DAILY TARGETED EVIDENCE REPORTS

FOR ORTHOPAEDIC SURGEONS

DAILY TARGETED EVIDENCE REPORTS FOR ORTHOPAEDIC SURGEONS: A MIXED METHODS STUDY IN INDIA

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Abstract

Background: There is limited research on how web-based, point-of-care, evidence-based medicine (EBM) tools, such as evidence summaries, are being implemented and used in developing countries.

Objectives: To investigate accessibility, use, and impact of an online EBM knowledge dissemination portal in orthopaedic surgery. To explore whether receiving daily targeted evidence summaries results in more frequent use of an EBM tool compared with receiving general weekly reports. To identify and explain the barriers and benefits of a point-of-care resource in the Indian context.

Methods: Forty-four orthopaedic surgeons in Pune, India, were provided free access to OrthoEvidence (OE), a for-profit, online EBM knowledge dissemination portal. Participants were subsequently randomized to an Intervention group receiving daily targeted evidence summaries or a Control group receiving general weekly summaries. This study employed an explanatory sequential mixed methods design that incorporated two questionnaires, OE usage data, and semi-structured interviews to gain insight into the surgeons' usage, perceptions and impact of OE.

Results: There were no observable differences in OE usage between the Intervention and Control groups. OE was deemed to be comprehensive, practical, useful, and applicable to clinical practice by the majority of surgeons. The exit survey data revealed no differences between groups' perceptions of the OE tool. Semi-structured interviews revealed barriers to keeping up with evidence that included limited access to relevant medical literature (limited internet connection, lack of time, minimal access to medical journals) and limited

incentive to keep up with it (limited decision-making powers for residents, textbook-based residency curriculum, lack of research methods knowledge, limited context-specific research). Changing trauma practices at the hospital were noted following the intervention.

Recommendations: The practice of EBM and the use of point-of-care tools in India can be promoted by investing in adequate electronic infrastructure (improvements to internet access) and by integrating EBM into training programs and surgical cultures.

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This research only scratches the surface of evidence-based medicine (EBM). Moving towards EBM practices in developing countries requires more than access to resources. It requires a collaborative approach and a simultaneous, paradigm shift in the process of how surgeons train and provide patient care.

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CHAPTER I: INTRODUCTION

Evidence-based medicine (EBM) is defined as the "conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients" (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996, p.71).

Global Health Relevance

Regardless of a country's development status, failure to use evidence from research to make informed decisions in healthcare is evident amongst healthcare providers, patients, managers and policy-makers, and across all disciplines of primary and specialty care (Grimshaw, Eccles, Lavis, Hill, & Squires, 2012; Prasad, 2013; Sprague, Smith, & Bhandari, 2015; Straus, Tetroe, & Graham, 2009; Wilkinson, Bosanquet, Salisbury, Hasler, & Bosanquet, 1999). It is known that point-of-care tools and decision aids are underused despite the availability of novel methods of appraising and disseminating research findings (Goodyear-Smith, Kerse, Warren, & Arroll, 2008; Lang, Wyer, & Haynes, 2007; Sprague et al., 2015; Van Dijk, Hooft, & Wieringa-de Waard, 2010). Consistent findings in health services research demonstrate a gap between best practice as determined by scientific evidence and its implementation in clinical care; this has resulted in poorly informed clinical decision-making and negative outcomes for patients around the world (Grimshaw et al., 2012; Grol & Wensing, 2004; Lang et al., 2007; Prasad, 2013). For example, studies have found that at least 30 - 40% of patients in the United States and the Netherlands did not receive care according to current scientific evidence, while 20 - 25% or more of the care provided was unnecessary or potentially harmful to patients (Grol, 2001; Grol & Grimshaw, 2003; Schuster, McGlynn, & Brook, 1998).

In developing countries, it has been noted that healthcare systems continue to face the challenges of poverty, inadequate health infrastructure, and difficulties incorporating evidence into decision-making processes; as a result, it is a constant struggle to improve health indicators and quality of care while also minimizing adverse health outcomes (Agarwal, Kalita, & Misra, 2008; Kohn, Corrigan, & Donaldson, 2000; Prasad, 2013; Straus et al., 2009). In an effort to improve healthcare quality and physicians' decision-making to promote positive outcomes, EBM practice has emerged as an international and national priority (Adily & Ward, 2005; Dawes et al., 2005; Plsek, 2001; Prasad, 2013; Sadeghi-Bazargani, Tabrizi, & Azami-Aghdash, 2014).

Evidence-Based Medicine: A Short History

EBM has been described as one of the top 15 most important medical discoveries in the last 160 years (Watts, 2007). Dr. Dave Sackett, regarded as the "father of EBM", applied EBM at McMaster University's Medical School by training clinicians to read and use the medical literature in the early 1980s (Sackett, 1982; Smith & Rennie, 2014). He and his colleagues published a series of papers for clinicians – a reader's guide to the medical literature – in the Journal of Canadian Medical Association Journal (CMAJ) which had significant impact on the medical community (Sackett, 1982; Smith & Rennie, 2014).

In 1990, Dr. Gordon Guyatt took over as director of the internal medicine residency program at McMaster; he wanted physicians to manage patients "based not on what authorities told them to do but on what the evidence showed worked" (Smith & Rennie, 2014, p.366). The term "evidence-based medicine" was coined by Dr. Guyatt and has since been adopted across medical and surgical specialties (Evidence-Based Medicine Working

Group, 1992; Guyatt, 2003, Smith & Rennie, 2014). It was under the direction of Dr. Sackett and Dr. Guyatt that the Evidence-Based Medicine Working Group published a new series of users' guides to the medical literature in the Journal of the American Medical Association (JAMA) with an emphasis on teaching clinicians how to use the literature in daily practice (Oxman et al., 1993; Smith & Rennie, 2014).

Learners of EBM must acquire the skills of question formulation, search and retrieval of the best available evidence, and critical appraisal of study methods to determine the validity of results (Montori & Guyatt, 2008). Learners must also gain the ability to provide a balanced application of the conclusions to the clinical problem also known as clinical decision-making – an essential component of practising EBM (Bhandari, 2009): "The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research" to stay current and individualize care (Sackett et al., 1996, p.71). Evidence-based practice focuses less on expert opinion by authority figures and unsystematic observations and instead emphasizes the impact of evidence derived from clinical research such as randomized controlled trials (RCTs) and high-quality meta-analyses (Guyatt, Rennie, Meade, & Cook, 2008; Montori & Guyatt, 2008). Patient values and preferences are also incorporated into the EBM approach of clinical decision-making by physicians to promote shared decision-making (Montori & Guyatt, 2008; Smith & Rennie, 2014).

Dr. Guyatt's impression is that "between the years 2000 and 2010, almost every institution in North America came to view the ability to read and apply the literature as something that is a requisite skill for both undergraduate and postgraduate students"

(Agarwal & Eryuzlu, 2014, p.12). Studies have confirmed that most medical schools and residency programs teach EBM in some form (Kim et al., 2008; Slawson & Shaughnessy, 2005; Srinivasan et al., 2002). Without the ability to understand the evidence, it is difficult for physicians to optimize their medical practice, to individualize care, and to engage in shared decision-making with their patients (Agarwal & Eryuzlu, 2014; Smith & Rennie, 2014).

However, clinicians commonly face the challenges of lacking skills in knowledge management due to the sheer volume of research evidence currently produced, time to access and read the evidence, and the skills to appraise, understand and apply the research evidence (Straus et al., 2009). Yet, "today, with the advent of large databases of medical research, a wealth of new evidence-based resources, the rise of 'information mastery' and easy access to information via the Internet, evidence-based medicine is finally becoming doable for busy practitioners" (Zaidi, Hashim, Iqbal, & Quadri, 2007, p.556).

Study Purpose

Utilisation and impact of pre-appraised resources and associated benefits to patients in practice have rarely been studied in developing countries such as India (Goodyear-Smith et al., 2008; Lang, Wyer, & Haynes, 2007; Van Dijk et al., 2010). The purpose of this mixed methods study was to explore orthopaedic surgeons' usage and perceptions of OrthoEvidence (OE), a private, for-profit, EBM knowledge dissemination portal, and its targeted pre-appraised evidence summaries in the Indian context.

The literature surrounding barriers and facilitators of point-of-care EBM tools in India is minimal and thus provides limited conclusions on their benefits and/or drawbacks

within the healthcare system. This study's aim was also to understand the barriers and benefits of point-of-care knowledge dissemination tools in the Indian context. The results of this project helped to determine the potential for an evidence-based knowledge dissemination portal in a developing nation.

There is widespread adoption of mobile devices by healthcare practitioners motivated by a desire for more accurate and accessible communication and information resources at the point of care (Mosa, Yoo, & Sheets, 2012; Ventola, 2014). Yet, there is limited evaluation of the use of mobile technology in providing immediate electronic resource access in healthcare settings (Hardyman, Bullock, Brown, Carter-Ingram, & Stacey, 2013). While mobile technology is making a difference in healthcare practices around the world, testing the perceived value of mobile applications (apps) to healthcare providers in India has not fully been explored. Given that OE is easily accessible through the internet and on mobile devices at the point of care, orthopaedic healthcare providers are in a better position to incorporate the principles of EBM into their clinical practice. This study took an in-depth look at OE as a mobile, evidence-based knowledge dissemination portal to gain an understanding of its overall impact for surgeons using the service in the Indian context.

Through an explanatory sequential mixed methods design, this study used two questionnaires, OE usage data, and semi-structured interviews to gain the perspectives of orthopaedic surgeons using the OE tool.

Research Questions

This study aimed to answer the following primary research question:

1) How do orthopedic surgeons in Pune, India describe their experiences using and applying clinical evidence provided to them through an online medium such as OE?

The study also aimed to answer the following secondary research questions:

1) Does providing daily targeted evidence summaries to orthopaedic surgeons in Pune, India enable more frequent use of the OE service compared with providing weekly orthopaedic evidence summaries over a one-month time span?
2) What barriers and/or facilitators (technical, personal, contextual) do orthopaedic resident trainees, consultants, and visiting fellows face when asked to incorporate evidence into their practice in Pune, India?
3) What are orthopaedic surgeons' perceptions of the OE EBM knowledge dissemination portal for clinical decision-making and patient care in Pune, India?

OrthoEvidence as a Point-of-Care Tool

Introduction to OrthoEvidence

OE (www.myorthoevidence.com) is a for-profit, online, evidence-based knowledge dissemination portal which gathers the most relevant, high-impact literature articles, summarizes them and sends out Advanced Clinical Evidence (ACE) reports to subscribers via email or a mobile app. To address the growing need for a clinical resource and evidence-based summary tool for orthopaedic surgery, OE was founded in 2009 (Sprague et al., 2015). Its goal is to provide critical information access to orthopaedic healthcare providers

and their patients everywhere: “OrthoEvidence is the global online source for high quality and timely orthopaedic-only evidence-based summaries, pre-appraised by orthopaedic medical experts” (OrthoEvidence, 2015).

Although the name, OE, suggests that the tool focuses on evidence related to orthopaedics, it actually provides evidence for a variety of related specialties such as anesthesiology and physiotherapy. Physicians can choose their specialty on the website and access relevant ACE reports. OE membership currently exceeds 15,500 individuals from over 100 countries and includes orthopaedic surgeons and trainees, physicians, physiotherapists, chiropractors, nurses, and other allied healthcare professionals (Sprague et al., 2015).

OE offers three different types of accounts: basic, premium, or group (OrthoEvidence, 2016). A basic, free account provides access to ACE Report synopses, subscription to OE newsletters, and topic summary charts. Premium paid subscriptions cost $8.99 USD/month; in addition to basic account features, premium subscriptions offer access to clinical research/educational videos, exclusive author interviews, and early access to content from worldwide conferences. Group member accounts are paid for by the institution such as the Canadian Physiotherapy Association and provide additional features that include user analytics and personal engagement strategies. If an individual from a developing country contacts OE for a subscription to the service, they will be charged a discounted rate of $50 USD/year.

OrthoEvidence Process of Developing Evidence Summaries

A rigorous and unique process is used to review and summarize orthopaedic-related research studies and their implications for clinical practice (Sprague et al., 2015). OE uses a search strategy that was created with input from surgeons and librarians to identify all RCTs or meta-analyses of RCTs relevant to orthopaedics. The search strategy uses multiple algorithms that were designed to target orthopaedic-related journals, orthopaedic-related key words, and leading medical journals which are known to publish musculoskeletal-related research. If evidence meets the search strategy criteria and algorithms, it is included in OE and summarized as an ACE report. However, if during the review process, errors are identified in the data analyses and reporting of the results, the author is contacted for clarification. If clarification is not provided, then the article is not included in OE.

ACE reports are approximately one to two pages providing a study overview and answering the following questions focusing on the key take-home messages: 1) Why is the research needed now? 2) What is the principal research question? 3) What are the important findings? 4) What should I remember most? 5) How will this affect the care of patients? (See Appendix A for a break-down of an ACE report).

Each month, over 100 new ACE reports are added to OE's database from over 300 medical journals; there are over 3,000 ACE reports in OE's database to date (OrthoEvidence, 2015; Sprague et al., 2015). The reports are categorized into specialties including arthroplasty, foot and ankle, general orthopaedics, hand and wrist, metabolic disorders, osteoarthritis, pediatric orthopaedics, physical therapy and rehabilitation, shoulder and elbow, spine, sports medicine, trauma, and tumour.

Instead of spending 20 to 30 minutes reading a full journal article, each ACE report simply takes 2 to 5 minutes to read (Sprague et al., 2015). The barrier of limited time to search for relevant evidence, summarize it, and critically appraise it, is removed for orthopaedic surgeons because ACE report summaries are promptly available, easy to access and read. This knowledge dissemination portal is accessible through the internet and at the point of care enabling orthopaedic healthcare providers to incorporate the principles of EBM into their clinical practice and stay up-to-date with literature.

OrthoEvidence and Knowledge Translation

Within a month of an article being published in an academic journal, the research is summarized in the form of an ACE reports and made available to OE subscribers (Sprague et al., 2015). Moreover, ACE reports from RCTs and meta-analyses that are presented at high impact orthopaedic meetings and conferences are also made available to subscribers within weeks of the conference. Thus, the latest orthopaedic research evidence is promptly accessible to subscribers.

OE's online website provides an interactive forum for subscribers to discuss research findings, methodology, and relevance to clinical practice (Sprague et al., 2015). ACE reports can be downloaded in PDF format, saved to a personal computer, and/or printed and disseminated at journal clubs. These reports can also be shared through email and social media platforms such as Facebook and Twitter. The full-text manuscript of the original publication can also be accessed through the OE website for select journals.

OE additionally provides educational features such as videos on surgical trial methodology, presentations on the language of EBM, the hierarchy of evidence,

randomized trials, and measuring outcomes in surgery (Sprague et al., 2015). These educational features were created to offer OE subscribers a solid foundation in research methodology.

OrthoEvidence Usage Survey

OE sent out a survey from July 9th to August 4th, 2015 (OrthoEvidence, 2015). There were 804 respondents out of 6,590 who were OE subscribers – a response rate of 12.2% (OrthoEvidence, 2015). There were 389 respondents out of 5,638 who were non-OE users – a response rate of 6.9% (OrthoEvidence, 2015). The survey found that approximately 80% of OE users were frequent readers of musculoskeletal research compared to 50% of those who were not OE users (OrthoEvidence, 2015). Out of the users surveyed, 70% expressed that the service kept them current while 55% stated that it saved them time (OrthoEvidence, 2015). The quality of OE content was rated as "good" or better by 95% of users (OrthoEvidence, 2015). For 80% of users, OE content did not replace academic medical journals but supplemented current subscriptions (OrthoEvidence, 2015). Most notably, 60% of users said that OE allowed them to improve patient care (OrthoEvidence, 2015). As a direct result of OE content, 60% of users were found to have changed patient-related treatment decisions (OrthoEvidence, 2015). The specific findings from this research study in Pune, India were compared to these overall results.

CHAPTER II: GEOGRAPHICAL SETTING

India's Health Structure

According to the World Bank Group (2016), India is the second-most populous country in the world with 1.295 billion people and a high prevalence of poverty (Prasad, 2013). As a result of varying definitions and samples used, estimates range from 21.9% to 23.6% of the population living below the poverty line (Reserve Bank of India, 2013; World Bank Group, 2015).

Complex socio-economic characteristics are reflected in India's medical system with over 70% of the population living in rural areas with limited access to adequate healthcare (Jaroslawski & Saberwal, 2014). Rural and semi-urban areas lack a sufficient number of primary care physicians (Rao, Rao, Kumar, Chatterjee, & Sundararaman, 2011). Moreover, private practitioners provide approximately 80% of care (Prasad, 2013). However, with 90% of the population lacking adequate health insurance, 80% of consultations, drugs, and procedures, are out-of-pocket expenditures for patients (Jaroslawski & Saberwal, 2014; Prasad, 2013; Reddy et al., 2011).

