating research evidence into practice. I used stochastic actor-oriented modeling to study the evolution of networks. I tested the effect of engagement in the intervention, EIDM behaviour scores, organizational divisions, and structural dynamics of social networks on the tendency of staff to select information sources, and the change in its trend between years 1 and 2 of follow up.

1-7-2 Social Influence Manuscript (Chapter 3)

In this study I measured the social influence of opinion leaders (OLs) in promoting the adoption of EIDM. It addressed propositions #5 (social influence of the staff who were highly engaged in the intervention), #6 (social influence through friendship ties), and #7 (social influence of highly engaged opinion leaders). I used the baseline social networks to identify OLs using a sociometric approach. I developed multi-level linear regression models to predict the change in EIDM behaviour scores associated

with being an OL, highly engaged in the intervention, seeking information from highly engaged peers, and seeking information from highly engaged OLs.

1-7-3 Name Generator manuscript (chapter 4)

In this study I used data obtained on the three rounds of surveys to assess the effect of the structure of name generator questions on the characteristics of responses. This study did not address any mixed-methods propositions and instead provided some empirical evidence regarding the validity of name generators to elicit network data, which informed the implications of this study (chapter 6).

The name generators that I used to obtain the social network information were inserted in random order in the online surveys and allowed me to collect four types of network data: respondents' information sources, who turned to them for information, experts, and their friends. I tested the association between the location of the question in the order of name generators on the likelihood of refusal, choosing "I don't know anyone" and the size of provided name lists as indicators of strong and weak satisficing. I developed multi-level regression and generalized estimating equation (GEE) models to predict the relationship between a question's position on the list (1st, 2nd, 3rd, or 4th), the question type (information-seeking, reverse information-seeking or who seeks information from the respondent, expertise recognition, and friendship), and their interaction on the likelihood of refusing to answer, answering "I don't know anyone", and size of lists of names.

1-7-4 The Explanatory Qualitative Case-Study (Chapter 5)

With the aim of explaining and complementing the quantitative findings, I designed a qualitative case study with embedded units to investigate the process of knowledge flow in health departments through the implementation of the KT intervention, with health departments as embedded units. The quantitative analysis previously completed informed the sampling frame and the qualitative interview guides. I interviewed the highly engaged influential staff at each health department, analyzed the resultant transcripts using thematic framework analysis, and organized emerging themes into meaningful clusters. In chapter 5, I provided a detailed explanation of the qualitative methods used and a narrative presentation of main themes, along with relevant quotes from participants.

1-7-5 Integration and Conclusion (Chapter 6)

In this chapter I provided a narrative integration of quantitative and qualitative results by summarizing the quantitative findings, explaining how the qualitative interviews helped me interpret and contextualize quantitative results, and how the integrated results informed by the current literature addressed the study propositions. I provided implications for the use of network analysis in the implementation and KT research and practice. Chapters 5 and 6 will eventually be used to write a separate mixed-methods manuscript submitted to a peer-reviewed journal for publication.

**CHAPTER 2- Evolution of Information Seeking Networks
through the Process of Knowledge Translation; A Case Study
of Three Public Health Departments in Canada**

2-1 PREFACE TO CHAPTER 2

This chapter describes an observational study aimed to assess the evolution of information seeking networks over a two-year period through which the organizational KT intervention was implemented in the public health departments.

This manuscript is ready to be submitted for peer review. Upon acceptance, a request will be made to the publisher of the journal to obtain permission to include copyright material in this thesis. The student was the main contributor of this study, conceived the study design and theoretical framework, performed all statistical analyses, interpreted the findings, and drafted the manuscript. The co-authors reviewed each step of the study and write up, and guided the student through the design, analysis, interpretation, and writing up.

2-2 NETWORK EVOLUTION MANUSCRIPT

Evolution Of Information Seeking Networks Through The Process Of Knowledge Translation; A Case Study Of Three Public Health Departments In Canada

Reza Yousefi Nooraie, Maureen Dobbins, Alexandra Marin, Robert Hanneman, Lynne Lohfeld

2-2-1 Abstract:

Objectives: We studied the evolution of information seeking networks over a two-year period through which an organization-wide intervention was implemented to promote evidence-informed decision-making (EIDM) in three public health departments in Ontario, Canada. We tested whether engagement of staff in the intervention and their EIDM behavior were associated with being chosen as information source, and how the trend of inter-divisional communications and the dominance of experts evolved over time.

Methods: At each health department a group of staff was selected to get engage in Knowledge Broker-led workshops and consultations, and development of evidence summaries to address local public health problems. The staff were invited to answer three online surveys (at baseline and two annual follow ups) including name generator questions eliciting the list of the staff they would turn to for help integrating research evidence into practice. We used stochastic actor-oriented modeling to study the evolution

of networks. We tested the effect of engagement in the intervention, EIDM behavior scores, organizational divisions, and structural dynamics of social networks on the tendency of staff to select information sources, and the change in its trend between year 1 and year 2 of follow up.

Results: In all the three health departments, and especially in the two departments with higher levels of engagement in the intervention, the network evolved towards a more centralized structure, with an increasing popularity of already central staff. The staff showed larger tendencies to seek information from peers with higher EIDM behavior scores. In the department that had highest engagement and stronger leadership support the engaged staff became more popular. In all departments the engaged staff showed an increasing tendency towards forming clusters. The staff in the three departments showed a tendency towards limiting their connections within their divisions.

Conclusions: The longitudinal analysis provided us with a means to study the microstructural social changes and sustainability of the implementation. The hierarchical transformation of networks around experts, and formation of clusters among staff engaged in the intervention show how implementing organizational interventions to promote EIDM may affect the knowledge flow and distribution in health practice communities, which may lead to unanticipated consequences.

2-2-2 Keywords:

evidence-informed decision making, social network analysis, stochastic actor-oriented modeling, social selection, longitudinal analysis

2-2-3 Background:

Knowledge translation (KT) in public health is a complex and multidimensional process, and several factors apart from the development and provision of high quality research evidence are interacting through the process, including community norms, social and political influence, and organizational structures [1, 2]. The association between social structure and KT is intricate and bi-directional. On the one hand, several social factors may impede or facilitate the implementation and adoption of KT interventions [3]. On the other hand, KT interventions, like other organizational behavior change interventions, may have social consequences and affect how individuals interact with each other [4]. KT models and frameworks highlighted the role of contextual and social factors [5], but mainly recognized them as the barriers/facilitators of the KT process, and not the outcomes that are influenced by it [3, 6, 7]. We do not know much about how implementation of KT interventions affects social fabric of health care settings.

Individuals live in social networks, which provide them with channels to access to support and information [8], and also influence and constrain their beliefs and behaviors [9]. Understanding the composition of social networks is an important perspective to study the determinants of behavior change [10]. Social network analysis (SNA) is a well-established perspective to understand social relations, that focuses on the patterns of relationships between individuals and social groups [11, 12], and can shed light on social processes that are not easily identifiable with conventional research methods.

Networks as complex and dynamic systems naturally evolve over time [13]. Social networks tend to emerge towards more balanced states [14], and network members

tend to form connections with others who are more similar to themselves [15]. Apart from the tendency of networks towards inertia and stability, external forces can affect the formation, maintenance, or dissolution of ties among network members [16].

Organizational innovations as an external force can affect the social relations.

Implementation of innovations is a complex and dynamic process by which the people who are bound within relationships with each other in a social context make adjustments to achieve desired outcomes [17, 18]. Changes in the personal and collective knowledge and attitude over time may affect individuals' willingness to action and choices of interaction, subsequently affecting the network composition [4].

In a recent two-year study we examined the information-seeking relationships of staff of three public health departments in Ontario, Canada, before and after implementing a multi-faceted and site-tailored KT intervention. Our goal was to understand how information-seeking networks evolved over time, and how engagement in the KT intervention and evidence-informed behavior of staff associated with their evolving network positions and relational tendencies.

2-2-4 The Evolution of Information Seeking Networks:

Advice- and information-seeking networks represent the pattern of connections by which people share information and ideas and seek guidance and information. Selecting an information source is the result of various competing and interlacing mechanisms, and the process may differ based on the nature of the problem, the type of information being transferred, the social network structure, and the norms and values shared by the involved parties. Borgatti and Cross suggest that information-seeking behavior in organizations is a

function of: 1) how much the information seeker recognizes the information source's knowledge and skill, 2) the potential cost of seeking information, and 3) accessibility of the source [19].

People turn to peers who are known experts, when they want to acquire high quality information [19]. So less experienced people tend to seek advice from more experienced peers. In the context of our study, a group of staff in each health department was recruited to participate in the intervention comprised of short educational workshops, followed by engagement in development of summary evidence reviews to address local public health problems, while the majority of their peers had very limited contact with the intervention. We expected that the staff would recognize the expertise of these highly engaged individuals, as well as the peers whose behavior were more in line with EIDM principles. These experts might have been already at the center of expertise networks due to their personal characteristics and formal roles in the public health departments, or they gained expertise as a result of participation in the intervention. So we hypothesized that the highly engaged subgroup and the staff who improved their EIDM behavior would gradually take a more central position in the social network over time, as noted below:

Hypothesis H1: Staff were more likely to seek information from individuals who were highly engaged in the KT over time.

Hypothesis H2: Staff were more likely to seek information from individuals who became more expert in EIDM over time.

According to social exchange theory [20], information exchange in organizations is an economic transaction through which receiving information from a source obliges the

seeker to reciprocate. The price is usually the recognition of the source's superiority in exchange for the received information [21]. However, many people may avoid deferring to experts because it highlights their lack of knowledge and exposes them to others' judgment as being less knowledgeable or accomplished. In order to reduce the cost of information-seeking, people may prefer to seek information from peers to whom they have closer bonds and more similar values and characteristics [21, 22]. Accessibility of the information source is another contributing factor in shaping information-seeking behaviors. In addition to practical barriers to access, e.g. geographical distance, the issue of access could be defined by more subtle relational mechanisms. For example, timeliness of the advice (i.e. asking the person who can provide help within the desired timeframe) and the level of engagement the advice seeker expects (i.e. asking the person who can spare enough time and resources to become sufficiently engaged in the seeker's problem) are also important determinants of accessibility of information source [19].

So it seems that, turning to peers who are geographically more accessible, are socially closer to the seeker, and have more common interests should reduce the cost and accessibility barriers. Health practitioners tend to form small local circles based on overlap in professional duties [21, 23–25]. In an analysis of baseline social networks of staff in one of the study public health departments we have seen that the information-seeking networks were highly segregated by organizational divisions [26]. This tendency towards segregation of social networks based on formal structural boundaries may result in trapped information within social clusters and formation of information silos. Organizations with more non-routine tasks and more uncertainty in workflow require a

more dynamic social structure with less complex hierarchy, less segmented networks, and more reciprocated connections [27]. Consequently, organizational segregation seems to be a barrier to optimal decision-making in public health organizations, particularly in dealing with unprecedented and uncertain issues. Accordingly, Canadian health decision-makers identified this structural tendency as a potential barrier to EIDM [28].

The KT intervention in this study would affect inter-divisional communications in two ways. On the one hand, the participatory nature of the KT intervention (which consisted of several small and large group workshops and journal club meetings) might facilitate the formation of inter-divisional connections. More frequent contact between staff members from various organizational divisions through co-participation in training programs might facilitate the formation of sustainable ties among segregated divisions. On the other hand, the staff's tendency to seek information from peers in their own division would increase after the intervention because the training might enable more local experts to help their peers in a timely manner, reducing the need to seek information from external elite experts. Consequently, we tested the following hypothesis:

Hypothesis H3: Staff were more likely to seek information from peers in other organizational divisions over time.

The KT intervention would affect the distribution of knowledge in health departments in two alternative ways. On the one hand, training more staff would result in a more even distribution of knowledge in the department, making the networks less centralized around a limited number of experts. So when connections become more localized and less formal, the reciprocity and bi-directionality of information-seeking

connections would increase, because people would feel a moral or social obligation to return favors granted them, especially when the network is small and dense [29, 30]. Alternatively, selective training of experts might result in an ever-increasing popularity of experts, leading to a more centralized pattern, and a decrease in tendency towards reciprocation. So we hypothesized that:

Hypothesis H4: The information-seeking network became less centralized around a few central experts.

Hypothesis H5: Staff were more likely to reciprocate information-seeking connections over time.

2-2-5 Methods:

The KT intervention we tested aimed to promote EIDM in public health decision-making, and was implemented during a 22-month period in three public health departments in Ontario, Canada. It was tailored to the specific needs and characteristics of health departments through discussions between the research team and public health department leaders. It included introductory workshops and knowledge broker (KB) consultations and mentoring of small groups through the EIDM process: formulating practice-based questions, searching for evidence, appraising the scientific quality of the evidence, synthesizing the evidence, appraising the applicability and transferability of the findings, and applying it to local practice [40].

The three public health departments enrolled in the study had different demographic and organizational structures, and differed in terms of their capacities and policies to promote EIDM. Department A served a large urban population (>1.5 million).

The leaders of the organization were strong advocates for EIDM, and had started capacity development efforts (e.g. a strategic plan and a specific budget line to promote EIDM) before the study began in 2011. They hired and trained project specialists assigned to practice-based teams, who were Masters-trained staff experienced in finding and interpreting research evidence, with responsibility for conducting literature reviews to address practice issues. At the beginning of the study more than 100 staff members, mainly managers and project specialists, were sent to a one-week workshop on the principles of EIDM. After the workshop the participants were assigned to small groups in charge of developing rapid reviews to address public health problems. The rapid review teams were supervised and directed by a senior organizational leader and a knowledge broker who tutored the staff through the process of finding, summarizing, and synthesizing the evidence. The rapid review groups frequently met at progress meetings and critical appraisal clubs to share their concerns, problems, and progress with other review teams. The knowledge broker had a desk and regular office hours allowing her to consult the teams regarding the development of the rapid review and other issues related to EIDM. At the end of the project, completed reviews were presented in department-wide research events and other local meetings. Based on the KB's journals, attendance lists of educational workshops and rapid review teams, and data exported from the online survey, we classified 51 (8%) of staff at department A as highly engaged in the intervention. This group was involved in developing 18 evidence reviews.

Department B was the largest health department in the study, serving a large urban population area (>1.5 million). They identified EIDM as a strategic priority and attached

health promotion consultants to specific teams to conduct literature reviews to address practice issues. The adoption of the KT intervention was more localized to specific organizational divisions in this department. Within participating divisions, managers identified important public health questions and assigned relevant health promotion consultants and other staff, based on their specializations and background, to conduct rapid reviews to address the questions. In department B, the KB was mainly involved in capacity building and training sessions offered through workshops and weekly on-site/off-site consultations. Thirteen staff members (1%) were highly engaged in the KT intervention, and developed five evidence reviews.

Department C served a smaller mixed urban-rural community (~600,000 population). At department C public health nurses had the responsibility for searching and applying evidence to practice, along with carrying out their daily public health duties, under the supervision of program managers. Much like department B, a few divisions of department C participated in the intervention, and nurses were assigned to small groups according to their relevance to the public health question to be addressed by the evidence review. At department C, the KB was mainly involved in mentoring teams through evidence reviews and leading workshops. There were 18 highly engaged staff members (2%), who developed five rapid evidence reviews.

2-2-5-1 Data Collection:

The staff were invited by a letter sent by senior management to participate in an online survey at baseline and two follow up assessments with yearly intervals (from 2011 to 2013). The invitation letters provided information on the purpose of the study, the

importance of the recipient's participation, and the hyperlink to the survey. The organizational management was not informed about who participated in the study. The study was approved by the Hamilton Integrated Review Board (HiREB) and corresponding bodies of three health departments.

The staff who consented to participate in the survey (Appendix 1) answered name generator questions about their information-seeking relationships in the health department [26] (Appendix 2), as well as demographic information. Respondents named peers in the department to whom they regularly turned to for help integrating research evidence into practice-based decisions. For the purpose of this survey, evidence was defined as “knowledge from a variety of sources including qualitative and quantitative research, program evaluations, client values and preferences, and professional experience”. In addition, we included a broad range of activities in our definition of ‘decision’, such as how to implement programs/policy, how to address local issues requiring their decisions, and how to identify and respond to community needs.

We used the Evidence Based Practice (EBP) Implementation Scale of Melnyk and colleagues to assess the extent to which respondents implemented EIDM in their practice [41] (Appendix 3). This scale has good internal consistency (Chronbach's alpha >0.9), a significant association with educational level and prior exposure to EBP [41]. It includes 18 EBP activities (different aspects of using and appraising evidence). Each respondent provided the frequency of his or her involvement in an activity during the 8 weeks prior to the survey using a 5-point frequency scale. We administered the scale at baseline,

follow up 1 and follow up 2. Non-respondents received two reminder emails one week apart [42].

2-2-5-2 Descriptive Analysis:

To depict the longitudinal changes in network structure, we calculated basic aggregate network structural indicators at baseline and at two follow-up periods (half way through the intervention and at the end of the intervention), using UCINET 6 [43].

We calculated density as a basic measure of connectivity by dividing the number of existing ties by the total possible number of ties among all the network actors. We used ‘reciprocity’ to quantify the bi-directionality of information-seeking ties. Reciprocity measures the extent to which the directed tie from Actor A to Actor B is returned by Actor B [44] and is calculated by the percentage of all ties in the network that are reciprocal.

In order to show the changes in inter-divisional connections, we calculated the E-I index, which is the number of external connections (outside divisions) minus the number of internal connections (within divisions), and divided the result by all connections [44]. The measure ranges from -1 to 1, with negative values indicating a tendency toward intra-divisional and positive values indicating the tendency towards inter-divisional connections.

We also used network Freeman’s degree centralization and Krackhardt’s hierarchy index as indicators of the distribution of popularity in social networks. Centrality is the measure of dominance or activity of actors in the network, and is calculated for each actor based on his or her position in a network [45]. Degree centrality,

which is the number of connections from (out-degree) and to each actor (in-degree), is the most conventional measure of activity or popularity. In-degree centrality in directed networks is a rough measure of popularity [44]. We calculated the indegree centrality of highly engaged group, as the percent of non-engaged staff who turned to this group [46], at each time point.

By using the centrality measures of all actors in the network, Freeman's centralization measures are calculated to give an overall picture of the variation between actors in the network in terms of their centrality. It is the ratio of the sum of the differences of all centralities from the highest centrality in the network over the largest possible sum in networks of the same size. The extent of hierarchy and inequality of networks may be identified by comparing centralization measures with the values from a theoretical perfect star-shaped network (i.e., if all actors are exclusively connected to one popular actor) of similar size [45]. Larger centralization measures indicate more resemblance to a star-shaped network. We calculated the centralization index for in-degree centrality in information seeking networks at baseline and follow ups.

We also measured, Krackhardt's hierarchy index, which shows the extent to which the paths (including indirect connections between pairs of actors) are not reciprocated, and represents the tendency of the network towards a hierarchical structure [47]. In a perfect connected out-tree (with a single stem, and all actors located at different levels of the branches all orienting towards the stem) the value of hierarchy index is 1.

2-2-5-3 Stochastic Actor-Oriented Models for Network Evolution:

We used a stochastic actor-oriented modeling technique to assess the dynamics of longitudinal changes of social networks. Stochastic actor-oriented modeling techniques are flexible and powerful methods to model the dynamics of longitudinal changes in social networks [31]. These models predict the formation of ties among people as the product of various micro-structural properties of networks and personal attributes of the people, controlling for internal tendencies of social networks [32]. The main advantage of these models over conventional regression models is their ability to realistically predict structural tendencies in social networks and consider longitudinal changes as continuous processes rather than discrete changes, while addressing the dependence of observations in social network data [33] as briefly explained below. (For detailed information see technical resources including an introduction by Snijders [32].)

Unlike conventional survey data, the dyadic (pairwise) relationships of people in social networks are not independent, and there are structural tendencies in networks that involve more than pairs of actors, and should be considered (or at least adjusted for) in a realistic model. Some of the most well-known tendencies are the tendency to reciprocate the connections [34], the tendency to be directly connected to peers' information sources (transitivity) [35], the tendency to connect to peers who are similar (homophily) [15], and the tendency to connect to popular peers (preferential attachment) [36]. Controlling for structural tendencies is very difficult in conventional regression models, which generally assume independence among observations [37].

The other advantage of actor-oriented models is their continuous-time assumption. Observed changes in different time points of longitudinal study of networks do not happen abruptly. They are the result of gradual evolution of network relationships over time, through which network actors change their ties and re-evaluate the outcomes in an iterative feedback process [32]. The suitability of continuous-time models for network evolution has been proposed for a long time, particularly by Holland and Leinhardt [38].

Stochastic actor-oriented models assume that observed changes between time points (e.g. baseline and follow up) are the cumulative presentation of several unobserved consecutive micro-steps. Through each step actors make myopic decisions (which means they respond mainly to the behavior of their neighboring peers, rather than the overall changes in network [39]) to optimize their utility in the network whenever they have the opportunity, which includes maintaining a tie with a peer, disconnecting that tie, or making a tie with a new peer [32]. The function of actors' satisfaction with their local network configuration is called *evaluation function*, which is the likelihood that each actor changes her ties in a certain way [32]. It is constrained by the current composition of the network ties, the behavior of other actors, and random variation. For example, if a network actor shows a positive tendency to make or maintain connections to peers in other organizational divisions between two observations, the evaluation function for interdivisional connections will be positive. The mechanism of change through micro-steps is a Markov process, which means that the probability of change at each step depends on the combination of network structure and characteristics of all other actors,

and also random error [32]. Actors play the mentioned optimization game several times, until the observed pattern at follow up is achieved.

The parameter corresponding to an independent variable of the model is the log odds ratio of making or maintaining connections with actors j or k with one unit difference in independent variable, keeping all other values the same. The independent variables included the characteristics of network actors (such as gender, age), dyadic associations (such as being in the same division), and endogenous network structural tendencies (such as tendency towards reciprocity and transitivity). Their statistical significance represents their difference from zero in predicting the tendency of actors in forming or maintaining social ties with others. We included a dummy variable for time, corresponding to the evolution from baseline to follow up 1 (period 1), and the difference in the parameters between period 2 (follow up 2 to follow up 3) and period 1. We used the parameters at period 1, the changes in parameters from period 1 to period 2, and differences in trends between health departments to test the study hypotheses.

The convergence of the model is checked by measuring the deviation of simulated values from observed patterns, which would be zero in a fully converged model. The deviation is represented by t-ratios (mean over standard deviation of deviations), with good convergence indicated by t-ratios of <0.1 [48].

The included variables, their definitions, and their corresponding hypotheses are provided in Table 1. We included a few structural tendencies as elementary effects in the model, including reciprocity, transitivity, 3-cycle formation, and indegree popularity, as they are strongly suggested to be included to improve the convergence [48]. They were

also used to test some of the study hypotheses. Reciprocity is a natural tendency of social relations. When Actor A does Actor B a favor, then Actor B will feel the urge to return the favor as a moral obligation (*norm of reciprocity*) [34, 49]. The coefficient for reciprocity at each time period showed the tendency of actors to make or maintain reciprocated ties with others. We tested hypothesis H5 about an increased tendency towards reciprocation of information seeking ties by assessing the trend of changes in the reciprocity effect over two study time periods.

People also tend to close triangles and form social clusters. So if Actor A seeks information from Actor B, and B turns to C, A has the tendency to also turn to C directly, and form a transitive triplet or triangle. Cartwright and Harary [35] discussed the issue of transitivity as a psychological tendency of humans for balance, which was rooted in Heider's formulation of balance theory [14]. Alternatively, the above-mentioned triangle between actors A, B, and C may get closed by a connection from actor C to actor A, forming a 3-cycle. A positive effect of transitivity, in presence of a negative effect of 3-cycle formation may show the tendency of network to form local hierarchy [48].

Indegree popularity indicates the tendency of actors to preferentially attach to already central individuals, which deepens the inequality of actors in the network (rich get richer) [50]. We investigated the trends of transitivity, 3-cycle formation, and in-degree popularity to test hypothesis H4.

We included variables corresponding to being highly engaged in the intervention (yes/no), EBP implementation scores at baseline, and the difference of EBP implementation score at follow up 3 from baseline as ego, actor, and dyadic variables,

testing for hypotheses H1 (tendency towards connecting to highly engaged peers) and H2 (tendency towards connecting to people based on their EIDM behavior). The tendency towards forming ties with people in other divisions was used to test hypothesis H3.

Due to basic differences in the structure of the health departments in this study and the way the intervention was implemented at each site, we ran stochastic actor-oriented models for each health department separately. The models were developed in Siena software (version 4.0) in R environment [48].

2-2-6 Results:

At department A, 316 staff members participated in the survey at least once during the study, of whom 119 (38%) provided the information-seeking data at all three rounds of assessment. Among those, 111 (93%) were female, 71 (60%) had a Bachelor's degree and 42 (35%) had a Master's degree or higher level of education. The most frequent job titles they held were public health nurse (n=30, 25%), supervisor (n=26, 22%), consultant or project specialist (n=19, 16%), and manager (n=19, 16%). Among those, 41 (34%) were highly engaged in the KT intervention, of whom 12 (32%) were consultants and 10 (24%) were managers.

At department B, 534 staff answered the surveys at least once, of whom 133 (25%) provided information-seeking data at all three rounds. Of those, 118 (89%) were female, 54 (41%) had a Bachelor's degree and 70 (53%) had a Master's degree or higher education. The most frequent job titles held at department B were consultants (n=37, 28%), public health nurses (n=27, 21%), and managers (n=30, 23%). Of these

respondents, 10 (8%) staff members were highly engaged in the intervention, of whom 8 were consultants, 1 was a public health nurses, and 1 was a manager.

At department C, 185 staff members answered the surveys at least once, and 49 of them were included in information-seeking networks at three rounds. Of these, 42 (86%) were female, 30 (61%) had a Bachelor's degree, and 13 (27%) had Master's degree or higher education. The frequently reported job titles were nurse (n=24, 49%), public health inspector (n=7, 14%), and manager (n=10, 20%). In this department, 15 (31%) staff members were highly engaged in the intervention, of whom 4 (27%) were nurses, 6 (40%) were managers, and 3 (20%) were health inspectors.

As shown in Table 2, in all the three health departments, the staff who provided network data at all time points (baseline, follow up 1, and follow up 2) on average were more educated and more experienced, more likely to be managers and to be highly engaged in the KT intervention, compared to other respondents who either did not provide network information in all time points or only answered the EBP questionnaire. This shows that the network analysis is biased towards a subgroup of staff in the health departments who were closer to managerial levels and also considered EIDM more relevant to their practice.

2-2-6-1 Descriptive Analysis of Networks:

Table 3 shows the aggregate structural indicators of networks at each time point. In department A, the density of information-seeking networks showed a small increase, from 1.5% at baseline to 2% at second follow up, while the two other departments stayed unchanged. The reciprocity of connections did not change noticeably in department A,

but showed a decrease from 25% to 17% at department B, and a transient increase at first follow up in department C (from 16% to 24%), which regressed to values below baseline at follow up 2 (13%). In-degree centralization at the 3 health departments showed a transient decrease at first follow up, which was more prominent in departments C (6% decrease). Krackhardt's hierarchy index showed a transient decrease towards less hierarchical structure at follow up 1 in the three departments, followed by a subsequent increase in follow up 2. The E-I index of the three health departments was negative, indicating an overall tendency towards intra-divisional connections, but showed a transient decrease (towards less inter-divisional connections) at follow up 1 in departments A and C, and a transient increase (towards more inter-divisional connections) at follow up 1 in department B.

At baseline 37% of non-engaged staff at department A, 11% at department B, and 44% at department C turned to highly engaged staff for information (group centrality in Table 3). The centrality of the highly engaged group only increased in department A over time (with an increase to 56% at follow up 3).

Figures 2 to 4 show the information seeking networks at three time points in the health departments. By visual inspection of department A network (Figure 2), we observed a network prominently segregated by organizational divisions, with interdivisional ties mainly limited to connections from practice-based divisions to the supervisory/administrative division (lower right), a pattern which continued over time. There was a group of highly engaged staff in the supervisory/administrative division who improved their positions in the network prominently over time (increased node size).

Highly engaged staff were more central than others at baseline, and preserved their central position in the network over time.

Figure 3 shows the information seeking networks at department B. There was no noticeably central division, and inter-divisional connections were more frequent. Apart from four already central highly engaged staff in the upper left division (who were local information sources for the staff in their division) other highly engaged staff were not noticeably central at the baseline assessment. The only visible increase in centrality over time was in those four highly engaged staff at upper left division at follow up 1.

Figure 4 shows the information seeking networks at department C. Similar to department A, inter-divisional connections were limited to connections from practice based divisions to the supervisory/administrative division (lower right), which showed a slight increase over time. One highly engaged individual in the supervisory/administrative division was already central at baseline and gained relatively more centrality over time.

2-2-6-2 Stochastic Actor-Oriented Models:

After 2000 iterations in phase 3 of the procedure [48], all three models converged acceptably, with the t-ratios < 0.05 for deviations of estimated from observed values. The parameter estimates (and standard errors), and their statistical significance in the model are provided in Table 4. The speed of network evolution, which is represented by the *rate parameter*, in department A was more than two other departments at both periods (period 1: from baseline to follow up 1, period 2: from follow up 1 to follow up 2), implying more opportunities for network restructuring in department A. At period 1, the parameter for out-degree, which is the tendency of actors to make (or maintain) ties with an arbitrary

actor with no specific characteristic, was negative in all three health departments, which is expected in networks with small density [32]. The changes in out-degree effect in period 2 were small and statistically insignificant.

At period 1, the staff in the three health departments showed a significant positive tendency to make or maintain reciprocated ties, which was larger in department B (*reciprocity-period 1*: 1.87). The tendency towards reciprocation decreased at period 2 in all three health departments, with a larger decrease in department C (*reciprocity-period 2 change*: -0.71). The positive reciprocity effect at period 1 shows an internal tendency towards reciprocation in networks, as well as the possibility of a transient increase in tendency towards reciprocation, which was followed by a decrease in tendency, not supporting hypothesis H5 about reciprocity increase over time. It was also consistent with the observed decrease in reciprocity in all three departments from follow up 1 to follow up 2 (Table 3).

The staff in the three health departments did not tend to make or maintain ties with other divisions, as indicated by the significant and negative values for inter-divisional connections at period 1. At period 2, the tendency showed a larger decrease in department B (-0.40), which was consistent with a decrease in E-I index at follow up 2 in this department. The tendency only increased in department C with a 0.81 increase in the coefficient, supporting hypothesis H3 about an increase in inter-divisional connections only in department C (generally from practice-based divisions towards the supervisory/administrative division: Figure 4). These findings were consistent with a

larger increase in E-I index from follow up 1 to follow up 2 in department C, compared to the other two departments.

The indegree popularity effect, that shows the tendency of actors to make or maintain ties with the staff who are already central, was significant and positive in all networks at period 1, with a larger value in department C (*in-degree-popularity-period 1*: 0.18). The tendency increased at period 2 in all the three health departments. At period 1, the coefficients for transitivity were significant and positive, and the coefficients for making or maintaining 3-cycles were negative, indicating a tendency to form hierarchical relations (either as an internal tendency or the effect of intervention). At period 2, the change in trend towards a local hierarchical structure was more prominent in department A with an increasing transitivity and a decreased tendency towards 3-cycle formation from period 1, not supporting hypothesis H4 in this department.

At period 2, department B showed a small increase in transitivity and a large increase in 3-cycle formation (an indicator of generalized reciprocity). These findings in presence of a decreased tendency towards making inter-divisional connections and a decrease in E-I index from follow up 1 to follow up 2 imply that the staff tended to maintain and strengthen the intra-divisional ties rather than turning to external experts.

In department C, at period one, the transitivity effect was highest and 3-cycle effect was lowest among all departments (i.e. largest tendency towards local hierarchy). At period 2, both the effects for transitivity and 3-cycle formation decreased. This finding along with a decreased reciprocity and an increase in tendency of inter-divisional connections implies a trend in staff to make new connections (to the central staff in the

supervisory/administrative division) rather than closing triangles. It is also consistent with the observed pattern in Figure 4 between follow up 1 and follow up 2, which shows more connections from practice-based divisions towards the supervisory/administrative division (bottom right).