Weak regulations for both private practice and pharmaceutical companies, put practitioners at risk of prescribing ineffective or harmful medicines to patients (Prasad, 2013). Furthermore, given India's large patient load, clinicians are at greater risk of being out of date with new practices and procedures and may provide poor quality of care with their limited time and incentives (Prasad, 2013). Therefore, there exists a strong need to update the knowledge of healthcare practitioners serving rural and urban areas in India (Prasad, 2013; Syed-Abdul, Scholl, Jian, & Li, 2011).

Introduction to the Sancheti Institute of Orthopaedics and Rehabilitation

The Sancheti Institute of Orthopaedics and Rehabilitation (SIOR) is located in Pune, India. Pune is one of India's largest centers for education, industry, information technology, and entertainment (Maharashtra Tourism, 2015). The SIOR is recognized as one of India's most vital hospitals for quality orthopaedic care, education, and research; it ranks as one of the top three best hospitals for orthopaedics in the country (Sancheti Institute, 2015). Its vision is to become a global leader in providing state-of-the-art orthopaedic services (Sancheti Institute, 2015). Its mission is to lead by example by pursuing best clinical practices in patient care, surgical expertise and academics (Sancheti Institute, 2015). The SIOR seeks to keep up-to-date with the latest developments in the field of orthopaedics (Sancheti Institute, 2015).

The SIOR is a post-graduate teaching institute with a large number of surgical resident trainees (Sancheti Institute, 2015). The hospital is divided into the private Joint Replacement Center (JRC) and the SIOR's main public hospital. The SIOR is comprised of three trauma units, a hip unit, a knee unit, three spine units, a pediatric unit, two hand units, a shoulder unit, an oncology unit, a rheumatology unit, and a research unit. Approximately 24,000 patients are seen in the JRC as out-patients every year while 30,000 are seen in the main public hospital in out-patient departments. The JRC serves 3,000 in-patients in the JRC and 4,500 in-patients in the SIOR per year. Of the total number of patients seen annually, approximately 300 are from abroad.

CHAPTER III: LITERATURE REVIEW

Methodology

This review explores notable challenges to evidence-based practice in medicine, surgery, and orthopaedics as well as methods of knowledge translation through the use of evidence-based summaries and mobile technology at the point of care. The electronic databases that were searched included MEDLINE/PubMed, Scholar's Portal, and Google Scholar. The keywords used for this literature review were *evidence-based medicine, evidence-based orthopaedics, evidence-based practice, clinical decision-making, evidence-based knowledge, decision-making aid, clinical decision support system, pre-appraised evidence, residency training/program, evidence-based curriculum, point-of-care resource/tool/aid, knowledge dissemination, knowledge translation, best practice, OrthoEvidence, mobile device, mobile health application, smart phone, and smartphone.*

The inclusion criteria for the peer-reviewed articles encompassed articles, interviews, reports and conference proceedings written in English; the existence of an abstract; and research focusing specifically on evidence-based practice and implementation. A cut-off period for the inclusion of articles was not used as the researcher wanted to capture all relevant papers to portray a history of EBM. See Appendix B for a word cloud of the top 100 most cited words from the full-text literature review articles.

Challenges for Evidence-Based Practice

Evidence-based medicine is broadly defined as an integration of best available external clinical evidence obtained from systematic research with individual clinical expertise and patient preferences (Sackett et al., 1996). In the surgical specialty specifically,

"with the ever-increasing amount of available information, surgeons must consider a shift in paradigm from traditional practice to one that involves question formulation, validity assessment of available studies, and appropriate application of research evidence to individual patients" (Bhandari, 2009, p.297). Practising EBM has been challenging for numerous reasons as is discussed below.

Challenges of Evidence-Based Medicine for Practising Physicians

Although many physicians strongly believe that practising EBM improves patient care, few consistently practice it (Al Omari et al., 2009; McCord et al., 2007; Wilkinson et al., 1999). The full integration of the fruits of the EBM movement in routine clinical care remains a conceptual and practical challenge (Wyer & Silva, 2009). In order for physicians to keep up-to-date with current evidence, research in adult internal medicine demonstrated that 17 articles needed to be read each day (Davidoff, Haynes, Sackett, & Smith, 1995). Since this finding was reported 20 years ago, and given that more than 1000 articles are indexed daily in MEDLINE, the number of articles that would need to be read by clinicians today would likely double (Straus et al., 2009).

Evidence-based practice requires the ability to locate the best available research such as RCTs and high-quality meta-analyses as well as the ability to critically appraise and judge the validity of the available evidence (Fletcher & Fletcher, 1997; Sprague et al., 2015). However, research has found that a low percentage of RCTs and high-quality meta-analyses are actually read by their target audiences; only 40% of relevant published RCTs are read by surgeons (Alper et al., 2004; Sprague et al., 2015). Without formal training in research methodology, the practice of EBM can be challenging for clinicians (Hurwitz,

Slawson, & Slaughnessy, 2000). Busy clinicians often "satisfice" by using information at hand and sacrifice quality over convenience (Slawson & Shaughnessy, 2005).

A systematic review that focused on 106 articles identified research barriers, lack of medical resources, lack of time, inadequate skills, inadequate access, lack of knowledge and financial barriers as the most commonly cited challenges to practising EBM (Sadeghi-Bazargani et al., 2014). Lack of resources included inadequate facilities, institutional support and equipment (Sadeghi-Bazargani et al., 2014). Lack of time encompassed both time to search for, study and learn from studies, as well as lack of time to implement study results in the job setting perhaps due to a high workload for clinicians (Sadeghi-Bazargani et al., 2014).

Another systematic review of 19 studies mainly from the United States found that convenience of access, habit, reliability, high quality, speed of use, and applicability made information seeking more likely to occur and be successful (Dawes & Sampson, 2003). Barriers to information seeking included limited time available to search, the vast amount of material, forgetfulness, the belief that there was no answer, and a lack of urgency (Dawes & Sampson, 2003). The authors suggested that careful planning of information delivery to physicians was necessary to keep them up-to-date and improve knowledge transfer (Dawes & Sampson, 2003).

A qualitative study using a thematic analysis of 44 in-depth semi-structured interviews with general practitioners found that although most practitioners were aware of recommended advice, few acted on it (Wilkinson et al., 1999). Intervention studies have demonstrated that physicians' habits are relatively resistant to change (Wilkinson et al.,

1999). Barriers to implementation of evidence into practice included scepticism towards EBM, information overload, limited time to assimilate information, and unavailability of appropriate resources, skills or motivation to implement change (Wilkinson et al., 1999). Most of the general practitioners in the study expressed ambivalence towards EBM and questioned its relevance and usability in the real-world environment of the consultation room (Wilkinson et al., 1999).

Kitto and colleagues (2011) conducted a qualitative study with in-depth interviews of 22 surgeons to explore surgeons' understanding of EBM and challenges to the adoption of EBM; the Miles and Huberman's Matrix Analyses approach to qualitative research was followed. The authors found that though some surgeons saw value in evidence-based surgery, 50% of these surgeons consistently resorted to the same traditional practices they had learned through experience (Kitto et al., 2011). But, if the traditional orthopaedic culture of 'eminence-based practice' continues without learning what emerging treatment options are available, patients may be subjected to harmful treatments (Hayashi, 2011). Thus, more EBM training for practising surgeons is needed to better combine evidence-based practice with experience-based surgery (Kitto et al., 2011; Kwaan & Melton, 2012).

Challenges of Evidence-Based Medicine During Residency Training

Although insufficient time, lack of skills, and inefficient processes to search for evidence during direct patient care interactions, are commonly cited barriers to the practice of EBM, residents face additional barriers as a result of institutions, educational systems, and clinical supervisors (Van Dijk, Hooft et al., 2010; Bhandari et al., 2003). A systematic review of residents' EBM practices discussed more specific barriers associated with the

residents' position in the organization, lack of experience with EBM practices, and limited ability to make decisions (Van Dijk et al., 2010). Given the specific barriers that residents experience in attempting to practice EBM, these issues must be recognized and integrated into EBM training programs for residents (Van Dijk et al., 2010).

In a qualitative study using a thematic analysis of three focus groups including 34 medical residents from Yale University, Green and Ruff (2005) explored why residents failed to answer clinical questions. Some of the technical barriers included inferior technology with outdated hardware, slow internet connections, firewall restrictions, and inability to make printouts (Green & Ruff, 2005). Lack of time and awareness of the different methods to search for medical literature to solve clinical questions were also significant barriers (Green & Ruff, 2005). The authors concluded that it was not sufficient to simply have the electronic infrastructure available – adequate training on using resources was necessary (Green & Ruff, 2005).

In Green and Ruff's (2005) study, authoritative teaching styles of attending physicians suppressed residents' inclination to seek answers to their clinical questions. Overall, if the resident had limited decision-making autonomy, he/she was less likely to pursue literature searching for his/her clinical questions especially if they were not able to act on the answers (Green & Ruff, 2005). Similarly, in a study of EBM uptake using a grounded theory approach to qualitative research, Bhandari et al. (2003) found that due to a fear of repercussions from staff members, surgical residents did not implement evidence-based practices. Among the 28 Canadian surgical trainees in this focus group, most residents embraced an evidence-based approach and sought to incorporate it into their

training but they did not believe that staff surgeons encouraged its use (Bhandari et al., 2003).

Mittal and Perakath (2010) conducted a study to examine the attitudes, awareness, and barriers to EBM among surgical trainees in a developing country by surveying 110 surgical trainees using the McColl questionnaire and the BARRIERS scale (Mittal & Perakath, 2010). The authors found a positive attitude towards EBM among surgical trainees in India, but it was noted that only about 50% of actual practice could be considered evidence-based. Approximately 1/3 of respondents used the primary literature to practice EBM while over 50% sought and applied evidence-based summaries (Mittal & Perakath, 2010). About 80% of respondents believed that EBM improved patient care (Mittal & Perakath, 2010). Barriers described in this study revolved around education (poor understanding of statistics), access (articles not available), lack of centralized sources of information, inadequate facilities for implementation, lack of time, and a disapproving attitude or cultural barriers to implementation (administration would not allow incorporation or individuals did not have the authority to change practice) (Mittal & Perakath, 2010). Participants were unaware of the fact that the Cochrane Library was free for individuals residing in India due to a national license purchased by the Indian Council of Medical Research; therefore, it is necessary to increase the knowledge of available resources for trainees (Mittal & Perakath, 2010).

Potential solutions for residents to improve their practice of EBM include EBM training, use of pre-appraisal of resources, and the implementation and active involvement in journal club meetings (Bhandari et al., 2003; Haynes, 2007; Sackett & Straus, 1998).

Green and Ruff (2005) suggest the use of handheld devices to overcome barriers in access and time; they also recommend specifically designed websites to assist residents in their searches.

Challenges of Evidence-Based Practice in the Developing World

Though many studies have discovered that physicians in developed and developing countries believe in the power of EBM to benefit their practice (as noted in previous sections), the relevance of EBM in the developing world is limited for multiple reasons.

A review article by Zaidi and colleagues (2007) discussed the benefits and pitfalls of EBM in Pakistan, a resource-limited country bordering India. Many homes, hospitals and academic institutions continue to operate without basic computer facilities: "Even where there are computers, access to literature databases may be limited" (Zaidi et al., 2007, p.558). Many of the reliable resources of EBM require paid subscriptions and libraries rarely have the necessary journals given inadequate library facilities in developing countries (Zaidi et al., 2007).

There have been few efforts to implement EBM training in developing countries (Tomatis et al., 2011). Al-Almaie and Al-Baghli's (2004) cross-sectional study using questionnaires explored barriers facing 273 physicians practising EBM in Saudi Arabia. The authors found that 73% of physicians surveyed felt they lacked adequate training (Al-Almaeie & Al-Baghli, 2004). Similarly, a cross-sectional study of 181 physicians in various medical specialties in Iran demonstrated that the main barrier to practising EBM was a lack of training courses (Mozafarpour et al., 2011). These results were different from developed countries where the main barrier noted was a lack of time (Al-Almaeie & Al-Baghli, 2004;

Mozafarpour et al., 2011; O'Donnell, 2004; van Dijk et al., 2010). Physicians in the Saudi Arabian sample agreed that the lack of resources was a major factor in their inability to provide effective healthcare (Al-Almaie & Al-Baghli, 2004). In the face of uncertainty, non-EBM textbooks and consulting with colleagues were the most popular means of obtaining information while applying the best evidence from literature was the method least used (Al-Almaie & Al-Baghli, 2004).

It is also difficult to teach EBM without appropriate role models who can demonstrate various strategies of implementation (Zaidi et al., 2007). The critique that EBM undermines authority and suppresses clinical freedom continues to produce some resistance towards evidence-based practice (Agarwal & Eryuzlu, 2014; Bhandari et al., 2003; Green & Ruff, 2005; Sackett et al., 1996; Zaidi et al., 2007). A review article written by Karthikeyan and Pais (2010) discussed the problem of integrating clinical judgement and EBM in India specifically. In India, the practice of medicine is largely paternalistic and physician-centered: "While EBM requires that the clinician objectively appraise the strength of evidence and make a decision about its applicability in a given context, some clinicians continue to persist with subjective, 'black-box' methods for decision-making" (Karthikeyan & Pais, 2010, p.624).

The transferability of evidence from research in developed nations to low-income countries has been questioned due to differences between patient populations and in the delivery of healthcare; the most effective treatment concluded from an RCT conducted in a developed country may not be the most effective in a developing country (Chinnock, Siegfried, & Clarke, 2005). The majority of reviews published to date address health

conditions considered to be priorities in the developed world (Swingler, Volmink, & Ionnidis, 2003; Waters & Doyle, 2004). The question of applicability of data from other countries to patients in different settings with unique socio-economic factors poses a problem (Zaidi et al., 2007): "Westerners set the standards for us to follow. But, what is the best in the western world may not yet be available in India or the cost may be exorbitant" (Salgotra, 2012, p.314).

Agarwal and colleagues (2008) found that South Asian countries had weak performance in the EBM domain. Some regions of South Asia have introduced EBM concepts while in other places, it is an uncommon sight (Agarwal et al., 2008). However, "surgeons all over Asia are prepared to challenge the dogma of yesterday" because in this information age, the world's information is instantly available and accessible (Maheshwari & Maheshwari, 2012). Some authors argue that evidence can be applied in India and in places with comparable facilities, infrastructure and training (Salgotra, 2012).

Solutions to Promote Evidence-Based Practice in the Developing World

All in all, the barriers cited in the previous section point towards a need for a targeted intervention that provides available, accessible, and applicable information resources at the point of care (Al-Almaie & Al-Baghli, 2004; Hunt, Haynes, Hanna, & Smith, 1998; Scott, Heyworth, & Fairweather, 2000; Shiffman, Liaw, Brandt, & Corb, 1999). Tailored educational interventions for professionals and early education on effective delivery and use of high-quality evidence use should be explored as a primary means of addressing these barriers and improving patient care (Al-Almaie & Al-Baghli, 2004; Gorgon, Barrozo, Mariano, & Rivera, 2013; Scott et al., 2000). To support these aspects,

adequate infrastructure and the availability of relevant evidence are necessary (Al-Almaie & Al-Baghli, 2004).

The cross-sectional study previously mentioned of 181 physicians in various medical specialties in Iran found that individuals with some understanding of research methodology were more likely to use EBM in their practice compared to those who had no skills in this area (Mozafarpour et al., 2011). In Iran, workshops on learning and applying EBM proved effective in improving attitudes of medical students toward EBM practices (Taheri et al., 2008). Thus, educational programmes should seriously consider integrating research methodology, searching skills, and training to analyse research findings to effectively practice EBM (Mozafarpour et al., 2011).

When EBM knowledge and skills are lacking, dissemination of EBM guidelines that are regularly updated may be an alternative for developing nations (Al-Almaie & Al-Baghli, 2004). Studies have found that computer-based guideline implementation is effective and having appropriate information systems easily accessible with quick links to relevant EBM websites may be beneficial (Al-Almaie & Al-Baghli, 2004; Hunt et al., 1998; Shiffman et al., 1999). Access to high-quality evidence should be provided to clinicians by healthcare organizations (Kwaan & Melton, 2012). EBM database access and provision of pre-appraised evidence in the form of EBM summaries have been recommended as the most useful ways to move toward practising EBM in developing countries (Al Omari et al., 2009; Mozafarpour et al., 2011). As a result of new methods of appraising studies, increased availability of systematic reviews of current best evidence, and information

technology such as computers with internet access, the practice of EBM has become feasible for clinicians around the world (Zaidi et al., 2007).

In the Indian context, Salgotra (2012) explains that the best way to transform evidence into good clinical practice lies in training physicians to find and use rapidly accessible and reliable information for specific clinical problems. For Indian physicians, there is now a section in the Indian Journal of Orthopaedics that discusses "Evidence Based Orthopaedics: Tips for Clinical Practice" and highlights concise practical tips for reviewing the orthopaedic literature (Bhandari & Jain, 2011). There is also a section titled "Evidence Scan" that provides a summary of important recent publications in the field (Bhandari & Jain, 2011). It is important to train the younger generation of orthopaedic doctors to incorporate EBM into their clinical practice in conjunction with the intuitive and clinical experiences of senior colleagues (Salgotra, 2012).

Summary of Challenges/Solutions for Evidence-Based Practice in Developing Nations

Implementing an evidence-based approach can be cost-effective by minimizing clinical practices that have no proven benefit (Agarwal et al., 2008; Hurwitz, Tornetta, & Wright, 2006; Prasad, 2013; Zaidi et al., 2007). The practice of EBM is constrained in developing countries due to its inherent complexity, misperceptions, absence in medical curriculum, rigidity and limited awareness by clinicians (Agarwal et al., 2008). Limited knowledge of EBM concepts, resource scarcity, time for training, patient overload, lack of personal time, financial barriers, limited availability of role models and limited capacity for continuing medical education, have all been identified as barriers and challenges to the practice of EBM (Ahmadi-Abhari, Soltani & Hosseinpanah, 2008; Al-Almaie & Al-Baghli,

2004; Al-Ansary & Khoja, 2002; Al Omari et al., 2009; Dans & Dans, 2000; Sadeghi-Bazargani et al., 2014; Siddiqi & Newell, 2005). For physicians, lack of time to attend EBM workshops and practice EBM continues to be a major problem; EBM has also been seen as a threat to clinical freedom and judgement (Al Omari et al., 2009; Zaidi et al., 2007). In resource-poor countries, there is limited access to databases and computer systems and the internet, limited literature relevant to local realities, and inadequate library facilities and infrastructure; publication biases with studies from developing countries being less likely to be published, are also issues (Al-Almaie & Al-Baghli, 2004; Al-Ansary & Khoja, 2002; Al Omari et al., 2009; Booth, 2008; Dans & Dans, 2000; Sabri & Qayyum, 2006; Siddiqi & Newell, 2005; Siddiqi, Newell & Robinson, 2005; Zaidi et al., 2007).

To overcome these barriers, effective teaching of EBM skills during residency, motivating established clinicians, developing locally applicable guidelines, increasing internet accessibility, and disseminating appropriately targeted information, are necessary (Agarwal et al., 2008; Hurwitz et al., 2006; Kitto, Petrovic, Gruen, & Smith, 2011; Kwaan & Melton, 2012; Prasad, 2013; Zaidi et al., 2007).

Knowledge Translation Tools

Pre-Appraised Resources to Facilitate Knowledge Translation of EBM

Due to the numerous barriers discussed in the previous section, the results of research evidence and critical advances in patient care are not consistently implemented by clinicians (Sprague et al., 2015; Wilkinson et al., 1999). It is necessary to determine a more efficient way of getting the relevant evidence integrated into the interaction between the physician and the patient (Agarwal & Eryuzlu, 2014). Wilkinson and colleagues (1999)

recommended that strategies to encourage successful implementation of evidence-based change should focus on facilitating the process for clinicians. In order for the principles of EBM to be implemented and effectively followed, there is a need for novel methods of summarizing, appraising, and disseminating the literature (Sprague et al., 2015).

With the growing amount of knowledge, "highly filtered and regulated systems are needed to provide succinct, current, and thoroughly objective EBM summaries for clinical assimilation" (Maier, 2006). Over the past ten years, various interactive electronic sources have been developed to rapidly access evidence-based summaries of clinical research (Goodyear-Smith et al., 2008). The advancement of EBM has largely been enabled by technology, such as computers and database software, which has allowed the compilation of substantial amounts of data (Claridge & Fabian, 2005). Evidence-based practice has also been aided worldwide by the development of the internet which has made finding and retrieving original articles much more efficient; internet websites allow healthcare providers to follow EBM principles by providing updated answers to clinical problems (Montori & Guyatt, 2008; Sprague et al., 2015; Weng et al., 2013).

"Pull" services which require the clinician to actively retrieve information include MEDLINE, PubMed, internet search engines (eg. Google), and OVID (Montori & Guyatt, 2008). They are used to retrieve articles with optimal sensitivity and precision (Wilczynski, Morgan, & Haynes, 2005). "Push" services such as the McMaster Premium Literature Service [PLUS] including the ACP Journal Club, send selected evidence screened for quality and newsworthiness to users (Montori & Guyatt, 2008). ACP Journal Club assesses the scientific merit of articles published in 110 journals on an ongoing basis; it identifies

articles that meet inclusion criteria based on "clinical impact ratings" from the McMaster Online Rating of Evidence (MORE) system (Annals of Internal Medicine, 2016). The MORE internet-based system gathers ratings of new articles, assessed for scientific merit by over 5000 physicians (Annals of Internal Medicine, 2016). The ACP Journal Club highlights articles with strong methodological quality (Montori & Guyatt, 2008). It presents structured abstracts with commentary by an expert who puts the study findings into clinical perspective (Hunt, Jaeschke, McKibbon, & Evidence-Based Medicine Working Group, 2000). The benefit of these push services lies in their stringent pre-appraisal of evidence (Montori & Guyatt, 2008). These services have focused only on the information which is both relevant and valid (Slawson & Shaughnessy, 2005).

The Cochrane Collaboration, founded in 1993, with more than 3,000 systematic reviews in its database, has also furthered the advancement of knowledge synthesis (Claridge & Fabian, 2005; Montori & Guyatt, 2008). Its mission is to track, evaluate, and synthesize RCTs in every area of medicine (Claridge & Fabian, 2005). As an international non-profit and independent organization, it seeks to produce and disseminate systematic reviews with up-to-date and accurate information about the effects of healthcare worldwide (Claridge & Fabian, 2005). The Cochrane Library is available free to all those residing in India as well (Cochrane Library, 2015).

Finally, many electronic textbooks such as *Physicians' Information and Education Resource (PIER),* the British Medical Journal's (BMJ) *Clinical Evidence*, *DynaMed,* and *UpToDate*, have revolutionized the way we gather, summarize, and make recommendations by pre-appraising evidence useful at the point of care (Montori & Guyatt,

2008). A randomized trial in primary care found that synthesizing results of systematic evidence in primary care through methods such as Dynamed, was a feasible method to meet clinical information needs (Alper, White, & Ge, 2005).

UpToDate is a subscription-based resource and is "designed to get physicians the concise, practical answers they need when they need them most – at the point of care" (Garrison, 2003). Specific clinical issues, mainly focusing on internal medicine, are addressed in the form of topic reviews which include recommendations for diagnosis, management, and therapy (Garrison, 2003). As a mobile app, UpToDate, is useful in the practice of EBM at the point of care (Mosa et al., 2012). A retrospective study found that the use of UpToDate by physicians led to patients with shorter length of stay, lower risk-adjusted 30-day mortality rates and better quality performance when compared with hospitals without this system (Isaac, Zheng, & Jha, 2012). This is strong evidence demonstrating that computerized tools at the point of care can improve patient care (Sondhi & Devgan, 2013).

However, it must be noted that implementing new evidence in practice remains a difficult task even with the rising availability of aggregated evidence in clinical practice guidelines or evidence-based textbooks (Grol & Grimshaw, 2003). Although electronic textbooks are touted as instrumental in improving evidence-based practice and uptake has been positive, utilisation of these resources in practice has not been studied extensively (Goodyear-Smith et al., 2008).

The Need for Evidence-Based Summaries for Orthopaedic Surgeons

There have been exponential advances in both diagnostics and therapeutics in every subspecialty of orthopaedics including spine, trauma, arthroplasty, arthroscopy, etc. (Salgotra, 2012). Evidence-based orthopaedics has become a popular paradigm in orthopaedic surgery with approximately 4,000 articles across 100 journals being published monthly (Hoppe & Bhandari, 2008; OrthoEvidence, 2013). Orthopaedic surgeons must read and evaluate 17 articles per day which could take up to 6 hours, simply to stay current with best evidence (OrthoEvidence, 2013).

Best evidence is not well-disseminated to the orthopaedic community (Hurwitz et al., 2006). Textbooks are often used by orthopaedic surgeons to keep abreast with the literature, but by the time a textbook is published, the information is often out of date (Poolman et al., 2007a; Hurwitz et al., 2000). One major barrier to implementing EBM in surgery is the lack of summarized evidence and guidelines in a useful and acceptable format for surgeons (Maier, 2006). Consequently, poor clinical decisions, both diagnosis and treatment, are felt at the expense of patients and society (Hurwitz et al., 2006).

A recent study found that across five point-of-care sites (First Consult, UptoDate, DynaMed, Clinical Evidence, and PIER), there was only an average of 18% surgical content (Turvey, Hussain, Banfield, & Bhandari, 2013). General surgery, pediatric surgery, and oncology-related surgeries were more commonly represented in these databases compared to orthopaedic surgical content (Turvey et al., 2013). Turvey et al's (2013) findings suggested that given the limited surgical content within these databases, it was difficult for physicians and surgeons to seek answers to complex clinical questions.

Surgical subspecialty focused resources are necessary to facilitate navigation of the databases and extraction of relevant evidence by surgeons (Turvey et al., 2013).

In 2000, the Journal of Bone and Joint Surgery (JBJS) developed a section devoted to "Evidence-Based Orthopaedics" (Poolman et al., 2007b; Wright & Swiontowski, 2000). JBJS also published a "User's Guide to the Orthopaedic Literature" to teach critical appraisal skills to orthopaedic surgeons (Bhandari, Guyatt, Montori, Devereaux, & Swiontkowski, 2002). The aim of these two sections was to allow busy clinicians to quickly answer their real-world questions and improve the quality of their practice (Poolman et al., 2007b). Through a questionnaire survey, 367 orthopaedic Dutch surgeons felt that the development and use of evidence-based resources including pre-appraised summaries, such as the abstracts from the JBJS and Cochrane reviews, were the best way to move towards evidence-based orthopaedic practice and away from opinion-based practice (Poolman et al., 2007a).

Orthopaedic surgery's relevance expands beyond surgeons and emergency medicine physicians to include allied healthcare professionals such as occupational therapists, physiotherapists, chiropractors, podiatrists, nurses, and medical students (Sprague et al., 2015). There is a strong need for resources that provide access to simple and concise summaries of orthopaedic literature for orthopaedic surgeons and allied healthcare professionals given the high prevalence of musculoskeletal issues in clinical practice and limited focus on musculoskeletal conditions by current electronic summary sources (Sprague et al., 2015). OE is an evidence-based knowledge dissemination tool that was developed to bridge this gap.

Delivery of Evidence at the Point of Care through Smartphones

One object has become an essential tool and is found in physicians' pockets around the world – a mobile phone (Dala-Ali, Lloyd, & Al-Abed, 2011): "Now that more than 5 billion people worldwide have a cell phone, mobile technology sits poised to revolutionize the way medical care and health information are delivered, particularly in the developing world" (Hampton, 2012). Over the last 10 years, smartphones and their related apps have fundamentally altered the way we deliver and access information with their ability to connect EBM knowledge dissemination tools to physicians (Angarita, Strickland, & Acuna, 2015; Franko, 2011): "the unparalleled connectivity, portability, accessibility, and ubiquity of smartphone and tablet devices among the public and healthcare professionals mean that these technologies have tremendous potential to revolutionize healthcare delivery processes" (Mobasheri, Johnston, Syed, King, & Darzi, 2015, p.15). Desktop systems have been replaced by smartphones and tablets as the preferred computing devices with fast access to information at the point of care for healthcare practitioners (Murfin, 2013). A "smartphone" provides easy and quick access to the internet (Dala-Ali et al., 2011).

Smartphone ownership and internet access is prevalent across both developed and developing countries with approximately 90% of the world's population having wireless coverage and 67% of total cellular subscribers located in developing nations (Chang et al., 2012; Hampton, 2012). The widespread adoption of mobile devices by healthcare practitioners has been driven by the need for better communication and information resources accessible at the point of care (Mosa et al., 2012; Ventola, 2014). In 2012, there

were over 12,000 healthcare apps and this number has been rapidly increasing (Sondhi & Devgan, 2013). In clinical practice, healthcare professionals use mobile devices due to their portability, rapid access to information and multimedia resources, flexible communications, and a choice of powerful apps to accomplish different purposes (Wallace, Clark, & White, 2012).

A study by Patel et al. (2015) found that of 341 physicians surveyed in the United Kingdom, over 90% owned a smartphone and 80% of these individuals were willing to use their own device in the workplace. Over 50% of smartphone users had purchased medical apps and greater than 85% of them used the internet to access medical information (Patel et al., 2015). A survey of orthopaedic residents and surgeons in the United States also found that 84% of respondents had a smartphone and 53% were already using mobile apps in clinical practice (Franko, 2011).

It has been suggested that surgeons should use the web to check the evidence when deciding the best course of action at the patient's bedside or in their out-patient clinics (Kumar, Gopalakrishna, Swaminath, & Mysore, 2011). Patient care can be enhanced by supporting accurate prescribing and treatment planning through access to reliable information at the point of care (Hardyman et al., 2013). When surgeons are confronted with difficult clinical situations, handheld devices can be useful in providing real-time access to the internet (Hurwitz et al., 2006). Smartphones are becoming increasingly valuable as a tool to improve the knowledge and performance of healthcare providers (Angarita et al., 2015).

In a survey of how medical students, residents, and faculty from McGill University, University of Alberta, University of Calgary, and the University of Ottawa, use their mobile devices, limited wireless access in the hospital or clinic was reported as the main barrier to using mobile devices for information seeking by 71% of participants (Boruff & Storie, 2014). Students and residents have an increased need for these devices as they are still in the process of learning and must navigate their way through a vast amount of information (Boruff & Storie, 2014). It has been predicted by medical school administrators and students that in the near future, mobile devices and apps will become even more integrated with patient care and will completely replace textbooks (Wallace et al., 2012). Thus, mobile technology has allowed point-of-care, bedside or 'just-in-time' information to assist learning and medical practice (Hardyman et al., 2013).

Mobile Applications for Orthopaedic Surgeons

A survey of current surgical smartphone apps across different platforms revealed a total of 72 orthopaedic apps dedicated to clinician training, student education, patient education, general orthopaedics, research, and more (Kulendran et al., 2014). A recent study by Franko (2011) found that most respondents wanted more orthopaedic apps to be made available and would pay up to 30$ for them. There has been a boom in ebooks with Amazon having developed apps for smartphones that allow surgeons to access virtually any book within minutes at a reduced cost (Al-Hadithy, Gikas, & Al-Nammari, 2012). All major textbooks such as the "Orthopaedic Knowledge" series and "Campbell's Operative Orthopaedics" have smartphone versions (Al-Hadithy et al., 2012). Instant access to

surgical approaches and relevant anatomy for most common orthopaedic procedures is provided by AO Surgery Reference (Al-Hadithy et al., 2012).

The proper use and integration of the increasingly sophisticated smartphones into medical practice needs to be established (Ventola, 2014). There is limited evaluation of the use of mobile technology and associated apps in providing immediate electronic resource access in healthcare settings (Hardyman et al., 2013).

CHAPTER IV: METHODOLOGY

This chapter provides an overview of the explanatory sequential mixed methods study design followed by a detailed description of the RCT (Phase #1) and semi-structured interviews (Phase #2). The chapter continues with a fuller description of each phase of analysis while the cross-analysis description explains how the researcher merged both phases.

Explanatory Sequential Mixed Methods Design

A mixed methods study does not rely on either quantitative or qualitative research alone; the best information for the research questions and hypotheses is obtained through a combination of the two (Creswell & Plano Clark, 2011). In mixed methods research, investigators collect and analyze data, integrate the findings, and draw inferences using both qualitative and quantitative means in a single study (Teddlie & Tashakkori, 2006).

An explanatory sequential mixed methods study design as described by Creswell, Plano Clark, Guttman, and Hanson (2003) was used to explore the surgeons' experiences receiving daily targeted reports or weekly general reports from an online knowledge dissemination tool such as OE in the Indian setting. The sequential explanatory mixed methods study design occurred in two distinct phases (see Figure 1) (Creswell et al., 2003). Quantitative (numeric) data was first collected and analyzed using an initial survey, exit survey, and participants' OE usage data (Phase #1). The quantitative data and its analysis provided a general understanding of the research problem (Creswell & Plano Clark, 2011). The quantitative data then guided purposeful sampling for the qualitative phase while the qualitative results were used to help describe the findings of the quantitative study

(Creswell et al., 2003). Qualitative data collected through semi-structured interviews was analyzed in order to better understand the findings from Phase #1 (Phase #2). The qualitative data specifically aided in refining and explaining the statistical results by exploring participants' perceptions about OE in depth (Creswell et al., 2003; Tashakkorie & Teddlie, 2010).