Only in department A did the staff show a significant positive tendency to make or maintain ties with highly engaged staff at period 1 (*source-highly engaged*: 0.31), with a small decrease at period 2, compared to a large decrease in tendency at period 2 in the two other departments (most prominent in department C with 1.05 decrease from period 1). These findings are consistent with a rising trend of group centrality of highly engaged staff (Table 3), and support hypothesis H1 in department A about the tendency of the staff to form or maintain ties with highly engaged peers over time. In all three health departments, highly engaged staff showed a positive tendency to make or maintain ties with each other at period 1 (*Seeker × Source-highly engaged*). This tendency increased in period 2, especially in departments B and C. These findings imply that the highly engaged staff showed an increasing tendency towards forming clusters over time.

At period 1, the staff had a positive tendency to make or maintain ties with others with higher baseline EBP implementation scores (*Source-baseline EBP score*), which was statistically significant in departments A and B. At period 2, the change in the trend was larger in departments C (0.05 increase) and A (0.02 increase), implying an increasing tendency to seek information from staff with higher EBP scores over time in these two departments. We observed a positive tendency in staff to make or maintain ties with others with higher improvement in their EBP implementation scores (*Source- EBP score*

change) at period 1, which was significant in all the three health departments. The change at period 2 was small and positive in three departments. The positive tendency towards staff with higher EBP scores at period 1 could be explained either by the effect of intervention on the social selection of staff or the already central position of those staff at baseline (perhaps because of their formal roles). The positive increase in tendency from period 1 to period 2 supports hypothesis H2, especially in departments A and C.

At period 1, the staff with higher baseline EBP implementation scores (*Seeker-baseline EBP score*) and higher changes in scores (*Seeker-EBP score change*) were more active at department B compared to other 2 departments. At period 2, the staff with higher changes in EBP scores significantly improved their tendency towards being more active in department C (0.07) and A (0.03).

2-2-7 Discussion:

2-2-7-1 Popularity of Experts:

In all three health departments, and especially in departments A and C, the network evolved towards a more centralized structure, with an increasing popularity of already central staff, not supporting hypotheses H4 and H5. The staff showed larger tendencies to seek information from peers whose behavior was more in line with EIDM principles over time, supporting hypothesis H2. Only in department A did the highly engaged staff become more popular, supporting hypothesis H1.

If the intervention to empower health practitioners through the EIDM process is adopted successfully, we expect that the peers of those engaged in the intervention will recognize the expertise they gained through the intervention. Seeking information from

peers in finding and applying research evidence into practice is a routine behavior in public health organizations [26] and among health practitioners [51]. It is rooted in *transactive memory* principles explaining how group members retrieve and distribute knowledge to effectively improve their collective productivity [52]. Group members turn to peers who are considered experts when they need knowledge and expertise that is beyond their personal capabilities. An important requirement for this process of information sharing is that the group members have a tacit knowledge about who knows what in their group [53]. Consequently, it is expected that if an intervention provides opportunities for knowledgeable staff to be presented to and recognized by a larger number of peers, as a result the knowledgeable staff will be added to the referral directory of more people and will be approached by more over time.

Analyzing the evolution of networks showed that in department A the highly engaged staff (who were mainly already popular at baseline) gained even more popularity through time. Our other observation about the effectiveness of the intervention in this department (chapter 3) showed that local opinion leaders who were highly engaged in the intervention significantly improved their EIDM behavior in departments A and C. In contrast, in department B no significant behavior change was seen in the small group of staff who were intensively involved in the intervention. Therefore it seems that in department A a group of highly engaged staff (who were already popular at baseline) improved their EBP behavior and in parallel became more popular. This trend suggests the effectiveness of the intervention in the routine information-seeking practice of health practitioners in this department. In department C we did not observe a positive tendency

in staff to seek information from highly engaged staff. However, an increase in tendency of staff to form connections to a small group of central epidemiologists in the supervisory/administrative division (Figure 4) could also support the effectiveness of intervention in this department. It seems that the intervention might have influenced the attitude of the staff (mainly nurses) in practice-based divisions regarding the need for and the value of EIDM, which resulted in more communication with the epidemiologists at the central division, even though most of them (apart from a highly central epidemiologist) were not engaged in the intervention. In contrast, in department B, where only a handful of staff were engaged in the intervention, the already localized structure of the network became more clustered by organizational divisions.

This tendency towards centralization may show that the KT intervention was more effective in empowering and popularizing the already known experts, rather than distributing the knowledge more evenly among staff. Bunker et al. observed a similar increase in centralization of clinicians' advice networks around faculty experts, with a decline of local private connections among clinicians after a learning collaborative intervention, which was the result of a wider recognition of experts by the clinicians [54]. This increased dominance of a small group of experts has both positive and negative consequences. Adoption of innovations is facilitated in centralized networks where there are prestigious actors who have enough credibility to influence the behavior of others and have routes of access to diffuse information to a large group of people [55]. However, strong dependence on a small group of experts may lead to less autonomy and productivity of health practitioners overall. This dominance of a few may hamper the

dynamic communication and productivity of staff [24]. In addition, staff may gradually hesitate to turn to those central elite and prefer less optimal local information sources because of their limited availability [19] (due to work load) and larger disparity in social status [20, 22].

In department B, only a very small group of staff, who were not prominently central at baseline, were highly engaged in the intervention. The network analysis did not show any evidence of increasing popularity of this group. However, their activity in the network increased over time. This implies that highly engaged staff became more socially active and formed more ties with their peers. This activity may result in more visibility over time, which may itself lead in being gradually recognized by others as information source [49].

2-2-7-2 Cluster Formation:

In all departments the highly engaged staff showed an increasing tendency towards forming clusters, which was largest in department C. This could be the result of the communicative nature of the intervention. As explained before, the intervention provided the highly engaged staff the opportunity to meet each other and share their experiences through progress meetings and critical appraisal clubs. Co-participation in those events might have resulted in formation of sustainable ties.

The formation of clusters among experts could be interpreted as an indicator of the establishment of communities of practice (CoP), which are groups of people with common values and interests who work together to solve a common problem through continuous interaction and feedback [56, 57]. Barwick et al., in a randomized study on

mental health practitioners in Ontario, showed that CoP is a promising model for KT and for promoting practice change [58]. White et al. used this approach in seven clinical sites across Alberta [59], and concluded that CoP enhances inter-professional communication and patient safety.

Formation of ties among staff who are comparable in terms of social and organizational status (so status inequality does not compromise their information seeking behavior [22]) but are based in different organizational divisions (so they are not bound by the politics and hierarchies of each other's programs) enhances the voluntary, dynamic and productive communication through which the members share their experience and progress, listen to each other's stories, and provide reflection and feedback [60]. This continued engagement over time may result in development of tacit knowledge and a repertoire of solutions to shared problems that further enhances the solidarity of connections and productivity of communications [56, 61].

From a more general perspective, the formation of stronger ties among the staff engaged in the intervention potentially promotes further adoption of the new behavior among them. Because behavior change is a potential threat to current routines and norms, especially for the members who benefit more from the status quo, such organizational changes usually face resistance and reluctance [62, 63]. Formation of strong cohesive ties among members nurtures the atmosphere of trust, support, and feedback, and is a powerful step in overcoming the social resistance and enhancing the commitment in adopting new innovations [4]. This tendency should coincide with formation of weaker bridging ties outside the cohesive circle to prevent entrapment of information. Formation

of a cohesive core along with continuous development of new weak ties with periphery has been suggested as a successful step in the evolution of networks through organizational innovation processes [64].

2-2-7-3 Ties Within and Between Divisions:

The staff in the three departments showed a tendency towards limiting their connections within their divisions, which increased in department B over time. Conversely, the inter-divisional tendency increased in department C, perhaps from practice based divisions towards the central epidemiologists of the supervisory/administrative division. These findings did not support hypothesis H3 about the effect of the intervention in increasing the communication between divisions. The tendency of health practitioners to seek information from socially and geographically proximate peers has been shown in different studies [65, 66]. Our previous analysis of baseline data in department A also confirmed this tendency of public health practitioners to connect to peers within their own organizational division [26, 67]. In addition to the natural tendency to turn to local peers due to ease of access and common values and interests, this tendency may also show an increased autonomy of organizational divisions and reduced reliance on external experts after the intervention. The qualitative interviews with influential staff of three health departments (chapter 5) supports this speculation, as the informants in departments B expressed that less dependence on busy external experts was an important outcome of the intervention.

2-2-7-4 Implications for KT:

An important consideration in KT processes is ensuring sustainability of change in practice/policy over time [68]. Sustainable adoption is achieved when new ways of working become the norm [69] and the innovation continues to be used after initial implementation [70]. This is important because even when the initial effort is successful, the resulting behavior and process change may not last very long or may evolve and result in unintended consequences due to the complex effect of broader environmental forces and contextual factors [71]. An indicator of sustainable organizational change is the extent to which the desired behavior is observed in organizational routines after the innovation was introduced [72]. Therefore studying long lasting changes in social relations and routines within working units of an organization could be a useful indicator of sustainability of changes. Our findings showed that the social changes occurring after the organizational KT interventions extend beyond personal behavior change to the formation of social relations among public health practitioners, popularity of experts and shaping of clusters. These patterns support the sustainability of the change, especially in one health department that showed a stronger support by the leaders and participation by the staff. We suggest that longitudinal analysis of professional networks is a helpful tool that can reveal underlying social processes after implementing KT interventions if considered as representation of dynamic and complex social processes rather than static and determinate outcomes of intervention [73].

Our findings also confirmed that trajectories of implementing capacity building interventions is complex and far from being a linear domino reaction [57]. Therefore KT implementers should consider and balance different objectives of educational

interventions, such as empowering practitioners to deal more independently with research evidence by themselves or facilitating recognition and access to qualified experts who help them through EIDM. In this study, the KT intervention focused on a subgroup of staff who mainly already held expert and consultant roles. It resulted in an increase in centralization of information-seeking networks around an already well-known group of consultants and managers. On the one hand, this centralization may pave the way to easier access to appropriate experts who can provide high-quality consultations to practice-based teams. On the other hand, the increased status gap may result in an imbalance in the distribution of knowledge in the organization. Further studies are needed to compare the short- and long-term effectiveness of selective training versus broad capacity development on sustainable adoption of EIDM and the distribution of knowledge in public health organizations.

Organizational interventions can alter the structure of social networks. However, due to the complexity of networks and multi-dimensionality of social relations, achieving a predetermined alteration in social networks is very difficult [74]. A few studies in different contexts tried to restructure social networks by forming ties among independent clusters and individuals or by adding actors to bridge social gaps. For example, Latkin et al. implemented a network-oriented intervention on injection drug users to promote psycho-educational programs designed to prevent AIDS through social influence. They observed a significant peer effect and some evidence of formation of sustainable connections among participants [75]. Norman and Huerta assessed the effect of hosting a meeting of health professionals involved in a web-assisted tobacco intervention program

on the formation of network ties among participants three weeks after the meeting, and found that the participants shaped new ties with each other and became involved in KT activities beyond their local social networks [76]. They concluded that a network-oriented approach could be successful in building communities of practice. Likewise, we suggest that KT interventions can lead to more widespread and long-lasting desired changes if they are informed by knowledge of formal and informal social networks of the target health care settings. Identification of central actors (including local opinion leaders) and pre-established social clusters, the distribution of knowledge and expertise in the network, and structural holes among sectors of a network are a few useful pieces of information that could help when targeting and tailoring the KT interventions to fit local contexts.

The findings of this study should be confirmed in controlled interventional studies; such as the effectiveness of intentional formation of communities of practice among EIDM experts, the effect of formal and informal collaborative strategies (such as progress meetings and appraisal clubs) to foster the development of sustainable social ties among health practitioners, and the effect of network oriented selection (such as recruitment of opinion leaders and network brokers) of staff for trainings on the behavior change towards EIDM.

2-2-7-5 Strengths and Limitations:

In this study we modeled the information seeking behavior of staff in public health departments through the process of implementation of an organization-wide intervention to promote EIDM. The method let us to assess the role of engagement in the intervention and EBP behavior, controlling for the natural tendencies of social networks.

Comparison of the trends between two yearly periods after the introduction of the intervention, and between three health departments with varying characteristics provided us with the opportunity to assess long term effects within the contexts.

However, low response rate is the main threat to the generalizability of findings of this study. According to our analysis of the characteristics of the non-respondents, our field knowledge and the results of qualitative interviews with the participants (chapter 5) many of the non-respondents were the staff who did not consider KT relevant to their practice (such as administrative staff). This difference biases the results of the current study to the staff of health departments who deal with research evidence more frequently and are more supportive of the EIDM in general, so the conclusions about the effects of the intervention are probably optimistic.

In addition, due to the lack of a parallel control group, our findings on the changes in social networks through the implementation of the intervention could be simply the result of natural tendencies in social networks through time and not the effect of the intervention *per se*. However, comparison of trends between two periods provides clues for the causality.

Moreover, the Markov process in stochastic actor-based modeling assumes that at each micro-step the actors make independent decisions regarding the choice of sending ties to others, maintaining or cutting old ties. In other words, the decisions in the model are not joint decisions that are made by negotiation [48]. However, through the iterative revision and feedback network actors have the opportunity to revise their decisions by the feedback they receive from the network. This mechanism of tie formation resembles the

process by which health practitioners recognize and seek advice from experts, but may not be applicable to all aspects of information seeking in public health organizations, such as the situations in which the staff are required to turn to certain peers as a part of their formal responsibilities and not based on the source's characteristics.

2-2-7-6 Conclusions:

In summary, we found a significant association between engagement in the KT intervention and improving EBP behavior with gaining popularity where the organization's context and leadership promoted participation in the KT intervention. The networks became more centralized around a few already central experts, leading to a more hierarchical information-seeking structure. Highly engaged staff formed clusters among themselves. The staff tended to seek information from others in their own division. However, where formal EIDM professionals were not available locally (such as department C) the staff also turned to known external experts. The role of behavior change and the additional effect of engagement in KT on popularity, hierarchical transformation of networks, and formation of clusters among highly engaged staff show how implementing KT interventions may affect the knowledge flow and distribution in health practice communities, which may lead to unanticipated positive or negative consequences. In addition, our analysis showed how studying the evolution of networks depicts the underlying changes in social structure as an indicator of sustainability of the implementation.

2-2-8 References:

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Table 1: Variables included in the stochastic actor-oriented models, their definitions, and corresponding hypotheses

<i>Actor effects</i>
Seeker-highly engaged: The tendency of highly engaged staff to make or maintain ties with others
Source-highly engaged: The tendency of staff to make or maintain ties with highly engaged staff. Positive changes support hypothesis H1.
Seeker × source- highly engaged: The tendency of highly engaged staff to make or maintain ties with each other. Positive changes support hypothesis H1, but limits that tendency within highly engaged subgroup.
Seeker-baseline EBP score: The tendency of the staff with higher EBP implementation score to make or maintain ties with others
Source-baseline EBP score: The tendency of staff to make or maintain ties with others with higher baseline EBP implementation score
Seeker-EBP score change: The tendency of the staff with larger improvement in EBP implementation score to make or maintain ties with others
Source- EBP score change: The tendency of staff to make or maintain ties with others with larger improvement in EBP implementation score. Positive changes support hypothesis H2.
<i>Dyadic effects</i>
Inter-divisional: The tendency of staff to seek information form staff from other divisions. Positive changes supported hypothesis H3.
<i>Structural effects</i>
Reciprocity: The number of reciprocated ties for each actor. Positive changes support hypothesis H5
Transitive triplets: The number of transitive patterns in actor A's connections, which is the number of B,C pairs which actor A is connected to both and also B is connected to C.
3-cycles: A generalized measure of reciprocity. The number of 3-cycles in actor A's connections, which is the number of B,C pairs which A connects to B, B connects to C, and C connects to A. A negative value for 3-cycle effect along with a positive transitivity effect is an indicator of tendency towards forming local hierarchy. Consequently, a reducing transitivity values in presence of increasing values for reciprocity and 3-cycle effect supports hypothesis H5.
In-degree popularity: sum of the in-degrees to actors to whom actor A is connected (the popularity of alter effect), which shows the tendency of network towards centralization. Negative changes support hypothesis H5.

Table 2: The characteristics of respondents at each health department based on the availability of network data at baseline and two follow-ups

Availability of network data at three time points	Department A		Department B		Department C	
	Yes	No	Yes	No	Yes	No
Size	119	197	133	401	49	136
Female (%)	111(93%)	171(87%)	118(89%)	364(91%)	42(86%)	108(79%)
Educational degree						
Baccalaureate (%)	71(60%)	113(58%)	54(41%)	208(52%)	30(61%)	77(57%)
Masters+(%)	42(35%)	48(24%)	70(53%)	122(31%)	13(27%)	8(6%)
Job title						
Manager (%)	19(16%)	6(3%)	30(23%)	28(7%)	10(20%)	10(7%)
Consultant (%)	19(16%)	28(14%)	37(28%)	61(15%)	-	-
Nurse (%)	30(25%)	71(36%)	27(21%)	168(42%)	24(49%)	60(45%)
Average years of experience in public health (SD)	13(8)	8(8)	17(9)	13(9)	13(9)	12(9)
EBP score baseline (SD)	11(7)	10(10)	10(9)	10(10)	8(7)	7(7)
EBP score follow up 2 (SD)	12(8)	9(9)	11(9)	10(11)	10(9)	7(8)
Highly engaged in intervention (%)	41(34%)	12(6%)	10(8%)	3(0.75%)	15(31%)	3(2%)

Table 3: Structural indicators of information seeking networks in each health department, at baseline and follow ups.

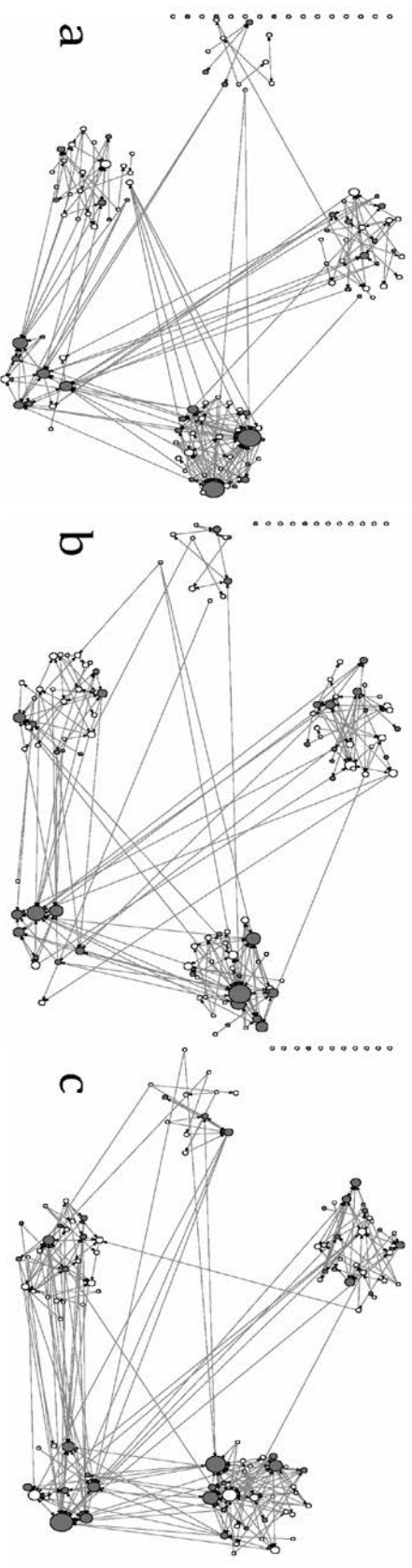
	Department A	Department B	Department C
Size	119	133	49
Density baseline	1.5%	1.0%	3.3%
Density follow up 1	1.6%	0.9%	3.1%
Density follow up 2	2.0%	1.0%	3.3%
Reciprocity baseline	12%	25%	16%
Reciprocity follow up 1	15%	22%	24%
Reciprocity follow up 2	13%	17%	13%
In-degree centralization baseline	16%	5%	20%
In-degree centralization follow up 1	12%	3%	14%
In-degree centralization follow up 2	17%	6%	22%
Krackhardt's hierarchy baseline	0.93	0.84	0.92
Krackhardt's hierarchy follow up 1	0.86	0.83	0.85
Krackhardt's hierarchy follow up 2	0.90	0.95	0.89
Normalized group centrality of highly engaged staff-baseline	0.37	0.11	0.44
Normalized group centrality of highly engaged staff-follow up 1	0.45	0.14	0.35
Normalized group centrality of highly engaged staff-follow up 2	0.56	0.10	0.35
Divisions: E-I index baseline	-0.56	-0.60	-0.34
Divisions: E-I index follow up 1	-0.60	-0.41	-0.46
Divisions: E-I index follow up 2	-0.56	-0.45	-0.32

Table 4: The log odds ratios (and standard errors) of the effect of personal, dyadic, and structural variables on the likelihood of forming or maintaining information seeking ties over time.

	Department A	Department B	Department C
Rate parameter-period 1	5.03(0.52)	3.30(0.36)	3.38(0.57)
Rate parameter-period 2	4.54(0.40)	3.75(0.44)	2.99(0.51)
Out-degree (density)-period 1	-3.39(0.11)*	-3.75(0.17)*	-3.68(0.29)*
Out-degree (density)-period 2 change	-0.21(0.23)	-0.29(0.31)	0.43(0.60)
Reciprocity-period 1	1.29(0.17)*	1.87(0.19)*	1.37(0.33)*
Reciprocity-period 2 change	-0.13(0.33)	-0.50(0.38)	-0.71(0.67)
transitive triplets-period 1	0.43(0.06)*	0.64(0.16)*	0.92(0.17)*
transitive triplets-period 2 change	0.25(0.12)*	0.08(0.32)	-0.54(0.34)
3-cycles-period 1	-0.45(0.13)	-0.35(0.30)	-0.47(0.37)
3-cycles-period 2 change	-0.53(0.26)*	0.60(0.58)	-0.79(0.75)
In-degree-popularity-period 1	0.03(0.01)*	0.08(0.04)*	0.18(0.05)*
In-degree-popularity-period 2 change	0.04(0.03)	0.14(0.08)	0.09(0.11)
Inter-divisional-period 1	-1.64(0.12)*	-1.35(0.14)*	-1.31(0.28)*
Inter-divisional-period 2 change	-0.06(0.24)	-0.40(0.28)	0.81(0.57)
Source-highly engaged-period 1	0.31(0.10)*	0.35(0.18)	-0.009(0.23)
Source-highly engaged-period 2 change	-0.04(0.21)	-0.52(0.37)	-1.05(0.47)*
Seeker-highly engaged-period 1	0.18(0.11)	0.39(0.29)	0.51(0.26)
Seeker-highly engaged-period 2 change	-0.15(0.23)	0.91(0.58)	-0.71(0.53)
Seeker ✕ Source-highly engaged-period 1	0.57(0.19)*	0.91(0.48)	0.90(0.43)
Seeker ✕ Source-highly engaged-period 2 change	0.19(0.37)	0.87(0.93)	1.85(0.87)
Source-baseline EBP score-period 1	0.05(0.007)*	0.02(0.008)*	0.01(0.02)
Source-baseline EBP score-period 2 change	0.02(0.01)*	0.0002(0.02)	0.05(0.03)
Seeker-EBP score-period 1	-0.0006(0.008)	0.02(0.008)*	-0.02(0.02)
Seeker-EBP score-period 2 change	0.002(0.02)	0.004(0.02)	-0.04(0.04)
Source-EBP score change-period 1	0.02(0.007)*	0.02(0.008)*	0.03(0.01)*
Source-EBP score change-period 2 change	0.006(0.01)	0.004(0.02)	0.005(0.03)
Seeker-EBP score change-period 1	0.01(0.008)	0.02(0.01)*	0.004(0.02)
Seeker-EBP score change-period 2 change	0.03(0.02)	0.001(0.002)	0.07(0.04)

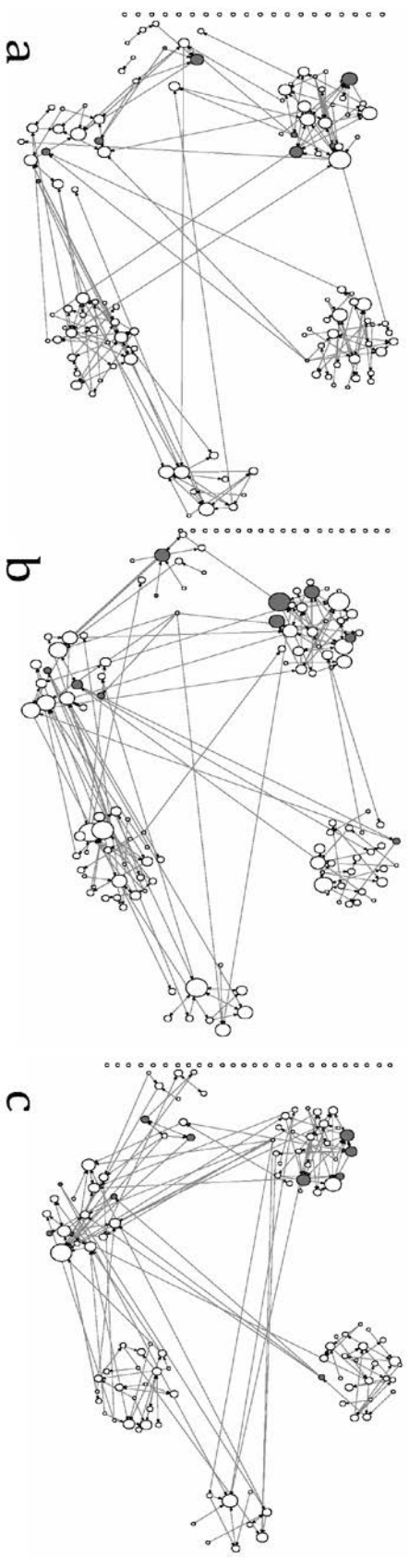
* the asterisk indicates the p-value less than 0.05 for the difference from zero

Figure 2: The information seeking network of department A, at baseline (a), follow up 1 (b), and follow up 2(c)



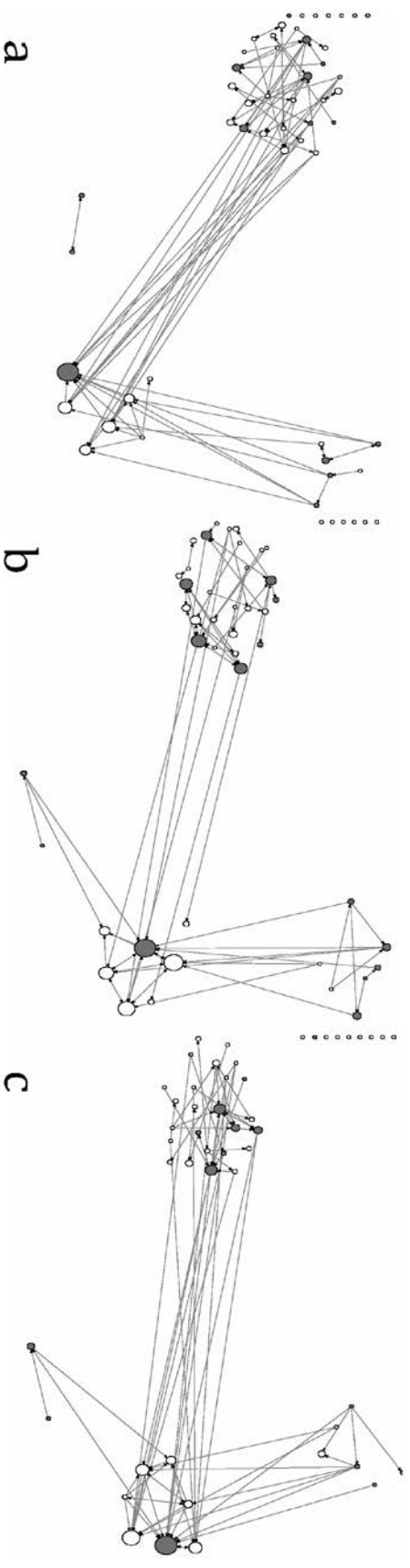
The nodes are grouped based on organizational divisions. Grey nodes were highly engaged in the intervention. The shapes of the nodes represent organizational divisions. Node size is proportional to the in-degree centrality. Asterisks represent opinion leaders (OLs).

Figure 3: The information seeking network of department B, at baseline (a), follow up 1(b), and follow up 2(c)



The nodes are grouped based on organizational divisions. Grey nodes were highly engaged in the intervention. The shapes of the nodes represent organizational divisions. Node size is proportional to the in-degree centrality. Asterisks represent opinion leaders (OLs).

Figure 4: The information seeking network of department C, at baseline (a), follow up 1(b), and follow up 2(c)



The nodes are grouped based on organizational divisions. Grey nodes were highly engaged in the intervention. The shapes of the nodes represent organizational divisions. Node size is proportional to the in-degree centrality. Asterisks represent opinion leaders (OLs).

**CHAPTER 3- Adoption of Evidence-Informed Practice
through Social Influence; A Case Study of Three Public Health
Departments in Canada**

3-1 PREFACE TO CHAPTER 3

This study aimed to assess the social influence of opinion leaders (OLs) in promoting the adoption of evidence-informed decision making (EIDM). It addressed propositions 5 (social influence of the staff who were highly engaged in the intervention), 6 (social influence through friendship ties), and 7 (social influence of highly engaged opinion leaders).

This manuscript has been submitted for publication and is under peer review. Upon acceptance, a request will be made to the publisher of the journal to obtain permission to include copyright material in this thesis. The student was the main contributor of this study, conceived the study design and theoretical framework, performed all statistical analyses, interpreted the findings, and drafted the manuscript. The co-authors reviewed each step and guided the student through the design, analysis, interpretation, and writing up.

3-2 SOCIAL INFLUENCE MANUSCRIPT

Adoption of evidence-informed practice through social influence; a Case study of three public health departments in Canada

Reza Yousefi Nooraie, Maureen Dobbins, Robert Hanneman, Alexandra Marin, Lynne Lohfeld

3-2-1 Abstract:

Local opinion leaders are an important component of practice environments, who can influence the attitudes and behaviors of their peers through channels of expertise and trust. However, their social influence effect is dependent on the their position in formal and informal social structure, the extent themselves adopt the innovations, and readiness of the context for change. We assessed the social influence of opinion leaders in promoting the adoption of evidence-informed decision making (EIDM) by the staff of three public health departments in Canada, over a two-year period during which an organization-wide KT intervention was implemented. **Methods:** A multi-faceted and tailored KT intervention to train select staff applying research evidence in practice was implemented in three public health departments in Canada from 2011 to 2013. Staff (n=572) were asked to identify those in the health unit whom they turned to get help using research in practice, whom they considered as experts in EIDM, and friends. We developed multi-level linear regression models to predict the change in EIDM behavior scores predicted by being connected to opinion leaders and the peers who had been highly

engaged in the intervention. **Results:** Only the group of highly engaged opinion leaders who were connected to each other, and the staff who were not engaged in the intervention but were connected to highly engaged opinion leaders significantly improved their EIDM behavior scores. Among the latter group, the staff who were also friends with their information sources showed a larger improvement in EIDM behavior. **Conclusions:** Social influence of opinion leaders increases through informal connections with peers. Opinion leaders themselves are more likely to adopt EIDM if they communicate with each other about it. These social channels should be reinforced and supported through the implementation of KT interventions in organizations as a means to promoting EIDM.

3-2-2 Keywords

Evidence-informed decision-making, social network analysis, information-seeking, social influence, local opinion leaders, knowledge translation

3-2-3 Introduction:

A crucial step in designing interventions to promote evidence-informed decision-making (EIDM) in public health organizations is determining the contextual capacities and barriers that may facilitate or impede adoption and implementation (Graham et al. 2006; Melnyk and Fineout-Overholt 2002). These contextual barriers/facilitators work at different levels including personal, inter-personal, and organizational (Mitton et al. 2007). Many of these barriers, such as lack of involvement of local experts, are directly relevant to social and interpersonal relations (Mitton et al. 2007), and many are indirectly influenced by social relations. For instance, social transmission and influence affect the

formation of attitudes and beliefs in individuals (Friedkin and Johnsen 1999), and norms in communities (Friedkin 2001).

Social networks provide individuals with access to resources while shaping their beliefs and behaviors. From a social capital perspective, individuals who possess central positions in social networks and the people who bridge unconnected clusters have more access to resources than isolated members (Coleman 1988; Burt 2000). On the other hand, social networks also constrain their members. Socially powerful individuals influence the beliefs and behaviors of network members (Friedkin and Johnsen 1999), and individuals tend to conform to social norms to minimize tensions (Lapinski and Rimal 2005).

We studied the complex interconnection between network structure and dynamics with adoption of EIDM in three public health departments in Ontario, Canada. In this paper we report the analysis to assess the effect of social network structure, with an emphasis on the role of opinion leaders, on the implementation of a knowledge translation (KT) intervention in three public health departments. We hypothesized that OLs who were highly engaged in the KT intervention would significantly increase their EIDM-related activities and those of their peers in the public health departments where they work.

3-2-4 Theoretical Framework:

In ambiguous situations individuals compare themselves with socially powerful individuals, in order to reduce mental conflicts (Erickson 1988). Referent and expert power are two main presentations of social power (French and Raven 1959), which are

characterized in local opinion leaders. Opinion leaders (OLs) are individuals who can influence the attitudes, beliefs, and behavior of their peers (Valente and Pumpuang 2007). This position is not part of the formal role of people in an organization, but is ascribed to people as a result of their competence, accessibility, trustworthiness, and conformity to social norms.

In this study, a group of the staff of three public health units participated in trainings and work groups to promote the translation of research evidence into their public health practice through EIDM. We hypothesized that the staff who were highly engaged in the KT intervention could influence the behavior of their peers as a result of the expert power they gained through the trainings:

H1: Staff who were highly engaged in the KT intervention influenced the adoption of EIDM by their peers

However, not all highly engaged staff were expected to have similar social influence power. We hypothesized that the social influence of highly engaged staff would be higher if they were among the OLs in the organization.

H2: OLs who were engaged in the KT intervention influenced the adoption of EIDM by their peers

The other important foundation of social influence is the solidarity of relationships, and the role of trust and similarity (Marsden and Friedkin 1993). People learn by observing the behavior of and non-verbal communication of their trusted peers (Bandura 1977). The role of informal routes of connection sometimes is even more important than formal connections in changing behavior (Zheng et al. 2010). In order to

assess the role of informal connections, and the extent to which OLs use their friendship ties to promote EIDM, we hypothesized that OLs would have a larger influence on their friends, compared to peers with whom their connections were only formal:

H3: OLs who were engaged in the KT intervention influenced the adoption of EIDM by their friends to a larger extent than other peers

However, OLs are not always the early adopters of innovations. Some believe this is because if they change their behavior too quickly and without scrutiny followers may doubt their judgment (Rogers 2003). Instead, OLs will often monitor the climate of the setting in which innovations are being proposed and advocate change when the advantages of the innovations are apparent or the change in norms is inevitable (Valente and Pumpuang 2007). OLs may impede the dissemination and implementation of interventions that they consider risky and radical (Gibson 2005). Consequently, convincing and engaging OLs about the value of evidence-informed practices seems an effective strategy in tailoring KT interventions to address organizational and social barriers in health care settings. So we expected that the engagement of OLs and the extent of their behavior change would also be dependent on context and norms. We hypothesized that in the health departments where the context was more prepared for EIDM (through the leadership and cultural support, and availability of resources), OLs were more likely to change their own behavior as well as the behavior of their peers, a result of the intervention:

H4: OLs who were engaged in the KT intervention were more likely to adopt EIDM in health departments where the context was more prepared for EIDM.

3-2-5 Methods:

3-2-5-1 Study Context:

The participating health departments varied in size, complexity, and commitment to EIDM and types of policies for implementing it. Departments “A” and “B” mainly served large urban populations (> 1.5 million population), and department “C” served a smaller mixed urban-rural community (~600,000 population).

At the start of the study in 2011, “A” had a 10-year strategic plan to achieve EIDM and a specific budget line for individual capacity development activities to meet this goal, and assigned project specialists to practice-based teams, who were Masters level trained staff experienced in finding and interpreting research evidence, with responsibility for conducting literature reviews to address practice issues. Department “B” also identified EIDM as a strategic priority and attached health promotion consultants to specific teams to conduct literature reviews to address practice issues. At department “C” responsibility for synthesizing evidence for practice issues rested with program managers and key front line staff. However this department did not have a strategic plan in place specifically for EIDM although it had dedicated some resources for capacity development.

3-2-5-2 The Intervention:

The KT intervention was multi-faceted and tailored to meet the needs and characteristics of each health department. It was implemented during a 22 month period, with the aim of facilitating EIDM in the public health departments. It included knowledge broker (KB) mentoring of small groups through the EIDM steps to answer practice-

relevant questions by a single expert (KB) with on-site and off-site services; one-day educational workshops for both specific teams and all staff; one-to-one consultation and support by the KB; presentations and meetings held with senior management; and advice on creating policies and procedures for the health department related to EIDM. Through the mentioned channels, the KB provided support on various steps of EIDM: formulating the questions, searching for evidence, appraising the scientific quality of the evidence, synthesizing the evidence, appraising the applicability and transferability of the findings, and applying it to local practice (Ciliska, Thomas, and Buffett 2012).

The KT intervention was tailored to meet the needs of each health department. Leadership at department A strongly advocated EIDM, and had started training programs to develop professional roles in the department assisting others in EIDM related issues. The leadership was also directly involved in the implementation of the KT intervention, monitored the progress, and promoted staff participation throughout the study. The KB was mainly involved in mentoring teams through developing the literature reviews to answer local public health questions (rapid evidence reviews), teaching in EIDM workshops, and moderating critical appraisal clubs.

We classified a group of staff as highly engaged in the intervention, based on information obtained from the KB's journals where she tracked the teams she worked with, attendance lists from the large-group training sessions, and data exported from the online survey. In department A, 51 staff members (8%) were identified as highly engaged in the KT intervention, and were involved in developing a total of 18 rapid evidence reviews. In department B, the KB was mainly involved in capacity building and training

in workshops. Thirteen staff (1%) were highly engaged in the KT intervention, and developed 5 rapid evidence reviews. At department C, the KB was mainly involved in mentoring teams through rapid reviews of the literature and leading EIDM workshops. The number of highly engaged staff was 18 (2%), who developed 5 rapid evidence reviews.

As a result of the differences in the organizational norms, availability of relevant workforce, and leadership support, we assumed that the context of health department A would be more prepared for EIDM, and it was implemented more successfully compared to departments B and C. Therefore we expected to observe larger effect of the intervention in department A.

3-2-5-3 Data Collection:

Senior management of the three enrolled health departments invited staff to participate in an online survey at baseline and after the intervention (in 2011 and 2013). The invitation letters provided information on the purpose and methods of the study, the importance of their contribution, and the link to the online survey. However, the management was not aware of the identity of participating staff. The study was approved by the Institutional Review Board of McMaster University and corresponding bodies in each health department prior to inviting staff to join the study.

Study participants answered four randomly ordered name generator questions about their social relations in the health department (Yousefi Nooraie et al., 2012) (Appendix 2), as well as demographic information. Respondents named staff members in the department whose input they regularly sought to help them integrate research

evidence into practice-based decisions (information seeking), who were experienced and knowledgeable in finding research evidence and translating it into practice (expertise recognition), and who they considered personal friends (friendship).

In order to assess the extent to which respondents implemented EIDM in their daily practice, the Evidence Based Practice (EBP) Implementation scale of Melnyk and colleagues was administered (Mazurek Melnyk, Fineout-Overholt, and Mays 2008) (Appendix 3). This tool has good internal consistency (Chronbach's $\alpha > 0.9$), and showed a significant association with educational level, and prior contact with EBP (Mazurek Melnyk, Fineout-Overholt, and Mays 2008). Respondents were asked to provide the frequency of their involvement in 18 EBP activities during the 8 weeks prior to the study, using a 5-point frequency scale. The EBP activities included different aspects of using and appraising evidence to inform public health practice, and sharing the evidence with colleagues and clients. The scale was administered at baseline and follow up. Participants received two reminder emails one week apart to encourage higher response rates (Dillman 2007).

3-2-5-4 Analysis:

We analyzed the structure of social networks with UCINET 6 program (Analytic Technologies 2010). For each respondent we calculated the in-degree, or number of peers in the health department who identified that member as the information source or expert in information-seeking and expertise recognition networks respectively (Hanneman and Riddle 2005). The degree for each respondent indicated his/her number of friends.

We used a sociometric technique to identify OLs, that identified OLs based on their in-degree centrality, which is the frequency of nomination by other members of the community (Valente and Pumpuang 2007). Therefore we defined OLs as staff members in a public health department whose in-degree centrality in both information-seeking and expertise recognition networks at baseline was in the highest quartile. We chose the highest quartile to include the staff who were identified by at least 3 peers in larger departments (A and B) and at least by 2 in the smallest department (C), which also provided us with a large enough number of individuals to run the regression analysis.

To address the study hypotheses, we developed multi-level linear regression models to predict EBP implementation scores. The multi-level model let us make the efficient use of available data in the presence of considerable missing data (Quené and Van den Bergh 2004). The random levels included individual assessments of EBP implementation scores at baseline and follow up as the first level, individuals as the second level, and public health departments as the third level. The predictors of the EBP implementation scores were being an OL, being highly engaged in the KT intervention, identifying at least one highly engaged information source at baseline, identifying at least one highly engaged OL as information source at baseline, and each variable's interactions with time of assessment (baseline=0, follow up=1). We developed the two-level models (observations and individuals) for each health department separately and a three-level model (observations, individuals, health departments) for the pooled data across all three departments.

We also developed a similar three-level regression model in the subgroup of staff who sought information from at least one highly engaged OL. The EBP implementation score was the dependent variable, which was predicted by the following variables and their interaction with time of assessment: being an OL, being highly engaged in the KT intervention, identifying at least one highly engaged peer as friend at baseline, identifying at least one highly engaged OL as friend at baseline. The analysis was carried out in STATA 12.1 (StataCorp. 2011).

3-2-6 Results:

In department A, 207 (33%) and 258 (42%) staff participated in the survey at baseline and follow-up respectively, of whom the networks of information seeking and friendship could be drawn for 207 and 168. In department B, the number of respondents at baseline and follow-up were 309 (28%) and 404 (37%), respectively, of whom 278 and 139 provided the network information for information seeking and friendship at baseline. The corresponding numbers for department C were 95 (47%) and 160 (79%), of whom 86 and 75 staff provided the information seeking and friendship network data at baseline.

3-2-6-1 Characteristics of Respondents:

Table 5 shows the baseline characteristics of staff based on their engagement and opinion leadership. In department A, 17% (n=53) of respondents were highly engaged, compared to 2% (n=11) in department B and 10% (n=18) in department C. In department A, 61% (n=17) of OLs were highly engaged in the intervention, compared to 10% (n=3) in department B and 56% (n=5) in department C. About 60% of highly engaged OLs in

the departments had Masters+ degree, which was significantly higher than other groups. In department A, highly engaged OLs were mainly managers and project specialists, in department B all were health promotion consultants, and in department C mainly management staff. In department A, apart from the two highly engaged OLs in one practice-based division who had extraordinarily high in-degree centrality, the majority of highly engaged OLs were in the supervisory/administrative division (Figure 5a: circles). In department B, the OLs distributed in various divisions, and only three of whom were highly engaged in the KT intervention (Figure 5b). In department C, most of the OLs who were epidemiologists in the supervisory/administrative division (Figure 5c: circles) were not highly engaged in the intervention.

Only in department A did the highly engaged OL group have significantly higher EBP implementation scores than other participants at baseline (with an average score of 14 in highly engaged OLs vs. an average of 8 in not engaged staff), and were also significantly more central than others in friendship network (with a median degree centrality of 4 in highly engaged OLs vs. a median of 1 in not engaged staff).

3-2-6-2 Change in EBP Implementation Scores over Time:

Table 6 shows the coefficients of regression models to predict EBP implementation scores at follow up. Pooling the data of all three health departments showed that two groups of staff significantly increased their EBP implementation scores over time: a group of highly engaged OLs who sought information from each other (average change of 4.9 in the implementation score; Table 6); and a group of staff who were not themselves highly engaged in the KT intervention but sought information from a

highly engaged OL (average change of 2.5 scores; Table 6). So the overall analysis did not support hypothesis H1 (the influence of the staff who were highly engaged), meaning that seeking information from a highly engaged peer does not necessarily have a significant effect on EBP implementation scores. But the model supported hypothesis H2 (the influence of OLs who were also highly engaged), meaning that the effect of seeking information from highly engaged OLs is significant both in other highly engaged OLs and the staff who were not engaged in the intervention.

In department A, the only group that showed significant change in EBP implementation scores over time were highly engaged OLs who identified at least one other highly engaged OL as their information source (average change of 4.6 score; Table 6). In department A, 80% (14/17) of the highly engaged OLs identified other highly engaged OLs as their information source. Five of those 14 people were working in the supervisory/ administrative division; six were project specialists and two were managers.

In department B, we did not observe any changes over time in any subgroup of staff. In this department, there were only three highly engaged OLs, one of whom, a health promotion consultant, identified other highly engaged OLs as her information source.

In department C, similar to the pooled model, two groups showed a significant improvement: highly engaged OLs who sought information from other highly engaged OLs, and the staff who were not engaged in intervention but sought information from highly engaged OLs. In this department, three of the five highly engaged OLs (two managers and a public health nurse) identified each other as an information source. All

three belonged to a practice-based division. The EBP implementation score of this subgroup improved an average of 8.7 points, which was a statistically significant improvement (Table 6). There were 14 staff who were not highly engaged, but sought information from highly engaged OLs. Ten were nurses, two epidemiologists, and two managers. Ten of them worked in a practice division, and 4 in the supervisory/administrative division. Their average improvement of EBP implementation scores was 5.9 points, also statistically significant.

The pooled analysis of the effect of friendship network at baseline on changes in EBP implementation scores in the group of staff who sought information from highly engaged OLs (Table 7) showed that three groups of staff significantly improved their behavior: highly engaged OLs who had at least one other highly engaged OL in their friends list (average change of 4.3 scores; Table 7), highly engaged OLs who did not have any other highly engaged peers in their friends list (average change of 8.3 scores; Table 7), and the staff who were not highly engaged but had at least one highly engaged OL in their friends list (average change of 3.7 scores; Table 7). So the findings supported hypothesis H3 mainly in the group of staff who were not themselves highly engaged in the intervention.

3-2-7 Discussion:

Our findings showed that staff who were connected to highly engaged OLs showed significant improvement in their EBP behavior, even if they were not themselves highly engaged in the intervention (hypothesis H2). Among staff who were connected to highly engaged OLs, friendship ties with highly engaged OLs significantly improved EBP

behavior, mainly in a subgroup who were not highly engaged in the intervention (hypothesis H3). However, the effects differ in three health departments, which had different organizational structures, preparedness for EIDM, and participation rates (hypothesis H4). These findings suggest that, on the one hand, targeting OLs for KT interventions is important for spreading EIDM among intervention non-participants, probably due to social influence through formal and informal connections; and on the other hand, OLs show the largest improvement if they are already connected to each other and can share the concerns and success stories and enhance each other's engagement.

3-2-7-1 Social Influence of OLs:

Our findings support significant social influence of OLs on their immediate peers. Several studies in various disciplines have used network analysis approaches to identify OLs and train them to promote behavior change, including smoking cessation and HIV prevention (Kelly et al. 2006; Valente, Gallaher, and Mouttapa 2004). Flodgren et al. (2011) conducted an update on a previously published Cochrane review on the effect of OLs. They found 18 moderate quality and heterogeneous randomized controlled trials that compared interventions led by OLs, alone or in combination with other interventions, in improving the behavior of health care professionals and patient outcomes. They found that OLs, alone or in combination with other interventions, might successfully promote evidence-based practice, which was comparable to other known interventions, but effectiveness varied between and within studies. However, due to the heterogeneous nature of the studies, the authors were not able to suggest the best way to identify OLs,

involve them in the intervention, or what the optimal contextual environment was for OLs to have an impact.

There are a few studies that used network analysis techniques and models to assess the role of social influence in health care organizations. For example, Nair et al. (2010) modeled the social network of physicians before and after dissemination of a new clinical guideline using primary and secondary data, and observed a significant social influence of OLs. Iyengar et al. (2011) assessed the role of OLs identified by the sociometric approach in influencing the prescribing behavior of physicians using network analysis. They observed a significant social influence effect over and above the effect of marketing and arbitrary system-wide changes.

Comparison of the social influence effect of OLs in departments A and C shows that the improvement in EBP behavior of staff who were not highly engaged in the intervention but sought information from highly engaged OLs was significant only in department C. This could be attributed to the unequal importance of social contagion in the two public health departments. As shown in Tables 5 and 6, the baseline EBP behavior scores of staff in department A was considerably higher than in department C. This baseline difference, as well as the information we gained through qualitative interviews (chapter 5) about higher motivation and enthusiasm of leaders in department A towards EIDM, implies that the context of department A more readily supported staff adoption of EIDM. Social contagion and influence are best suited for risky and ambiguous situations in which individuals need the confirmation of OLs to mitigate the risk of adoption at the evaluation stage (Iyengar, Van den Bulte, and Valente 2011). In

department C, where the context was not as supportive of the adoption of EIDM than in department A, staff who were not directly exposed to the intervention were more likely to change their behavior under the influence of OLs who were involved in and had a positive experience of EIDM training and mentoring, whereas direct exposure to the intervention had greater impact on staff working in department A. An alternative explanation would be due to the differences in mechanisms of selecting staff to participate in intervention at department A and C. At department A, because a large number of staff participated in the intervention, the ones who were not highly engaged were more likely to be staff whose jobs were less relevant to EIDM, as opposed to department C where the unit's overall participation was more limited.

We also found that among staff who sought information from highly engaged OLs, the existence of friendship ties reinforced the influence. Friendship and advice-seeking ties are distinct but overlapping social connections in organizations. Friendship generally happens as a result of shared values and frequent interactions (Gibbons 2004), and is more sustainable than formal advice-seeking connections (Lewis and Weigert 1985). Friendship connections lead to the formation of bonds of trusts that provide a safe foundation for social influence, especially in risky matters that individuals need stronger motivations to change their behavior (Mayer, Davis, and Schoorman 1995). In our study, friendship ties reinforced behavior change more prominently among staff who were not themselves engaged in the intervention. This subgroup probably differs considerably from highly engaged staff in terms of the value of EIDM in their practice and their positions in the organizations. So we can assume that for this subgroup changing behavior towards

EIDM was probably more risky and less convenient, compared to the staff who were recognized and chosen by management for the KT intervention. Consequently, friendship connections, which coincide with more frequent interactions, similarity of interests and values, and the existence of the bonds of trust strengthened the social influence in this subgroup.

3-2-7-2 Behaviour Change of OLs:

We found that OLs highly engaged in EIDM were more likely to adopt EIDM if they were connected to other highly engaged OLs. This implies there is an advantage to forming cohesive clusters of highly engaged OLs in an organization seeking to promote EIDM related to health issues. In order to be able to change the behavior of others, OLs should themselves support and embrace EIDM. Although OLs are sometimes considered as innovative and creative (Childers 1986; Van Eck, Jager, and Leeflang 2011), they generally tend to conform to social norms (Rogers 2003) and are, in fact, more often conservative and behave within the normative bounds of their social networks. If they perceive an innovation as radical and risky, and its adoption as a potential threat to their credibility and social position, OLs often will reject it (Dearing 2008). So depending on the readiness of the organization to adopt change and the risk of adopting the innovations, OLs may act to promote or oppose the change (Rogers 2003).

In addition, the association between OLs and their peers is not a unidirectional connection between a leader and followers. OLs are themselves influenced by their peers and may change their behavior to conform to group or organization-wide norms (Iyengar, Van den Bulte, and Valente 2011; Myers and Robertson 1972). The significant effect of

interaction with other highly engaged OLs in our study is consistent with the findings of other studies supporting the role of teamwork and interaction in implementation of evidence-based resources (Forsetlund et al. 2009). Interactions in small groups and the influence that people have on each other's beliefs and attitudes assist in the formation of shared understanding and agreements, and subsequently evolving social norms due to individuals' tendency to reach agreement with their peers (Friedkin and Johnsen 1999). Formation of positive norms subsequently motivates the more conservative OLs to promote EIDM and influence their peers' behavior.

3-2-7-3 Limitations:

The findings of this case study only provide clues to potential organizational complexities that should ideally be studied in a more systematic way. Even though we found some evidence that the behavior change in staff is beyond the effect of common context, a longitudinal network analysis that takes direct dyadic relations into account and controls for the effect of social selection and common context is a more systematic analysis approach (Snijders et al. 2010; Steglich, Snijders, and Pearson 2010). In addition, controlled studies are needed to assess the effect of promoting communication among OLs as a step in tailoring KT interventions in public health organizations. Finally, the response rate in three health departments, especially to friendship name generator, and the number of highly engaged staff in departments B and C was small. As a result, the findings regarding the role of friendship and the regression models of departments B and C should be interpreted with caution.

3-2-7-4 Conclusions and Implications:

The findings of our study suggest that identifying OLs using sociometric approaches and engaging them in a KT intervention can significantly promote the adoption of EIDM by staff in public health departments. Engagement of OLs can be incorporated into the tailoring process when developing programs to promote EIDM in public health.

Studies have shown that interactive KT strategies that are also tailored to address local needs and barriers are more likely to change the behavior of practitioners (Oxman et al. 1995; Dobbins et al. 2005; Baker et al. 2010). Many of these barriers are associated with social and organizational structure, either directly (e.g. organizational climate, leadership support, network structure, and team composition and processes) or indirectly (e.g. staff's motivation and attitudes, and readiness for change) (Wensing, Bosch, and Grol 2009). Our findings imply that engagement of OLs may be a useful tool to overcome social barriers to behavior change and broaden the diffusion boundary of the intervention; because OLs are able to use their formal and informal connections to promote behavior change in their social networks.

Furthermore, the effect of intervention on OLs is more prominent if they belong to communities in which they reinforce each other and mitigate the potential pressures of changing unsupportive norms. However, the magnitude and direction of the social influence of OLs depends on the readiness of the context, and willingness and support by organizational leaders.

3-2-8 References:

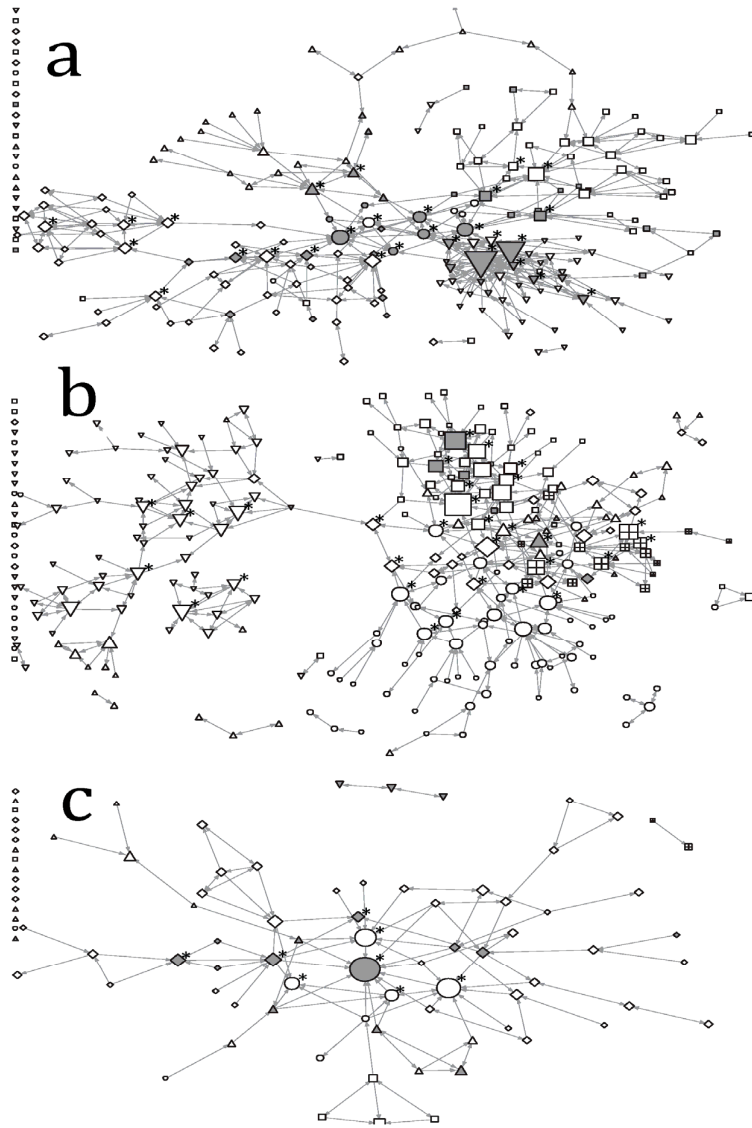
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Figure 5: Information-seeking networks at baseline; a: department A, b: department B, c: department C



Legend: Grey nodes were highly engaged in the intervention. The shapes of the nodes represent organizational divisions. Node size is proportional to the in-degree centrality. Asterisks represent opinion leaders (OLs).

Table 6: Regression models to predict EBP behavior scores over time in different groups of respondents based on their information seeking patterns

Regression coefficients		Department A	Department B	Department C	Three departments pooled
Respondents	Information sources				
Baseline¹					
<i>Not highly engaged</i>	<i>Not highly engaged</i>	10(0.8)	10.7(0.7)	10.0(1.5)	10.5(0.5)
	<i>Highly engaged, but no highly engaged OLs</i>	1.4(2.8)	0.3(3.9)	-4.8(2.0)*	-3.2(1.4)*
	<i>Highly engaged OL</i>	0.1(1.4)	-0.3(2.8)	-1.6(2.4)	-0.7(1.1)
<i>Highly engaged, but not OL</i>	<i>Not highly engaged</i>	2.5(2.8)	1.1(4.2)	-2.0(7.3)	1.5(2.3)
	<i>Highly engaged, but no highly engaged OLs</i>	-5.0(4.5)	-8.7(10.1)	-2.2(3.5)	-4.3(3.0)
	<i>Highly engaged OL</i>	-1.8(2.0)	-0.2(7.1)	-2.0(3.3)	-2.1(1.9)
<i>Highly engaged OL</i>	<i>Not highly engaged</i>	22.0(7.8)**	2.7(7.1)	-	5.5(5.2)
	<i>Highly engaged, but no highly engaged OLs</i>	2.0(7.8)	-	1.1(4.5)	2.0(4.8)
	<i>Highly engaged OL</i>	6.0(2.2)**	-1.7(10.1)	0.6(4.4)	4.3(2.1)*
Change from baseline²					
<i>Not highly engaged</i>	<i>Not highly engaged</i>	-1.3(0.9)	-0.6(0.8)	-0.6(1.7)	-0.8(0.6)
	<i>Highly engaged, but no highly engaged OLs</i>	-1.7(2.8)	-1.6(4.5)	0.3(1.1)	-0.3(1.3)
	<i>Highly engaged OL</i>	1.9(1.2)	-0.2(3.0)	5.9(1.5)***	2.5(1.1)*
<i>Highly engaged, but not OL</i>	<i>Not highly engaged</i>	-0.9(3.2)	-1.7(3.8)	10.0(5.6)	-0.5(2.3)
	<i>Highly engaged, but no highly engaged OLs</i>	-2.4(6.7)	3.0(9.4)	-2.9(2.8)	-1.8(3.2)
	<i>Highly engaged OL</i>	3.4(1.9)	2.5(6.6)	1.5(2.7)	2.9(1.7)
<i>Highly engaged OL</i>	<i>Not highly engaged</i>	-8.0(7.4)	3.5(6.6)	-	-0.3(4.7)
	<i>Highly engaged, but no highly engaged OLs</i>	5.0(7.4)	-	-	4.7(7.5)
	<i>Highly engaged OL</i>	4.6(2.0)*	-1.0(9.4)	8.7(3.2)**	4.9(1.9)**
Random effects variance					
Health Units		-	-	-	~0
Individuals		32.5(6.0)	57.3(9.0)	34.7(7.0)	46.8(4.7)
Residual		27.2(3.5)	43.9(5.6)	15.6(2.9)	33.0(2.7)
<p>1: the coefficients for all levels at baseline represent the difference from the first row: the respondents who were not highly engaged, and did not identify any highly engaged peer as their information source at baseline. For example, at department A, the average baseline EBP implementation score of highly engaged OLs who sought information from at least one other highly engaged OL was 6 points more than the respondents who were not highly engaged, and did not identify any highly engaged peer as their information source.</p> <p>2: the coefficients for all levels at follow up represent the difference from their baseline. For example, at department A, the highly engaged OLs who sought information from at least one other highly engaged OL, on average, improved their EBP implementation score by 4.6 points.</p> <p>*:p<0.05, **:p<0.01, ***:p<0.001</p>					

Table 7: Regression models to predict the EBP behavior scores over time based on their friendship patterns in the subgroup who sought information from highly engaged OLs

Regression coefficients		Three departments pooled
Respondents	Friends list	
Baseline¹		
<i>Not highly engaged</i>	<i>Not any highly engaged</i>	12.7(1.7)
	<i>At least one Highly engaged, but no highly engaged OLs</i>	-6.7(3.1)*
	<i>At least one Highly engaged OL</i>	-3.3(1.9)
<i>Highly engaged, but not OL</i>	<i>Not any highly engaged</i>	0.7(4.4)
	<i>At least one Highly engaged, but no highly engaged OLs</i>	-6.8(3.3)*
	<i>At least one Highly engaged OL</i>	-4.2(2.4)
<i>Highly engaged OL</i>	<i>Not any highly engaged</i>	2.6(3.9)
	<i>At least one Highly engaged, but no highly engaged OLs</i>	-2.7(5.3)
	<i>At least one Highly engaged OL</i>	2.7(2.6)
Change from baseline²		
<i>Not highly engaged</i>	<i>Not any highly engaged</i>	-0.8(1.7)
	<i>At least one Highly engaged, but no highly engaged OLs</i>	3.2(2.8)
	<i>At least one Highly engaged OL</i>	3.7(1.1)***
<i>Highly engaged, but not OL</i>	<i>Not any highly engaged</i>	-2.0(4.0)
	<i>At least one Highly engaged, but no highly engaged OLs</i>	4.6(3.0)
	<i>At least one Highly engaged OL</i>	3.3(1.9)
<i>Highly engaged OL</i>	<i>Not any highly engaged</i>	8.3(3.4)*
	<i>At least one Highly engaged, but no highly engaged OLs</i>	2.0(4.9)
	<i>At least one Highly engaged OL</i>	4.3(2.0)*
Random effects variance		
Health Units		~0
Individuals		26.3(5.9)
Residual		23.8(3.5)
1: the coefficients for all levels at baseline represent the difference from the first row: the respondents who were not highly engaged, sought information from at least one highly engaged OL, but did not identify any highly engaged peer as their friends at baseline. For example, the average baseline EBP implementation score of highly engaged OLs who sought information and were friends with at least one other highly engaged OL was 2.7 points more than the respondents who were not highly engaged, sought information from at least one highly engaged OL, but did not identify any highly engaged peer as their friends. 2: the coefficients for all levels at follow up represent the difference from their baseline. For example, the highly engaged OLs who sought information and were friends with at least one other highly engaged OL, on average, improved their EBP implementation score by 4.3 points. *:p<0.05, **:p<0.01, ***:p<0.001		

**CHAPTER 4- The Relationship between the Position of Name
Generator Questions and Responsiveness in Multiple Name
Generator Surveys**

4-1 PREFACE TO CHAPTER 4

In this study I used the data obtained through three rounds of survey to assess the effect of the structure of name generator questions on the characteristics of the response. This study did not address any mixed-methods propositions. But it provided empirical evidence regarding the validity of name generator to elicit network data, which informed the implications of this study (chapter 6).

This manuscript has been submitted for publication and is being peer reviewed. Upon acceptance, a request will be made to the publisher of the journal to obtain permission to include copyright material. The student was the main contributor of this study, conceived the study design and theoretical framework, performed all statistical analyses, interpreted the findings, and drafted the manuscript. The co-authors reviewed each step and guided the student through the design, analysis, interpretation, and writing up.