By analyzing the perspectives and perceptions of the surgical resident trainees, consultants, and visiting fellows through surveys, interviews, and online use of OE, their insights provided an understanding of the EBM knowledge dissemination portal's barriers and benefits in the Indian context. One of the major strengths of this explanatory sequential mixed methods study was that multiple sources of evidence were used (Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2006). The purpose of this design was to ensure that a phenomenon was understood in its entirety.

Figure 1: Model of Explanatory Sequential Design

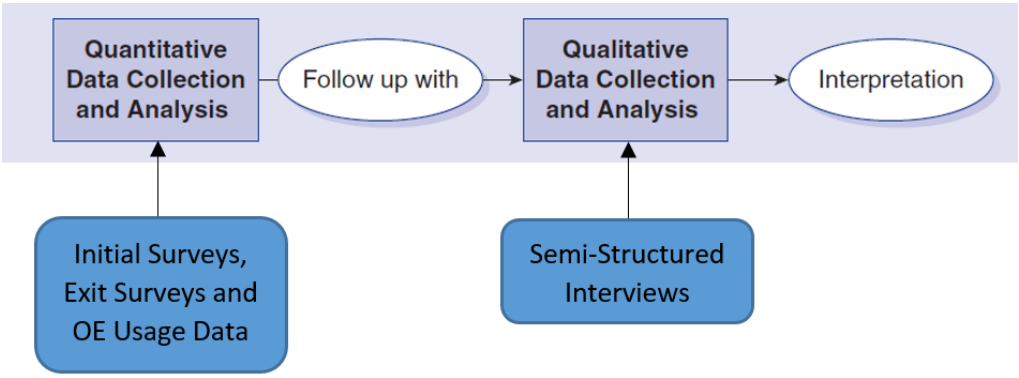


Image modified from: Creswell, J. W. & Plano Clark, V.L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: SAGE Publications, Inc.

Data Collection Tools

This study included the following instruments:

1) An initial survey to obtain a description of the surgeons' educational backgrounds, current uses of medical literature, use of mobile technology and the SIOR's internet access. This survey was also used as a means for participants to consent to taking part in the study.
2) An exit survey to compare perceptions of OE and OE use between the group that received daily targeted reports and the control group that received weekly reports.
3) Statistics from the OE database and MailChimp on each participant's behaviour on the website i.e. whether they were opening the daily or weekly newsletters, which articles they were accessing, and how frequently they were engaging with the website by actually clicking on a link within a newsletter.
4) Semi-structured interviews with probes designed by the researcher to allow for an in-depth view of surgeons' experiences and opinions of the OE evidence-based knowledge dissemination portal.

Rationale for Selection of Study Hospital

The SIOR was purposefully chosen as the study site due to their focus on orthopaedics and as a post-graduate teaching institute serving a large number of surgical resident trainees. Its departments include three trauma units, a hip unit, a knee unit, three spine units, a pediatric unit, two hand units, a shoulder unit, an oncology unit, a rheumatology unit, and a research unit. It is one of the best three hospitals for orthopaedics

in all of India (Sancheti Institute, 2015). Its vision is to become a world leader in providing state-of-the-art orthopaedic services while its mission is to lead by example and showcase best clinical practice in patient care, surgical expertise and academics by keeping up-to-date with the latest developments in the field of orthopaedics (Sancheti Institute, 2015). It is recognized as one of India's most important hospitals for quality orthopaedic care, education, and research. Given this background, the SIOR was an ideal site to carry out this research study with its focus on evaluating the integration of evidence into practice in a developing country like India. The researcher had access to the 83 doctors at the SIOR and the site was geographically and temporally convenient (Hulley et al., 2013).

Phase #1: Randomized Controlled Trial Design

Total Population Sampling for Overall Study

A purposive sampling method of total population sampling was used as the overall sampling strategy because the goal was to recruit all the orthopaedic surgeons in the hospital to participate. Total population sampling is a technique used to examine the total population with a particular set of characteristics (Laerd, 2015a). In this study, the units of interest were the orthopaedic surgeons at the SIOR and it was their specific characteristic of occupation which linked them all.

If the population size is relatively small, a total population sampling strategy is also advantageous to include as many participants as possible to provide the most accurate picture. There were only 69 participants eligible to take part in this study based on inclusion criteria - a small number. Thus, it was more valuable to use a total population sampling method to obtain deeper insight into the phenomenon of interest (Laerd, 2015a).

Given the total population, purposive sampling method, the maximum number of orthopaedic surgeons working at the SIOR determined the proposed sample size of participants to be 69 individuals.

Recruitment Methods and Randomization

The project was presented at morning rounds on Friday, May 22nd, 2016, to the SIOR's orthopaedic surgical residents, junior and senior consultants, and visiting fellows. The purpose of the study was to collect, analyze, and compare surgeons' experiences receiving daily targeted reports or weekly general reports from an online knowledge dissemination tool such as OE in an Indian setting. Thus, randomization of surgeons to the OE intervention of receiving daily targeted reports and the comparison group receiving weekly general reports was optimal. Randomized trials have an advantage in that randomly assigning study participants to the intervention group or the control group minimizes the influence of confounding variables and can demonstrate causality better than observational studies (Hulley, Cummings, Browner, Grady, & Newman, 2013).

The researcher obtained a list of all physicians and surgeons working at the SIOR (n=83). To be eligible for the study, participants had to be (1) orthopaedic surgeons in training or teaching, (2) full-time employees of the SIOR, (3) at least 18 years of age, (4) able to read and write in English, and (5) provide written informed consent. Physicians who were not trained as surgeons, surgical resident trainees on vacation or who graduated, and individuals working part-time, were excluded from taking part in the study. An initial screening ruled out physicians defined as internal medicine doctors, nephrologists, neurologists, rheumatologists, psychiatrists (n=14).

A recruitment email was sent out to the remaining potential participant candidates (n=69). The email described the purpose of the study, included a link to the OE website, a letter of information about the study including participant confidentiality, and a link to the initial survey through Google Forms (see Appendix C for the recruitment email and Appendix D for the letter of information).

The initial survey was used to obtain demographic information about the surgeons' educational backgrounds, current uses of medical literature, use of mobile technology, and the SIOR's internet access (see Appendix E for the initial survey). This information was used to ensure that both Intervention and Control groups possessed similar characteristics at baseline. The initial survey's Google Forms link was included in the recruitment email sent on Friday, May 22nd, 2015. The survey took approximately 10 minutes to complete. As a result of low response rates on the electronic version of the survey, the survey was also administered in person by the student researcher on Monday, May 25th, 2015. A total of 47 people responded to the initial survey. A total of 44 surgeons provided their consent and email addresses to be enrolled in the study and obtain full access to OE. These individuals included 27 surgical residents, 13 junior and senior consultants combined, and 4 visiting fellows.

The randomization process was stratified by level of training. The participants were separated into their respective occupations as surgical resident trainees, consultants, and visiting fellows, and then pseudo-randomized into the Intervention Group 1 receiving daily targeted mailers or Control Group 2 receiving weekly mailers. The researcher ensured that an equal number of surgical resident trainees, consultants, and visiting fellows were in each

arm of the study for comparison purposes. There were 22 participants (7 consultants, 13 residents, and 2 visiting fellows) in Group 1 and 22 participants (6 consultants, 14 residents, and 2 visiting fellows) in Group 2. See Figure 2 below for a flow diagram of study participants.

After the accounts were created, an individual email was sent to each participant with their unique username and password by the researcher. Instructions on how to login to the OE website, information about the types of newsletters they would be receiving (daily or weekly), and a YouTube link to a 2-minute introduction video on OE functionalities, were also sent in this email (see Appendix F for the email template sent to users upon creation of their accounts).

OrthoEvidence Trial Intervention

Following completion of the initial survey and provision of consent, the participants were pseudo-randomized into two groups – Group 1 receiving the OE daily targeted reports intervention and the comparison control, Group 2, receiving general weekly mailers. Group 1 participants received daily targeted mailers sent by the student researcher which included ACE reports specifically chosen for the SIOR's orthopaedic practice based on the cases presented at morning rounds. Group 2 simply had full access to OE and received the general weekly mailers sent by OE but did not receive the daily targeted reports. Participants in both groups received free, full online access to the OE website and could use the site as they pleased. Both groups also received newsletters presenting newly uploaded evidence or recent interviews that were sent out by the OE company to their subscribers at least once a week; these newsletters were not specific to the SIOR.

The student researcher (SK) attended daily morning rounds from 6:30 am to 8:30 am to determine which ACE reports would be most suitable for the surgeons based on the cases presented. Meticulous notes were taken on cases presented. Cases that were more controversial were noted along with the reason for admission, diagnosis, and/or treatment plan. Relevant ACE reports specific to these cases were sent to surgeons in Group 1 receiving daily targeted mailers. For example, there was a great deal of discussion around surgical and non-surgical management of clavicle fractures. Thus, every couple of days, at least one clavicle fracture ACE report was included in the daily targeted mailers.

ACE reports were sent to Group 1 participants by the researcher via a newsletter created through MailChimp. Each newsletter included nine ACE reports with a minimum of one report for each sub-specialization department at the SIOR including pediatrics, trauma, knee, spine, hand and shoulder, hip, ortho-oncology, rheumatology, and general orthopaedics (see Appendix G for an example of a daily newsletter sent to Group 1). For the month of June, the student researcher sent out a total of 21 daily targeted mailers to participants in Group 1 from May 30th until June 19th, 2015 (see Appendix H for the break-down of ACE reports sent in each orthopaedic category).

Each ACE report was accompanied by an assessment of the evidence's methodological quality (risk of bias score) designed by OE based on the Cochrane Risk of Bias Assessment, a standard tool for assessing the level of bias within RCTs (see Appendix I for the methodological quality assessment) (Higgins et al., 2011; Sprague et al., 2015). A high risk of bias score according to OE's methodological quality assessment indicated that the study was believable. Though it should be noted that adding up risk of bias items to

create aggregate scores has the potential to be misleading by Deschartres and colleagues (2014), this point was not deemed to be a major issue for the purposes of this study. A quality of reporting score was also provided for each ACE report and was used to assess the overall comprehensiveness of the original published study. The reporting quality scores were based on a 20-item modified Detsky Score checklist which focus on: Randomization, Outcome Measurements, Inclusion/Exclusion, Therapy Description, and Statistics (see Appendix J for the quality of reporting checklist) (Detsky, Naylor, O'Rourke, McGeer, & L'Abbe, 1992). Authors of the original publications could be interviewed for their unique insights or for further explanation of their research; in that case, the ACE report would be "author-verified" (Sprague et al., 2015). Subscribers also had the ability to rate ACE reports on their level of usefulness in practice. All of these scores were essential given that many surgeons lack the formal training and skills necessary to accurately and consistently critically appraise the literature (Sprague et al., 2015). High risk of bias scores (above 6/10) based on OE's methodological quality assessment (see Appendix I), recent articles (published within the last five years), high reporting quality scores (above 17/20), author-verified ACE reports, high user scores (above 7/10), sample sizes with greater than 50 participants, randomized controlled trials and meta-analysis, were preferable to include in the daily ACE report newsletters sent to Group 1.

Hypotheses

It was expected that providing daily targeted evidence summaries to orthopaedic surgeons would enable more frequent use of OE compared to providing weekly general reports which were not locally relevant. It was also expected that consultants would use OE

more often than residents as they would have a greater need to keep up with new research in the field to teach and practice.

Overall, it was hypothesized that Group 1 participants would respond more positively because they had more opportunity to engage with OE content with the consistent delivery of daily reports. It was expected that Group 1 would find ACE reports to be more comprehensive, practical, and useful compared to Group 2. Finally it was expected that OE would improve the efficiency and ability to stay apprised of current medical literature for Group 1 compared to Group 2. Group 1 would also be better informed to make medical decisions as a result of knowledge gained from OE ACE reports. Participants in Group 1 would be more likely to discuss ACE reports with colleagues or patients. All of these results were captured from responses to the exit surveys.

Outcome Measurements

OrthoEvidence Usage Statistics

Individual participants' usage data (open and click rates) was tracked through the OE database and MailChimp to determine whether receiving daily targeted evidence summaries led to more frequent use of the OE service compared to only receiving weekly general newsletters. In both groups, the researcher was able to track the number of newsletters sent to each participant, the percentage of newsletters that were opened through the participant's email (open rates), the percentage of reports that were clicked within the newsletters for each participant (click rates), and the specific reports that were accessed. During the trial period, 21 daily targeted mailers were sent to participants in Group 1 in

addition to the 14 general mailers for a total of 35 mailers. Group 2 received a maximum of 14 general mailers which were sent by OE.

Exit Survey

Post-intervention, all participants were surveyed about their experience with OE after a minimum of three weeks. The exit survey included 18 multiple-choice questions and one open-ended question to provide an example of how the surgeons used the knowledge they gained from an ACE report in practice (see Appendix K for the exit survey). The exit survey was used to compare OE use and perceptions of OE between the group that received daily targeted reports and the control group that received weekly reports. OE use between the two groups was compared through self-reported data on the number of ACE reports reviewed, average time spent on OE, method of accessing OE, and ease of access to OE within the SIOR. Participants provided their perception of ACE report comprehensiveness, practicality, usefulness, efficiency, and applicability in practice on a five-point Likert scale from strongly agree to strongly disagree (Likert, 1932). Surgeons also rated whether they felt better informed to make medical decisions and whether they believed their patient care had improved as a result of knowledge gained from ACE reports. They were asked whether they took action to put any of the new knowledge they gained from ACE reports into practice by actively discussing reports with a colleague or changing patient care decisions. Responses were compared between the two groups.

Surveys took less than 15 minutes to complete and were administered initially through Google Forms on Saturday, June 13th, 2015. Due to a low response rate on the electronic version of the survey, the survey was also distributed in person by the student

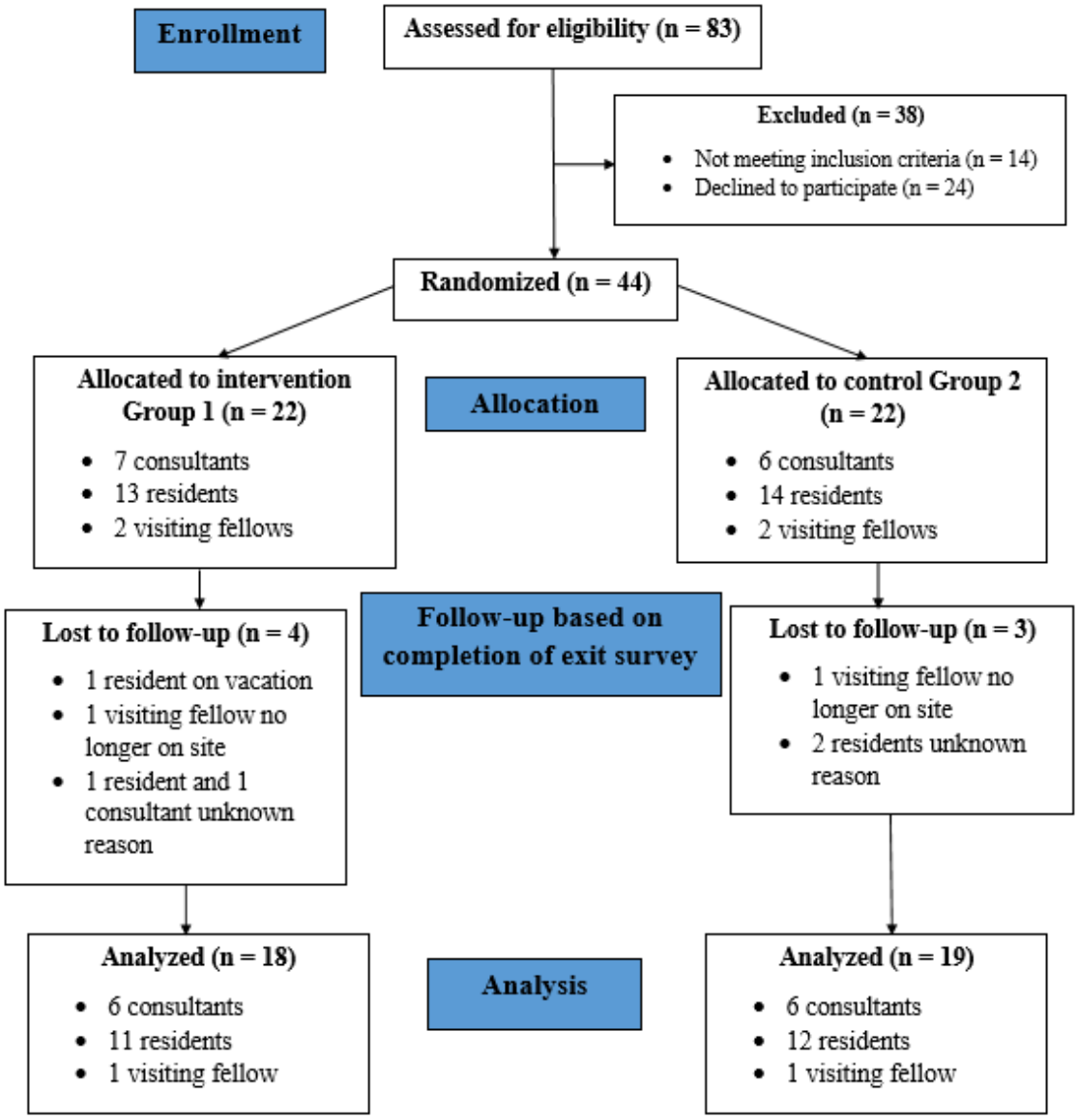
researcher on Monday, June 15th and Tuesday, June 16th, 2015. There were a total of 37 surgeons (18 from Group 1 and 19 from Group 2) who responded to the exit survey. Thus, 7 individuals out of the 44 (15.91%) enrolled in the trial were lost to follow up. Reasons for loss to follow-up included residents on vacation (14.28%; n = 1), visiting fellows no longer working at the SIOR (42.86%; n = 3), and other unknown reasons (42.86%; n = 3). See Figure 2 for a flow diagram of participants enrolled in study.