4-2 NAME GENERATOR MANUSCRIPT

The Relationship Between the Position of Name Generator Questions and Responsiveness in Multiple Name Generator Surveys

Reza Yousefi Nooraie, Maureen Dobbins, Alexandra Marin, Robert Hanneman, Lynne Lohfeld, Eleanor Pollenayegum

4-2-1 Abstract:

Using randomly ordered name generators we tested the association between name generators' relative position and likelihood of respondents' declining to respond or satisficing in their response. An online survey of public health staff elicited names of information sources, information seekers, perceived experts, and friends. Results show that when name generators are asked later they are more likely to go unanswered and respondents are more likely to satisfice by responding that they do not know anyone or listing fewer names. Friendship name generator showed the strongest association, suggesting that high cognitive burden and question sensitivity are especially prone to order effects.

4-2-2 Keywords:

name generator, satisficing, refusal, online survey, social network, fatigue

4-2-3 Introduction:

In many social network analysis (SNA) studies, the collection of egocentric network data occurs by surveying a sample of people, who identify others who fulfill certain criteria (e.g. friend, acquaintance). ‘Name generators’ are used in egocentric network analysis, and in sociocentric analysis when rosters (the whole list of population) are not available or feasible to ask (Burt, 1984). The name generation process requires respondents to free recall from memory to provide names of relevant people (Marsden, 2011). It is impossible to elicit a complete list of individuals’ social interactions, which may include hundreds of names (Killworth et al., 1990). As a result, researchers take various approaches to focus on a subset of personal networks based on specific time limits (e.g. recent interactions), relationship types (e.g. discussing important matters), relationship quality (e.g. strong ties) and frequency (e.g. frequent exchange of resources) (Van der Poel, 1993).

However, the human mind is not good at recalling social relations data (Freeman et al., 1987), and survey techniques have their inherent limitations (McColl et al., 2003; Schwarz et al., 1991; Tourangeau and Rasinski, 1988). Consequently, the accuracy and usefulness of name generators in eliciting social network information have been debated (Bailey and Marsden, 1999; Campbell and Lee, 1991). Name generators are prone to various biases, which are rooted in how the memory stores and retrieves the names, and how the survey structure and context affects the responses (Brewer, 2000). Wording

matters, and different respondents may interpret the name generator concepts (such as “close friends”, “important matters”) differently (Bailey and Marsden, 1999; Bearman and Parigi, 2004; Burt, 1983; Fischer, 1982). The network size and average tie characteristics may vary by the way of asking name generating questions (Campbell and Lee, 1991). Also the reliability of name generators is dependent on several cognitive, contextual, and social factors (Marsden, 1993).

In many network studies, researchers are interested in more than one type of network, such as friendship, advice-seeking, and daily conversations (Marsden, 2011) because no single name generator is able to capture all aspects of social relations (Marin and Hampton, 2007), and sometimes the researchers study the associations among various social networks. Therefore multiple name generators may be provided in a single survey. However, little attention has been paid to how multiple name generators interact with one another.

Network questions are cognitively demanding. Asking several complex questions in multiple name generators may lead to respondent fatigue, as it happens in surveys (Tourangeau and Rasinski, 1988). Fatigue may simply result in a person refusing to answer a question. But in less extreme situations, the respondent may look for shortcuts to complete the survey in order to make it less burdensome, which may include choosing the easiest available option (e.g. choosing “I don’t know”) (Fischer, 2009), or limiting the name list to the minimum allowable (Pustejovsky and Spillane, 2009).

Refusal and fatigue may affect the accuracy of network data in a unique way that is rooted in the mechanisms by which the mind stores and retrieves network information,

and the structural characteristics of social networks. Individuals store and retrieve social network information by clustering the social relations into triads and groups, and retrieve the data from conceptual lists (Brashears and Quintane, 2014; Brewer, 1995).

Consequently, shortening the name lists as a result of fatigue may bias the resulting social networks to certain social clusters (Burt, 1986). In addition, when using name generators to study whole networks missing data and incomplete tie lists do not just bias data related to the relevant respondent, they bias measures of *other* network members' positions as well as measures of the structure of the entire network. If a considerable proportion of the population is missed, it results in a significant challenge to the validity of the findings, especially when the reason for missing values is not due to random error (Borgatti and Molina, 2003; Costenbader and Valente, 2003; Kossinets, 2006).

In this study, we examined how the position of name generator questions in a survey influences the willingness to answer. We assessed the relationship between the position of the question and the likelihood of refusal, identifying no alters in the network, and the size of name list provided.

4-2-4 Conceptual Framework

Several factors affect the responsiveness to survey questions. Respondents are more likely to refuse to answer sensitive questions (i.e. embarrassing questions, and the ones invading privacy) (Tourangeau and Smith, 1996), and the likelihood of refusal increases in longer surveys (Galesic, 2006). In the context of name generators, Vehovar et al. (2008) and Manfreda et al. (2004) found that increasing the number of spaces provided for names resulted in a higher dropout rate. Therefore, similar to other survey questions,

we expect that in a multiple name generator, the likelihood of refusal will be higher for questions further to the end of survey. Stated as a hypothesis:

H1: The likelihood of refusal to answer increases for later questions.

When the respondents are motivated to answer the questions but not motivated enough to endure the burdensome cognitive tasks of comprehension, retrieval, judgment, and reporting (Tourangeau, 1984), they may look for shortcuts to complete the survey. Krosnick (1991) referred to this process of choosing more cognitively convenient answers while still appearing to participate in the survey as “survey satisficing”. Satisficers might avoid all the required cognitive steps and instead “opt out” by selecting the “I don’t know” or “not applicable” options (strong satisficing) (Krosnick, 1991). Fischer et al. (2009) found this tendency in his network surveys, where fatigue in answering network questions led to a tendency to not list any alters. This was also famously the issue with the controversial social isolation finding (McPherson et al., 2006) which was later shown to be a consequence of fatigued respondents falsely claiming not to have any discussion partners (McPherson et al., 2008; Paik and Sanchagrín, 2013)(Fischer, 2012). So we expect that in a multiple name generator:

H2: The likelihood of strong satisficing (answering “I don’t know anyone”) increases for later questions.

Alternatively, respondents may partially execute the cognitive steps but provide less than optimal answers. In the context of name generators, this could be in the form of limiting the list of the named individuals to only the most prominent names or minimum allowable. Pustejovsky and Spillane (2009) studied the effects of various mechanisms for

the effect of ordering of two social network questions. They randomized the order of two advice-seeking name generators (math vs. reading) provided to a sample of elementary school staff. They found some evidence supporting satisficing. The effect of fatigue may be more prominent in questionnaires including more than two name generators. So we hypothesize that in a multiple name generator survey:

H3: The extent of weak satisficing (shorter name lists) increases for later questions.

However, the extent of various above-mentioned mechanisms may also depend on the sensitivity and cognitive burden of the question. The likelihood of refusal depends on questionnaire length, respondent's initial interest in participating in the activity, and the cumulative burden of answering survey questions (Galesic, 2006; Knapp and Heidingsfelder, 2001). Shoemaker et al. (2002) found that choosing between refusing to answer a question or selecting the "I don't know" answer is the result of an interaction effect between the cognitive effort to answer the question and question sensitivity. More sensitive questions get more refusals, but questions with a heavier cognitive burden have a greater likelihood of both refusal and answering "I don't know". So we hypothesize that:

H4: The extent of refusal, and strong and weak satisficing will be greater for more complex or sensitive questions.

4-2-5 Methods:

In 2011-2013 the staff of three public health departments in Ontario, Canada, participated in three rounds of online surveys sent at 12-month intervals to respondents to elicit their workplace social networks (Appendix 2). Respondents identified the names of

peers in their health department who fulfilled the following conditions: people to whom the respondent regularly turned to for help applying research evidence to their professional practice (information-seeking), peers who regularly turned to the respondent for help applying evidence in practice (reverse information-seeking), peers the respondents deemed to be the experts in the health department in terms of finding and applying research evidence (expertise recognition), and names of the respondent's friends (friendship network). For each of the four questions, 5 blank spots were provided with specific fields for writing down the names and affiliating organizational division of relevant people, as well as an extra open space in which they could write as many extra names as they desired. In addition, for each question respondents could choose "I prefer not to answer this question" or "I don't know anyone".

We assumed that the friendship question would be the most sensitive because of its more private and less professional nature. In contrast, the expertise recognition question dealt with the least personal information and so was thought to be the least sensitive of them. The information-seeking networks in the study departments were highly centralized with most staff turning to a few experts for information, while no body identified themselves as information source (Yousefi Nooraie et al., 2012). Therefore, we expected that the frequency of answering "I don't know anyone" would be highest for the reverse information-seeking question.

The four name generators were presented in random order, but each respondent saw the same sequence at all the three time points. More details of study design are provided elsewhere (Yousefi Nooraie et al., 2012).

Since the respondents answered the same name generator questions at three time points (with varying response rates), with the aim of making the best use of available data, the answers to name generators at different time points were included in multi-level models, with name generators (level 1) nested within individuals (level 2: n=781). We did not include the variance between the three health departments in the analysis because inter-departmental variance was negligible in the preliminary analysis. We developed a multinomial mixed effects logistic regression to predict the relationship between a question's position on the list (1,2,3, or 4), the question type (information-seeking, reverse information-seeking, expertise recognition, and friendship), and their interaction on the likelihood of refusing to answer and answering "I don't know anyone". A significant association between question position and the likelihood of refusal and "I don't know anyone" would support hypotheses H1 and H2, respectively, and a significant interaction between the question position and network type would support hypothesis H4. The inter-individual random effects to predict refusal and answering "I don't know anyone" were considered to be separate but correlated. We also included the time of assessment as the fixed effect variable in the model to adjust for any changes in refusal over time. The analysis was carried out using the generalized structural equation modeling (gsem) command in Stata 13.1 (StataCorp, 2013).

We developed a generalized estimating equation (GEE) model with Poisson family and a log link function to predict the size of the list (number of identified alters) by the place of question in the list, network type and their interaction, and the time of assessment in the subgroup who did not refuse to answer at each time point (n=662). A

significant relationship between question position and list size would support hypothesis H3, and a significant interaction between the question position and network type would test positive for hypothesis H4. We chose GEE as the analysis of choice due to the zero-inflated distribution of list size and robustness of the Huber-White-Sandwich estimator of variance in GEE to misspecification of variance structure (Overall and Tonidandel, 2004). We carried out this analysis using `xtgee` command in Stata 13.1, after defining individuals as the panel variable (StataCorp., 2013).

4-2-6 Results:

In total, 781 individuals from the three health departments answered at least one network question (n=272, 370, and 139 in departments A, B, and C, respectively). Seventy-nine percent of the respondents were female; they were mainly public health nurses (35%), professional consultants (e.g. specialists, consultants, and epidemiologists: 17%) and managers (10%), with other job titles less frequent (e.g. nutritionist, health inspector, unit directors, and medical officer of health). The majority of respondents had a Bachelors (54%) or Masters+ (30%) degree.

Twelve percent of the respondents did not answer the information-seeking question, compared to 17% for the reverse information-seeking, 10% for expertise recognition, and 42% for friendship questions. Figure 6 shows the percentage of refusal responses for each network question. The percentage of refusal increased by the question sequence in all question types. The refusal percentage increased by 7% from first to fourth question in information seeking, compared to a 9% increase in reverse information seeking, a 5% increase in expertise recognition, and a 20% increase in friendship.

The percentage of respondents who answered “I don’t know anyone” was 22% in information-seeking, 40% in reverse information-seeking, 19% in expertise recognition, and 6% in the friendship question. The percentage at different orderings is provided in Figure 6. Based on the descriptive analysis, the relationship between the place of the question and the probability of choosing “I don’t know anyone” did not seem to be linear. The percentage increased by 5% from first to fourth order in information-seeking and friendship. However, the percentage showed an initial increase followed by a slight drop in reverse information- seeking, and an initial drop followed by a slight rise in expertise recognition.

Table 8 shows the odds ratio of refusing to answer each question at different places in the questionnaire compared to the first question in the list. The likelihood of refusing to answer all question types significantly increased when the question was asked third and fourth in the list, supporting hypothesis H1. The greatest increase happened in friendship, with an odds ratio of 4.54 for the fourth vs. first question, and the lowest in expertise recognition with an odds ratio of 2.42. Moving further down in the question list resulted in a fairly incremental increase in the likelihood of refusal in all question types, not supporting hypothesis H4 regarding the moderating effect of question type on the association between the place of question and refusal.

Table 8 also shows the odds ratios of answering “I don’t know anyone” in different positions of questions in the survey as compared to the first question for various network types. The relationship of the place of the question in the survey and the likelihood of answering “I don’t know anyone” was inconsistent across different question

types. The likelihood increased by moving further down the list in information seeking and friendship questions, supporting hypothesis H2 for the association between the place of question in the survey and the likelihood of strong satisficing for these questions. The greatest increase was observed in friendship, with an odds ratio of 4.83, 4.17, and 8.07 for comparing the 2nd, 3rd, and 4th questions, respectively, with the first question in the list. The pattern for reverse information-seeking showed only a significant increase in the second order followed by a drop to the previous value in subsequent orders. The expertise recognition did not show a significant association between position and the likelihood of answering “I don’t know anyone”. The difference in the likelihood of choosing “I don’t know anyone” among network types supports hypothesis H4, indicating a moderating effect of question type on the association between the place of question in the survey and the likelihood of strong satisficing.

The median of the number of reported names was 2, 1, 3, and 4 for information-seeking, reverse information-seeking, expertise recognition, and friendship questions, respectively. Table 9 depicts the average list size at different orders for each question type. The median size decreased by 1 name in all four questions from first to fourth question.

Table 10 shows the ratio of list size in different positions in the survey compared to the first question, obtained from the GEE model. The list size significantly decreased by moving further down the survey in all questions but the reverse information seeking, supporting hypothesis H3, indicating the association between the place of question in the survey and weak satisficing. The ratio of the list size in fourth vs. first question was 0.68

and 0.72 in information-seeking and expertise recognition, respectively. In friendship the decrease was only significant for the fourth position, with a ratio of 0.85 as compared to the first position. In reverse information-seeking, the size initially decreased at second and third position (with a ratio of 0.78 and 0.77) followed by an increase to previous values. This supports hypothesis H4, indicating a moderating effect of question type on the association between the place of question in the survey and the likelihood of weak satisficing.

4-2-7 Discussion:

We observed a significant relationship between the position of name generators and respondents' likelihood of refusing to answer or satisficing, with the magnitude and pattern differing by network type. In all network types, the likelihood of refusal increased the later the question was placed in the questionnaire, implying a significant association between fatigue and refusal. The likelihood of choosing "I don't know anyone" increased when information-seeking and friendship questions were moved towards the end of the questionnaire, implying an association between the place of question and the likelihood of strong satisficing.

Among the respondents who provided an answer, the average list size decreased significantly as the question appeared later in the survey, implying an association between the place of a question in survey and weak satisficing. The reverse information-seeking question showed an initial fall followed by a subsequent rise, and friendship, which had the largest average list size among all four networks (median of 4 names), showed only a significant decrease in list size at fourth question.

The substantial relationship between questionnaire length and response rate has been shown consistently in the literature (Heberlein and Baumgartner, 1978; Yammarino et al., 1991). Respondents are more likely to refuse to continue to answer long online surveys (Galesic, 2006). Network analysis questions are cognitively burdensome. Providing a response is the result of a complex process of comprehension of the meaning of the question both overall (syntactic) and in terms of its components (semantic, e.g. the meanings of terms advice-seeking, research evidence), retrieving people's names from long-term memory into working memory, judging whether they meet the requested criteria, choosing the most relevant names, and providing the chosen names within the provided spaces (Tourangeau and Bradburn, 2010). This complexity can explain the large percentage of refusal in later questions, even in a small survey like the one we developed (4 items) without name interpreters or additional questions. The increased refusal to answer network questions that occurred later in the sequence of questions was also quite consistent across different network types, with a significantly increasing likelihood of refusal by moving each step towards the end, which supports hypothesis H1. The relationship was strongest for the friendship question, which was the most sensitive question (and also had the highest overall rate of refusal among question types), and lowest for the expertise recognition question, which was the least sensitive question. This difference in the overall likelihood of refusal by question position among network types supports hypothesis H4, that more sensitive questions increase both the overall refusal rate and the relationship between refusal and question position.

We hypothesized that providing zero lists (by choosing “I don’t know anyone”) represents strong satisficing by respondents. However, considering zero lists as a less extreme presentation of refusal or strong satisficing is not always appropriate. Providing zero lists may be simply a reflection of reality, that the respondent does not know anyone meeting the criterion of interest. The highest percentage of null lists in our study occurred for the reverse information-seeking question (“Who regularly turns to you seeking help applying evidence in practice?”). This appears to be mainly due to the centralized nature of information-seeking networks in our study, where a large number of people turned to a small core of known experts for information (Yousefi Nooraie et al., 2012) but not the converse. Consequently, it is likely that many people are not approached by their peers to serve as an information source. For the respondents who were not an information source for anybody, listing no one may reflect their true position in the network, and that response therefore is not a negative reaction to a cognitively burdensome question. This may explain why there was not a prominent relationship between later presentation and the likelihood of answering “I don’t know anyone” for the reverse information-seeking question.

In contrast, friendship (“who are the staff you consider a personal friend?”) is a more sensitive question, and listing no one might be a reflection of refusal for a small group of respondents who did not formally refuse yet did not feel comfortable providing their friends list. This may explain the observed similarity of the relationship between later position and refusal and choosing “I don’t know anyone” answers to friendship name generator.

For information-seeking and expertise recognition questions, choosing “I don’t know anyone” might be the result of a varying combinations of the aforementioned reasons. Therefore it seems that the relationship between question position and the “I don’t know anyone” option is based on a multifactorial process determined by the meaning of “I don’t know anyone” to the respondents, which supports hypothesis H4.

More motivated respondents may take a weak satisficing approach by limiting their answers to subsequent questions to the minimum allowable number. Significant decrease of list size by later position of questions supports the increasing role of weak satisficing in later questions (hypothesis H3).

Weak satisficing by providing shorter lists may lead to problems in constructing social networks based on the information obtained by name generators. Dropping names at the end of free-lists results in considerable changes in estimated network structural measures (McCarty et al., 2007). Brewer (1995), in a study of the cognitive process of classification of people’s names in memory, found that names are organized in memory according to social structural principles. Affiliation to social groups and dominance of the person are two main dimensions of the organization. Brewer et al. (2005), in a literature review of the associative patterns in recall of persons, found various studies that consistently showed that persons recalled adjacently to one another in temporal terms (the order of retrieval) are perceived to interact more with each other than with non-adjacent persons. So the larger likelihood of censoring of the later names in name generators that appear at the end of the questionnaires may result in ignoring some more weakly

connected social clusters (Burt, 1986). Consequently, we expect that weak satisficing may result in biasing networks towards more recent or stronger social interactions.

Reverse information-seeking was perhaps the least cognitively challenging question for many respondents because, as explained above, the majority of respondents were not the information source for anyone. Therefore this question had the smallest average list size of all, and the association between question position on a survey and list size was not strong. Friendship had the largest average list size among all four questions, and the association between the position and the list size in friendship was less prominent than refusal and “I don’t know anyone”. This may imply that in sufficiently motivated respondents (those who did not refuse and also did not choose “I don’t know”) weak satisficing was less likely to happen for friendship compared to other questions, supporting hypothesis H4.

In this study we used a large dataset to assess the pattern of responsiveness to multiple name generators, and studied various possible mechanisms that may result in an incomplete answer. However, there are also limitations to this study. Our findings are based on a statistical assessment of the response pattern in several non-overlapping groups of respondents. An optimal method of analysis would be to compare the response pattern of a single panel of respondents, in order to minimize inter-individual variations (which have shown to be very substantial in our data).

We also limited our analysis to responsiveness regardless of the response content. Preceding questions may affect the answer to subsequent ones in several ways, including non-redundancy (interpreting subsequent questions as request for only new information

which has not been provided before), cognitive priming (through which the preceding questions activate a set of relevant memories that would not have been activated otherwise, leading to the identification of different names), and question scope redefinition (the preceding questions lead to new interpretation of the meaning of subsequent questions, resulting in identification of a different list) (Pustejovsky and Spillane, 2009; Schwarz, 1999). These mechanisms can only be tested by taking the content of the answers (such as similarity of name lists among pairs of questions) into account.

In addition, we did not control for the effect of the structure and presentation of online questionnaire (Matzat and Snijders, 2010), and characteristics of respondents and their network members (Marin, 2004), which have been shown to affect the responsiveness in online surveys. In addition, the association between the position of questions and the list size could also be attributed to non-redundancy, since the respondents may tend to retrieve names not previously identified. This may lead to the shortening of name lists in later questions. Moreover, the significant increase in the likelihood of refusal and answering “I don’t know anyone” in the last round of survey may indicate to the existence of a panel conditioning effect, where some respondents decided to choose those option to reduce the amount of effort, based on the experience they had with previous rounds of the survey (Eagle and Proeschold-Bell, 2015).

In conclusion, our findings show that survey respondents are more likely to satisfice when answering later name generator questions. In addition, the place of the name generator in the sequence of questions has a significant relationship to the

likelihood of refusal, which is more prominent in sensitive questions (like friendship). Choosing “I don’t know anyone” may be the result of several factors, including the sensitivity of the question, cognitive burden associated with providing names, and/or reflect reality. In motivated respondents who do not refuse to answer, weak satisficing increased in later questions. The relationship between question position and list size is greater in cognitively burdensome (such as information seeking and expertise recognition).

When designing a survey, choosing between comprehensiveness and practicality is difficult, and should be guided by the study hypotheses and theoretical framework. On the one hand, incompletely capturing the constellation of relationships that connect a set of actors may result in a partial understanding of social processes (partial system fallacy), which is misleading (Laumann et al., 1983). On the other hand, answering several closely overlapping name generator questions requires great cognitive resources from the respondents and may affect the validity and reliability of their answers. We suggest that researchers either provide multiple name generators in random order, or place questions that are more sensitive to the position effect (such as friendship) earlier in their surveys. When analyzing data based on multiple name generators, we suggest considering the position and ordering of questions in statistical models. In online surveys, probes and graphical aids could be used to motivate respondents (Deutskens et al., 2004).

4-2-8 References:

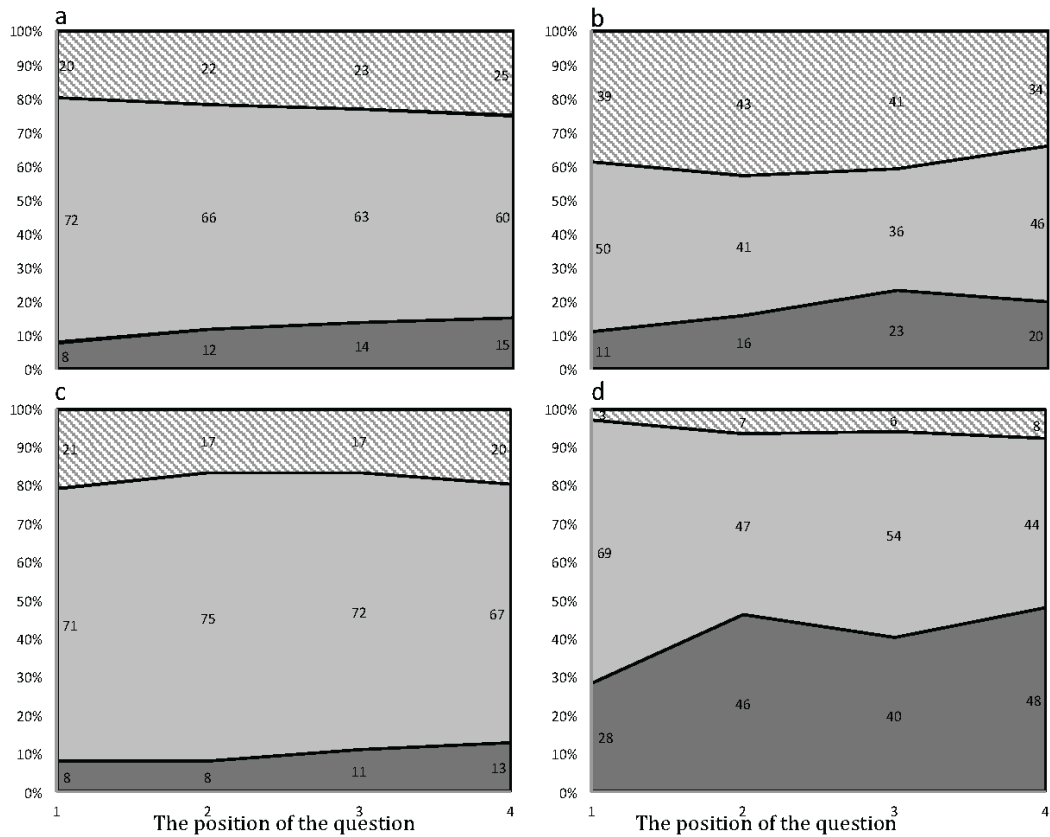
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Figure 6: The frequency of refusal and “I don’t know anyone” responses for each question provided at different positions in the survey (and percentage within each cell category).



a: information seeking, b: reverse information seeking, c: expertise recognition, d: friendship.

Dark grey: refusal, diagonal stripes: “I don’t know anyone”, light grey: answer

Table 8: The odds ratio (95% CI) of refusing to answer and answering “I don’t know anyone” to each question at different positions in the survey

	Information seeking	Reverse information seeking	Expertise recognition	Friendship
Refusal				
First in the list	0.06 (0.04 to 0.10) ¹	2.64 (1.40 to 4.97)** ²	0.73 (0.37 to 1.42) ²	4.55 (2.52 to 8.19)** ²
2 nd vs. 1 st	1.44 (0.76 to 2.74)	2.97 (1.69 to 5.22)** ²	1.10 (0.52 to 2.32)	3.24 (1.88 to 5.60)** ²
3 rd vs. 1 st	2.33 (1.27 to 4.26)**	3.04 (1.60 to 5.79)** ²	2.04 (1.08 to 3.85)*	2.95 (1.76 to 4.95)** ²
4 th vs. 1 st	3.18 (1.74 to 5.81)** ²	2.72 (1.42 to 5.19)**	2.42 (1.24 to 4.75)**	4.54 (2.81 to 7.36)** ²
Time 2: 1.09 (0.83 to 1.45)				
Time 3: 1.32 (1.03 to 1.70)*				
I don’t know anyone				
First in the list	0.12 (0.08 to 0.19) ¹	6.51 (3.87 to 10.97)** ²	0.81 (0.47 to 1.40) ²	0.11 (0.04 to 0.27)** ²
2 nd vs. 1 st	1.31 (0.75 to 2.29)	1.78 (1.11 to 2.83)*	0.89 (0.48 to 1.64)	4.83 (1.72 to 13.61)**
3 rd vs. 1 st	1.83 (1.07 to 3.15)*	1.10 (0.62 to 1.95)	1.10 (0.64 to 1.90)	4.17 (1.52 to 11.38)**
4 th vs. 1 st	1.90 (1.11 to 3.25)*	0.94 (0.53 to 1.68)	1.75 (0.98 to 3.14)	8.07 (3.20 to 20.39)**
Time 2: 1.11 (0.83 to 1.48)				
Time 3: 1.33 (1.03 to 1.73)*				
Variance (Identifier) refusal: 4.16 (3.37 to 5.14)				
Variance (Identifier) “I don’t know”²: 5.78 (4.74 to 7.06)				
Covariance: 3.58 (2.77 to 4.38)**²				

¹:the odds of the event for information seeking question when it comes first on the list

²:the odds ratio of the event for different question types compared to information seeking when they all come first on the list

*:<0.05 **:<0.01 ***:<0.001

Table 9: The median (1st and 3rd quartiles) of list size for each question at different positions in the survey

The position of the question	Information seeking	Reverse information seeking	Expertise recognition	Friendship
1st	3(1 to 5)	2(0 to 4)	4(1 to 5)	5(3 to 5)
2nd	2(0.5 to 4)	0(0 to 3)	4(1 to 5)	4(2.5 to 5)
3rd	2(0 to 4)	0(0 to 3)	3(1 to 5)	5(3 to 5)
4th	2(0 to 3)	1(0 to 4)	3(1 to 5)	4(2 to 5)

Table 10: The ratio (95% CI) of the list size of each question at different positions in the survey, as compared to the first question

List size	Information seeking				Reverse information seeking				Expertise recognition				Friendship			
	Information seeking		Reverse information seeking		Expertise recognition		Friendship		Information seeking		Reverse information seeking		Expertise recognition		Friendship	
First in the list	2.63 (2.43 to 2.85) ¹		0.74 (0.63 to 0.86)** ²		1.20 (1.08 to 1.33)** ²		1.30 (1.15 to 1.48)** ²		0.87 (0.77 to 0.98)*		0.78 (0.64 to 0.95)*		0.93 (0.83 to 1.04)		0.90 (0.77 to 1.06)	
2 nd vs. 1 st	0.87 (0.77 to 0.98)*		0.78 (0.64 to 0.95)*		0.93 (0.83 to 1.04)		0.90 (0.77 to 1.06)		0.75 (0.67 to 0.84)***		0.77 (0.61 to 0.98)*		0.80 (0.72 to 0.89)***		0.94 (0.82 to 1.08)	
3 rd vs. 1 st	0.75 (0.67 to 0.84)***		0.77 (0.61 to 0.98)*		0.80 (0.72 to 0.89)***		0.94 (0.82 to 1.08)		0.68 (0.59 to 0.79)***		1.0 (0.81 to 1.26)		0.72 (0.63 to 0.81)***		0.85 (0.74 to 0.97)*	
4 th vs. 1 st	0.68 (0.59 to 0.79)***		1.0 (0.81 to 1.26)		0.72 (0.63 to 0.81)***		0.85 (0.74 to 0.97)*		Time 2: 0.98 (0.91 to 1.05)				Time 3: 1.04 (0.97 to 1.11)			

¹:the size of the list for information seeking question when it comes first on the list

²:the ratio of the list size for different question types compared to information seeking when they all come first on the list

*:<0.05 **:<0.01 ***:<0.001

CHAPTER 5- The Qualitative Strand

5-1 PREFACE TO CHAPTER 5

This chapter describes the methods and results of the explanatory qualitative case study used to address and explain the quantitative findings of the study from the viewpoint of key staff members in the three public health departments. The student designed the study, performed and transcribed all qualitative interviews and analyzed the qualitative data. The supervisor and committee members provided critical support and guidance on different steps and reviewed the drafts.

This chapter has not been prepared as a separate qualitative manuscript because as part of the explanatory mixed-methods study the qualitative strand was conceived to explain and deepen the understanding of the quantitative findings and not as a stand-alone study. We believed that publishing the qualitative findings separately, without their being integrated in quantitative findings, will result in a report lacking the unique insight or ‘yield’ which is expected from a mixed-methods study. This approach to publication of mixed-methods studies has been advocated by experts in the field (O’Cathain, Murphy, and Nicholl 2007). This chapter along with chapter 6 will form a mixed-methods analysis manuscript to be submitted to a peer-reviewed journal for publication in the future.

5-2 SCOPE AND DESIGN:

The qualitative phase of this mixed methods study was an explanatory single case study with embedded units designed to answer how the KT intervention and the network structure interacted, how this interaction shaped the behaviour of the staff, and how contextual and organizational factors influenced this complex change process. It aimed to answer the following question:

How do the influential staff engaged in the KT intervention in three public health departments describe the composition of social networks, the implementation of the KT intervention, and its interaction with communication patterns?

A major proponent of the post-positivist qualitative case study, Robert Yin (1995), served as the source of inspiration and guidance when I designed this portion of the study. Key elements that he posits as necessary to design a rigorous case study are developing a well-formulated study question and relevant propositions, defining the units of analysis, linking data to the propositions, and developing criteria for interpreting the findings (Yin 2008). I provided the research question and corresponding propositions in sections 1-5 and 1-6, respectively. In summary, the propositions focused on 1) the effects of the KT intervention on the directionality of information seeking connections, the distribution of knowledge, the connectivity of organizational divisions, and the network position of early adopters; and 2) the social influence of experts and opinion leaders (OLs), and the role of informal ties in the social influence. In the following sections I will elaborate on the units of analysis and study context, data collection and analysis techniques, and a proposed framework for integration of the case study findings with the quantitative findings.

5-2-1 Binding the Case

Miles and Huberman defined the case as “a phenomenon of some sort occurring in a bounded context” (Miles & Huberman, 1994, p. 25). The boundaries around the definition of the case could be time, place, context, definition, et cetera (Baxter and Jack 2008). The phenomenon that I was interested to explore in the current study was the process of knowledge flow within a public health department and how it interacted with the implementation of the KT intervention. Comparison of the success/failure of the intervention in the three health departments was not the primary objective of this study, and has been explored by other PHSI team members elsewhere (Traynor, DeCorby, and Dobbins 2014). My main intention was to explore common themes across all health departments to answer “how” and “why” questions relevant to the study propositions from a more general perspective, while also recognizing the context-bound nature of the phenomenon (Yin 2008; Baxter and Jack 2008). Therefore I considered the health departments as units embedded within a more general case, and not as separate cases.

I used the following boundaries to delimit the case: the health department as the organizational boundary of the connections to define the embedded units, the participants (a select subgroup of the department staff who are involved in making public health decisions within the health department and for whom the KT intervention may affect the quality of their decisions), place (the three health departments), and time (2011-2013).

5-2-2 Propositions

Data collection and analysis were guided by the study propositions described earlier, which were developed after extensive literature review and examining the

findings of the network analysis. In the quantitative strands I tested hypotheses corresponding to the mentioned propositions. In order to use the quantitative findings to inform the qualitative data collection and analysis, I interpreted the findings and their meanings in the context of the study, and developed a list of quantitative findings (Table 11). In this table I classified the quantitative findings into three main categories:

- Baseline characteristics and engagement in the study
- The effect of baseline network structure on EBP behavior over time
- Evolution of information-seeking networks over time.

I used this list to develop an interview guide for each health department, and shared it with the interviewees asking for their interpretations and experience regarding those findings.

Table 11 The detailed list of quantitative results: baseline characteristics, effect of baseline networks on behavior change, and evolution of information-seeking over time

Baseline characteristics and engagement in the study
<p>Department A</p> <ul style="list-style-type: none"> • A1: 207 (33%) participated in the survey at baseline • A2: 53 (25%) of respondents at baseline were highly engaged • A3: the visual inspection of information-seeking network at baseline showed a network segregated by organizational divisions, with administrative division serving as the central cluster with inter-divisional connections exclusively toward it. • A4: 28 were OLs of whom 17(61%) were highly engaged • A5: the 28 OLs were mainly from chronic diseases, family health, and administrative division, and of whom 10 were project specialists and 5 were managers. • A6: 57% of respondents from administrative division were highly engaged. Highest among all divisions • A7: Highly engaged OLs were mainly from family health (6) and administrative (5) divisions • A8: 15(31%) and 11(23%) of highly engaged respondents were project specialists and managers (compared to 18(11%) and 7(4%) in non-engaged group) • A9: 8(47%) and 3(18%) of highly engaged OLs were project specialists and managers • A10: 26 (49%) of highly engaged respondents had Masters+ (compared to 22% non-engaged) • A11: 11(65%) of highly engaged OLs had Masters+ • A12: at baseline, highly engaged OLs had significantly higher average degree centrality in friendship network than other highly engaged and non-engaged staff (median of 4 vs. median of 1 in non-engaged) • A13: at baseline, highly engaged OLs had significantly higher average EBP scores than other highly engaged and non-engaged staff (mean of 14 vs. mean of 8 in non-engaged)
<p>Department B</p> <ul style="list-style-type: none"> • B1: 309 (28%) participated in the survey at baseline • B2: 13(4%) of respondents at baseline were highly engaged • B3: visual inspection of the information-seeking network at baseline showed a network segregated by organizational divisions, with no visibly central division as was observed in department A. • B4: 31 were OLs of whom 3(10%) were highly engaged • B5: of 31 OLs 50% were from chronic disease and performance & standard divisions, and 14 were consultants and 9 were managers. • B6: 9(70%) and 1(8%) of highly engaged respondents were consultants and managers (compared to 65(22%) and 42(14%) in non-engaged group) • B7: All 3 of highly engaged OLs were health promotion consultants • B8: 9 (70%) of highly engaged respondents had Masters+ (compared to 42% non-engaged) • B9: Two of three highly engaged OLs had a Masters degree. • B10: at baseline, highly engaged OLs had did not significantly differ from other staff in terms of average degree centrality in friendship network (median of 2.5 vs. median of 2 in non-engaged) • B11: at baseline, highly engaged OLs did not significantly differ from other staff in terms of average EBP scores (mean of 9 vs. mean of 7 in non-engaged)
<p>Department C</p> <ul style="list-style-type: none"> • C1: 95 (47%) participated in the survey at baseline

<ul style="list-style-type: none"> • C2: 18(19%) of respondents at baseline were highly engaged • C3: Visual inspection of information-seeking network at baseline showed a network segregated by organizational divisions with the administrative division as the central hub. • C4: 9 were OLs of whom 5(56%) were highly engaged • C5: the 9 OLs were from administration and public health nursing, and were 1 director, 4 epidemiologists, 2 managers, and 2 nurses • C6: 4(22%) of highly engaged respondents were managers (compared to 8(10%) in non-engaged group) • C7: Among highly engaged OLs, there were 2 managers, 1 director, 1 epidemiologist and 1 nurse. • C8: 4 of 9 OLs were epidemiologists of whom only one was highly engaged. • C9: 4 (22%) of highly engaged respondents had Masters+ (compared to 12% non-engaged) • C10: 3(60%) of highly engaged OLs had a Masters degree. • C11: at baseline, highly engaged OLs had did not significantly differ from other staff in terms of average degree centrality in friendship network (median of 2.5 vs. median of 2 in non-engaged) • C12: at baseline, highly engaged OLs had higher average EBP scores than other highly engaged and non-engaged staff, which did not differ significantly (mean of 13 in highly engaged OLs vs. mean of 8 and 6 in other highly engaged and non-engaged respectively)
<p>The effect of baseline network structure on EBP behavior over time</p>
<p>Department A</p> <ul style="list-style-type: none"> • A14: In the regression analysis, the only group that showed significant change in EBP implementation scores over time were highly engaged OLs who identified at least one other highly engaged OL as their information source at baseline (average change of 4.6 score). • A15: Other highly engaged and non-engaged groups who identified at least one other highly engaged OL as their information source also showed non-significant improvement over the same group who did not identify any highly engaged OL.
<p>Department B</p> <ul style="list-style-type: none"> • B12: The regression analysis did not show any effect of being highly engaged, OL, and being connected to other highly engaged OLs on improvement in EBP scores over time
<p>Department C</p> <ul style="list-style-type: none"> • C13: In regression analysis, highly engaged OLs who sought information from other highly engaged OLs significantly improved their EBP behavior over time (average of 4.9 units increase over time) • C14: the staff who were not engaged in intervention but sought information from highly engaged OLs significantly improved their EBP behavior over time (average increase of 2.5).
<p>Evolution of information-seeking networks over time</p>
<p>Department A</p> <ul style="list-style-type: none"> • A16: In actor-based modeling, network actors showed a significant positive tendency to seek information from highly engaged staff (alter effect) • A17: Highly engaged staff tended to seek information from each other (ego-alter interaction) • A18: Staff tended to seek information from staff with higher baseline EBP scores (alter effect) • A19: Staff tended to seek information from staff with higher improvement in EBP scores (alter effect) • A20: there was a significant tendency to form ties within organizational divisions (ego-alter interaction) • A21: overall trend towards centralization and formation of hierarchies (positive transitivity, negative 3-cycle, positive preferential attachment) • A22: Many staff identified the knowledge broker as an information source and expert. Even though

<p>the knowledge broker was not an official staff in the department. This did not happen in any of other 2 health departments in the study.</p>
<p>Department B</p> <ul style="list-style-type: none">• B13: In actor-based modeling, highly engaged staff showed an increasing positive tendency towards being more active in the network (ego effect)• B14: Highly engaged staff tended to seek information from each other (ego-alter interaction)• B15: Staff tended to seek information from staff with higher baseline EBP scores (alter effect)• B16: Staff with higher baseline EBP scores were more active (ego effect)• B17: Staff tended to seek information from staff with higher improvement in EBP scores (alter effect)• B18: Staff with higher improvement in EBP scores were more active (ego effect)• B19: there was a significant tendency to form ties within organizational divisions (ego-alter interaction)• B20: overall trend towards centralization and formation of hierarchies (positive transitivity, positive preferential attachment)
<p>Department C</p> <ul style="list-style-type: none">• C15: In actor-based modeling, highly engaged staff tended to seek information from each other (ego-alter interaction)• C16: Staff tended to seek information from staff with higher improvement in EBP scores (alter effect)• C17: there was a significant tendency to form ties within organizational divisions, but tendency toward interdivisional connections increased over time (ego-alter interaction)• C18: overall trend towards centralization and formation of hierarchies (positive transitivity, negative 3-cycle, positive preferential attachment), but over time, the network showed less tendency towards local closure, implying being more directly connected to the supervisory/administrative division

5-2-3 Data Sources

The main objective of this study was to understand the interdependence between the communication pattern among staff and the extent to which research evidence informs decisions, and the role of the KT intervention in this mutual association. The main source of information I used to understand the pattern of daily communication among staff was their self-report and judgment disclosed during the interviews and responses on self-administered surveys. Observation of staff behavior was not feasible because full-time monitoring would be extremely resource-intensive and would not likely result in capturing many verbal and behavioral interactions among staff. Moreover, people often change their normal behaviour when they know they are being observed (Hawthorne effect (McCarney et al. 2007)).

I also used the following complementary sources of information to obtain a broader understanding of the effect of the KT intervention on organizational capacity and the behavior of staff:

- Detailed documentation and reports of the tailored intervention in each health department, which were obtained through other PHSI reports and publications
- The Canadian Health Services Research Foundation's validated Organizational Self-Assessment tool, collected through PHSI study (Dobbins et al. 2009b). The tool assesses organizational capacity to acquire, assess, adapt and apply research evidence in practice. The tool has been evaluated for face and content validity in 32 focus groups including a variety of health service organizations across Canada (Thornhill, Judd, and Clements 2009).

- Individual capacity indicators collected through the PHSI study (Dobbins et al. 2009b), including Evidence Based Practice Implementation scale (Mazurek Melnyk, et al., 2008) (Appendix 2). The EBP activities include different aspects of using and appraising evidence to inform public health practice, and sharing the evidence with colleagues and clients.
- Organizational charts and job definitions of each health department during the study period, to understand and compare the formal structure of the three health departments
- Information about location of health departments and their organizational divisions and geographical distance between organizational divisions during the study period.

5-2-4 Sampling and Recruitment:

The findings of the quantitative network analysis informed the purposeful criterion sampling strategy I used in this qualitative study. This technique entails the selection of study participants according to predetermined criteria (Patton 1990). The study participants included a group of staff who were highly engaged in the intervention and participated in both baseline assessment and follow up, with the following qualifications:

- The most central staff in terms of centrality in the information-seeking network
- The staff with average centrality measures in the information-seeking network.

I limited the interviewees to highly engaged staff because I considered the interviewees as informants who were aware of the implementation process and could

comment on different social processes happening during the implementation through both first-hand (personal experience) and second-hand experience (what they observed in the behaviour of their peers). I assumed that the informants' experience and observations could provide a realistic picture of the process in their health departments because many of the interviewees were central (popular) staff in social networks and frequently communicated with other staff regarding EIDM issues. However, because of the heavier involvement of participants in EIDM, it is possible that results were biased towards a more positive perspective and I have missed some negative reactions to the intervention. In addition, the personal experience of interviewees could not be treated similarly as their indirect experience by observing others' behaviour and hearing their stories, because proxy reports on others' attitudes and behaviours are prone to various cognitive biases and should be interpreted with caution (Elliott et al. 2008). In the results section, where appropriate, I tried to highlight this distinction.

I treated the public health departments as embedded units of a single case study. Comparison of three health departments was not the primary objective of the study, although it was done as a part of the cross-unit analysis. The preliminary estimate of the sample size included 12 participants, comprised of 4 participants from each health department including 2 central and 2 less central staff who were highly engaged in the intervention. I also planned to recruit additional staff until I reached data saturation (informational redundancy), the point at which no new information is heard in subsequent interviews, and informational saturation, or the point at which all key findings are clearly

understood by the researcher (Lincoln and Guba 1985). I conducted a total of 14 interviews in this study.

I sent personal invitation emails to the selected staff and explained the significance and details of the qualitative phase, the process of the interviews, and the role of the qualitative findings in complementing the quantitative analysis. I arranged the interviews for a convenient time in a private location in their workplace. I conducted interviews with five staff at department A, five at department B, and four at department C. The interviewees consisted of five managers or leaders, three consultants, two project specialists, two nurses, one epidemiologist, and one librarian. Of these, seven were OLS according to our definitions (the highest quartile of centrality in information seeking and expertise recognition networks at baseline). Among the interviewees six were from a supervisory/administrative division, and the rest from the practice-based divisions (such as divisions dealing with family health, chronic diseases, environmental health).

5-2-5 Data Collection

I collected the qualitative data using focused interviews, which were flexible and conversational in nature, allowing new questions to emerge while the interviewer asked a predetermined set of questions that addressed the process of information-seeking and peer influence (Yin 2008). The interview guides differed across the three health departments according to the quantitative findings for that department (Appendix 4). I began by asking the interviewees to think about the recent occasions that staff sought their help about finding and using research evidence to inform practice. The interviewees were asked to

comment on the context, the problems, and the speculated reasons why certain staff chose them as the source of information, and how they influenced the beliefs and behaviors of staff who sought their help. Then I asked the interviewees to think about whether other colleagues have influenced the way they used evidence in practice. These questions helped reveal the underlying mechanisms of social influence and what factors contribute to the diffusion of EIDM through interpersonal communications.

I then provided a brief summary of the quantitative network analysis of each respondent's department. I asked the interviewees to comment on the effects of the KT intervention on the way staff interact, on the prominence of experts in the department, and on the communication among the organizational divisions. The interviewees also explained how they thought the organizational structure and interpersonal communication norms might have influenced the success/failure of the KT intervention. Each interview lasted between 45 and 60 minutes.

I pilot tested the interview guide with two professional consultants in two separate health departments prior to implementing the full study. I reflected on the time needed to complete interviews and made some revisions to the guide based on the feedback from the pilot interviewees regarding the fluency of the questions and their relevance to their practice. I used the transcripts of the pilot interview in the final analysis, because the revised questions did not change the overall direction of the interview substantially. A copy of the interview guides appears in Appendix 4.

5-2-6 Data Analysis and Interpretation:

All interviews were tape recorded and transcribed verbatim with respondents' prior permission. I stored and analyzed all the transcripts and field notes using the TAMS Analyzer software program (Weinstein 2013). This is an open-source Computer Aided Qualitative Data Analysis (CAQDAS) software program that allowed me to code the data, sort the data according to the selected codes, search within codes and keywords, group together and visualize the themes, and provide summary reports. All transcripts were anonymized, and personal identification of interviewees were removed before their use and storage.

I analyzed the transcripts using thematic framework analysis (Ritchie and Spencer 1994), an analytic method frequently used in qualitative health policy studies. Unlike many other methods it combines both the thoroughness of a deductive framework (based on the study's aim, scope and propositions) and the flexibility of inductive thinking based on additional information identified in the data (Pope, Ziebland, and Mays 2000). Therefore it is highly appropriate in situations in which some predetermined objectives and hypotheses exist such as this study.

Analysis consisted of the following five stages: (1) **Familiarization**: immersion of the researcher in the data by repeated listening to audios, reading field notes and transcripts. (2) **Identifying a thematic framework**: discovering all key themes and concepts, by looking through the data, and referring to prior objectives and hypotheses, as well as emerging issues that rose in the study. At the end of this step, a codebook was developed, revised interactively during data analysis, and included in Appendix 5. (3) **Indexing**: applying the index to the data by annotating relevant phrases and paragraphs

identifying the related themes. (4) **Charting**: rearranging the whole data based on the thematic framework, and grouping all associated parts of the text together in the form of charts. In addition to the verbatim, these charts contained more abstract summaries of respondents' views and experiences. (5) **Mapping and interpretation**: connecting the relevant themes and redistributing them based on conceptual similarity, in order to explain and interpret the phenomena.

I analyzed the data for each health department separately. I developed a report of the findings by organizing all annotated texts from interviews by health department, along with a narrative explanation of the findings (Miles and Huberman 1994). Then, with the aim of developing a cross-unit synthesis, I developed word tables to compare the list of findings in the three health departments (Yin 2008). Subsequently, I reorganized the report of the findings according to the main themes, and provided department-wise findings within each section, as presented in the section 5-3. I provided quotes from interviewees, who will be identified as *informants* in the results, to support the interpretations. I present quotes from transcripts of interviews in italics to distinguish participants' views from my own. To increase clarity without changing intended meaning, where needed I removed some text segments (indicated by '...') and/or added words [in square brackets]. At the end of the quoted text, I provided an alphanumeric anonymous label referring to the interviewees (for example the label '5-A' represents the 5th interviewee from department A).

5-2-7 Mixed Methods Analysis and Integration

The overarching mixed-methods research question was:

How do the qualitative interviews with the influential staff engaged in KT intervention help to explain the longitudinal changes in the information-seeking social networks and EIDM behavior during the implementation of an organizational KT intervention in three public health departments?

I used four of the seven steps of mixed methods analysis of Onwuegbuzie and Teddlie (2003) that were most relevant to the current study:

Data reduction: Separate analyses of quantitative and qualitative data resulted in reduction of the dimensionality of data. The quantitative analysis reduced the data to graphical maps of networks, summary measures of network structure, and the results of statistical comparisons (chapters 2-4, and Table 11). The qualitative analysis reduced the data into themes overall and across study units.

Data display: I presented the quantitative findings using tables and charts. I organized the quantitative findings by comparing them between health departments. I presented the qualitative themes in the form of a narrative story of the process. I provided cross-unit analysis, comparing health departments, embedded in the narrative presentation of the findings.

Data comparison: I arrayed and organized both quantitative and qualitative data in a joint-display table (Appendix 6), as suggested by Creswell and Plano Clark (2011). Data in that table illustrated the findings of the quantitative network analysis in parallel to the corresponding emerged themes from the qualitative data, seeking to confirm, disconfirm, contextualize, and explain the quantitative findings.

Data integration: I integrated the quantitative and qualitative findings as a coherent whole, in which the qualitative themes and patterns, along with relevant quotes to complemented and expanded the findings of the quantitative analysis.

5-2-8 Strategies to Increase the Validity

I used several recognized strategies to increase the inference quality in this study. Leech, Dellinger, Brannagan, & Tanaka (2009) developed a “validation framework” to organize and unify information for construct validation and legitimation of mixed methods studies. I organized this section to address different components of this validation framework.

5-2-8-1 Foundational element:

This element refers to a thorough examination of past theories, empirical research, and researchers’ preconceptions that offer insight to the meaning of data, interpretations, and implications. Speaking of myself, I am a physician and health researcher with interest and experience in studying social networks, and a belief in the power of social influence. I have conducted a comprehensive literature review on relevant network theories that may influence the process of implementation of KT interventions, which are provided in chapter 1 and the theoretical framework sections of each manuscript in this thesis. The literature review informed the purpose, design, measurement, and analysis plan. The models and theories informed the formulation of study propositions and corresponding hypotheses.

5-2-8-2 Traditional quantitative elements:

I explained the strengths and limitations of each quantitative study in each manuscript separately. I used various graphical, descriptive, and analytic techniques to test the quantitative hypotheses. The sociometric approach to social networks captured a more realistic picture of the social structure, compared to analyzing a sample of the study population. The repeated assessments of social networks through time also provided the information that led to more valid conclusions about the potential causal associations, compared to a cross-sectional analysis of social structure. In the statistical models, I addressed the rival mechanisms of social selection, social influence, and the effect of common context.

However, the small response rate and the possibility of attrition of less enthusiastic staff resulted in a selective and biased picture of the process that likely depicts a more positive and supportive picture of the implementation of the KT intervention than what may have occurred. In addition, because the network questions relied only on the self-perceived behaviour of the respondents, they might not always reflect actual behaviour. They might also be subject to recall bias. Moreover, the long temporal distance between the before and after assessments might reduce the sensitivity of the analysis to more subtle and transient changes in social structure through time. Because of the above-mentioned shortcomings, as well as the lack of a parallel control group, the associations analyzed in the quantitative strand could be interpreted in different ways, and do not necessarily indicate causality.

5-2-8-3 Traditional qualitative elements:

I employed several strategies to increase the rigor and trustworthiness of the qualitative research findings using the four criteria of excellence of credibility, transferability, dependability, and conformability developed by Lincoln and Guba (1985). I describe each of the criteria and methods used to achieve them in some detail below.

Credibility; corresponding to internal validity in quantitative research, this is the description and interpretation of human experience in a way that the people who share that experience would immediately recognize it as portrayed by the researcher (Sandelowski 1986). To increase the credibility of the study, I used both quantitative and qualitative sources of data along with different supplementary resources (*data triangulation*), and analyzed the findings through matching them with rival theories and models (*theory triangulation*) (Patton, 2002). I presented the main themes of the qualitative analysis along with the overall interpretation of the qualitative and quantitative findings to two participants at each health department (for a total of six respondents) for their feedback (*member checking*) to assess the comprehensiveness and accuracy of descriptions and interpretations. Five of these six individuals replied to my email requests for confirmation of study findings, and noted that the results accurately depicted their experience and what they shared during the interviews. One respondent also suggested I place more emphasis on the role of geographical distance in the lack of connections between the divisions, which I addressed it in the report of findings.

Transferability; corresponding to external validity or generalizability in quantitative research, this is the ability to transfer the research findings and methods to

other groups (Thomas and Magilvy 2011). Transferability in qualitative research is not the same as generalizing from a sample to a population, but rather involves generalizing theoretically and through example. It is also the responsibility of subsequent researchers to decide whether and how to use findings from a qualitative study in their context/setting/population, based on adequate evidence or examples provided by the qualitative researcher. In the results section of the qualitative analysis (section 5-3) I provide a rich or “thick” description of the research context. I also provided a narrative story-like description of the research process along with the exact verbatim as needed to increase transferability.

Dependability; Corresponding to reliability in the quantitative paradigm, dependability is achieved when another researcher is able to follow the process of the study as it was carried out by the investigator (Thomas and Magilvy 2011). According to Lincoln and Guba (1985), there is a close tie between dependability and credibility. In addition, providing a detailed description of the study process will help future researchers to follow the same procedure for replication studies. The necessary details include the research design and its implementation, operational details of data gathering, and a reflective appraisal of the project (Shenton 2004).

Confirmability; comparable to objectivity in quantitative research, this refers to strategies used to ensure that the findings of the study reflect the experiences of the informants rather than expectations or views of the researcher (Shenton 2004). Confirmability is reached through providing a rich description of the methods and findings of a study, a narrative presentation of the researcher’s interpretations, along with

detailed documentation of the strategies taken to increase credibility of the findings. A key strategy to ensure confirmability is to maintain an *audit trail* or detailed documentation of the process and findings used in the study including raw data and how they were transformed into the final set of findings and/or recommendations that an external expert could use to assess the rigor of the study. The goal is to ensure that the findings and interpretations are supported by the data (Miles and Huberman 1994). After coding of the first interview, my supervisor independently coded one transcript, and we then compared the code lists to ensure the inclusiveness and consistency of the codes. I also developed separate trail documents for the study objectives, sampling frame, interview guides and codebooks, and presented them as a progress report of the qualitative analysis.

5-2-8-4 Mixed methods elements:

According to Tashakkori and Teddlie (2008), the inference quality in a mixed methods study is a factor of the design quality and interpretive rigor. Design quality relates to the appropriateness of the methods and procedures to answer the research question. I believe that a sequential explanatory design was highly appropriate to answer the overarching study question, as explained before. However, this analysis relies on the judgment of the respondents in qualitative interviews about the intervention's impact and their experience, which may be faulty or exaggerated.

I ensured the *interpretive rigor* and *inferential consistency* of meta-inferences by drawing conclusions that were consistent with the study purpose and guiding

propositions. I compared the findings with the relevant theories and previous research, proposing alternative explanations. I made interpretations that were more plausible than other possible conclusions and incorporated the findings of quantitative and qualitative strands in an integrative manner (Tashakkori and Teddlie 2008; Dellinger and Leech 2007).

5-3 RESULTS:

5-3-1 Overview:

In this section I provide a framework for the presentation of the qualitative findings. The following sections of this chapter are organized according to the classification I present here. I classified the main themes emerging from the data into three key categories related to the *context* of health departments, the *process* of the implementation of the KT intervention, and the *consequence* of the implementation and other parallel events that happened through the follow up period:

- **CONTEXT:** themes related to the informants' explanations about how their social networks were composed and how EIDM was related to the social structure. This category was comprised of the following sub-categories:
 - **The distribution of knowledge:** in this sub-category I included data related to how knowledge and expertise were distributed in the health department. The informants answered my questions about the characteristics of staff they had in mind to choose information sources. The two following groups of data emerged, which were related to the cross-sectional analysis of social networks at baseline (Table 11):
 - **Segregation:** the tendency of staff to choose information sources among peers who were closer to themselves in terms of organizational structure and solidarity.
 - **Centralization:** the characteristics of opinion leaders and factors that contributed to their popularity.

- **Friendly culture:** the role of friendship in social relations of the respondents, and how some central staff used those informal routes to influence the practice of staff in the department.
- **EIDM culture:** the value and relevance of EIDM to the respondents' practice and the norms in the department regarding its usefulness and feasibility. Even though data related to this subtheme were not directly relevant to the social network composition, they helped me contextualize the process of implementation, and explained varying engagement processes in the three health departments. I categorized main sub-classes of data in this category into the following groups:
 - ***Nature of decisions:*** the differences among organizational roles and divisions in terms of how they believed EIDM was relevant to their jobs.
 - ***Organizational norms:*** organization-wide beliefs among the staff of the health department regarding the relevance of EIDM to public health practice, and its importance in organizational strategic priorities.
 - ***Availability of formal EIDM roles:*** availability of formal roles and job categories related to EIDM to support the staff in the health departments.
- **ENGAGEMENT:** This category included the mechanisms by which certain staff were chosen to become engaged in the KT intervention, which was rooted in the leadership visions and strategies, and eventually affected the process and outcomes of the implementation.
- **Leadership support:** Involvement and support by organizational leaders, and how they promoted the implementation process.

- **Staff recruitment:** the process of selecting, motivating, and informing staff to participate in the intervention.
- **PROCESS:** this category included themes related to the process of the implementation of the KT intervention, particular organization-wide strategies that aimed to improve of adoption of EIDM, and influential actors in the process. The subthemes in this category explained the quantitative findings regarding the behaviour change of the staff towards EIDM and the longitudinal changes in the structure of networks and the position of staff (Table 11).
 - **Communications among highly engaged:** the channels through which the engaged staff communicated with each other, and how they affected behaviour change towards EIDM and the formation of ties among engaged staff.
 - **Communications with professionals:** the role of communication with influential actors through the process of the implementation, with an emphasis on the role of KB and the librarian.
- **OUTCOMES:** this category included subthemes related to the consequences of implementing the KT intervention. Like data in the Process theme, data in this category explained the quantitative findings regarding the behaviour change of the staff towards EIDM and the longitudinal changes in the structure of networks and the position of staff (Table 11). However the variables included in this theme were different, including:
 - **Inter-divisional connections:** the role of the intervention in the formation of inter-divisional connections vs. divisional independence.

- **Recognition:** the strategies and processes that led to the popularity and recognition of engaged staff in the departments.
- **Elite and ordinary:** negative reaction by the staff who did not have the opportunity to get engaged in the intervention (mainly based on the interviews with the informants in one department).
- **Resistance:** negative reactions to the intervention related to the workload, lack of knowledge, and engagement strategies.

5-3-2 The Context:

5-3-2-1 The Distribution of Knowledge:

Expertise and knowledge of EIDM were not distributed evenly among staff in the three public health departments. Instead, information-seeking networks were clustered mainly by organizational divisions and centralized around a small group of staff.

5-3-2-1-1 Segregation: In all three of the health departments the information-seeking networks were segregated by organizational divisions. Inter-divisional connections were very sparse. Informants identified various factors that influenced their preference to seek information from peers who were physically and organizationally closer to them than from other staff who might be deemed more professionally trained to help with EIDM but not perceived to be as closely linked. I classified key factors discussed during the qualitative interviews into three main themes: *physical proximity, shared values and assignments, and solidarity*.

Physical proximity of the information source made information seeking comfortable and less demanding, as explained by a project specialist at department A:

“One [reason they choose to seek help from me] is comfort level, if the staff know me already and I sit beside them or sit in their cubicle area. There is that level of comfort [in] just being able to ask someone you already know.” (5-A)

In addition, physical proximity increased the likelihood of more frequent daily contact, and those serendipitous interactions kept some names at the forefront of the mind. A consultant at department B explained about her experience of moving to another division as follows: “It is out of sight out of mind. So those people don't call me because maybe I am not in the forefront of their mind, or they don't see me”(4-B).

Another factor that explained the tendency of staff to seek information from peers in their own divisions was the similarity of experiences and relevance of assignments. Public health practitioners in different divisions worked on quite different public health problems, which resulted in the formation of specialized tacit knowledge and professional jargon. Staff found it a better use of their limited time to ask questions from peers who did not need a comprehensive introduction to the health problem at hand before being able to help with a certain issue. A project specialist at department A explained why peers sought out information from others similar to them in this way: “Knowing that they have had a similar type of situation before and they have had to do something like that, and they will have knowledge on it as a result”(5-A)

Solidarity was yet another determining factor, given that many health practitioners tried to prevent exposing themselves to others' negative judgment, as explained by a manager at department B: “There are some people; you call them and they would say, ‘You should know that’... I am trying to avoid calling those people, because I don't need

to feel like an idiot.”(1-B), or as indicated by a librarian at department A: “I am very selective in choosing people to ask from, and avoid the staff with judgmental behavior.”(3-A)

Friendship provided a safe and non-threatening context for seeking advice and sharing information without exposing people to embarrassment. Therefore health practitioners preferred to seek information from the peers they considered to be friends, as explained by a project specialist at department A describing the characteristics of the people she called on for help: *“especially if I am friends with them already, I would first call them, just because you are just more comfortable going to someone that you talk to every day already.”(5-A)*, or as mentioned by a public health nurse: *“I rely on informal connection, especially interacting with other groups” (3-C).*

5-3-2-1-2 Centralization: Especially in departments A and C there was a central organizational division to which the staff from other divisions turned for help, forming a clustered network with a central hub. This division had staff who filled administrative and supervisory roles, mainly by organizational leaders (MOH, AMOH), managers and project specialists at department A, and by organizational leaders and epidemiologists at department C. The informants at department A explained this centralized structure was a result of the exceptionally prominent role of the organizational leaders and a few managers as the widely recognized experts and champions of EIDM in the department. At department B, which was larger and had greater geographical distribution of divisions than the two other departments, the pattern was less extreme, and it was more difficult to

identify a prominently central division, mainly due to the difference in organizational structure.

In each health department, I identified the staff members who were in the fourth (highest) quartile of centrality in information-seeking and friendship networks at baseline, and labeled them local “opinion leaders” (OL), as explained in chapter 3. OLs were mainly managers or professional consultants whose role varied according to the job definitions in each health department. They included project specialists at department A, health promotion consultants at department B, and epidemiologists at department C. In departments A and C many of the OLs were based in the central hub division.

In qualitative interviews, OLs identified several factors for their exceptional centrality, which I classified into the following domains: *widely recognized expertise*, *supportive personality*, *formal jobs*, and *networking*.