Bias Reducing Measures

To reduce non-response bias and obtain a high response rate, the initial and exit surveys were distributed via email and in person. To reduce the risk of drop-outs from the study, the researcher also provided one-on-one and group training sessions on how to access OE newsletters through participants' email and how to use OE effectively.

Participants' usage of OE was tracked based on their username. The few participants (n = 3) who already had OE accounts were asked whether they wanted to continue in the study with new accounts or simply continue using their old ones. Their prior experience with OE was noted for further follow-up in the interview process.

Figure 2: Flow Diagram of Study Participants for the RCT



Phase #2: Semi-Structured Interviews

Semi-structured interviews were conducted with probes that were designed by the researcher and validated by a qualitative expert to gain further insight into the surgeons' experiences with OE. These semi-structured interviews were an integral part of the mixed methods sequential explanatory design and served to explain the findings from Phase #1.

The purpose of these interviews were to: understand the experiences of orthopaedic residents, consultants, and fellows with OE at the SIOR; evaluate whether knowledge from OE ACE reports had translated into a perception of improved patient care by surgeons; describe the impact of an evidence-based knowledge dissemination tool on surgeons' practice; and identify perceived barriers and facilitators to implementing OE at the SIOR and elsewhere in India (see Appendix L for the semi-structured interview guide).

A well-conducted semi-structured interview is one which uses an open-ended conversational style, while exploring the question of interest (Yin, 2009). Semi-structured interviews allowed the researcher to be flexible in the pre-determined questions that were asked and to make adjustments based on the interviewee's responses (Harrell & Bradley, 2009). Qualitative interview guide questions were adjusted based on the survey responses that the researcher received from participants. This study's interview guide was validated by the researcher's thesis committee to avoid the use of leading questions. In case interviewees had difficulty answering a particular question, probes were used for each question to elicit additional information and clarify responses (Harrell & Bradley, 2009). The semi-structured interviews allowed the researcher to explain the impact of an evidence-based knowledge dissemination tool on surgeons' practice and to identify barriers and facilitators to implementing OE at the SIOR.

Maximum Variation Sampling for Semi-Structured Interviews

Methods of purposive sampling were used for this study to recruit orthopaedic surgical residents, junior and senior consultants, and visiting fellows. The aim of a purposive sampling method is to identify certain groups of people who either possess

characteristics or live in circumstances relevant to the phenomenon being studied (Mays & Pope, 1995). In this way, the researcher can make use of a wide range of types of informants and can select key informants with access to important sources of knowledge (Mays & Pope, 1995). Researchers can use this non-probabilistic sampling technique to search for specific cases of participants to be interviewed (Patton, 2002).

A specific method of purposive sampling, maximum variation sampling, was used to recruit surgeons for the interviews because the goal was to include and capture a range of perspectives from the residents, consultants, and visiting fellows. Maximum variation sampling searches for a variation in perspectives and includes those with typical experiences or more extreme accounts in an attempt to gain insight into the phenomenon by looking at it from all angles (Laerd, 2015b).

Given that in this study surgeons' usage of OE was tracked, the researcher was able to identify low, middle, and high users of this evidence-based knowledge dissemination portal based on who was opening the newsletters. In particular, those individuals who had expressed positive or negative feelings towards OE or who had demonstrated a consistent use of OE or no use of OE, were approached in person or via email by the researcher to coordinate an interview.

The researcher sought different perspectives and accounts of experiences from participants during the interview process to reach data saturation (Strauss & Corbin, 1998). The point at which no new information is found is defined as data saturation (Strauss & Corbin, 1998). For the semi-structured interviews, the sample size was dependent on the data quality and whether it achieved data saturation. The proposed sample size for the semi-

structured interviews was a total of 20 participants because Strauss and Corbin (1998) found that 15 to 20 cases were an appropriate number to achieve saturation of emergent themes from interviews.

In this study, data saturation was reached after 19 interviews were conducted with eight surgical residents, nine consultants, and two visiting fellows. Thirteen of the interviewees were receiving daily targeted reports (Group 1) from the student researcher while six received weekly general reports (Group 2) from OE.

Semi-Structured Interview Process

Residents, consultants, and fellows who completed the exit survey were emailed and approached in person by the researcher to ask whether they would take part in a semi-structured interview. Interviews began on Monday, June 15th and lasted until Friday, June 19th. Interviews took place in the participant's natural environment inside the SIOR either in the research department offices, clinical meeting room, surgeons' private offices, or in the trauma unit's private office depending on the surgeon's availability. Apart from the researcher and study participant, nobody else was in the room as to promote honesty and to avoid response bias (Harrell & Bradley, 2009). Interviewees were also able to express themselves in their native language, Hindi, which was understood by the researcher. In doing so, the researcher was more sensitive and aware of the data being collected (Mays & Pope, 1995).

Prior to beginning each interview, the informed consent form was explained by the student researcher and signatures from the interviewee were obtained. Permission to audio-record and take notes on the interview was also obtained while participants were reassured

that study results would not allow them to be identified. Participants were made aware that they may choose not to answer some questions during the interview. The interview guide was tailored to the specific position of each participant (orthopaedic resident or consultant or fellow).

Each interview took approximately 15-20 minutes and the interviews were audio recorded with permission to ensure an accurate transcription of the surgeons' responses. Type-written notes were taken during the interview if a participant refused to be audio-recorded. There were a total of 16 interviews that were audio-recorded. Three surgeons did not give consent for recording and thus notes were taken by the student researcher as the interview progressed.

Researcher as an Instrument in Qualitative Research

The researcher became interested in the topic of EBM and knowledge translation during a Health Research Methodologies course. A heated class discussion focused on the lack of knowledge translation from clinical research to clinical application. The class's common sentiment was that the benefits of research were not felt by those who needed them most; there was a disconnect between clinical research, improvements to population health, and strengthening of health services and systems (Grol & Wensing, 2004; Straus et al., 2009). The student researcher decided to explore this gap between clinical research and clinical application internationally. Thus, her journey to India began.

The student researcher was present at the SIOR for a total of five weeks. Given that researchers are the main tools in data collection and analysis in qualitative studies, it is essential that their assumptions be acknowledged and disclosed to enhance the credibility

and validity of the findings (Mays & Pope, 1995). This is accomplished through a process of reflexivity as described by Holloway and Wheeler (2013). It is important to note that the student researcher is: (1) a female, (2) Canadian born and raised in Montreal, and (3) of Indian descent and is able to speak two Indian languages (Hindi and Gujarati). These factors are important to consider because the researcher was usually the only female in a room full of male orthopaedic surgeons and she held a dual identity that may have affected the way these surgeons interacted with her. The relationship between the researcher and the surgeons was always professional. She was able to communicate and partake in discussions more effectively as a result of her ability to integrate into the culture.

Ethical Consideration

Provisional ethics approval from McMaster University's Hamilton Integrated Research Ethics Board (HiREB) Student Research Committee was obtained on April 8th, 2015 while final ethics approval was granted for this project on April 22nd, 2015. Provisional approval from the SIOR's Ethics Committee was obtained on April 10th, 2015 and final approval was given on April 28th, 2015.

Along with the first recruitment email (see Appendix C for the recruitment email), the project's letter of information (see Appendix D for the letter) was also attached describing the purpose of the study, procedures, and any potential discomforts or benefits that could arise from involvement in the study. Risks to participants in the study were minimal. Reading additional information through OE every day may have been inconvenient. Some participants may have felt uncomfortable about investing time in the OE project by providing answers to surveys or interview questions. Participants were

informed that their feedback would help us learn more about how targeted evidence summaries could help orthopaedic surgeons in practice. For the benefit of the surgeons participating in this study, their access to OE will continue for a total period of two years.

Participants were made aware that surveys and interview data would be kept confidential and all information would be de-identified, thereby reducing potential harm. It is possible that participants may have been identified by their peers based on the experiences they shared about how they used OE in their day-to-day practice. Participants were told that their participation was voluntary and they could withdraw at any time without any consequences.

The initial email included a link to the first online survey and completing it implied consent on the part of the participants to partake in the research study. Usually, electronic surveys do not require a signed consent, because clicking the 'submit' button at the end of the survey implies consent (Sprague, Quigley, & Bhandari, 2009). To ensure continued consent, each orthopaedic resident, consultant, and fellow was asked to consent prior to their interview in India (see Appendix M for the interviewees' informed consent form). Participants were informed that they would have the option to view the results of the study upon its completion.

All hard copies of interview informed consent forms, initial and exit surveys, and semi-structured interview notes were kept anonymous and confidential in a locked cabinet which was only accessible by the research team. The audio-recording device, a mobile tablet, used for the semi-structured interviews was password protected. All questionnaire data and semi-structured interviews that were transcribed verbatim were organized using

Microsoft Word, Excel Spreadsheets, IBM Statistical Package for the Social Sciences (SPSS) 23.0, and QSR NVivo Pro 11.0. This data was kept on a password protected computer accessible only to the student researcher. The archive of data, without identifying information, will be maintained for three years after which time all files will be deleted from the personal password-protected computer and all hard copies of the consent forms and questionnaires will be shredded and discarded.

Disclosure of Potential Conflict of Interest

Dr. Mohit Bhandari is the Founder and Editor-in-Chief of OrthoEvidence. He holds shares in the company. Any competing interests were disclosed prior to the start of the project. No financial gain was obtained from this thesis project.

Data Management

Participant Data

After completion of the initial survey, those who consented to being part of the study obtained free, full access to the OE website. The researcher individually created each user's OE account. An Excel document with all participants' account information was kept up to date by the researcher. The student researcher was able to track participants' usage of OE based on the username assigned to them. Participants who completed the initial and exit surveys were also noted in this Excel file.

Daily Targeted Mailer ACE Reports

An Excel file was kept by the researcher to track ACE reports sent in newsletters and to avoid duplications in future newsletters. This Excel file included the date the ACE report was sent in the targeted newsletter, specific ACE report number, title, year of

article's publishing, category (knee, general orthopaedics, osteoarthritis, hand and wrist, hip, pediatric orthopaedics, shoulder and elbow, spine, trauma, or foot and ankle), OE Evidence level, author verification (yes or no), sample population in the study, risk of bias score, reporting criteria score, usefulness score, and reason why the specific report was chosen by the researcher.

Interviews

Transcription of the interviews took place within a week of their completion to ensure accuracy. Each audio recording was listened to at least twice and was transcribed verbatim by the researcher. Identifiers were removed as soon as transcription was complete. The transcripts were transferred into NVivo for further coding and analysis. NVivo is a common tool used in qualitative research and allows for effective management of data. Hoover and Koerber (2011) explain that NVivo has the ability to enhance efficiency, multiplicity and transparency within the research process with its built-in tools created for easy coding. Therefore, NVivo assisted in developing and organizing themes.

Data Analysis

Data analysis included aggregation of survey responses, interviews, and usage data from the OE database. SPSS and NVivo were used to analyze the results of the surveys, interview transcripts, and statistics from the OE database. Data analysis software programs such as SPSS and NVivo facilitated new levels of analysis by making the process of content analysis more manageable and ordered (Gerbic & Stacey, 2005).

Initial and Exit Survey Analyses

Participants' initial survey information and exit survey responses were analyzed using SPSS to produce descriptive statistics, frequencies, measures of dispersion and central tendencies (means, medians, and standard deviations) for each of the questions in the surveys. Microsoft Excel was also used to generate data tables to display the results.

The data from the surveys was collected as ordinal dependent variables and responses were non-normally distributed. The non-parametric Mann-Whitney U test was thus used to analyze the data as the assumptions for parametric tests were violated. A threshold p-value of 0.05 with a confidence interval of 95% was used to determine the significance of the results.

OrthoEvidence Usage Statistics Analysis

In both Group 1 and Group 2 of the trial, the researcher was able to track the number of newsletters sent to each participant, the percentage of newsletters that were opened through the participant's email, the percentage of reports that were clicked within the newsletters for each participant, and the specific reports that were accessed. Group 1 received 21 daily targeted mailers during the trial period. This information provided concrete evidence of surgeons' usage (behaviour) with the OE knowledge dissemination portal. It helped to cross-check and validate the responses from the surgeons obtained during interviews and surveys.

The open and click rates for the daily newsletters were compared to the rates for the group receiving the weekly newsletters from OE. Stratified analyses within groups and across groups were also performed to compare open and click rates based on position of

authority (resident trainee/visiting fellow, or consultant). There were a few outliers in the data and the researcher did not want to ignore these users in the analysis section. The data was also not normally distributed. Hence, the assumptions for parametric tests were violated. Mann-Whitney U tests were thus conducted to deal with these issues and to determine if there were differences in the open and click rates between the Intervention and Control groups. A threshold p-value of 0.05 with a confidence interval of 95% was used to determine the significance of the results.

Semi-Structured Interview Analysis

An exploratory descriptive thematic analysis was undertaken for the semi-structured interviews (Sandelowski, 2000; Sandelowski, 2010; Silverman, 2011; Thorne, 2008; Thorne, Kirkham, & MacDonald-Emes, 1997; Thorne, Kirkham & O'Flynn-Magee, 2004). NVivo was used to help conduct a deeper analysis of the interview data by enhancing the retrieval and qualitative coding processes.

Thorne (2008) described coding as "gathering together data bits with similar properties and considering them in contrast to other groupings that have different properties" (p.145). In this study, an edit organizing style, as defined by Miles and Huberman (1994), was used to code the interview transcripts through the data reduction process. Data reduction is the process by which interview transcripts, field notes, and observations, are condensed and organised through coding (Miles & Huberman, 1994). Once all interviews were transcribed, irrelevant information was removed but accessible if unexpected findings required a re-examination of the data.

The interview transcripts were carefully read and significant points relating to the research questions were highlighted and assigned a code or category. In the open coding process, raw data was organized into conceptual categories: "Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. Codes are usually attached to 'chunks' of varying size – words, phrases, sentences or whole paragraphs" (Miles & Huberman, 1994, p.56). In order to best fit the data, codes were continuously modified (Crabtree & Miller, 1999). Coding that is well-done validly reflects what is being researched, is mutually exclusive from other codes, and is exhaustive for all relevant data to fit into a code (Miles & Huberman, 1994).

The interview transcripts in this study were reread to search for statements that could fit into any of the initial categories through a process of axial coding – the second stage of coding (Miles & Huberman, 1994). The researcher asked whether certain codes could be grouped together in a more general code. These pieces of data were chunked together.

The final stage of coding, selective coding, involved rereading interview transcripts for cases that explained certain themes in detail. To minimize confirmation bias, the researcher looked for data that was both contradictory and confirmatory.

The coded data units of statements were clustered into common themes. A thematic analysis of the data, as described by Silverman (2011), allowed the student researcher to build a comprehensive picture around whether or not a knowledge dissemination portal could help orthopaedic surgeons to improve their practice at the SIOR.