OLs were known experts of EIDM across the health departments, as explained by a central manager in department A: *“People come to me because I am kind of an expert in this. I understand the process so I can help people navigate the process and help them decide where to get in.”* (1-A), or expressed by a manager at department C when explaining why she would turn to a central epidemiologist from another division: *“because [the epidemiologist] is very adept at interpreting the statistics and results from studies”* (4-C). Staff become aware of these individuals’ expertise either first-hand or through others’ recommendation and referral in three ways:

Through positive previous interactions (as explained by a manager describing the reasons staff chose her as an information source: *“I gave the answers to their problems before and have been helpful”*; 1-B);

-Through word of mouth (as explained by a librarian: *“because the supervisors go and update their teams and they have got information for management, and they heard [that I] did a rapid review. People hear that and sort of assume you have done a bunch of them”*; 3-A);

-Or by being referred by someone who had a positive experience before (as explained by a manager: *“Somebody they asked said, ‘Call [respondent’s name]. She will point you into the right direction”*; 1-B).

In addition to being recognized as experts, personal characteristics and communication skills were important determining factors for being an OL. The OLs were available to help others and were known by their peers as the experts who secure some time to help them use research evidence in practice, as explained by a project specialist: *“People say that I was really helpful, or, ‘I always know that I can come to you and you’ve got time to listen’”*(2-A). OLs had the reputation of addressing their peers’ problems in a non-threatening and non-judgmental way, as indicated by a manager: *“People see me, I think, as a fairly safe person to talk to, that I’m not gonna be judgmental or dangerous, and I can keep confidential information if I have to, but I can also help them with their problem.”* (1-A)

The OLs were also great networkers who could bridge unconnected groups and people and direct them to appropriate resources, as mentioned by a central epidemiologist

at department C: *“I know who works in what, so [when] they come to me I also say: ‘You know what? So and so also has done this before’.”* (2-C), or as explained by a manager: *“I sometimes help them connect with the librarians [to develop a] search strategy. I help them connect to the writing support. So I am kind of the connector of people into the existing process”* (1-A).

Ultimately, OLs did jobs that could only be filled by a person in a central position either because it was a professional consulting or management job that involved supporting staff and programs (as expressed by a manger: *“Some of it is just positional. It’s my job”*; 1-A), or a key position in the organizational hierarchy (as explained by a manger who stated, *“I think some of them are my staff so they come to me because of that reason”*; 1-C).

5-3-2-2 Friendly Culture:

Formal and informal networks significantly overlapped in all the three health departments in the study. However, only in department A were central staff in information-seeking and expertise recognition networks also significantly central in the friendship network (chapter 3). A few managers at department A clearly discussed the friendly atmosphere of their health department and the overlap between formal and informal connections:

Even though we are [a very big health department], it felt like what I call a mom and pop shop. It felt like a small place where everybody knows about the name of everybody else's dog, even though it was big. So they dress up for Halloween here. The commissioner dresses up for Halloween ... and we have Halloween parties... there is a lot of that kind of conversation in this health department. Even though it is big and crosses divisions...there is a lot of natural interactions. (4-A)

One possible reason for the strong friendship bonds among central staff would be a *slow turnover* of personnel at the managerial level, as indicated by a central manager in department A: *“I have known these people for 20 years. So the people that are in the central expert decision-maker level they are often people that have been around for a long time.”*(1-A) Two other possible reasons would be *being located in the same building* and the *frequency of social events* enjoyed by staff in the organization. A central manager at department A expressed the importance of frequent communication in facilitating the formation of friendship ties:

Being all in the same building here is so helpful. We run into each other in the cafeteria, the elevators. I think we also have enough events ... and you see the same people at those [times] ... the people that are in these networks cross over fairly frequently. It develops those friendship things. (1-A)

5-3-2-3 EIDM Culture:

Finding, evaluating, and applying research evidence are activities that are critical to public health decision-making. However, the extent and frequency to which they are applied in practice varied depending on the *nature of decisions* to be made, *organizational norms*, and *availability of formal EIDM roles*.

5-3-2-3-1 Nature of decisions: The value of research evidence in practice differed across public health disciplines and programs, with the greatest difference between public health nursing and environmental health staff. There was a consistent belief that environmental health context was quite different from other divisions in terms of the staff’s attitude towards the usefulness of EIDM to their practice. This is because staff working in environmental health believed that most of their practice was to enforce existing

legislation, as indicated by a manager at the environmental health unit of department C:

“Because a lot of the work we do is enforcement-based. We have regulations that we enforce, [so] evidence is not much used in some programs. It is used more in some programs like health hazard.”(4-C) On the other end of the spectrum, public health

nurses I spoke with recognized the relevance of EIDM to their practice:

I think as nurses we always practice EIDM, and so it is one of the things that we value as nurse professionals. I am not saying others don't value [EIDM]. I am just trying to help you understand the difference of service delivery versus having some of these program areas that need you to ensure you are doing the best practice on the regular basis. (1-C)

5-3-2-3-2 Organizational norms: Despite its importance in public health programs and the widespread demand for it, EIDM was not considered a part of formal job definition for many public health practitioners. As one organizational leader in department A explained:
“It's a tricky thing because they don't look at this work as local public health work. They think of it as extra work. They think of delivering service as local public health work.” (4-A)

In this context, the application of EIDM to public health decisions depended highly on the attitude and level of support by organizational leaders. The leadership support was more prominent at department A, where EIDM was an organizational strategic priority, and was demanded by the leaders even before the intervention, as expressed by the organizational leader: *“We ended up engaging a lot of people, because it was directly tied to what we are doing day to day.”(4-A)*

5-3-2-3-3 Availability of formal EIDM roles: Making evidence-informed decisions require team effort. Public health practitioners usually are not able to do it on their own,

and may need professional support to carry this out. To address this need health departments created specific roles for staff who would be expected to help practitioners through the EIDM process.

Project specialists at department A had formal responsibility for helping other staff find and apply research evidence in practice. They were assigned to practice-based divisions and in some cases to the central supervisory/administrative division. Many of them were Masters-level trained with formal coursework relevant to EIDM. At department A, the central project specialists already had higher-than-average EBP scores than other staff at baseline (chapter 3), so even before the start of the study some central staff had already been identified as experts in EIDM.

In department B health promotion consultants mainly helped other staff deal with research evidence. However, due to their diverse backgrounds and broad definition of their roles, health promotion consultants considerably differed in terms of their expertise in EIDM, their attitudes towards the use of evidence in practice, and its relevance to their jobs. It seems that the role of health promotion consultant was very broad and fluid, and differed in local divisions. Furthermore EIDM was not explicitly defined as part of their formal job. A health promotion consultant explained this diversity as the result of a previous organizational change at department B:

What complicates things is years ago we [underwent an organizational change] ... and they put the people from different health units into similar jobs and similar pay. But what they did unfortunately [is] – like, some job titles are very obvious, like dental hygienist, nurse. [But] everybody else that they didn't really know what to do with, for convenience they put them in the health promotion consultant [category].
(4-B)

At department C there was no specific organizational role directly created to help staff address EIDM issues. Instead public health nurses generally took on that responsibility under supervision of local managers. Therefore the local reporting hierarchy in the organization -- individual practitioners reported to their local managers who, in turn, reported to divisional directors who were connected to higher organizational decision-making levels -- was also applied to information-seeking connections, as explained by a manager:

The hierarchy is that people are assigned to projects by the manager. Then [if] they face [any] kind of problems or questions, they ask the manager [who] would refer [them] to appropriate person outside...something with regard to evidence, we probably started the discussion with the manager and within our team, and so that's why they don't go [to epidemiologists] first. [It's] the same for MOH and director, the staff go to the managers first then those ... it really does make sense that staff go to the manager for direction on EIDM (1-C).

The baseline network analysis at department C showed that some epidemiologists in the central division were among the most central information sources for staff addressing EIDM issues. However, epidemiologists did not believe that it was their job to deal with research evidence, mainly because their formal roles were more evaluation-oriented and “tied to the processes”, as mentioned by a central epidemiologist at department C when explaining why other epidemiologists did not consider EIDM as part of their job: *“they can consult or ask anyone of my [epidemiologist] colleagues, but probably my colleagues would say OK, I can help you here but [the interviewee] would probably do it faster and more efficient”* (2-C). Similarly as expressed by a consultant at department B:

We had epidemiologists who were picked to participate [in the intervention], and they said: 'We don't do any of this. We just go through the databases and we find data, and we give it to programs. This is completely irrelevant to us.' Even though towards the end we realized it is not irrelevant because sometimes they look at like what is the best indicator for diabetes... so they have to look at research. (4-B)

5-3-3 Engagement:

5-3-3-1 Leadership Support:

In the three health departments the decision to participate in the study, the level and breadth of engagement, and the mechanism of staff recruitment in the KT intervention, was mainly a top-down process initiated and supported by each department's organizational leaders.

The leaders of public health departments (MOH and AMOH) were potential initiators and champions of this process. This role was much more prominent in department A probably due to the charismatic character of their leaders, as explained by a project specialist: *"I think her style is to commandeer the resources that she needs. I sometimes get the impression that what [the organization head] wants she gets, in terms of staff time or resources or whatever."*(2-A)

The strong message given by the departments' leaders was very effective in showing support of the study and motivating the staff to participate, as explained by a manager at department C: *"a message from MOH; knowing that EIDM was a priority, and I think he had sent those messages to the staff a number of times. And so all staff in the department knew, and he often would bring it up whenever he could."*(1-C)

However, the role of the leader in championing organizational change towards EIDM involved more than merely expecting change from the staff and prescribing the

reform. The leader also needed to serve as a role model for the behaviour change. The leader at department A considered herself to be a mentor who supported the staff through the process of EIDM: *“I am their mentor and I see my job as making sure that everybody who embarks on findings and applying research is successful. We set a pretty high bar for the reviews that they do”*(4-A). She personally led the regular appraisal meetings, interacted with each review team, and prepared them for presenting their project to the MOH. At department A, all rapid reviews had to be presented to the MOH in a formal meeting, which was widely recognized by the staff as both a difficult and prestigious meeting:

When they finished it, they would go and talk about what they found and what it means. And the MOH goes into the findings in very great details. So we create these data extraction tables, and he goes in and looks at effect size, study design, sample size and so on. In order to prepare our people for that one hour with the MOH, we spend at least an hour and sometimes more getting them to practice talking about the research evidence, anticipating that he is gonna ask a lot of details. So right from the very top, there is a detailed focus on what it actually says, and what the issues are with the research... it is like defending your thesis, and all their colleagues will see they came out alive and MOH is happy and it is up on the website. (4-A)

The role of the leader in the process of implementation was never brought up in the interviews at department B where decisions about study recruitment and the level of involvement was left more to each division. Some divisions had a high participation rate and others refused to participate. As explained by a manager in department B, *“What we had is it was really left up to different [divisions] to set their own level of involvement, and many of them sadly did not pick up the opportunity”*(1-B).

5-3-3-2 Staff Recruitment

The level of organizational involvement in the intervention and recruitment strategies were influenced by how the departments envisioned organizational change. Department A, which was already implementing strategies to achieve their strategic direction towards EIDM, used the KT intervention in this study to further support its ongoing capacity development strategies. Before involving eligible staff in the intervention, the department sent several staff members to a series of university-affiliated weeklong workshops on EIDM and continued sending different cohorts of staff to the workshop throughout the study period. This intervention was not a part of the implemented KT intervention but prepared the context and influenced the process of the implementation of the intervention. These independent activities to promote EIDM rooted in the organizational leader's 'change management theory':

The reason was the change management theory that I was using said in order to embed these processes in the culture of the organization, and make them the way we do our work, I needed at least a hundred people who could do it, out of the six hundred. So I targeted them all. (4-A)

With the aim of fulfilling the envisioned organizational change, department A targeted a group of staff whose professional roles were relevant to EIDM for engaging in the intervention, as explained by the leader: *"We chose participants by the roles in the organization. Every specialist, every supervisor, every manager is eligible to participate. And we have systematically tried to enlist every single one."*(4-A); and by a manager: *"There was a pretty solid mandate to say, for example, if you are a manager or a specialist then you should go... we didn't say you must go... it's in their job to be that*

person”(1-A). The strong message by leaders asking for participation resulted in perception by some that “*staff were kind of forced to go to the workshops*” (3-A). This, in turn, negatively impacted staff’s motivation, as explained by a librarian at department A: “*You didn’t have a choice. [The] organization expected you to do so. It was like force feeding the staff.*”(3-A).

In departments B and C the engagement of staff was mainly in the form of one-time involvement in the development of short evidence-based reviews, unlike the continuous strategy in department A. At departments B and C, staff involvement was more based on the relevance of people’s jobs to the predetermined health problems that they were designated to work on through the course of the KT intervention. Program managers chose relevant staff, as explained by a health promotion consultant at department B: “*the management team chose them because of programming gaps and issues that they wanted addressed, and so chose the topics... and then assigned staff, I guess, based somewhat on workload and somewhat our assignments*” (2-B). A similar mechanism was used in department C, as explained by a manager regarding the factors managers had in mind when choosing staff: “*a) [someone] who is interested, and b) [the] activity or assignments that they have*” (1-C).

At department B, health promotion consultants were the most frequently chosen to develop evidence reviews. In department C nurses were the main group recruited by program managers because of the relevance of their prior experience to the chosen health problems. As explained by a manager:

It would be very hard to do it otherwise because they are assigned to specific work. So if I had a staff [member] who was not assigned to that work, that means she has

less time to do her other work. And she wouldn't be able to do it. Because we just don't have enough resources. (1-C).

A recurring theme in the interviews that appeared most frequently with participants from department B was that at the beginning of the PHSI study the staff were not fully aware of what the intervention was about, how evidence would be useful in their practice, why they had been chosen to be trained, and what were they supposed to do with whatever they would learn in the training. As explained by a consultant: *"I kind of found we were really in the dark, I just got an email [that said], 'You are coming to this meeting so you are gonna look at this topic area' ...and personally when this is over I don't even know what is gonna happen."*(5-B) Another consultant at department B told the story of miscommunication between the managers and staff regarding the aims of the study and the reasons for choosing certain staff to participate: *"So they picked a whole bunch of health promotion consultants. So I remember a consultant ... who wasn't even told why she was there... It was not marketed like: 'here is this initiative; who is interested?' It was like: 'you have been selected'."*(4-B)

Compared to department A, it seems that expectations from managers at departments B and C about study participation were not as clear and enrollment tended to be more voluntary. As explained by a manager: *"[it] wasn't really saying all managers have to participate in the intervention."*(1-C) This may be because at departments B and C managers were not expected to be directly involved in EIDM processes. They considered their roles instead to be that of overseeing the process, with the rapid review work being done by their staff, as explained by a manager in department C: *"Actually*

managers probably don't write those reports. It is staff. Managers oversee it but it is the staff who are involved in writing the EIDM reports. Mainly nurses.” (1-C)

Despite their central positions in information-seeking networks, during the implementation of the KT intervention at department C the epidemiologists were not invited to be involved in the study. This could be as a result of their attitude regarding irrelevance of EIDM to their jobs (as discussed in section 5-3-2-3-3) and also the problem-oriented and division-based nature of staff recruitment in this department, as explained by a manager at environmental health: *“to be honest, I never thought of involving them. I thought we were supposed to keep it within our divisions.” (4-C)* Only one epidemiologist was brought on board and subsequently shifted towards the center of the information-seeking network, mainly because of her personal interest and background in EIDM.

5-3-4 Process:

5-3-4-1 Communications among Highly Engaged:

Co-participation in workshops and regular progress meetings provided highly engaged staff with an opportunity to share their concerns and progress in development of short evidence reviews with their peers, and shape new social ties. However, this communication had to be facilitated and sustained through regular progress meetings and workgroups. The informants at department A recognized the university-affiliated weeklong workshops, which happened before the intervention and in a location outside the department, as the first important step in forming ties among the participants,

especially due to their longer duration, as opposed to the workshops in other divisions which were mainly one or two days long and were held in the staff's workplace. Even though it was not a part of the KT intervention, co-participation in the mentioned workshops in department A established connections and facilitated the recognition of experts through the process of the intervention. As a manager in department A explained about how the co-participation enhanced the formation of ties among staff:

Because we all went to [the university affiliated one-week workshop] as a group, and especially in those early years [we formed close ties]; went to have a couple of drinks together, went for dinner, and we kind of bonded a little bit cross-divisionally those groups that went to [the workshop]. (1-A)

This view was echoed by a project specialist at department A who stated:

Going to [the workshop], having that week away together helped us, because we were in groups with people from other divisions, and also we were in a learning environment and had learning activities, and we all stayed at a hotel and did work in the evenings. (2-A)

After the (week-long or single-day) workshop, staff of each health department were assigned to short evidence review development teams and worked under the supervision of a KB on the development of reviews addressing the local public health issues. At department A the evidence review teams gathered in regular progress meetings moderated by the KB and the organizational leader. To maintain the newly formed social ties it was very important to continue communicating through progress meetings. The main effect of continuous interaction in those meetings was observing each other's progress and learning from each other's experience, as explained by a project specialist at department A: “[For] six to eight months we were meeting every couple of weeks. So we

were hearing what other people's projects are and watch them struggle, and think, 'Oh! They find synthesis just as difficult [to do as I do]'”(2-A). Another participant shared a similar perspective: “People often would say at the end of meeting: 'Oh! I found it so interesting that such and so were having this problem, because that was my problem too.’ And there was a lot of identification with other people's process and experience” (4-A).

Communications among the work groups were much more limited in departments B and C, and mainly limited to the separate meetings of short evidence review team members and KB. So the initial effects of the co-participation in workshops were transient, and did not last long, since they were not followed by regular meetings among groups, as happened in department A. A consultant at department B explained this as follows:

Way back at the beginning, it was an introduction to PHSI, it was a cross-section of people. But at that point, people didn't even know where we were going to, it was so early in the process, there weren't any structure that I know of, points and times for us, to come together initiated by the health department or by PHSI, I don't recall. (2-B)

Or by a manager at department C:

We had regular meetings with [KB] ... The [team member] and I. We would meet sporadically about it; usually before meeting with [KB]. We didn't have scheduled meetings. But we met [KB] regularly. (4-C)

5-3-4-2 Communications with Professionals

Two key themes emerged regarding the communication of staff with EIDM experts through the implementation of the KT intervention: the role of the KB and that of the librarian.

The KB was the main deliverer of the intervention and had a critical role to fill in all steps of the process at each of the public health departments. At department A, the KB was heavily involved in leading the rapid reviews and appraisal clubs, and had a close relationship with the organizational leader. As a result, the role of the KB at department A was very unique and well-recognized, as pointed out by the organizational leader:

“Everybody in this organization sees the [KB] role as absolutely central for success. And every time I say, ‘Well, where I am going to get the money for this?’ I say. ‘I better find it because we are not losing it’.”(4-A) As a result of successfully promoting EIDM her contract with the health department as a formal KB was extended even after the end of PHSI study.

One reason the KB was so deeply embedded in the EIBM processes at department A was that she was brought on board after the process had begun. As a manager in department A explained, *“There was the [KB] in the intervention [and she] came into a kind of a system that was already flourishing, and she added a very helpful part.”(1-A)* The KB served as a link and bridge in the department, as expressed by a project specialist: *“She knows staff in all divisions, she says: ‘Oh, actually we had a similar experience in that division’. So she kind of links projects together and she can transfer learnings from one division to another.” (5-A)* In addition to these personal characteristics, the location of her desk was mentioned frequently as a reason for her high degree of approachability, as pointed out by a project specialist at department A:

Her desk is right opposite the office of MOH. So she is not buried. She is front and center. There is even a sort of drive-through window shelf. She is not even behind a full wall. So there is a low wall. Then you can see visually. Anyone who walks by can see it. (2-A)

Another reason for this wide recognition would be that the KB was widely seen as an external and neutral person, not involved in the policies and hierarchies of the department, as noted by a project specialist in department A: *“She is objective in the sense that she is not involved in the dynamics and politics in each division, so if you go to her for advice she can provide that without having those things in mind. I think she can kind of give you her opinion without taking politics into consideration.”*(5-A) Having such a central role in the EIDM process at department A explained why only the survey respondents in this department identified the KB as a central actor in information-seeking and expertise-recognition networks in the quantitative survey.

On the other hand, this extra-divisional and non-judgmental role of KB had its limits. Her leadership role and close collaboration with the organizational leader resulted in the formation of some boundaries that limited the types of questions staff would share with her. As indicated by a project specialist:

I know sometimes certain things won't go to [the KB] or won't be sent to her, because we know that if [the KB] sees it, that means other senior management would see it, and there is something that we are not ready, not to say we are doing secret work, but if it is not ready or at a stage we are not comfortable to bring it to that level...Because once it is seen at that level then the whole thing could change.
(5-A)

The informants at departments B and C did not consider the KB as exceptional and influential as those in department A, despite the fact that the KB at departments A and C was the same individual. The informants at these two departments mainly considered the

KB as an external expert who could help them develop short evidence reviews, as explained by a consultant at department B:

[KB] is great in terms of just kind of setting us up in the process, and then as [a colleague] and I were working on the stuff it was nice to have another kind of person to go through if we wanna to run by our interpretation of some of the results. Yeah I think that was a really important role. (5-B)

Similarly a manager at department C noted: *“it was very helpful to have someone to go to, to be able to help us with those steps along the way. So I think it was that part was certainly appreciated.” (1-C).*

In addition to the formal role played by the KB in promoting EIDM, at department C, the KB became involved in organizational policy development. With the help of the KB, the department promoted its policy and procedures in line with EIDM, and developed an EIDM user’s guide. The user’s guide has subsequently been included in the nursing education curriculum in a university that had close connections with the department.

Another important professional supporter of EIDM through the implementation of KT intervention was the librarian associated with each department. Although the public health librarians were considered to be an integral part of EIDM process by the informants in all the three health departments, the perceived level of involvement and usefulness of librarians differed considerably across sites. At department A, during the study period the department hired new librarians who were formally assigned to do rapid reviews and develop and update search strategies. Likewise at department C the librarian was involved in the process and was helpful in assisting staff through EIDM steps. In

contrast at department B a recurring theme in interviews was that the library system did not help staff meet EIDM standards. The library basically provided “*a million single studies*” and the staff struggled with classifying and appraising the information, as expressed by a consultant at department B:

One of my biggest frustrations, which is not PHSI's fault, is PHSI was trying to work organizationally with [Department B], and one of the greatest barriers is the way our library access is used. If you follow the PHSI process you can stop when you have enough higher level of evidence. When you request a search by the library you get a stack of papers with no order, a mix of single studies and systematic reviews. You get a hodge-podge which for most of us... I wouldn't have before PHSI known how to tease [out] what was what, how to quickly go through and see which one was synthesis and which one weren't. It is a bit overwhelming. (2-B)

The role of librarians in the EIDM process was not limited to only providing useful information and assisting staff in appraising it. Because of their accessibility, neutrality and distance from local politics and formalities, and their cross-divisional position they also acted as supporters and brokers. The staff at department A also looked at the librarians as neutral outsiders who were easily accessible, as expressed by a librarian: “[The] *library is not in a division, it is in the office of MOH between 6th and 8th floors where many people work. It is physically approachable.*” (3-A)

Some highly engaged staff shared their concerns regarding the burden of their work with the librarians, one of whom who noted “*People were telling the librarians about those negative aspects [of their work] and the burdens and frustrations [they felt]. They saw us as psychologists.*” (3-A)

Because of their extra-divisional role, librarians were able to connect projects and bridge organizational silos, a similar role that was identified for the KB, as explained by

the librarian: “*I [am the] link between people, so I can connect people with the ones who already had done that work. Because the organization is siloed and there are several parallel projects going on, people may have similar questions and needed to be connected.*” (3-A)

5-3-5 Outcomes

5-3-5-1 Inter-Divisional Connections:

Many inter-divisional ties did not last long, likely because the forces and motivations to communicate within rather than across divisions were stronger, as pointed out by a project specialist at department A: “*Because the work tends to be quite different in different divisions, and there are different politics and different dynamics, we tend to go to staff in our division for support.*” (5-A) The communication among divisions was limited to attending similar events, and the nature of intervention was basically intra-divisional. Therefore the intervention probably did not promote forming significant interdivisional bridges. However, those cross-divisional meetings and conferences were influential in promoting the recognition of highly engaged staff as experts, and raising awareness about what was going on in other groups, as explained by a project specialist at department A:

You are still from your own division so unless you know each other well you might not chat a lot. But at the same time you get to know new faces, and you get to know what other work people are doing and how other projects going on. Because you tend to be within the bubble of your division, I did find those [new contacts] very helpful and people appreciate those cohorts a lot. (5-A)

One benefit of the intervention was it empowered the staff in practice-based divisions to independently deal with evidence. This was more prominent in departments

B and C where the local EIDM experts were not available at the practice-based divisions at baseline. At department B the intervention reduced the need for external consultations to the library or other divisions, as explained by a consultant in a practice-based division:

I hate to say it, we can go to our epidemiologists, but they are so busy. It is hard to get support from them. That's why in a way PHSI is great. Because it decentralizes the expertise to our own staff. Because we are kind of on our own sometimes it is important to build that expertise within our divisions. (5-B)

Similarly, at department C, staff who were trained in the intervention became more independent and autonomous, which resulted in a decrease in their reliance on external consultations from epidemiologists and library, as indicated by a manager:

I think before the study we probably turned to the admin epidemiologists more frequently as public health nursing division, and the health librarian, compare to what we do now. I think what we do now; nurses can do independently and seek help if they need further assistance. (1-C)

5-3-5-2 Recognition

Especially at departments A and C, highly engaged staff had various opportunities to present their work to a larger audience. This allowed them to share their successes with a broad population, both inside and outside of the health department, as explained by a manager at department C: “Twice a year we have our research and knowledge exchange symposium, and so all the department is there to hear about EIDM, and they see and hear from various sources who is knowledgeable on the topic” (1-C). Presenting work in those venues resulted in widespread recognition of highly engaged staff by their peers, as expressed by the leader at department A: “If your work has been showcased in that venue people from all over would say, ‘Oh you did a really good job on that’. They might not

even know the name of that person before, and all of a sudden they know who they are.”(4-A) As a result of this increased recognition and visibility, some highly engaged staff migrated towards the center of the information-seeking network (chapter 2), as explained by a manager: *“because of that reputation they became more central then. Because [highly engaged staff] were actually more able to help people.” (1-A)*

Organizational leaders also had a significant role to play in recognizing highly engaged staff, as explained by a central manager at department A: *“Because there is kind of a little bit of mystique about rapid review businesses ... [the leader] makes a big fuss about it. When you get in the meeting with [the leader], there is a fair amount of social capital attached to joining the rapid review. It's a little bit like you are kind of famous!”(1-A)* The recognition of the newly gained expertise of highly engaged staff also happened through word of mouth, as pointed out by a manager at department C: *“Here we are a smaller division; lots of people just knew [who were engaged in the intervention] by osmosis. Because we talk, at our managers meetings we talk about it.”(4-C)*

As the information spread through word of mouth, sometimes it became exaggerated and unrealistic. As expressed by a project specialist at department A:

People would always say..., ‘Oh, you have done so many rapid reviews, like 8 rapid reviews.’ They actually think that I did at least minimum of 5 rapid reviews, and I said, ‘Actually I have done 1, and I am working on the second’.... because the supervisors go and update their teams, and they have got information for management, and they heard [person X] did a rapid review, and people hear that and sort of assuming you have done a bunch of them, so you are the ‘queen of rapid reviews’ or something. (5-A)

In contrast, in the larger and more diffuse public health department, word of mouth was not as frequently invoked. So engagement in the intervention did not result in

a gain in prestige, as suggested by a consultant at department B: *“The people who were involved were selected and were sent stuff electronically that wasn't in our newsletter or anything. So I don't think they had any exposure.”*(4-B)

5-3-5-3 The Elite and the Ordinary:

An interesting and unanticipated consequence of department A's strategy to target project specialists and managers, and promote the individuals who were engaged in KT activities was a negative reaction of the staff who were not chosen to take part in the intervention. The selected staff enjoyed working in an *“ivory tower”* environment of recognition and prestige. But many staff who were not chosen felt left behind, as indicated by a librarian in department A: *“That mechanism of picking resulted in emotional responses for not being chosen... because they were not viewed as elite. They were not part of the club.”*(3-A), As another project specialist in department A noted:

I think the front line staff that were not been sent to [the university-affiliated one-week workshop], they felt left behind and frustrated, because it was like all these staff specialists are moving forward and advancing their skills, and they are gonna be used more and appreciated more by management, again this is the sense I got. That definitely caused tension, feeling of that ivory tower of the specialists. (5-A)

Paradoxically, being chosen for training resulted in a heavier workload and more pressure due to greater responsibilities. Prestige and workload were positively correlated, as explained by a project specialist: *“but there is also more pressure on us too, so it goes both ways. For if you got more trained there is also more pressure on you to do more work”* (5-A); or pointed out by the leader of department A: *“We happen to have created very hard work that seen as very desirable to do.”*(4-A)

This conflict between the role and interest could not be resolved easily because it was mainly rooted in the role definition in the organization. The organizational leader at department A discussed this as follows:

They are hired specifically for other kind of work. And there is not a lot of overlap and that's intentional. And that's from the senior team.... A little bit of union thing. People are hired for particular types of work. And even though they might wanna do another kind of work, it is the role they are hired for, and from an HR perspective you can get a lot of role creep. And in this organization this work has been decided by the senior leaders to be the work of specialists. (4-A)

The informants at departments B and C did not observe such reactions among staff. For example, when I asked about the possibility of such reactions a public health nurse at department C indicated: “*it is not about the prestige*” (3-C). The staff who were engaged only became more skilled to help others and not necessarily more popular or advantaged.

5-3-5-4 Resistance:

Not all staff responded positively to the intervention. The main reasons for resistance stemmed from *involuntary participation* (discussed in section 5-3-3-2), *heavy work load*, *disconnect from the common view of public health practice*, and a *disconnect from real problems*. It is noteworthy that a few respondents raised the issue of resistance when describing their observations of other staff’s reactions but not as their first-hand experience. So the following themes do not reflect the direct experience of respondents.

The process of developing short evidence reviews was time-consuming and burdensome, as expressed by a librarian at department A: “*Many [members of our staff] would say they do not want to do it again, because it was very resource intensive and also in addition to their normal work, it had to be done quickly.*”(3-A) The problem was even

more visible in department A where this hard work was accompanied by the expectation of higher standards of quality by the leaders, as explained by the leader:

I've heard feedback that people really got a lot out of the first rapid review they did but they are not eager to do it again. It was too much work. My idea had been the more you do this you get faster... So everybody always complains about how much work they have. I don't know if I ever had somebody say, 'Oh, it wasn't too much work. I could manage that.' And at the same time they almost all really liked the result and felt very confident about that. (4-A)

In addition, changing expectations and culture were stressful processes for some staff who were used to another practice style, as indicated by a project specialist at department A:

There definitely was resistance to [the practice change towards EIDM], and even about why we are not supposed to use single studies [and instead] we have to find systematic reviews and guidelines, and people didn't know why.... [It leaves] people feeling probably inadequate. I am not Masters-trained, I don't have this knowledge. [And so it's] scary for people because they may have thought their job was at risk, or is their position still relevant to practice. I think all of those emotions came up throughout the process. (5-A)

Staff also showed resistance when they found the intervention, and EIDM in general, irrelevant to their roles and job definition, as explained by a manager at department C:

I found the process somewhat complicated even though I know it doesn't necessarily meant to be, but I think the way we were seeing is that: here is the main work that we have to do and here is the process, separate, while really they should be integrated. (4-C).