Cross Data Analysis

Findings from both the quantitative and qualitative sections of the study were merged after analyzing each component separately in order to answer the overall mixed methods research question: "How do orthopaedic surgeons in Pune, India describe their experiences using and applying clinical evidence provided to them through an online medium such as OE?". The quantitative usage data pointed towards surgeons' actual behaviour with OE to understand whether providing daily targeted evidence summaries entailed more frequent use of the OE service compared to providing weekly orthopaedic evidence summaries. Any differences between the Intervention and Control groups were noted as were any differences in usage rates between consultants and residents/visiting fellows. The quantitative exit survey responses indicated overall ability to access online knowledge dissemination tools and perceptions of OE. Reasons for high or low usage rates and varied exit survey responses, were further clarified through the qualitative semi-structured interview data which allowed for a deeper understanding of barriers or facilitators faced by surgeons when asked to incorporate evidence into practice. The interviewees also discussed changes in clinical decision-making and patient care as a result of the OE knowledge dissemination portal. Findings were looked at as a whole to make further recommendations of how to improve EBM practices in developing countries such as India.

Rigour

The validity of a study relies on the reproducibility of the research design and analysis (Mays & Pope, 1995). For both quantitative and qualitative research, the basic

strategy to ensure rigour involves systematic research design, data collection, interpretation, and communication (Mays & Pope, 1995).

Both questionnaires and interview guides were developed with orthopaedic, quantitative and qualitative experts from the researcher's thesis committee for validation purposes and to enrich content validity (Hulley et al., 2013). The surveys were designed based on an article written by Sprague and colleagues (2009) which discussed survey designs specifically targeted at orthopaedic surgeons. The types of questions included, wording used, and the order in which the questions were presented, were carefully considered. Email was chosen as the means to distribute both surveys because it was found that electronic surveys allowed for faster responses and efficient data collection/analysis, a decreased number of questions left unanswered, and a reduction in data-entry errors on the part of the researcher (Sprague et al., 2009). However, some limitations to this method of survey distribution for orthopaedic surgeons include a decreased response rate, unfamiliarity with internet or e-mail, or the survey went to junk mail (Sprague et al., 2009). Thus, a mixed mode design was used to ensure adequate response rates; the survey was first administered electronically and then distributed in person (Sprague et al., 2009).

In qualitative research, trustworthiness is established through credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Credibility is the confidence in the 'truth' of the findings (Lincoln & Guba, 1985). Transferability is the demonstration that research findings have applicability in other contexts; establishing transferability can be accomplished through thick description (Holloway & Wheeler, 2013; Lincoln & Guba, 1985). Dependability implies showing that findings are consistent and

could be repeated through such means as an inquiry audit (Lincoln & Guba, 1985). Confirmability revolves around the extent to which the findings of a study are shaped by the respondents as opposed to researcher bias, motivation, or interest (Lincoln & Guba, 1985).

During the initial interviews, the student researcher's external qualitative expert listened to the first two audio recordings and provided feedback to ensure neutrality and consistency in future interviews. To further improve the credibility, reliability and rigour of the study, the student researcher and the qualitative expert independently coded the first three interview transcripts. They compared and discussed the coding scheme to ensure that all transcripts were coded consistently. Once the student researcher coded all the interview transcripts, a consensus regarding the main themes was made by the researcher's thesis committee.

External validity or generalizability or transferability is the degree to which results of a study can be applied to other settings (Hulley et al., 2013; Lincoln & Guba, 1985). Given that the implementation of OE was a pilot project, this study explored initial themes and concepts related to its strengths and weaknesses in the Indian context. Interviewees answered whether they believed OE could be expanded to other areas with similar infrastructure as the SIOR and provided a rationale for generalization and transferability of the study's findings (Gibbert, Ruigrok, & Wicki, 2008; Lincoln & Guba, 1985).

To ensure the credibility and confirmability of the researcher's analysis, a process of triangulation was used to combine the different sources of information and provide a well-rounded picture (Holloway & Wheeler, 2013; Lincoln & Guba, 1985; Mays & Pope,

1995; Yin, 2009). This improved internal validity for the researcher to make logical conclusions (Gibbert et al., 2008). Through a process of reflexivity, the student researcher was aware of her integral role in the data collection process and disclosed any assumptions to the reader to enhance the study's credibility and confirmability (Holloway & Wheeler, 2013; Lincoln & Guba, 1985). Furthermore, credibility was enhanced by the student researcher's persistent observation and prolonged engagement in the field to understand the culture, social setting, phenomenon of interest (use of EBM tools), and build trust with members of the SIOR (Lincoln & Guba, 1985).

An audit trail was kept to ensure the reliability, dependability, confirmability of the research (Hulley et al., 2013; Holloway & Wheeler, 2013; Lincoln & Guba, 1985). Rigour was enhanced by creating an account of method and data that could be analyzed by another trained researcher to come to the same conclusions (Mays & Pope, 1995). To establish retest reliability of the researcher's analysis, meticulous records of interviews and observations were kept to document the process of analysis as described by Mays and Pope (1995). Other researchers could judge the process by which this research study was conducted through an external audit because electronic records of coding schemes were maintained through NVivo. Detailed accounts of the data analysis process including thesis drafts and records of committee meetings were kept. The use of computer programs such as SPSS and NVivo improved the audit trail by facilitating the organization of data, and thereby strengthened the rigour of the study.

CHAPTER V: RESULTS OF EXIT SURVEY AND USAGE DATA (PHASE #1)

Demographics of Participants in the Research Study

A total of 44 surgeons provided their consent and email addresses to be enrolled in the study and obtain access to OE. All participants were male except for one female. Of the respondents, 61.36% (n = 27) were residents, 29.55% (n = 13) were consultants, and 9.09% (n = 4) were visiting fellows. These participants were randomized into Group 1 who received daily targeted mailers or Group 2 who received weekly mailers. There were 7 consultants (31.82%), 13 residents (59.09%), and 2 visiting fellows (9.09%) for a total of 22 participants in Group 1. There were 6 consultants (27.27%), 14 residents (63.64%), and 2 visiting fellows (9.09%) for a total of 22 participants in Group 2. Mann Whitney U tests were performed to compare responses to the initial survey's questions between each group. No significant differences existed and thus both groups were considered to be similar in baseline characteristics for the purposes of the RCT.

The mean age of respondents was between 26 and 30 and most were resident trainees. Given that the majority of the respondents were resident trainees, the group's mean number of years of practice was between 1 and 5 years (70.45%, n = 31). The consultants' years of practice ranged from 6 to more than 31 years (29.55%, n = 13). See Appendix N, Table 1, for a comparison of the two groups' demographic information.

When participants were asked whether there was a specialty that they were more interested in pursuing or were more focused on currently, Arthroplasty (34.09%, n = 15) and Trauma (31.82%, n = 14) were the most frequently cited overall.

Approximately 63.64% (n = 28) of survey respondents had access to computers connected to the internet within the SIOR. However, 63.64% (n = 28) of the group had difficulty browsing the internet on these same computers. All respondents used some form of mobile device (laptop, tablet, or cellular mobile phone). Furthermore, all respondents owned and used a smartphone within the SIOR. However, for 59.09% (n = 26) of survey respondents, connecting their smartphone to the internet and browsing websites while in the SIOR was only sometimes or never possible depending on the location and connection. Connecting to mobile apps within the SIOR was also only sometimes or never possible depending on the location and connection for 61.36% (n = 27) of respondents. See Appendix N, Table 2, for a comparison of the two groups.

Three quarters of respondents (75.00%; n = 33) said they accessed medical literature online while 72.73% (n = 32) also said they used textbooks. Only 38.64% (n = 17) said they read journals in paper form. Medical literature was read weekly by 52.27% (n = 23) of respondents while 65.91% (n = 29) read 1 to 3 scholarly journal articles in the week. Notably, 63.64% (n = 28) of individuals stated that their current method of keeping up to date with new research was inefficient. Interestingly, three quarters of the group (75.00%, n = 33) stated that their current method of staying up to date with research still improved their patient care. See Appendix N, Table 3, for a comparison of the two groups.

Results of Exit Survey

Given the RCT nature of this study, the researcher ensured that the Intervention and Control groups' baseline characteristics and demographics were similar as noted in the previous section.

Introduction to Exit Survey

The exit survey collected information about the surgeons' experiences with OE and perceptions of ACE reports (see Appendix K for the exit survey). The survey also gathered information about the number of ACE reports reviewed, average time spent on OE, method of accessing OE, and ease of access to OE within the SIOR. Responses to the exit survey allowed the researcher to answer the study question, "Does providing daily targeted evidence summaries to orthopaedic surgeons in Pune, India entail more frequent use of the service compared to providing weekly orthopaedic evidence summaries over a one-month time span?"

Respondents also provided their perception of ACE report comprehensiveness, practicality, usefulness, and applicability in practice. Surgeons rated whether they felt better informed to make medical decisions and whether they believed their patient care had improved as a result of knowledge gained from ACE reports. They were asked whether they took action to put any of the new knowledge they gained from ACE reports into practice.

The exit survey was used to compare the experiences and perceptions of surgeons receiving daily targeted ACE reports and those receiving general weekly reports. Mann Whitney U tests, based on a p-value significance level of 0.05 and a confidence interval of 95%, demonstrated no difference in the responses between the Intervention and Control groups for any of the exit survey questions.

Demographic Information of Surgeons Completing Exit Survey

Out of the 44 surgeons enrolled in the study, 37 completed the final survey (84% response rate). There were 18 Group 1 participants with 61.11% (n = 11) residents, 33.33% (n = 6) consultants, and 5.56% (n = 1) visiting fellows. There were 19 Group 2 participants with 63.16% (n = 12) residents, 31.58% (n = 6) consultants, and 5.26% visiting fellows (n =1).

The average time spent reviewing literature in online journals including the time it took to look up publications through web portals and to read the articles was found to be 30 minutes or less for 50.00% (n = 9) of Group 1 and for 52.63% (n = 10) of Group 2. The time spent reviewing literature in online journals was not significantly different (p = 0.753). See Appendix O, Table 4, for a further break-down and comparison between groups.

Accessibility of OrthoEvidence

Most of the surgeons (72.97%; n = 27) were accessing OE through their smartphones. However, the majority of respondents (70.27%; n = 26) were only sometimes able to load the OE website without problems depending on their connection and/or location within the SIOR. See Appendix O, Table 5, for further comparison between groups.

Usage of ACE Reports

When asked how often ACE reports were read over the weeks that they were sent, 33.33% (n = 6) of Group 1 said weekly while 63.16% (n = 12) of Group 2 said weekly. However, there was no significant difference in the frequency with which the two groups

were reading ACE reports (p = 0.142). See Appendix O, Table 6 for a further break-down and comparison between groups.

There were three surgeons in each group who said they never read an ACE report sent to them. Five of these six were residents and these five individuals were excluded from further analysis of the responses as their usage data also confirmed that they had never opened a newsletter. The sixth surgeon who claimed not to be reading ACE reports was found to be engaging with OE based on usage data and was therefore kept in the analysis of the exit survey responses. Thus all results below are based on the responses of 32 individuals. Group 1 thus consisted of 16 surgeons with 56.25% (n = 9) residents, 37.50% (n = 6) consultants, and 6.25% (n = 1) visiting fellows. There were 16 surgeons in Group 2 with 56.25% (n = 9) residents, 37.50% (n = 6) consultants, and 6.25% visiting fellows (n =1).

More than half of the respondents in Group 1, 62.50% (n = 10), confirmed that they were spending 30 minutes or less on the OE website weekly. Conversely, Group 2 participants had an equal number of surgeons, 37.50% (n = 6), spending either 30 minutes or less or 30 to 60 minutes on the OE website. However, these differences were not significant (p = 0.287).

In Group 1, 56.25% (n = 9), were reading 1 to 3 ACE reports weekly while 87.50% (n = 14) of Group 2, were reading 1 to 3 reports weekly. Yet, this difference was not statistically significant (p = 0.724).

The majority of respondents were accessing Arthroplasty articles (53.13%, n = 17) and Trauma articles (50.00%, n = 16). Categories that were least accessed included Physical Therapy and Rehabilitation (12.50%, n = 4).

Perceptions of ACE Reports

The majority of respondents, 75.00% (n = 12) in Group 1 and 93.75% (n = 15) in Group 2, agreed that ACE reports were comprehensive. There was no significant difference in perception of comprehensiveness between the two groups (p = 0.361). See Appendix O, Table 7, for a full comparison between groups.

In Group 1, 62.50% (n = 10) and 81.25% (n = 13) in Group 2 agreed that ACE reports were practical tools to enhance their knowledge by providing updated information. No significant difference in perception of ACE report practicality was noted between the two groups (p = 0.341).

When asked whether ACE reports were useful, 75.00% (n = 12) of Group 1 agreed while 100.00% (n = 16) of Group 2 agreed. Again, there was no difference in perception of ACE report usefulness between the two groups (p = 0.239).

Three quarters of Group 1 (75.00%, n = 12) and three quarters of Group 2 (75.00%, n = 12), agreed that ACE reports had improved their efficiency and ability to keep up with new research. There was no statistical difference between the two groups (p = 0.956).

Half of Group 1 (50.00%, n = 8) and 68.75% (n = 11) of Group 2 agreed that they were better informed to make medical decisions as a result of knowledge gained from the OE ACE reports. There was no statistically significant difference between the two groups (p = 0.402).

Participants were asked whether they believed that the patient care they provided improved as a result of the knowledge gained from ACE reports. Of Group 1, 56.25% (n = 9) neither agreed nor disagreed with the statement while 62.50% (n = 10) of Group 2 agreed with the statement. However, this difference was not statistically significant (p = 0.381).

The majority of participants, 81.25% (n = 13) of Group 1 and 93.75% (n = 15) of Group 2, felt that the evidence from ACE reports was applicable to their medical practice in India despite difficulties with limited resources. There was no significant difference between the two groups in their perception of applicability of ACE reports (p = 0.539).

If a surgeon read an ACE report and made an informed patient care decision based on the information read, changed a patient care decision, discussed some part of the ACE report with another orthopaedic doctor, physician, physiotherapist, nurse, or patient, then their response was coded as "took further action". If participants simply thought about how their decision would differ from the consultant's patient care decision or they indicated that they did not take further action, their responses were coded as "did not take further action". It was found that 62.50% (n = 10) of Group 1 and 81.25% (n = 13) of Group 2 took further action. No significant difference between the two groups was noted (p = 0.341).

Participants were asked to provide one or more examples of how they used knowledge gained from ACE reports in practice. One surgeon explained that the ACE reports allowed for an examination of protocols and standard operating procedures in patient care. Some surgeons explained that their knowledge became more evidence-based after reading the articles. Other surgeons said that the articles were good for discussion amongst colleagues, seniors, and patients. One surgeon was able to critically evaluate an

osteoporotic patient and felt that he managed the patient better as a result of an ACE report. Another surgeon explained that ACE reports helped in making decisions surrounding diagnosis and treatment while another surgeon said that he had become more open to operative management of clavicle fractures. One surgeon emphasized that decisions surrounding post-operative care had changed as a result of some ACE reports and the hope was that the surgeons would be able to incorporate some of the evidence into pre-op planning as well. It should be noted that one visiting fellow explained that he was not able to make patient-related decisions at the SIOR because he was a foreigner undergoing fellowship training. But he clarified that the knowledge he had acquired would be used when he returned home.

Summary of Exit Survey's Important Findings

Smartphones were the most commonly used method to access OE at the SIOR. However, the majority of surgeons had difficulty loading the OE website depending on their connection and/or location in the SIOR. ACE reports were read weekly with the majority of respondents spending 60 minutes or less on the OE website reading an average of 1 to 3 reports. The most frequently accessed specialty categories were Arthroplasty and Trauma. Given that there was no difference found between the Intervention group and the Control group in terms of self-reported OE usage, it was concluded that sending daily targeted mailers did not enable more frequent usage of the OE service compared to providing occasional orthopaedic summaries over a one-month time span.

Overall, OE ACE reports were perceived to be comprehensive, practical, useful, and applicable for most surgeons at the SIOR. Moreover three quarters of the group agreed

that ACE reports had improved their efficiency and ability to keep up with new research in the field. Confidence in medical decision-making and a perception of improved patient care also improved as a direct result of ACE reports for more than half of the group. Given that most of the group read an ACE report and took further action by either making an informed patient care decision based on the information read, changed a patient care decision, or discussed some part of the ACE report with another orthopaedic doctor, physician, physiotherapist, nurse, or patient, it was concluded that the surgeons were actually engaging with OE in practice.