This confusion about the relevance of one's role in relation to EIDM was prominent among health promotion consultants at department B who worked in a consulting division with a newly developed organizational structure where staff were not

sure about their role and the relevance of EIDM to it. As explained before, the role of consultant was defined broadly in department B, and could include roles that were not always relevant to EIDM. However, all consultants were invited to participate in the intervention, as explained by a consultant at that department:

Staff kept resisting, talked to [the researchers]. [The PI of PHSI] had to come in the end because they kept saying, 'This is irrelevant to us, I have done this in my Masters'. We had such a hard time finding staff who do this kind of work; they were very resistant. One person left the meeting and she was like, 'I've done this a million times, but I am not doing this right now. Why am I being forced to sit [here]?' (4-B)

The other reason for resistance by consultants at the newly developed division in department B was their lack of involvement in everyday public health decision-making. Therefore they were not engaged in the development of evidence reviews to answer local public health problems. EIDM was defined as a part of these consultants' formal roles. However, they were not directly involved in daily public health practice. Instead members of the practice teams would come to them when they have already reviewed the evidence and were looking for help on how to evaluate a new program. Therefore there was no opportunity for the consultants to become involved in the development of evidence reviews from the beginning. They therefore felt that the training they received was irrelevant to their job description, as explained by a consultant at department B:

In [practice based divisions] it went well. The staff were in the program and had the research questions. They were being trained, and they are the ones who do the work [that] we as the consultants previously did in the directorates. But here the structure has changed, and we were trying to fit a square peg into the round hole. ...So during two years we went to the workshops and did all the work, but we didn't have any examples; even at the follow up EIDM we really struggled. (4-B)

5-3-6 Summary

The qualitative case-study was designed to explain and contextualize the quantitative findings of the network analysis. The unit of analysis (case) was information-seeking in a public health department and how this process interacted with the implementation of an organizational intervention to promote EIDM. The study was bounded within the structural and contextual boundaries of the health department. The three health departments served as the embedded units for the analysis, enriching our understanding of the phenomenon by providing varying contextual and organizational characteristics. The development of sampling frame and data collection of the qualitative strand was informed by the quantitative findings.

The informants (the highly engaged staff of three health departments who were chosen based on their centrality in social networks) explained the mechanisms of choosing an information source, opinion leadership, the evolution of networks over time and their interpretation of quantitative findings, in focused interviews. The informants believed that the information-seeking networks were segregated by organizational divisions because the peers in the same divisions were more readily available, shared values and assignments, and were more likely to be friends.

There were also some highly central information sources in each network who were chosen by many due to their expertise, supportive personality, formal jobs, and networking capabilities. The importance of EIDM in public health

practice varied in departments and divisions, depending on the nature of decisions, organizational norms, and availability of formal EIDM roles.

The engagement of staff in the development of summary evidence reviews (as part of the intervention) was heavily influenced by the support and championship of organizational leaders, and the way the organization envisioned the role of the intervention in building capacity for EIDM. Staff involved in the intervention were mainly chosen by the program managers, based on the relevance of their roles to EIDM and the local public health problems to be addressed through the intervention.

Communications among highly engaged staff through co-participation in educational workshops and ongoing progress meetings was influential in overcoming personal and normative barriers to implementation of EIDM (by observing the progress of other teams, and being reinforced by positive feedbacks), and forming long-lasting social connections among staff.

The departments' KB and librarian were potential brokers and facilitators of the EIDM. They also played a pivotal role in the implementation process if their activities were integrated into the daily practice in health departments and reinforced by support from leaders.

Inter-divisional connections were limited and transient, and the effect of intervention in increasing the capabilities of local staff in EDIM limited inter-divisional consultations even more.

Organization-wide presentations and meetings facilitated the recognition of expertise that highly engaged staff gained, including their reputation as experts according to their peers in different divisions. In smaller divisions the role of word of mouth in disseminating knowledge about the expertise of highly engaged staff was more prominent.

The selective nature of recruitment, and the subsequent prestige and isolated ('ivory tower') experience of highly engaged staff (especially in one health department) resulted in a negative reaction by staff who were not selected for engagement in the intervention. On the other hand, some engaged staff considered the EIDM process to be time-consuming and burdensome, an increase in their workload in addition to their usual public health responsibilities, and not as an integral part of it.

CHAPTER 6-Integration and Conclusion

6-1 OVERVIEW

I performed a series of analyses on the interrelationship between social networks and the implementation of a tailored KT intervention in public health departments. The analysis of social networks at baseline provided a picture of structural characteristics of three health departments, and how information-seeking networks were shaped and situated in the organizational structure. The longitudinal analysis of networks (chapter 2) answered how the social networks, as the part of the process and outcome of the implementation, evolved over time. The longitudinal analysis of the effect of network composition on EIDM behaviour (chapter 3) answered how individuals' position and connections affected behaviour change towards EIDM, assuming networks as contextual opportunities and constraints for the adoption of new behaviors. The explanatory qualitative analysis (chapter 5) provided an insider view of the process, which helped contextualize the quantitative findings and further interpret them.

Aforementioned studies shed light on the implementation process through different methodological and theoretical lenses. By triangulating them it was possible to provide a more detailed and rich understanding of the case. In this chapter, I integrate the quantitative and qualitative findings to address the original propositions of the study, interpret them in light of the KT and SNA literature, and provide research and practice implications for the implementation of EIDM in health care settings. The chapter includes the following sections:

The distribution of popularity/power: I discuss the findings of the analysis of the evolution of networks over time in three public health departments in Ontario, Canada,

(chapter 2) and how the qualitative analysis helped expand and explain those findings (chapter 5). This section addressed propositions #1 (longitudinal change in network reciprocity), #2 (longitudinal change in network centralization), and #4 (longitudinal changes in popularity).

Interdivisional communication: this section addresses proposition #3 (tendency towards inter-divisional connections) based on the results of the longitudinal analysis of networks (chapter 2), and staff's viewpoints about them.

Social influence of OLs: I discuss the analysis of social influence on behavior change of staff towards EIDM (chapter 3), and their interpretations from the key staff's viewpoints (chapter 5). I addressed hypotheses #5 (the social influence of highly engaged), #6 (social influence through friendship ties), and #7 (social influence of engaged opinion leaders).

Implications for implementation of KT interventions: I discuss how the findings from this study can inform future KT practice and research in the health care context.

6-2 THE DISTRIBUTION OF POPULARITY/POWER

6-2-1 Integration of Findings

I studied the changes in the distribution of knowledge in the networks over time (chapter 2), testing propositions #1 (longitudinal change in network reciprocity) #2 (longitudinal change in network centralization), and #4 (longitudinal changes in the popularity of highly engaged staff). Analysis of the network evolution showed that the networks in the three health departments evolved towards a less reciprocated and more centralized structure, with increasing popularity of already central staff. These findings were more prominent in departments A and C, where the KT intervention was adopted by a larger group of staff. The analysis also showed that in all health departments, staff with higher baseline and greater improvement in EBP scores became more popular over time. Only at department A did highly engaged staff became more popular over time.

The qualitative analysis confirmed and explained these findings (chapter 5). Especially in departments A and C, there were a few highly popular staff who were identified by several peers as information sources and experts. Staff mainly turned to them for information as a result of their widely recognized expertise (first-hand experience or through word of mouth), supportive personality (approachable, helpful, non-judgmental), formal roles (consulting roles or a part of the organizational hierarchy), and networking capabilities. In contrast in department B, probably due to different

organizational structure and wider geographical distribution, staff tended to turn to local experts for information.

Qualitative analysis showed that the central staff in information-seeking networks had a better chance of being recruited for the KT intervention (more prominent in department A) and become exposed to other EIDM trainings because of the relevance of their formal roles to EIDM activities (such as project specialists) and their reputation for being knowledgeable in EIDM (such as local opinion leaders). This explains the ever-increasing popularity gain of already central staff ('the rich get richer') that was observed in all three of the health departments.

Some health departments provided venues for presenting and recognizing highly engaged staff by a larger population. Means included poster presentations at department-wide conferences, lunch and learn sessions, and regularly scheduled journal clubs. These routes acted as channels to increase the awareness of staff of the expertise of highly engaged peers, and to encourage the highly engaged staff to become even more active by receiving positive feedback from many of their workmates. The popularity gain of knowledgeable staff appeared to be as a result of large-scale, department-wide presentations of their activities, and resultant change in attitude of staff regarding the importance of EIDM and the need for seeking information from experts. This explains the tendency of networks towards centralization around already popular and more knowledgeable staff over time.

An interesting finding in department C was the increased popularity of central epidemiologists over time, even though most of them did not engage in the

intervention. The qualitative analysis of data from respondents working in department C revealed the lack of formal EIDM roles to help the staff through the process. Staff mainly considered epidemiologists as experts in the field (despite epidemiologists disagreeing with this). Increased popularity of central epidemiologists in department C could be the result of a larger perceived need in staff to turn to experts for EIDM issues, as a consequence of the intervention.

In summary, the integration of the quantitative and qualitative findings showed that selective training and recognition of professionals in EIDM facilitated the identification of experts but also deepened the knowledge gap among various groups of staff. The analysis also highlighted the importance of communication and presentation channels in enhancing the recognition of EIDM experts. These channels should be established and nurtured by organizational leadership.

6-2-2 Interpretation

The popularity of experts is a positive sign showing that staff recognized the expertise of knowledgeable peers and were able to establish connections with them. According to the *transactive memory* theory, in a closely connected community knowledge is encoded, stored, and retrieved in a system shared by different members who enjoy a collective memory of where to find certain knowledge by communicating with each other (Wegner 1987). An important prerequisite for turning to experts for information is to be aware of their existence (Wegner, Erber, and Raymond 1991). In other word, staff need to first know where the desired knowledge is stored in the community in order to retrieve it. Social events facilitated the awareness of staff about the

existence and accessibility of experts in the organizations, which resulted in their increased popularity.

In addition to staff who were central to the EIDM process before the intervention, staff with higher EIDM behaviour scores at baseline also migrated towards the center of social networks over time. These people could be considered as early adopters and champions. They are theoretically known as risk-takers and innovators who adopt an innovation earlier than their peers and therefore may serve as role models for others. They may migrate towards the center of networks and even later become OLs (Schreier, Oberhauser, and Prugl 2007; Perry-Smith and Shalley 2003). Lead users stand at the border of a network and bridge network clusters so that they have access to more diverse and novel sources of knowledge than their peers (Kratzer and Lettl 2009), whereas OLs generally stand at the center of local clusters.

In this study, librarians in departments A and C filled lead user and broker roles. They acted as objective, independent, and knowledgeable information sources for staff of various divisions, and were recognized over time by many as filling these positions. This bridging role is consistent with what some scholars suggested for librarians, to be seen as more than mere suppliers of the information and to communicate with and connect various disciplines and groups (Guinea 2003). The advantageous position of librarians in social networks could partly be explained by their bridging social capital (Szreter and Woolcock 2004). The brokers who connect separate segments of the networks have competitive advantage over other members because they have access to and can control the flow of non-redundant information between groups (Burt 1997).

Social capital theories explain how social positions can affect a person's access to resources (Coleman 1988). Central actors in networks have access to more resources and are more likely to be aware of promotional opportunities (Wasserman and Faust 1994). In addition, because of their favorable social position they are more likely to get engaged in risky behaviors (Ibarra and Andrews 1993), which is a necessary characteristic of innovations. The favorable social exposure and status advantage result in an exceeding increase in their centrality, leading to the "rich get richer" phenomenon (Perry-Smith and Shalley 2003).

The networks of the three health departments tended to develop more centralized structures over time. Centralized networks may facilitate the adoption of innovations, because central actors have higher credibility and broader influence and can diffuse information to a large group of people (Valente, Chou, and Pentz 2007; Damanpour 1991). The social influence of central actors is rooted in their social power. The organizational leadership can represent different dimensions of social power in the organization, such as reward power (the perception of the ability to reward), coercive power (the perception of the ability to punish), and legitimate power (the perception of the right to prescribe behavior) (French and Raven 1959). Leadership can use them to promote and support the implementation process. The qualitative analysis of department A showed that the support and role modeling by a highly central leader motivated a large number of staff to become engaged in organizational change, whereas in department B the less prominent leadership engagement was insufficient to help the staff overcome the

local and cultural barriers of EIDM. Department C was in between, with a prominent role of divisional managers as the main champions of the intervention.

Leadership support is considered to be an important facilitator of the implementation of EIDM in health organizations (Stetler et al. 2014). In a qualitative study of health care providers from 22 organizations in Ontario, Canada, participants classified the role of leadership as crucial in supporting the implementation of guidelines by creating and supporting an organizational vision that embraces EIDM, providing staffing and resources, and embedding the guidelines in policies and procedures (Ploeg et al. 2007).

The role of leaders in promoting EIDM extends beyond inducing and prescribing EIDM behavior. Stetler et al. (2014) in a qualitative study of the role of leadership in developing, enhancing, and sustaining EBP as the norm in health organizations, found that in addition to the ability to ‘inspire and induce’ EBP activities, leaders intervened actively and were involved directly in EBP activities. They helped staff learn about EBP “how to’s” by becoming engaged in education and development, role modeling and monitoring the adoption process. This highlights the key role of organizational leaders who, as the champions, initiators, and role models of change interventions (Peirson et al. 2012) should stimulate and monitor the implementation process. They should also help to develop a safe and collaborative environment for staff and preserve the participatory nature of the intervention (Nembhard and Edmondson 2006). The leadership of department A in our study fulfilled different above-mentioned roles attributed to an effective organizational leader. They used social power to induce the implementation of

EIDM, advocated for EIDM as an organizational strategic priority, supported the participation of staff in training and work groups as a part of their formal roles in the department, led and coordinated the training activities, and monitored and evaluated the process.

However, the strong dominance of a few staff over others may be a barrier to productivity and innovation. Individual autonomy is limited in a vertically differentiated network, in which the person at the top of the chain of command dictates the behaviour of members at lower levels (Damanpour 1991). Over-hierarchical (vertical) network structures in which the information flow is mainly in a top-down channel (from leaders to subordinates) are unsuitable contexts for innovation and productivity, which require dynamic communication among individuals and social groups (West et al. 1999). These over-hierarchical networks hamper the implementation of new interventions (Greenhalgh et al. 2004).

6-3 INTERDIVISIONAL COMMUNICATION

6-3-1 Integration of Findings

The quantitative network analysis (chapter 2) showed that organizational divisions considerably segregated the networks of the three health departments. The longitudinal analysis of social networks showed that the negative tendency towards inter-divisional connections did not improve over time in departments A and B, not supporting proposition #3 (longitudinal change in inter-divisional connections). Only in department C did the tendency towards inter-divisional connections increase, mainly due to increased

number of connections from practice-based divisions towards the experts in the central supervisory/administrative division.

The qualitative analysis (chapter 5) explained the tendency of staff toward limiting their connection within organizational divisions as a consequence of staff's preference to seek information from their peers who were physically close to them, shared more values and experiences, and were connected through the bonds of solidarity. Peers who worked in the same organizational divisions more readily represented all these factors.

Qualitative analysis also showed that the tendency of staff towards connecting to others within their own divisions was still strong after the intervention, and inter-divisional connections remained limited and exceptional. The intervention was not effective in promoting the formation of significant inter-divisional bridges even though it increased staff awareness of the existence of experts in other divisions. This was due to the natural tendency of staff to become connected to similar and proximate peers, intra-divisional structure of evidence summary teams (which consisted of the staff who already worked on similar issues), and transiency of interdivisional connections (which were not reinforced through regular inter-divisional communications), In addition, especially at department B, the intervention helped staff in practice-based divisions feel more confident and be less dependent on external support by librarians and epidemiologists.

In summary, the integration of quantitative and qualitative findings revealed a strong tendency of staff in forming information-seeking connections within organizational divisions. Co-participation and communication of highly engaged staff in departmental training and progress meetings (especially in department A where those meetings were held regularly and extensively) resulted in the formation of some inter-divisional ties among the experts. However, without continuous reinforcement and maintenance those connections tended to wane. In departments where inter-divisional communication was not part of the intervention, a gain in expertise in EIDM resulted in an increase level of self-confidence that led to less extra-divisional communication among health practitioners.

6-3-2 Interpretation

The tendency of individuals to seek information from proximate peers is widespread and consistent across contexts (Keating et al. 2007; Zappa 2011; Borgatti and Cross 2003). Individuals who are physically closer are more readily available and accessible (Borgatti and Cross 2003). Frequent interactions among proximate individuals who share values and experiences leads to formation of friendship connections and trust over time (Gibbons 2004; Lewis and Weigert 1985). So the combination of ease of access, shared tasks, tacit language, and reinforcement by solidarity bonds makes intra-divisional connections competitively advantageous to seeking information from outside. This explains the tendency of staff to seek information from knowledgeable people within their own divisions.

Clustering and coalition formation of professionals is a sign of functional differentiation, which is positively associated with implementation of innovations more so than in simple undifferentiated organizations (Damanpour 1991). The optimal social network structure for the spread of innovations is a network with a high level of local clustering and short global separation and distance (i.e. a small world network) (Watts 1999). The lack or shortage of connections between clusters may lead to entrapment of knowledge that slows down the pace of diffusion of innovations. In our study, inter-divisional communication at baseline was almost zero in the three study sites. In addition, according to findings from the qualitative interviews the spread of news about the study through word of mouth was mainly limited to staff working in the same division. Staff in different divisions were not aware of the success stories of personnel in other divisions. The entrapment of knowledge (Delre et al. 2010) regarding the advantages of engagement in the intervention and its implications for public health practice within organizational divisions may explain a part of diversity in engagement in the intervention and adoption of EIDM by the staff in different divisions.

Social relations decay over time. This is more likely to occur for relationships that bridge structural holes than among closely connected peers (Burt 2002). Maintaining relationships is a costly process and needs frequent reinforcement. This reinforcement is easier to achieve in situations of strong ties among people in a close relation who interact with each other frequently and develop different types of social ties over time (such as friendship) (Reagans and McEvily 2003). In our study, the newly shaped inter-divisional connections formed through co-participation in the trainings were not sustained over time

due to the higher cost of maintaining connection with peers with infrequent interactions, small amounts of work overlap, and transient nature of training events.

This finding highlights the need for organizational strategies to maintain and reconnect newly shaped ties by facilitating continuous communication through regular meetings and conventions, developing common programs and tasks (such as communities of practice, as discussed in section 6-5-4), and reducing the cost of maintaining connections by facilitating the formation of third-party linkages or common partners for pairs who bridge clusters (Katz and Tushman 1981). The reactivation of currently inactive bridging ties is less costly than maintaining strong ties and may be even more beneficial than establishing new ties (Levin, Walter, and Murnighan 2011).

6-4 SOCIAL INFLUENCE OF OLS

6-4-1 Integration of Findings

Quantitative analysis of behaviour change towards EIDM (chapter 3) showed that at departments A and C, highly engaged central staff and non-engaged staff (only significant at department C) who were connected to other highly engaged central staff improved their EIDM behaviour. These findings supported proposition #7 about the social influence of highly engaged opinion leaders. In addition, among staff who turned to highly engaged OLS for information, the existence of friendship connections reinforced the social influence, supporting proposition #6 about the role of friendship in behavior change of information seekers.

Qualitative analysis (chapter 5) related to these propositions revealed the potential mechanisms for social influence. Especially in departments A and C, department-wide recognition and presentation venues helped the highly engaged staff be recognized by peers as experts in EIDM. In addition, the gradual change in culture regarding the importance of EIDM and its relevance to public health practice facilitated the social influence of highly engaged OLs by reducing the effect of normative barriers to behaviour change. The observed difference between the impact of OLs in three health departments could be attributed to various contextual and organizational differences, including the recognition of the role of OLs by organizational leaders, preparedness of the context for behavior change, ease of access to OLs, the intensity of the KT intervention, their formal jobs as evidence sources, and the existence of friendship ties between OLs and their peers.

The central staff (especially in department A) pointed to the prominent role of informal connections in their formal behavior and position in the organization. Being located in the same building, stability of managerial staff, and a friendly culture were among the reasons for the importance of informal connections in promoting formal behaviors. These qualitative findings were also confirmed by the quantitative observation that only in department A were staff central in formal information-seeking and expertise-recognition networks also significantly more central in friendship network (chapter 3). The availability of friendship ties helped OLs in department A influence their peers through channels of affective trust.

I also found that highly engaged OLs were more likely to improve their own behaviour towards EIDM if they were connected with each other. Qualitative analysis showed that co-participation in workshops and working on the same evidence summaries provided highly engaged staff with an opportunity to share their concerns and progress with peers and shape new social ties. Social support and influence through these regular meetings might improve the behaviour change process in highly engaged central staff by helping them overcome personal and organizational barriers, as expressed by study informants (especially in department A) during the qualitative interviews. The formation of ties among participants in those meetings also explains the quantitative findings on the increased tendency of highly engaged staff in the three departments to form clusters among themselves (chapter 2).

In summary, the integration of quantitative and qualitative findings showed that staff recognized highly engaged OLs as experts, which resulted in a significant social influence process. In addition, the existence of friendship ties between highly engaged OLs and their peers facilitated the behaviour change process. Highly engaged OLs themselves need support to overcome barriers to behaviour change. Co-participation in regular progress meetings provided them an opportunity to learn from the practice and progress of their peers and overcome such barriers, which in turn affected their behaviour change towards EIDM.

6-4-2 Interpretation

Our findings regarding the significant social influence effect of OLs are confirmed by several studies that used OLs as agents of change to promote EIDM in various health

care contexts (reviewed by Flodgren et al., 2011). Individuals may influence each other through various routes, which mainly rest on hierarchy (social power) and solidarity (Marsden and Friedkin 1993). These may establish two forms of trust: cognitive (based on the individual's belief about peers reliability and competence) and affective (based on emotional bonds) (McAllister 1995), through which people influence beliefs and behaviors. Being recognized as an expert provides individuals with social power through the direct perception of expertise (expert power) and also being referred and recognized by many as experts (referent power) (French and Raven 1959).

Social influence can also work through affective connections. Individuals are influenced by the behaviour of their friends and peers with whom they share values and interests (Marsden and Friedkin 1993). Friendship is the result of shared values and frequent communication, and happens in the context of mutual trust (Gibbons 2004). Friendship ties are more stable than formal advice-seeking connections (Lewis and Weigert 1985), and provide a safe foundation for social influence, especially in risky situations (Mayer, Davis, and Schoorman 1995). In our study, particularly at department A, the central actors in formal connections were also central in friendship connections and made use of their informal ties to promote EIDM initiatives. Mehra, et al. (2006), in a study of group leaders, found that the centrality of leaders in friendship networks positively relates to both group performance and leaders' reputation. In another study conducted in banking organizations, the researchers found that the leaders who were well connected with peers were recognized as having higher status and being more trustworthy by their subordinates (Venkataramani, Green, and Schleicher 2010). The researchers

suggested that organizations should encourage networking among central staff by providing opportunities for public gathering and informal communication. Our findings, consistent with the evidence found in other contexts, support organizational interventions expanding and sustaining informal connections among central staff, and also encouraging the use of informal channels to promote EIDM by OLs and central managers in public health departments.

However, influential actors are not always the early adopters of innovations. Due to their conformity to norms and sensitivity to peers' judgment, OLs are very conservative than early endorsers in promoting the uptake of new innovations (Rogers 2003; Dearing 2008). OLs are not helpful sources of organizational change if they do not endorse the change, or if they consider it too risky or costly (Valente and Pumpuang 2007; Kratzer and Lettl 2009). In our study, regular communication of OLs in progress meetings seemed to be an effective strategy to help OLs overcome normative barriers to change by witnessing reports of the success stories of other groups and sharing their concerns and problems.

The difference among the magnitude of effect in the three health departments also confirmed the context-dependent nature of OL effects. The effect of context may explain the observed heterogeneity among the findings of interventional studies on the effect of OLs in behavior change (Flodgren et al. 2011; Valente and Davis 1999). As explained above, OLs may have optimal social influence impact if they support and endorse an organizational change (Dearing 2008), the change is not considered too radical or risky (MacVaugh and Schiavone 2010), and they are able to influence their peers through

formal and informal routes (Reagans and McEvily 2003). Most of these factors are determined by the social and organizational norms and constraints.

6-5 IMPLICATIONS:

6-5-1 Network Analysis to Reveal the Contextual Barriers:

The analysis of information-seeking, expertise-recognition, and friendship networks provided a picture of how individuals and organizational units were constituted in the social context. The analysis of social networks can reveal the distribution of knowledge and power, and identify early adopters and OLs. It can depict social clusters and gaps that may hamper the diffusion of innovations, and help identifying potential brokers who can bridge the gaps.

Understanding the structure of social relations and networks in an organization is an important aspect of the implementation process (Damschroder et al. 2009). Implementation of change interventions is a complex process and a reductionist approach that does not recognize the complexity of social structures lacks enough depth to depict the process accurately (Kitson 2009). Social relations influence several contextual barriers and facilitators of the implementation. Some example of key contextual factors include norms and culture (the value of and need for EIDM, the relevance of EIDM to public health practice, and the role of informal social ties in formal practice), implementation climate (relative priority of EIDM and participation in the intervention, and organizational incentives for the engaged staff), and readiness for implementation (leadership engagement and support, access to knowledge through workshops and

trainings, and availability of resources such as time and workforce) (Damschroder et al. 2009).

Studies have shown that KT strategies that are tailored to fit local needs and barriers are more likely to promote desired change in the behaviour of practitioners (Oxman et al. 1995; Dobbins et al. 2005). Baker et al. (2010), in a systematic review of 12 randomized controlled trials on this subject, concluded that interventions that are tailored to address barriers to change have a significant effect on the behaviour of health practitioners. However, they could not identify which barriers were most important to address and how best to overcome them in a tailored intervention. They did note, however, that many barriers were associated with social and organizational structure either directly (e.g. organizational climate, leadership support, network structure, and team composition and processes) or indirectly (e.g. staff's motivation and attitudes, and readiness for change) (Wensing, Bosch, and Grol 2009).

The insight gained by social network analysis can help tailor implementation strategies to take into account the local needs and attributes of organizations. Mixed methods studies of social networks can help contextualize and explain observed network patterns and translate technical findings into a language more understandable for policy makers and practitioners.

6-5-2 Engaging Staff in EIDM Interventions

Findings from this research showed that the recruitment and informing strategies can affect staff perception about the usefulness of a KT intervention and its subsequent adoption. Highly engaged staff in three public health departments differed based on the

relevance of their formal roles to EIDM, their positions in the social networks, and their understanding about the intervention and how it could affect their practice.

Implementation models suggest that effective programs require four key individuals: *champions*, *opinion leaders*, *formally appointed internal implementation leaders*, and *external change agents* (Damschroder et al. 2009). The qualitative analysis showed that several of the above-mentioned roles overlapped in a group of highly engaged staff. In department A, a group of project specialists who were hired and trained to lead EIDM in the department (*formally appointed internal implementation leaders*) and were already central in information-seeking networks due to their professional activities (*opinion leaders*), were among the first groups engaged in the intervention and other capacity-building activities (*champions*), and had a significant influence on the behaviour of others towards EIDM. The overlap between these roles was less prominent in the two other health departments. For example, the epidemiologists in department C and some health promotion consultants in department B who were already central in the network at baseline did not engage in the intervention to a great extent because EIDM was not considered relevant to their jobs. This highlights the association between social position and formal roles in the process of engagement of staff in organizational EIDM interventions. Consequently, a more informed strategy to recruit staff based on the combination of their formal and informal roles should be more effective in sustainable organizational change.

Another insight from the qualitative analysis regarding the social consequences of engagement in the intervention is that the mechanism of staff recruitment into the KT

intervention is important. This process was generally a top-down, non-voluntary mechanism. Some informants noted the negative reactions and resistance of some staff to the intervention. Their resistance was mainly due to the involuntary nature of staff recruitment (staff generally were not given much choice and not optimally informed at time of recruitment in the study), added workload and high expectations by leaders, a perception of incoherence between EIDM and the norm of public health practice, and a perceived disconnect between EIDM training and real public health problems. Some informants in department B explained their lack of knowledge about their role in the intervention, its process, and how it would affect their practice. Greenhalgh et al. (2004), in a systematic review of models of innovation diffusion, highlighted the importance of compatibility of an intervention with the values, needs, and perceived risks of involved individuals. Interventions that are not considered to be in line with professional and organizational values, missions and competencies face resistance by health practitioners (Helfrich et al. 2007). Providing staff with knowledge regarding the relative advantage of a new innovation, its compatibility with current values and norms, and adaptability of the innovation to the needs of potential adopters are a few of the factors that affect the adoption of innovations in organizations (Greenhalgh et al. 2004). This also highlights the importance of collaborative networking and decentralization of decision-making as important strategies helping the organizational leaders implementing EIDM in health organizations (Champagne et al. 2014).

In summary, findings from this research suggest that implementers of organizational EIDM interventions should consider both formal and informal social roles

and the position of staff during the recruitment and engagement phases. In addition, participatory and voluntary strategies for recruitment, and informing staff about the intervention and its implications for their work tend to improve staff participation and promote subsequent behaviour change.

6-5-3 Networks as Outcomes of the Implementation:

Social networks naturally and dynamically evolve over time. The evolution is the function of different internal and external forces, which include the actors' agency (internal motivations to form or dissolve social ties), opportunity (tie formation due to constraints imposed by shared identity and similar background), inertia (the tendency of networks towards persistence and stability), and external forces (Ahuja, Soda, and Zaheer 2012). Organizational behaviour change, as an external force, can affect the composition of social networks (Doreian and Stokman 1997). Because of the complexity of social structures, predicting and engineering network changes is very difficult (Valente 2012). However, understanding the complexity of the implementation process is incomplete without demystifying its impact on social structure (Ahuja, Soda, and Zaheer 2012; Plsek and Wilson 2001), which itself shapes and constrains individuals' beliefs and behaviors, and affects the sustainability of implementations.

One important step in the implementation process is the evaluation of the process in regard to a few attainable and measurable outcomes (Damschroder et al. 2009). KT studies mainly focus on individual- or macro-level capacity outcomes rather than considering what happens in the social structure as the result of the implementation.

Changes in social networks can reveal important information about the sustainability of implementation efforts, which is an important outcome in promoting KT interventions (Graham et al. 2006). Sustainable change happens when a new practice becomes a part of normative and routine practice that continues to exist after the implementation (Maher, Gustafson, and Evans 2007; Rogers 2003; Pluye et al. 2004). An indicator of routine behavior is how individuals communicate with each other in their daily practice, and its association with the implemented behavior. Longitudinal analysis of the evolution of social networks through the implementation process can provide clues to the extent to which EIDM capacity development efforts are reflected in daily information-seeking behaviour of health practitioners over time. The mixed methods design helped interpret the findings of the quantitative analysis and provided sensible and practical interpretations.

In summary, understanding the relational outcomes of KT interventions can provide insight into the social consequences of the implementation process and also clues to the sustainability of the behaviour change.

6-5-4 Discovering and Developing Communities of Practice:

Staff engaged in the KT intervention tended to form clusters, in which they could influence each other's EIDM behavior. This tendency of experts towards clustering resembles the formation of communities of practice (CoP), which consist of individuals who have similar expertise and interests and can help each other through enhanced communication and feedback (Wenger, McDermott, and Snyder 2002; Estabrooks et al. 2006). The communication among a group of staff who are at similar levels of

organizational status and seniority provides a safe and non-judgmental context that supports information sharing and feedback (Cheshire 2007; Soubhi et al. 2010). Frequent interactions among group members results in the formation of sustainable ties and a repertoire of solutions to shared problems among experts, which facilitate the spread of knowledge and access to professional help in the long term, and increases the productivity of the system (Hildreth and Kimble 2004; Wenger, McDermott, and Snyder 2002).

CoPs are generally created and controlled by the researchers. But our findings support the effect of locating and promoting naturally occurring CoPs in organizations as groups of equally positioned experts who interact with each other in a non-judgmental manner that was not intentionally engineered by their health departments. We also suggest that the formation of CoPs among experts engaged in the intervention should be considered as an effective strategy to promote the implementation process.

6-5-5 Identification of OLs:

We used a sociometric approach to identify OLs in health departments. Different techniques to define OLs lead to the identification of different subgroups (J.M. Grimshaw et al. 2006). One plausible reason for this difference is that each technique emphasizes on different aspects of opinion leadership. For example, a self-identification technique may select OLs based on their values and traits, whereas a sociometric approach emphasizes the social position of leaders (Valente and Pumpuang 2007). Therefore it is suggested that different techniques should be combined to identify those who meet a greater number of criteria for opinion leadership (Valente and Pumpuang 2007).

In our study we used a combined approach, defining OLs as staff members who were at the fourth (highest) quartile of both the information-seeking and expertise-recognition networks through which we selected participating OLs based on the conceptual overlap between these two networks. When using sociometric techniques to identify OLs, this combined approach seems more justifiable, because it captures the group who fulfill more than one leadership characteristic. The significant social influence effect of this subgroup in our quantitative analysis implies that our identification technique was also empirically sensitive in identifying the channels of social influence in the health departments.