Results from Usage Data

Introduction to Open and Click Rate Data

The activity of the participants enrolled in the study was tracked by the OE database. An open rate was defined as the percentage of opened mailers sent via email. A click rate was defined as the percentage of mailers in which a link was actually clicked to redirect to the full ACE report. Each individual's average open rate and click rate was captured for the entire study period. Actual usage of OE helped to answer the question of whether providing daily targeted evidence summaries to orthopaedic surgeons entailed more frequent use of the service compared to providing weekly orthopaedic evidence summaries over a one-month time span.

There were 22 surgeons in the Intervention group and 21 surgeons in the Control group whose results were compared out of the 44 surgeons that were entered into the trial. Data from one visiting fellow was excluded from the Control group because their usage data was not captured clearly. There were 7 consultants (31.82%), 13 residents (59.09%),

and 2 visiting fellows (9.09%) in the Intervention group and 6 consultants (28.57%), 14 residents (66.67%), and 1 visiting fellow (4.76%).

Mann-Whitney U tests were run to determine if there were differences in the open and click rates for the daily targeted mailer (Intervention) group and the weekly mailer (Control) group. A threshold p-value of 0.05 with a confidence interval of 95% was used to determine the significance of results. Since visiting fellows were considered "trainees" at the SIOR and there were only three visiting fellows whose usage rates were captured, they were grouped with the residents for the purpose of the analysis.

Average Daily Mailer Rates (Intervention) vs. Average Weekly Mailer Rates (Control)

The average open and click rates for the daily targeted mailers that were received by the Intervention group were compared to the average rates for the weekly general mailers that were received by the Control group. The open rates were not significantly different ($p = 0.132$) between the Intervention group (Mdn = 14.29%; STD = 30.39%) and the Control group (Mdn = 0.00%; STD = 30.58%). The click rates were not statistically different ($p = 0.053$) between the Intervention group (Mdn = 5.51%; STD = 20.82%) and the Control group (Mdn = 0.00%; STD = 10.12%). It should be noted that the difference between the two groups in terms of click rates approached significance at $p = 0.05$, but the American Statistical Association "advises researchers to avoid drawing scientific conclusions or making policy decisions based on P values alone" (Baker, 2016; Wasserstein & Lazar, 2016). See Appendix P, Table 8, for a comparison of open rates and click rates between these two groups.

Stratified Analysis Comparing Consultants and Residents/Visiting Fellows within Group

A stratified analysis was performed comparing consultants' and residents'/visiting fellows' average open and click rates within the Intervention group or within the Control group. See Appendix P, Table 9, for a comparison of open and click rates between consultants and residents/visiting fellows within each group.

The open rates were not significantly different (p = 0.783) between the consultants (Mdn = 14.29%; STD = 39.77%) and the residents/visiting fellows (Mdn = 9.52%; STD = 25.83%) in the Intervention group. The click rates were not significantly different (p = 0.332) between the consultants (Mdn = 9.52%; STD = 18.17%) and the residents/visiting fellows (Mdn = 4.76%; STD = 22.39%) in the Intervention group.

The open rates were not significantly different (p = 0.424) between the consultants (Mdn = 10.70%; STD = 38.25%) and the residents/visiting fellows (Mdn = 0.00%; STD = 28.02%) in the Control group. The click rates were not significantly different (p = 0.677) between the consultants (Mdn = 0.00%; STD = 16.63%) and the residents/visiting fellows (Mdn = 0.00%; STD = 5.91%) in the Control group.

Stratified Analysis Comparing Levels of Training Across Groups

A stratified analysis was performed comparing consultants' or residents'/visiting fellows' average open and click rates in the Intervention group with the consultants' or residents'/visiting fellows' average open and click rates in the Control group. See Appendix P, Table 10, for a comparison of open and click rates between consultants or residents/visiting fellows across both groups.

The open rates were not significantly different (p = 0.836) between the consultants in the Intervention group (Mdn = 14.29%; STD = 39.77%) and the consultants in the Control group (Mdn = 10.70%; STD = 38.25%). The click rates were not significantly different (p = 0.366) between the consultants in the Intervention group (Mdn = 9.52%; STD = 18.17%) and the consultants in the Control group (Mdn = 0.00%; STD = 16.63%).

The open rates were not statistically significant (p = 0.148) between the residents/visiting fellows in the Intervention group (Mdn = 9.52%; STD = 25.83%) and the residents/visiting fellows in the Control group (Mdn = 0.00%; STD = 28.02%). The click rates were not statistically significant (p = 0.161) between the residents/visiting fellows in the Intervention group (Mdn = 4.76%; STD = 22.40%) and the residents/visiting fellows in the Control group (Mdn = 0.00%; STD = 5.91%).

Summary of Usage Data

Based on the above findings, it was concluded that there was no difference between the Intervention and Control groups in terms of open and click rates overall or within and across stratified groups. Thus, providing daily targeted evidence summaries to orthopaedic surgeons did not enable more frequent use of the service compared to providing weekly orthopaedic evidence summaries over a one-month time span.

Limitations of the Quantitative Usage Data Collection

One inherent limitation of the OE participants' usage data is that the website was unable to capture data from individuals who were perpetually logged in. For example, if an individual was logged into the OE website and he/she was viewing an ACE report without going through a mailer that was sent to them by the researcher or by OE, then his/her usage

was not captured. Furthermore, the surgeon could have simply been reading the synopsis published on the OE website without accessing the entire ACE report. Again, if this was the case, their usage data was not captured. Finally, we were unable to capture the usage data of participants using the OE mobile application as the data collection system did not allow for it. There were five people who were found to be using the mobile application, three of which were in the Intervention group. In the above mentioned cases, usage of OE, assessed through average open rates of newsletters and click rates of ACE reports within newsletters, would be underreported. However, given that these limitations would exist for both groups – those receiving daily mailers from the researcher and those receiving weekly mailers from OE, we could still compare the two groups' usage of OE. Thus, the validity of the findings were not compromised.

Another limitation of the study that must be acknowledged is that participants in Group 2 received a maximum of 14 general mailers from OE. Group 1 received a maximum of 35 mailers (21 daily mailers + 14 general mailers). Given that Group 2 participants were receiving mailers three times a week on a regular basis, their usage rates and responses to the exit survey may not have significantly differed from those of Group 1. If the project was continued for a longer period of time, the researcher may have noted a difference in the usage rates.

CHAPTER VI: RESULTS OF QUALITATIVE INTERVIEWS (PHASE #2)

This chapter presents the findings from the exploratory descriptive qualitative portion of the study based on the semi-structured interviews (see Appendix L for the interview guide) (Sandelowski, 2000; Sandelowski, 2010; Thorne, 2008; Thorne et al., 1997; Thorne et al., 2004). The purpose of this qualitative study was to describe the surgeons' experiences using and applying clinical evidence (for decision-making and patient care) provided to them through an online medium such as OE. An underlying objective was to understand the barriers and facilitators that orthopaedic surgeons faced when asked to incorporate such evidence into their practice. The goal of this chapter was to identify the emerging themes while providing a rich description of orthopaedic surgeons' experiences using OE to answer the research questions.

Nineteen semi-structured interviews were conducted with eight surgical residents, nine consultants, and two visiting fellows within one week. This number represents when data saturation occurred. Below is an overview of the themes that emerged from the data and that addressed each of the research questions. Definitions are provided for each theme as developed by the principal investigator to ensure the consistent application of each theme. See Appendix Q for an overview of the themes that emerged from this analysis.

Quotes from participants are used to support each of these themes. All quotes represent various individuals and do not focus on any one individual. Great efforts were made to ensure broad perspectives and all voices were captured in some way or other. Given that only two visiting fellows were interviewed, their responses were combined with those of the residents to preserve their anonymity in this analysis.

Barriers and Facilitators of Incorporating Evidence into Practice

When asked to describe the barriers and facilitators to incorporating evidence into practice, four main themes emerged. Each is fully explored below.

Barriers

Issues Accessing Relevant Literature

"Issues Accessing Relevant Literature" was defined by the researcher as the physical or technical factors that prevented surgeons from taking the first step in reading literature or attempting to access information (online or through OE). Internet connection and infrastructural issues were the most commonly cited barriers to accessing literature. A general lack of time to access information as a result of high patient workloads was also frequently mentioned. Minimal access to medical journals was also a large problem amongst surgeons.

Internet Connection and Infrastructural Issues

A large majority of interviewees described limited internet connection as a barrier to accessing OE. Only one small section on a floor of the SIOR had WiFi that was accessible to staff. In any other region of the hospital, staff were required to use their own data plans to access internet-based resources on their mobile devices. This also meant that ACE reports could not be opened in the clinical meeting room where the daily morning rounds took place. A slow download speed was encountered depending on the location within the hospital or the method by which OE was being accessed (mobile phone or laptop computer). Opening OE ACE reports via email took a lot longer because email communication services and downloading work best on a higher quality, 3G network which

was not always accessible to the surgeons in the hospital. If the email took too long to load, the surgeons stated they would "simply ignore it" and move on to the next order of business. Moreover, the hospital library did not have the infrastructural capabilities to provide their surgeons with internet access. Usage of OE decreased as a result of these many internet connectivity barriers.

> "[The] library does not have internet to download anything. It has only one computer working for the past two days…internet is not working on [my] phone and internet is not in [the] library. I cannot go home to sleep because I am here for 72 hours on weekends. So if I can't access OrthoEvidence, then usage will decrease." (Resident).

Lack of Time to Access Information

The majority of participants described time as a barrier to keeping up with evidence especially with the "sheer volume of literature that keeps appearing" and the difficulty in establishing what is "relevant". Some residents mentioned a high patient workload in India which also contributed to limited time to generally keep up with literature and use OE.

> "The most important problem today is browsing. You don't know what to look for and you end up wasting a lot of time reading unrelated things…because focused information is something which we lack in medicine. Or at least I personally don't know how to find it." (Consultant).
>
> "…you know how residents work at Sancheti, and it is the same everywhere – residents don't have time." (Resident).

Minimal Access to Medical Journals

Many interviewees described limited access to online journals and problems accessing the medical library within the SIOR as barriers to keeping up with literature. Some further emphasized exorbitant costs to purchase online memberships to journals. One consultant explained that the Medical Council of India required teaching institutes to subscribe to some journals in order to keep their accreditation. Although the SIOR as an institution did not have access to any online medical journals for its doctors, it did subscribe to print journals that were received in their library. Yet, accessing the print journals in the SIOR library was difficult for surgeons because the journals could only be viewed within the library and could not be taken out of that space. Many interviewees did not even know which journals were being subscribed to by the institute and had not visited the library in a couple of years. One consultant recommended that it would be better if the journals came directly to his office.

Half of the interviewees mentioned circumventing this problem by using PubMed or Google Scholar as a means to access information and recent literature. This was because both of these databases allowed users to access many articles' abstracts for free. While some surgeons believed that PubMed fulfilled their need to answer clinical questions, many believed that it was not comprehensive enough because they did not get the full gist of the article. The surgeons who felt that PubMed did not satisfy their need to answer clinical questions, explained that OE was able to give them a better perspective on the results of research studies. Moreover, OE did not limit its ACE report reviews to certain journals.

Thus, through the OE portal, surgeons had access to published research from a variety of journals and a subscription to multiple journals was unnecessary.

> "PubMed is the only thing we access. And Scholar articles on Google…most of them are abstracts in only four lines, so hardly we get to know directly about the results. So whatever are the free papers, we just get access to them and we try to learn things." (Resident).

Limited Incentive to Keep Up With Literature

"Limited Incentive to Keep up with Literature" was defined by the researcher as the personal or contextual factors that prevented surgeons from reading literature (online or through OE) even if they had access to it. Limited decision-making powers for residents was a significant issue, noted both by residents and consultants, in terms of preventing residents from taking initiative and accessing new research. Furthermore, the residency curriculum structure, which heavily relied on textbook-based exams, also served as a deterrent to keeping up-to-date with literature for residents. Another issue was the general lack of awareness and understanding of research methods, which meant surgeons were not actively engaging with medical research because they did not know how to access it or understand it. Moreover, other interviewees saw the lack of context-specific research as a disincentive to using OE.

Limited Decision-Making Powers

Half of the interviewees mentioned little need to keep up with literature on the part of residents because they were not the primary decision-makers for patients. Some residents felt that they did not have the authority to share what they read with their attending

consultants or challenge certain procedures because they were not the primary decision-makers on the case. The senior consultants were at the forefront of managing patients and making decisions with their extensive experience while the residents followed their lead. As a result, there was limited incentive to understand new research or seek external sources of information. EBM tools and training could be provided to residents but if they did not have the power to implement their learnings into practice, they would not be very motivated to use the knowledge. Thus, limited decision-making powers for residents were a barrier to using OE.

> "The common perception is that the residents should only know the clinical picture, history, diagnosis, and that's it. They are not supposed to treat…When it comes to the management part, the consultants have a say. The resident does not have to apply much of his brain." (Consultant).
>
> "What would normally happen is that you would only listen to what your consultant says and that would be the truth for you - like you would have no other input about the same thing." (Resident).
>
> "We are not here to decide what is to be used…Most of the time it is imposed on us." (Resident).

Reliance of Residency Curriculum on Textbooks

Textbooks were cited as the primary source of knowledge by the majority of consultants and residents. Reading journal articles would not significantly help residents on their exams which were based on established textbooks. Thus, there was limited

incentive for residents to read beyond textbooks through means such as medical journals or OE to gain further knowledge.

> "I think when they pass a stage and become consultants one day, that is the time when they will find it relevant…Until that stage, they just have to prepare for their exam that they have to pass. So this will not be very beneficial for them from the exam perspective. They need something like books, you know, like the textbooks." (Consultant).

One consultant expressed that the entire system would need to be overhauled to move away from relying solely on textbooks and move toward reading and incorporating more journal articles.

> "Our exam patterns fit the textbooks. So, people read to pass their exams. So, if they start reading journals, probably they'd flunk their exams. So, the entire system needs to be turned around. We can't just say to read journals; that won't help. They won't pass." (Consultant).

Lack of Awareness and Knowledge of Research Methods

The SIOR holds a journal club once a month for its residents where consultants disseminate a recent journal article and discuss it during a morning meeting. However, it seemed that there was limited understanding of research methodologies and the information was "quite difficult to read and retain" for some interviewees. This further prevented surgeons from picking up a medical journal and was a barrier to reading medical literature in general. One resident explained that few of his peers had been exposed to the world of medical literature as it was not part of their medical school curriculum.

> "Nobody understands meta-analyses. We just read the conclusion which says there is not enough evidence." (Consultant).
>
> "People do know about these journals which are out there. But no one knows how to use these journals or cite articles or read articles and actually gain something substantial from them. No one knows what these journals are out there for…We have never been inducted into the system of reading journals or trying to write for journals or publishing articles because we are very textbook-oriented here in this country." (Resident).

Limited Clinical Relevancy of Research

Half of the interviewees described limited clinical relevancy of ACE reports as a reason for which they were not using OE. They focused on how ACE reports should be discussing patient-related data and orthopaedic surgery instead of anesthesiology or pharmacological medical treatments which the physicians at the SIOR are responsible for. Thus, they were not opening the ACE reports because they did not believe they were relevant to their orthopaedic practice and/or they were not context-specific.

> "[We] don't care about the muscles or medicines. That is the anesthetist and physician. Surgeons only care about the knife…People will read if you send actual surgical related data." (Resident).

One consultant did not like the daily targeted mailers which he was receiving because he felt that it did not provide him with all the information that he was looking for in that moment. He believed that OE newsletters did not necessarily apply to the patient population he was treating. He explained that having been in practice for many years, OE

was not all that useful "and [did] not really change [his] general practice".

> "I think the problem with OrthoEvidence is that you are feeding us information that you want us to read and not necessarily what I want to read because I may be dealing with a different set of patients or conditions on a day to day basis. So your article doesn't help me because I am not doing…that every day…it makes more sense for me to go and look up things which I would use pertaining to that particular decision-making or surgery." (Consultant).

Another consultant did not think that the OE tool was applicable or useful to him because there were not enough articles available to him that were specific to the Indian context. The high-tech research papers were not as relevant to him because he thought basic comparisons were more appropriate for his purposes.

> "All kinds of evidence are not there….that is again a short-coming…I like to read more of India's articles instead of the Western ones...I think from India we are generally only having case series and comparative series. We don't have many randomized trials. But then even those case series have relevant issues that are clinically important to us. Rather than looking at high technical level implant comparison and having randomization, we look at very basic comparisons." (Consultant).

Facilitators

Helpfulness of Instruction and Coaching

"Helpfulness of Instruction and Coaching" was defined by the researcher as the participant's ability to access and use OE with comfort and ease after instruction and coaching.