6-5-6 Challenges to Social Network Analysis in Organizations:

Because of its specific features, social network analysis in organizations requires extra efforts to reduce harm to participants and preserve their confidentiality, in addition to addressing common ethical concerns (Borgatti and Molina 2005). In order to develop social networks, respondents must disclose their own names and reveal their personal attitudes and feelings towards colleagues in an open way. Therefore, anonymity is generally lacking in social network research. In addition, in small organizations people can easily identify themselves and their peers in network maps, which is a common concern in research on small organizations. In addition, organizational managers may interpret the findings of any public report on the employees' performance in an evaluative way, which may cost respondents their future career. Moreover, evaluating the behaviour of oneself and others in qualitative interviews may result in an emotional and judgmental atmosphere and tension in the organization.

In addition, responses on network name generators could be influenced by various cognitive and behavioral biases due to the limitations of human memory and the structure and context of surveys (Brewer 2000). Wording of name generator questions can affect respondents' interpretation of the questions and motivation to answer them (Burt 1983; Bailey and Marsden 1999; Bearman and Parigi 2004; Fischer 1982). Due to the cognitively demanding nature of network questions, asking multiple name generator questions may lead to respondent fatigue, similar to other kinds of surveys (Tourangeau and Rasinski 1988). Fatigue may result in respondents' refusal or looking for shortcuts to complete a survey in a less demanding way, which may include choosing the easiest available option (e.g. choosing "I don't know") (Fischer 2009), or shortening the lists of names they provide (Pustejovsky and Spillane 2009).

In an analysis of the effect of the place of name generators in surveys on the motivation to answer (chapter 4) we found that respondents were more likely to satisfice (look for shortcuts) when answering name generator questions asked later on a survey. In addition, the place of the name generator in the sequence of questions had a significant relationship to the likelihood of refusal, which is stronger for sensitive questions such as friendship. Respondents who were motivated enough to answer name generator questions were more likely to answer 'I don't know anyone' or provide shorter name lists if the question was asked later on the survey. The relationship between the position of question and list size was greater in cognitively burdensome questions, such as those asking for the names of members of information-seeking and expertise-recognition networks.

The above-mentioned challenges may result in low response rates and biased answers on network surveys. In our study, a low response rate and selection bias towards attrition of staff who were less interested in EIDM was an important threat to the validity and generalizability of study findings. As a result, the effect of the intervention in changing the behaviour of staff and also longitudinal changes in social structure are more exaggerated than what happened in the organization, and the perspectives of staff who had negative experiences with the intervention and EIDM in general could be missed in the overall picture presented in our studies.

Consequently, we suggest that network analysts use various strategies to minimize the ethical burden of network questions such as providing a detailed yet easy-to-understand informed consent form, anonymization and aggregation of findings, and meetings with organizational management to minimize possible harms to employees (Borgatti and Molina 2003, 2005). In addition, we suggest using strategies to reduce the cognitive burden of name generators to decrease the likelihood of refusal and satisficing. The number of name generators should be guided by the study hypotheses and theoretical framework, using only the minimum number needed to answer research questions. During the design of network surveys, we suggest that multiple name generators be presented in random order on electronic surveys or present more sensitive questions, such as those asking about members of friendship networks, earlier in surveys. Probes and graphical aids could also be used to motivate respondents in online surveys (Deutskens et al. 2004).

6-6 EPILOGUE

A mixed-methods study of the social networks of staff in three public health departments during the implementation of an organizational intervention to promote EIDM behaviour showed that the composition of networks in the organizational structure, the role of network position on behaviour change towards EIDM and the evolution of networks over time.

The findings showed that selective training and capacity development interventions might lead to the formation of an elite versus ordinary structure that facilitates the recognition and accessibility of qualified experts, and also may deepen the knowledge gap in an organization. Developing the presentation and recognition channels affected experts' recognition and popularity, and should be considered as part of the implementation of capacity-building interventions. The role of leadership as the source of power and influence was pivotal in championing and monitoring the implementation process.

In addition, due to the higher cost of connecting to staff in other divisions and the large possibility of decay of bridging ties over time, the influence of co-participation in training and subsequent organizational events were minimal and transient in regard to establishing sustainable ties among staff in different divisions. Interventions to sustain inter-divisional connections include regular meetings, common tasks and programs, and facilitating the formation of new shared third-party connections for the staff who bridge the divisions.

OLs who were engaged in the organizational EIDM intervention were able to influence the behaviour of their peers. The impact they exerted was reinforced when formal influence coincided with informal bonds of trust and solidarity. In addition, membership in clusters of support and communication helped the OLs to overcome barriers and recognize the value of EIDM in their practice.

These findings have several implications for successful organizational KT interventions. They supported the use of SNA to reveal the social structure and potential barriers/facilitators of the interventions. Implementers can also use network analysis through the implementation process to identify potential OLs and early adopters who should be engaged in a participatory and informed process, and also to target and support the CoPs. As part of the organizational intervention, there should be formal strategies to enhance and maintain communication among engaged staff, and increase their visibility and recognition by their peers. Moreover, network analysis can provide clues to the social and relational outcomes of implementations and sustainability of behaviour change.

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APPENDIX 1: PARTICIPANT INFORMATION SHEET & CONSENT FORM

STUDY TITLE: A tailored, collaborative strategy to develop capacity and facilitate evidence-informed public health decision making

This study is funded by the Canadian Institutes of Health Research (CIHR): Partnerships for Health System Improvement (PHSI).

We are inviting you to participate in the final survey of this study, led by Maureen Dobbins, PhD, at McMaster University. You have been selected to participate as a staff member in one of three selected health departments in Ontario. Participation in this research is voluntary. Participants will not be compensated for their involvement in the study. If you choose not to participate in this study there will not be any negative consequences.

The intent of this study is to build on the knowledge gained during previous interactions with local health departments to develop, tailor, implement and assess the impact of a knowledge translation and exchange (KTE) strategy targeted at the whole organization. Our goal is to work collaboratively with the health departments to enhance capacity for and facilitate contexts conducive to evidence-informed decision making (EIDM).

In 2010/2011, we recruited project specialists, health promotion consultants, program managers and key front line staff from three Ontario health departments to participate. Participation as a project specialist, health promotion consultant or managerial staff involved providing detailed information about the health department and the KTE strategy that is implemented in the health department. Components of the KTE strategy included participation in large and small group workshops; hands-on literature searching; individual and group interaction with a knowledge broker; electronic and telephone communication and the development of mechanisms to promote sharing of knowledge information within and across health departments. The intervention was implemented over 22 months and was tailored by each health department for local implementation. Part of the KTE strategy included questionnaires, interviews, and focus groups, part way through the intervention, and at completion of the intervention. Activities were scheduled at the convenience of staff. Not all staff were expected to take part in all activities; rather, the activities were divided among the staff participating.

We are nearing the end of this study and are now administering our final phase of data collection. You are invited to participate in this final survey, even though you have not been involved in the intervention, in order to improve the representativeness of our findings and better reflect your organization.

Basic personal information will be collected from you, such as name, position, work address, telephone number and email, but will be kept confidential and anonymous. The survey also asks for some information about who you connect with at work. The purpose

of these questions is to capture the interactions and links between people at your health unit. One member of the research team will review your individual responses for the purpose of completing the analysis, but your individual results will not otherwise be shared and will not be reported back to the organization in a way that identifies your responses. Anonymity of data will be maintained so that any reports produced from the study will not provide identifying information. This information will be kept in the project coordinator's office with electronic files on a computer that is password protected, so that only research staff will have access to this data. Your personal information will be kept and protected for 10 years, then will be destroyed in a manner that maintains confidentiality.

There are no foreseen risks in participating in this study. The knowledge gained from this study will be useful for several audiences including health departments, public health organizations (e.g., Public Health Agency of Canada), and knowledge translation and exchange (KTE) researchers and implementers. Identifying effective KTE strategies will facilitate the translation of what we know works in the prevention of disease and promotion of health into public health services. That in turn will result in significant reductions in healthcare expenditures particularly in relation to chronic diseases.

The results of the study can be made available to you, or you may request notification of any publications produced as a result of this study by contacting the research coordinator. You may also choose to withdraw from the study at any time for any reason by contacting the research team. Your decision to participate, decline, or withdraw from participation will have no effect on your current or future status with your employer. If you have any questions or concerns please contact the PHSI Research Coordinator, Robyn Traynor (rtraynor@health-evidence.ca; 902-407-6139) or the Administrative Director, Kara DeCorby (kdecorby@health-evidence.ca; 905-525-9140 ext. 20461).

This study has been reviewed by the Hamilton Health Sciences/McMaster Faculty of Health Sciences Research Ethics Board (HHS/FHS REB). The REB is responsible for ensuring that participants are informed of the risks associated with the research, and that participants are free to decide if participation is right for them. If you have any questions about your rights as a research participant, please call The Office of the Chair, HHS/FHS REB at 905.525.2100 x. 42013.

I have read the preceding information thoroughly. By clicking the submit button, I agree to participate in this study.

SUBMIT

Please print a copy of this consent form for your records.

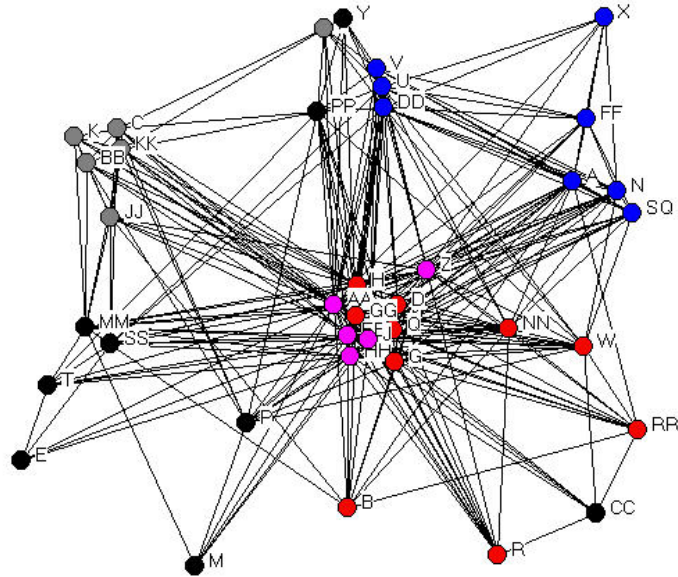
APPENDIX 2: NETWORK QUESTIONNAIRE

Social Network Analysis

The purpose of the following questions is to help us understand the way that knowledge flows within health departments. This will help us to develop more effective knowledge translation interventions. The results of the network analysis will be in the form of “maps” and quantitative measures of network structure. One member of the research team (R. Yousefi-Nooraie) will review your individual responses for the purpose of completing the analysis, **but your individual results will not otherwise be shared and will not be reported back to the organization in a way that identifies your responses.**

In the questions below, we will ask you to identify the names of other staff members with whom you share knowledge, or from whom you seek knowledge when making practice-based decisions. Your answers may vary from question to question. For example, “John” may consult you on practice-based questions, and “John” is your friend, but you don’t regularly seek his input related to your practice-based questions.

This is an example of how the results will appear. Any names you provide will assist in creating the map but will not appear on the map itself or in the results, except as pseudonyms (i.e. “A”, “B”. etc.) as stated and only where necessary.



1. Please identify up to 5 staff in this health department to whom you regularly turn to help you apply research evidence to inform your professional activities:

1. First name: _____ Last name: _____ Position in the department: _____
2. First name: _____ Last name: _____ Position in the department: _____
3. First name: _____ Last name: _____ Position in the department: _____
4. First name: _____ Last name: _____ Position in the department: _____
5. First name: _____ Last name: _____ Position in the department: _____

- I do not go to anyone for help in this area.
 I prefer not to answer this question.

2. Please identify up to 5 staff in this health department who regularly turn to you to help them apply research evidence to inform their professional activities:

1. First name: _____ Last name: _____ Position in the department: _____
2. First name: _____ Last name: _____ Position in the department: _____
3. First name: _____ Last name: _____ Position in the department: _____
4. First name: _____ Last name: _____ Position in the department: _____
5. First name: _____ Last name: _____ Position in the department: _____

- No one comes to me for help in this area.
 I prefer not to answer this question.

3. Please identify up to 5 staff in this health department who are experienced and knowledgeable in finding research evidence and translating it into practice:

1. First name: _____ Last name: _____ Position in the department: _____
2. First name: _____ Last name: _____ Position in the department: _____
3. First name: _____ Last name: _____ Position in the department: _____
4. First name: _____ Last name: _____ Position in the department: _____
5. First name: _____ Last name: _____ Position in the department: _____

- I do not know.
 I prefer not to answer this question.

4. Please identify up to 5 staff in this health department whom you consider a personal friend:

1. First name: _____ Last name: _____ Position in the department: _____
2. First name: _____ Last name: _____ Position in the department: _____
3. First name: _____ Last name: _____ Position in the department: _____
4. First name: _____ Last name: _____ Position in the department: _____
5. First name: _____ Last name: _____ Position in the department: _____

- I do not know.
 I prefer not to answer this question.

APPENDIX 3: EBP IMPLEMENTATION SCALE

These sets of questions are related to your use of research evidence in making decisions about your professional practice within your public health unit. Research evidence includes primary studies, systematic reviews, and meta-analyses that evaluate the effectiveness of an intervention. Although important sources of evidence for public health decision-making, the following are **not** considered research evidence in this study: discussions with colleagues, program evaluations, community needs assessments, client values and preferences, professional experience, and provincial guidelines.

We are interested in learning about the decision making process at all levels of your health unit so please answer these questions with your own role in mind. We expect there may be many roles within the health unit that take part in decision making in different ways, and that even in areas in which programs are mandated, health unit staff must make decisions about how to implement programs/policy, how to address local issues that arise, and how to identify and respond to community needs. For the purpose of this study, we include all of these types of activities (as opposed to just the “final decision”) in our definition of decision making. Thank you in advance for your time!

Evidence-Based Practice (EBP) Implementation in Public Health Scale

Melnik & Fineout-Overholt, Copyright 2003

Below are 18 questions about evidence-based practice (EBP). Some public health professionals do some of these things more often than other public health professionals. There is no certain frequency in which you should be performing these tasks. Please answer each question by circling the number that best describes **how often each item has applied to you in the past 8 weeks.**

In the **past 8 weeks**, I have:

1. Used evidence to change my public health practice ...
 - 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role

2. Critically appraised evidence from a research study ...
 - 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times

- Not applicable to my role
- 3. Generated a PICO question about my public health practice ...
 - 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
- 4. Informally discussed evidence from a research study with a colleague ...
 - 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
- 5. Collected data on a patient problem ...
 - 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
- 6. Shared evidence from a study or studies in the form of a report or presentation to more than 2 colleagues ...
 - 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
- 7. Evaluated the outcomes of a practice change ...
 - 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
- 8. Shared an evidence based guideline with a colleague ...

- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
9. Shared evidence from research with a client ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
10. Shared evidence from a research study with a multi-disciplinary team member ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
11. Read and critically appraised a clinical research study ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
12. Accessed the Cochrane database of systematic reviews ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
13. Accessed the National Guidelines Clearinghouse ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times

- ≥ 8 times
 - Not applicable to my role
14. Used an evidence based guideline or systematic review to change public health practice where I work ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
15. Evaluated a care initiative by collecting client outcome data ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
16. Shared the outcome data collected with colleagues ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
17. Changed practice based on client outcome data ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role
18. Promoted the use of evidence in practice to my colleagues ...
- 0 times
 - 1-3 times
 - 4-5 times
 - 6-7 times
 - ≥ 8 times
 - Not applicable to my role

APPENDIX 4: QUALITATIVE INTERVIEW GUIDE

(The interviewer thanks the interviewee for participation. He explains that the interview(s) will be coded and that the personal information being collected from participants (i.e., name, position, work address, telephone number, email) as well as the code list will be kept separately from the interview.

The interviewer continues with an introduction to the study objectives and methods:

- A longitudinal analysis to assess how a tailored KT intervention affected the pattern of knowledge flow, the distribution of power in the organization, and the development of interdivisional partnerships.
- Comparing the longitudinal changes in networks in different public health departments with different contextual and organizational characteristics, with the aim of understanding the role of context and organizational culture on the implementation process.
- Following the longitudinal analysis, the qualitative study will assist in translating the quantitative SNA findings into the real life experience of the staff, helping us understand how staff envision their position in the social network, and how they interpret the observed changes in the network shape over time, as an insider.
- Together the quantitative and qualitative analysis will inform the development of future KT interventions and will expand our knowledge about the mechanisms of KT in health care systems.

Then the interviewer reviews the process of network surveys and the four network questions that the respondents answered in online surveys. He explains that the lists provided by each respondent were combined and transformed into actor by actor matrices in which each cell represents whether actor A sought information from actor B, recognized actor B as an expert, and identified her as her friend. In those matrices some actors identified by more peers as information sources or experts. This determined the centrality of actors in the networks. Statistical techniques were used to model the formation that centrality and its changes through time.)

- **Please think about the recent occasions that the staff asked you helping them inform their decisions using research evidence.**
 - What kind of help did the staff ask from you?
 - What factors have led to you being identified as an information source?

Probes:

Expertise, personal characteristics, formal job definition, frequency of interaction, availability, informal connections

- How have you influenced the way the staff use research evidence in practice?

Probes:

Verbal influence

Non-verbal influence

- **Please think about the recent occasions that you asked a peer in the health unit for help informing your decisions using research evidence.**
 - What kind of help did you ask for from these staff?
 - What qualifications do you consider for a person to turn to for getting help in issues relevant to finding and using research evidence?

Probes:

Expertise and knowledge, job title/professional role, similarity of characteristics, ease of access and frequency of contacts, friendship

- How your interactions with other staff have influenced shaping of your current behavior and attitudes on using evidence in practice?

Probes:

Observing their behavior in daily practice

Being influenced by their expertise and professionalism

Informal chatting about those issues

The role of friendship and trust

The researcher will explain briefly about the main findings of the quantitative analysis. For each piece of findings seeks the opinion of the interviewee, her experience regarding those finding, and possible confirming/disconfirming examples:

Case A:

- There were a group of staff in the department who were more central than others in information seeking and expertise networks (more people turned to them asking for information, and recognized them as experts). We call them the local opinion leaders.
- Most of these local opinion leaders were from office of the medical officer of health and family health divisions.
- A large percentage of these local opinion leaders were intensively involved in KT intervention.
- The majority of these local opinion leaders who were intensively involved were managers and project specialists.
- In average these opinion leaders who were intensively involved in KT were also more central than others in friendship network (had larger friendship networks than average staff).
- These opinion leaders who were intensively involved in KT already had significantly higher scores of evidence-based practice behavior at baseline, compared to the rest of staff.
- After intervention, the staff who were intensively involved in KT, turned to each other for seeking information in a more reciprocal way than before (if Jack turned to Joe, Joe also turned to Jack asking for information). But that increase did not happen in the staff who were not intensively involved.

- Likewise, the staff who were intensively involved recognized each other as experts in a more reciprocal way at follow up, compared to baseline.
- A group of intensively involved opinion leaders who sought information from each other significantly improved their EBP behavior scores over time. But that improvement did not happen in other staff who were intensively involved in KT but were not opinion leaders.
- The staff who sought information from those opinion leaders also showed a significant improvement in EBP behavior scores over time, regardless of their involvement.
- The improvement in EBP behavior was associated with shifting one's position towards the center of the network/being identified by more people as an information source. In other words, the more people improved their EBP behavior, the more they identified by peers as information source (or vice versa)
- Averagely, the staff who were intensively involved in KT significantly improved their position in the information-seeking network. Even though it did not necessarily coincide with improvement in their EBP behavior.
- Many staff identified the knowledge broker as an information source and expert. Even though the knowledge broker was not an official staff in the department. This did not happen in any of other 2 health departments in the study.

Case B:

- the number of staff who were intensively involved in KT was the lowest among the three study departments, even though department C was the largest department in the study.
- There were a group of staff in the department who were more central than others in information seeking and expertise networks (more people turned to them asking for information, and recognized them as experts). We call them the local opinion leaders.
- Most of these local opinion leaders were from Chronic disease prevention and performance and standards directorates.
- Only a very small fraction of these local opinion leaders were intensively involved in KT intervention.
- After intervention, the staff who were intensively involved in KT, turned to each other for seeking information in a more reciprocal way than before (if Jack turned to Joe, Joe also turned to Jack asking for information). They also recognized each other as experts in a more reciprocal way than before.
- The improvement in EBP behavior was associated with shifting one's position towards the center of the network/being identified by more people as an information source In other words, the more people improved their EBP behavior, the more they identified by peers as information source (or vice versa).
- Averagely, the staff who were intensively involved in KT significantly improved their position in the information-seeking network. Even though it did not necessarily coincide with improvement in their EBP behavior.

Case C:

- There were a small group of staff in the department who were more central than others in information seeking and expertise networks (more people turned to them asking for information, and recognized them as experts). We call them the local opinion leaders.
- Most of these local opinion leaders were epidemiologists from Administration division, and managers in public nursing and nutrition.
- Half of these local opinion leaders were intensively involved in KT intervention.
- The majority of these local opinion leaders who were intensively involved were managers and directors.
- A group of intensively involved opinion leaders who sought information from each other significantly improved their EBP behavior scores over time. But that improvement did not happen in other staff who were intensively involved in KT but were not opinion leaders.
- The staff who sought information from those opinion leaders also showed a significant improvement in EBP behavior scores over time, regardless of their involvement.
- The improvement in EBP behavior was associated with shifting one's position towards the center of the network/being identified by more people as an information source. In other words, the more people improved their EBP behavior, the more they identified by peers as information source (or vice versa)
- The improvement in EBP behavior was associated with shifting one's position towards the center of the network/being identified by more people as an information source. In other words, the more people improved their EBP behavior, the more they identified by peers as information source (or vice versa)

- **In what ways, do you think, the KT intervention affected the way staff turn to each other seeking information?**

- How did it influence how staff get help from each other?
- How did it influence how staff get help from you?
- How did it influence your own interaction with other staff?
- How did it affect communication among the divisions?

Probes:

The frequency of interactions

The types of help needed

Change in the definition of expertise

Identification of new experts

Staff autonomy and independence

Formation of new clusters in the network

- How did the pattern of communication among the staff in the health unit affect the implementation of KT intervention?
- How did the organizational structure of the health unit affect the implementation of KT intervention?

Probes:

The role of formal job definitions

The role of informal, friendly communications

Accessibility

What do you think we might have missed or have shown incorrectly in the analysis?

APPENDIX 5: THE CODEBOOK

source	the characteristics of information source
source>situations	the situations of information seeking
source>why	why the information source was chosen
source>why>being_there_long	why the information source was chosen. Being in the organization for a long time
source>why>availability	why the information source was chosen. Availability and approachability of the source
source>why>expertise	why the information source was chosen. expertise
source>why>formal_job	why the information source was chosen. The formal role/job definition of the information source
source>why>friendship	why the information source was chosen. Seeking information from friends
source>why>sociability	why the information source was chosen. Being sociable and communicating
source>why>well_known	why the information source was chosen. Being a well known person in the organization. Many people know me
source>why>non_judgmental	why the information source was chosen. Non judgemental behavior
source>why>past_experience	why the information source was chosen. Past experience of seeker with the source
source>why>same_division	why the information source was chosen. Working in the same division
source>why>personality	why the information source was chosen. Personal characteristics of the source
source>why>referral	why the information source was chosen. Being referred by another one
source>why>similarity_of_perspectives	why the information source was chosen. Having similar perspectives and situations
source>why>trust	why the information source was chosen. Trusting the source
central	the characteristics of opinion leader/central actor
central>network_overlap	the central actor uses several network types to influence people
central>networking	the central actor connects people to the appropriate sources
central>I_am_central	the central actor is aware of her position
central>influence	the influence of central actor
central>influence>telling_stories	the central actor tells personal experience stories
central>influence>uncertainty_culture	the central actors teaches the staff about the culture of uncertainty in eidm
central>influence>negative_influence	the negative influence of central actors
orgaznatiional_structure	the structure of the organization
orgaznatiional_structure>divisions	the characteristics of divisions

orgaznatiional_structure>environmental_health	the unique characteristics of environmental health division, especially regarding eidm
orgaznatiional_structure>managers	the role of managers in the department
orgaznatiional_structure>managers>network_builders	the role of managers as network builders
orgaznatiional_structure>librarians	the role of librarians
central>moving_to_center	how people become central in this network
orgaznatiional_structure>network_formation	how social networks are shaped in this organization
orgaznatiional_structure>leadership	the role of leadership in this department
orgaznatiional_structure>suitability_of_context	this organization has been a suitable/unsuitable context for implementation of the kt intervention
orgaznatiional_structure>eidm	eidm in this organization
orgaznatiional_structure>changes	the changes in the organization which are not directly the result of the intervention
intervention	what happened during the intervention
intervention>intensively_involved	the characteristics and story of intensively involved staff
intervention>intensively_involved>awareness	the role of being aware of the project in uptaking and involvement
intervention>intensively_involved>being_chosen	how intensively involved staff were chosen
intervention>intensively_involved>characteristics	the characteristics of intensively involved staff
intervention>intensively_involved>opinion_leaders	involvement of opinion leaders
intervention>intensively_involved>communications	the communications among intensively involved staff
intervention>intensively_involved>cross_divisional	the cross-divisional communications through the intervention
intervention>role_of_leaders	the role of organizational leaders in the implementation
intervention>structure	the role of organizational structure in the implementation
intervention>effect	the effects of the kt intervention
intervention>barriers_facilitators	barriers and facilitators of the implementation of the intervention
intervention>effect>change_in_culture	changes in attitudes and culture of the staff as a result of the intervention
intervention>effect>indirect_effect	indirect effect of the kt intervention on the staff who were not directly involved
intervention>effect>restructuring_of_networks	changes in network structure as a result of the intervention
intervention>effect>skills_learned	the skills staff learned after intervention
intervention>envy	people who were not involved (were not chosen) felt envious and left behind
intervention>visibility_prestige	the visibility/prestige of the intensively involved staff as a result of their involvement
intervention>kb	the role of knowledge broker in implementation
intervention>resistance	the resistance against the implementation

APPENDIX 6: THE JOINT PRESENTATION OF QUANTITATIVE AND QUALITATIVE FINDINGS

	<u>quantitative</u>	<u>qualitative</u>
<p><u>Context</u></p> <ul style="list-style-type: none"> • The information-seeking networks were segregated by organizational divisions • At departments A and C the administrative division, consisting of senior managers and a few project specialists (Department A) or epidemiologists (Department C), clustered at the center of information-seeking network. • At departments A and C two third of OLs were highly engaged • Only at department A, the highly engaged OLs were also significantly more central than others in friendship network. • At departments A and C, at baseline, highly engaged OLs had higher average EBP score than other staff (non-significant at department C). • At department C half of the OLs were epidemiologists who mainly did not engage in the intervention. 		<p><u>Organizational segregation:</u></p> <ul style="list-style-type: none"> • The staff preferred to seek information from peers who were physically (accessibility and availability), socially (shared values and assignments), and emotionally (friendship ties) closer to them. <p><u>Centralized information-seeking networks:</u></p> <ul style="list-style-type: none"> • The opinion leaders identified widely recognized expertise (first-hand experience or through word of mouth), supportive personality (approachable, helpful, non-judgmental), formal roles (consulting roles, organizational hierarchy), and networking capabilities as the main reasons for their exceptional centrality. <p><u>Friendly culture:</u></p> <ul style="list-style-type: none"> • Being located in the same building, stability of managerial staff over time, and the friendly culture resulted in a prominent overlap between formal and informal networks at department A. <p><u>EIDM culture:</u></p> <ul style="list-style-type: none"> • The value and relevance of EIDM in public health practice depends on the nature of decisions (public health nursing vs. environmental health), organizational norms (EIDM as public health job), and availability of support (professional EIDM roles).

<p><u>Process and outcomes</u></p>	<ul style="list-style-type: none"> • Department A had the largest and department B had the smallest engagement rate among three departments. • The highly engaged staff at department A were mainly managers and project specialists, while in department B they were mainly consultants, and in department C mostly public health nurses • At departments A and C two third of OLs were highly engaged • Highly engaged OLs at department A were mainly project specialists and managers, mainly had Masters+ degrees. • At department B only 3 health promotion consultants were OLs and also were highly engaged in the intervention • At department C highly engaged OLs were 3 managers, an epidemiologist and a nurse. • At department C half of the OLs were epidemiologists who mainly did not engage in the intervention. • At departments A and C, at baseline, highly engaged OLs had higher average EBP score than other staff (non-significant at department C). • Only at department A, the highly engaged OLs were also significantly more central than others in friendship network. 	<p>Leaders support:</p> <ul style="list-style-type: none"> • The level and breadth of participation in the study was a top-down decision influenced by the willingness and support of leaders, organizational structure, and the balance between capacity development and addressing public health problems. • Organizational leaders at department A were the main initiators and champions of the intervention, who promoted the participation, continuously monitored the progress, and controlled the quality of the output <p>Staff recruitment:</p> <ul style="list-style-type: none"> • In all the three health departments the groups in charge of developing evidence summaries were shaped based on the public health problem that was addressed in the evidence summary. • However, in department A, the staff were also chosen based on the relevance of their roles to EIDM (project specialists and managers), and then were assigned to evidence summary development groups. While in two other departments, the staff were mainly chosen based on the relevance of their jobs to the health problem, rather than to the EIDM. • The practitioners generally did not have given much choice at time of recruitment, and were not optimally informed about the value of the study and the importance and consequences of their participation in the study. • The epidemiologists at department C were among the most central information sources, but were not engaged in the intervention because of the program-oriented nature of the intervention (the epidemiologists were not assigned to programs), and their lack of interest in EIDM (they did not believe EIDM was relevant to their practice).
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<p><u>Process</u> <u>and</u> <u>outcomes</u> (cont'd)</p>	<ul style="list-style-type: none"> • Only at department A, the KB was identified as a central staff. Even though she was not a formal employee • At departments A and C, the highly engaged OLs and non-engaged staff (only significant at department C) who were connected to other highly engaged OLs at baseline improved their behavior. • At department B the analysis did not show any improvement in EBP behavior in staff based on their position in the network and engagement in the intervention • At department A, highly engaged staff became more popular, but at department B, they showed a tendency toward more activity in the network • Staff with higher baseline and higher improvement in EBP scores became more popular • In three health departments highly engaged staff showed a tendency to form cluster among them. • Staff tended to connect with others in their own divisions • Network became more centralized around already central staff 	<p><u>Communications among highly engaged:</u></p> <ul style="list-style-type: none"> • Co-participation in workshops and working on the same evidence summary provided the highly engaged staff with an opportunity to share their concerns and progress with their peers and shape new social ties, if they were sustained by regular communications (progress meetings) through time (as seen in department A). <p><u>Communications with professionals:</u></p> <ul style="list-style-type: none"> • Librarians, if get engaged in the intervention, supported the EIDM process by assisting staff through EIDM steps, holding a neutral and objective consultant position, and brokering the connections among unconnected groups • KB was the main deliverer of the intervention. (Especially at department A) KB's professionalism, the coherence between her and the leadership, her physical accessibility, and her neutral and objective role resulted in a strong embeddedness of the KB in the EIDM processes. <p><u>Inter-divisional connections:</u></p> <ul style="list-style-type: none"> • Due to the natural tendency of staff, intra-divisional structure of evidence summary teams, and transiency of interdivisional connections the intervention was not effective in forming significant inter-divisional bridges. • Especially at departments B and C the intervention helped practice-based divisions to become less dependent in external support (by librarians and epidemiologists) <p><u>Recognition:</u></p> <ul style="list-style-type: none"> • Some of the highly engaged staff became widely popular after presenting their findings in department-wise events, being promoted by the leaders, and word of mouth
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<p><u>Process</u> <u>and</u> <u>outcomes</u> (cont'd)</p>		<p>Elite and ordinary:</p> <ul style="list-style-type: none"> • At department A (where engagement in the intervention resulted in a considerable prestige effect) the staff who were not chosen responded negatively to the unequal career promotion opportunities and the 'ivory tower' position of project specialists <p>Resistance:</p> <p>The resistance to the intervention was mainly due to the involuntary nature of staff recruitment, work load and high expectations from leaders, incoherence between the EIDM and the norm of public health practice, and disconnect between the trainings and real public health problems (in a group of consultants at department B who were not directly attached to practice-based divisions)</p>
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