The student researcher used a series of screenshots during a presentation at morning rounds to walk the surgeons step-by-step through finding and opening the OE newsletters in their email accounts (see Appendix R for the screenshot presentation). Dr. Parag Sancheti, the Chairman and Managing Director of the SIOR, asked every single surgeon in the room to take out their mobile device and follow the lead of the student researcher. Most interviewees found this session as well as any one-on-one coaching that the student researcher provided as helpful in navigating the newsletters and the OE website. In this way, the researcher's instruction and coaching was a facilitator that strongly encouraged the surgeons to engage with OE.

> "It did help because until you showed that, I don't think I would have known because I never check my 'Promotions' folder. So yes it helped tremendously." (Resident).

Convenience of ACE Report Format and Dissemination

"Convenience of ACE Report Format and Dissemination" was defined by the researcher as the physical factors which encouraged the use of OE and/or its use in clinical decision-making. The pre-appraised short and focused summaries in the form of ACE reports were well-received by the majority of interviewees and promoted the use of OE.

The ability to conveniently access OE's online website through a mobile device was a driving force that also allowed the surgeons to easily use OE.

Convenience of Pre-Appraised Summaries

ACE report summaries were considered to be efficient, useful, and reliable at providing concise research evidence by more than half of the surgeons. A great majority of the interviewees found these evidence summaries to be valuable for them to keep up with evidence in the field. OE helped the surgeons to consolidate information and navigate their way through the research world. They explained that sifting through the articles could be time-consuming but having focused information provided through OE solved this problem. Many interviewees explained that ACE reports were "concise" and "easy to digest" in a short period of time. Some interviewees also liked having the ability to save the ACE report in PDF format on their laptops or mobile devices and to access at a later date to share with colleagues or patients. Overall, the pre-appraised format of ACE reports were facilitators in encouraging the use of OE for most surgeons.

> "It has made a difference in [my] daily work life. We have a limited amount of time in a day…when you open a complete article, you have to read the article and then summarize it. So when you get a summary of an article, it is very easy to read it and understand it and then go on to the next article. So it is very very helpful." (Consultant).

One resident pointed out that he liked receiving the targeted daily newsletters from the researcher because he was able to choose what to read from the pre-selected reports instead of spending time browsing through the hundreds of ACE reports that exist. Another

resident further explained that the targeted mailers helped residents to keep up to date with knowledge because it was specifically directed toward them.

> "It is very important to spoon-feed – 'we are still kids'. If we are spoon-fed, we can use the knowledge… [If] knowledge comes to us we will read it." (Resident).

However, an alternative perspective was provided by some interviewees who said that the pre-appraised ACE report summary was a limitation to using OE. This was because they felt that the conclusions were biased and the summaries were too short for them to actually use in practice. They wanted to be able to read the full journal article to come to their own conclusions and not simply rely on the ACE report summaries. Ultimately, however, some of these same interviewees mentioned that OE ACE reports would be more beneficial for the resident trainees compared to the consultants to use and stimulate discussion.

> "It just gives you the abstract and an analysis of the abstract which actually I think [is] a double-edged [sword]…Somebody else is interpreting the abstract for me and giving it. I like to read my own and have my own interpretations." (Consultant).

> "They have reached the limitation with the summary…It's going to be more difficult to convince somebody to use the summary and apply it – especially somebody who has been practising for a long time. But among the residents, it is going to be something that can stimulate you to look at more opinions. So in the long-run, it is going to be useful." (Resident).

Convenience of Mobile Devices

Most of the interviewees mentioned the ability to open the OE website and ACE reports on their mobile devices as helpful in keeping up with evidence. This easy access and dissemination of ACE reports through mobile devices prompted the surgeons to use the website more often. Thus, mobile devices were a facilitator in accessing and using OE. One consultant explained that OE is great for residents to use and keep up with the latest evidence because "each and every one of them has a smartphone" and it is easy for them to "read [and] access this on their phones". Hard copies of journal articles are no longer required.

> "…it is difficult to actually read books also during residency…I used to give some time to reading the papers and getting some recent knowledge. Even if I am bored and maybe not in [a] capacity to open the textbook and read, maybe just scrolling down the phone and getting the recent thing…is refreshing...So, that has helped." (Resident).

The mobile device was also convenient in showing patients ACE reports during clinical consultations to reassure them of surgical techniques and treatments that were being considered or used. One consultant stated that he physically showed his patients an ACE report on his mobile device. Again, the mobile device facilitated the use of the OE website not only by aiding surgeons to keep up with evidence but also by conveniently sharing the knowledge with their patients and practising EBM by incorporating patient values.

> "These patients who are an information technology people…are very very well-read or maybe misread...Certain people...will constantly keep bugging you to say 'Sir, is

> this drug good, what is the proof?' So then you can show them that this is the proof…And it is very easy to convince them that way…I just showed them on my phone." (Consultant).

Five of the residents in the study were found to be using the IOS app for the OE website after one of the residents shared the link in their WhatsApp group. The residents' WhatsApp group included all residents that had recently graduated from the SIOR's program and those currently training at the institute. ACE reports were being shared by the residents in this WhatsApp group. Thus, WhatsApp, a social media mobile app, was considered a facilitator to using OE at the SIOR.

Summary of Barriers and Facilitators

In summary, there were many barriers and facilitators discussed by interviewees to keep up with literature and use OE. Barriers included issues accessing literature as a result of internet connectivity and infrastructural issues, lack of time, and minimal access to medical journals. Limited incentives were also barriers in keeping up with literature and included limited decision-making powers, dependency on textbook curriculum, lack of awareness and knowledge of research methods, and limited clinical relevancy of available research in the Indian context. Facilitators encouraging the use of OE were noted to be the extensive instruction and coaching provided by the researcher, as well as the convenience of the ACE report format and content with its easy retrieval through a mobile device.

Perceptions of OrthoEvidence for Clinical Decision-Making and Patient Care

The next section of this chapter explores user perceptions of OE at the SIOR. It considers outcomes pertaining to the effect and impact of OE on decision-making processes

and patient care. Two themes emerged from the data to answer the research question, "What are orthopaedic surgeons' perceptions of the OrthoEvidence knowledge dissemination portal for clinical decision-making and patient care in Pune, India?" The themes of "Communication of Knowledge, Decision-making and Changing Practices" and "Applicability of OrthoEvidence" are discussed below.

Communication of Knowledge, Decision-making and Changing Practices

Interviewees were asked whether receiving evidence summaries and having access to a large database of orthopaedic evidence made a difference in their daily work-lives. They described times where they used newfound knowledge from ACE reports to change a decision or to make a decision. They discussed the influences of the knowledge gained from OE on any discussions they had. The majority of interviewees described what reports they shared with their colleagues, students, or patients. Thus, "Communication of Knowledge, Decision-making and Changing Practices" included the examples which were given by orthopaedic surgeons to describe how they integrated OE into their clinical practice at the SIOR.

It was noted that the trauma unit was actively discussing evidence from ACE reports in the emergency department and had implemented changes to better their practice. Two trauma unit heads and many other members of the team were interviewed. One resident noted that prior to having access to OE, the team was not actively discussing recent literature. But as a result of relevant ACE reports that everybody could access, the team was coming together to share their perspectives and discuss new research on a more consistent basis. One consultant explained that discussion of ACE reports with colleagues

and senior consultants had led to changes and "limit[s] in certain protocols". If he felt that he needed more information to make a decision, he would actively search for more articles and evidence to support a conclusion. In turn, he felt more confident that he was "treating his patients better".

Management of osteoporosis patients at the SIOR also changed. The surgeons began prescribing combinations of Vitamin D, Vitamin K, and calcium to patients suffering from osteoporosis because an ACE report showed that calcium supplements would be better absorbed this way. The trauma department also began limiting pre-operative DXA scans as a result of an ACE report describing a comparative study of pre-operative and post-operative osteoporosis patients. They realized that regardless of the DXA scan score, if there was a fracture, they would normally have to operate – so the "management essentially never changes" at the SIOR. Thus, by being more cautious and aware of patient outcomes with or without pursuing DXA scans, the SIOR would be saving limited resources such as time and money.

Within the SIOR, clavicle fracture treatments were discussed extensively by the trauma team. As a result, management of clavicle fractures within the trauma unit shifted from non-operative conservative treatment to operative treatment. Many interviewees discussed specific ACE reports related to clavicle fractures and the impact they had at the SIOR and beyond the institute's doors. One ACE report on clavicle fractures was also discussed at an orthopaedic conference in India by SIOR consultants.

> "I was the one who after reading your meta-analysis…kept on advocating for fixation of clavicle fractures. Now traditionally, clavicles has always been treated

> non-operatively…but based on this ACE report, I started operating on them. And now it has become more or less an acceptable modality. So this is how it helps...Certain things which are radically different from your standard teaching can be justified based on that and applied in practice." (Consultant).

At the SIOR, Achilles tendon ruptures were surgically operated for the most part. Now, they are being conserved more often as a result of the trauma team's discussions around some ACE reports that recommended the Achilles tendon ruptures not be operated. Post-operative tibia fracture care has also changed. Usually, upper tibia fractures around the knee were managed with a brace support. However, ACE report showed that there was no difference in outcome between a group of patients with upper tibia fractures using brace supports and those not using brace supports. Thus, the SIOR has begun to reassess their post-operative care of tibia fracture patients.

Overall, OE helped the SIOR and its surgeons to rethink, reassess, and redefine certain procedures in the trauma department to improve their patient care and clinical decision-making. Interestingly, one consultant even admitted that he gave his OE account password to some of the visiting fellows and junior consultants on his team in order for them to start accessing the website. He thought it was a great tool to improve knowledge in order to make appropriate clinical decisions with patients in mind.

Applicability of OrthoEvidence

"Applicability of OrthoEvidence" was defined by the researcher as the differing perceptions of OE's usefulness and its benefits for clinical decision-making. There were differences noted based on the surgeons' position of authority within the hospital and level

of training. There were also differences noted between applicability of OE at the SIOR versus applicability beyond the SIOR in India.

Applicability of OrthoEvidence at the SIOR

It seemed that there was a division in terms of whether the consultants, residents, and fellows thought OE was relevant to their practice. Many consultants and fellows explained that OE was useful but it would be better suited for the residents to use to keep themselves updated and to learn. On the other hand, some residents said that the tool was better for the consultants because, as stated earlier, the residents were not the primary decision-makers for patients; the residents were usually restricted in their decision-making capabilities. Interviewees, both consultants and residents alike, agreed that once residents transitioned into full-time consultants and practising surgeons, OE would be more "useful" to them.

> "I think this would be a good thing for post-graduates…we have to force-feed them [with daily reports]…otherwise they will not do it. They can get this on their phone so they can access it much better and at least they have some knowledge rather than zilch." (Consultant).

> "I think at this point it is only useful for the consultants because…in our residency program, this kind of information is good to know but it does not affect our daily lives or what we do every day directly." (Resident).

A senior consultant, who has used OE for many years, provided multiple reasons for which it was valuable in his career. He described how OE helped him learn about "treatment…[that was] being done all over the world", providing him with the most

advanced evidence-based care knowledge. He spoke in particular about the importance of "updat[ing] [him]self…on evidence and evidence-based practice[s] so that he [could] teach…and inculcuate it in [his] presentations" (Consultant).

The majority of the interviewees agreed that the ACE reports were relevant because they referred to practices that were already in place at the SIOR: "I accessed mainly trauma articles and most of the articles just reinforced the belief that what we are practising is the standard of care" (Consultant). It provided support for the surgeons' decision-making. Some residents found OE useful when trying to understand certain surgical techniques and practices at the SIOR especially when they were in doubt. They felt that the ACE reports they were reading were relevant because they were witnessing these procedures in the Operating Room or discussing cases at morning rounds. It allowed them to obtain a better understanding of the surgery and its outcomes, leading to an increased knowledge base for future decision-making in the treatment of their patients.

Applicability of OrthoEvidence to Other Regions

Most interviewees agreed that OE could be expanded to other regions of India or other countries with similar technological infrastructure as the SIOR; OE would be appealing to anyone in the field of orthopaedics who was "looking to be more academically aware". There was a use for OE beyond the SIOR – for surgeons all over India to keep up to date with research. Many surgeons emphasized that a person could be anywhere in the world and have access to OE with its full range of topics to refer to – whenever they have free time, they could access it through its mobile app.

Some surgeons explained that the relevancy and applicability of OE would depend on where the orthopaedic surgeon was practising. They differentiated between barriers that existed for rural doctors compared to urban doctors. One consultant stressed that 80% of doctors in India were actually working in rural settings, unlike the high-tech SIOR. They were dealing with "routine" problems and thus there was little need or desire for them to seek new knowledge as their management and decision-making rarely changed in these cases. If there were limited resources, then it may not be feasible to apply the knowledge from ACE reports.

> "I mean what applies to me, applies to practically every other orthopaedic surgeon who is into practice in the metros and who is in a teaching facility. So he needs to be updated. Now this may not be very applicable to somebody who is practising in a remote part of the country in a rural set-up...So he may say 'wow I know [the] clavicle needs to be operated but I will not [do so] because the patient is not willing or I don't have a lot of resources'." (Consultant).

However, some consultants explained that OE would be useful for doctors all over India who do not have access to journal articles. Receiving some sort of evidence update through OE on their smartphone could help them to keep up-to-date and stimulate their interest: "It would be useful for them because otherwise they have no access so at least they are reading something" (Consultant).

In summary, OE had an effect and impact on clinical decision-making processes and patient care at the SIOR. The surgeons were actively discussing new literature as it emerged and were actively incorporating this evidence into their practice as they saw fit in

their local Indian context. Though there were differing opinions on which group of surgeons (residents, consultants, or visiting fellows) should and would actually find OE useful, the majority of interviewees believed that OE knowledge was applicable and useful at the SIOR and beyond its walls.

CHAPTER VII: DISCUSSION OF FINDINGS

The results of the exit surveys, usage data, and semi-structured interviews provided a comprehensive picture of how orthopaedic surgeons in Pune, India use and apply clinical evidence provided to them through an online medium. The exit surveys provided information about the surgeons' perceptions of the OE tool; did they find it comprehensive, practical, useful, or applicable in their clinical practice? The usage data demonstrated surgeons' actual behaviour with OE and allowed the researcher to determine whether providing daily targeted reports led to more frequent use of the OE service compared to the Control group. Statistical tests confirmed no difference between the usage rates of both groups and no difference between consultants and residents/visiting fellows. The semi-structured interviews elucidated the barriers and facilitators that were felt by the orthopaedic surgeons when asked to incorporate evidence into their practice.

Discussion of Quantitative Findings

Accessibility of Medical Literature at the SIOR

It was noted that 75% of survey respondents were accessing the medical literature online even though 59% of surgeons admitted they were having difficulty connecting to the internet. Moreover, 64% of survey respondents did not find their current method of keeping up with literature to be efficient. These findings point towards an electronic infrastructural problem – an inability to engage with research as a result of limited access to the internet. Of survey respondents, 73%, were resorting to textbooks to keep up with medical literature. This number is comparable to the 73% of medical practitioners surveyed in Dhaka, Bangladesh who described their most popular source of information about clinical evidence

to be textbooks (Agarwal et al., 2008). This finding is also concerning because most textbooks are five years out of date by the time they are published (Poolman et al., 2007a; Hurwitz et al., 2000); many of the interviewees at the SIOR acknowledged this flaw.

All surgeons owned and used a smartphone within the SIOR. This is comparable to the 84% of orthopaedic surgeons in the United States and 90% of physicians in the United Kingdom who owned a smartphone (Franko, 2011; Patel et al., 2015). In the United Kingdom sample, greater than 85% of physicians used the internet to access medical information (Patel et al., 2015). Though smartphones were the preferred method of accessing OE for 73% of surgeons at the SIOR, 70% of them experienced difficulty loading the OE website onto their mobile devices. This was not surprising given that the majority of the group were experiencing difficulties with connecting to internet websites on their mobile devices in general. Thus, if surgeons were having issues accessing OE, which was an internet based tool, then that implies they will likely have issues accessing online journals and other online EBM knowledge dissemination portals.

Perceptions of OE at the SIOR vs. OrthoEvidence's Worldwide User Survey

The OE survey that was sent to subscribers of the service by the company during the summer of 2015 found that 70% of users felt the service kept them current and 55% felt that it saved them time (OrthoEvidence, 2015). Similarly, 75% of the surgeons using OE at the SIOR felt that it improved their efficiency and ability to keep up with new research in the field. Thus, regardless of location and culture, OE was able to fulfill its purpose of providing point-of-care resources and improving the ability of surgeons to keep up with the research realm.

OE's user survey noted that 95% of their users rated OE's content as "good" or better (OrthoEvidence, 2015). At the SIOR, 85% agreed that ACE reports were comprehensive, while 88% agreed that ACE reports were useful in enhancing their knowledge by providing them with updated information. Though these percentages are not as high as the 95% of worldwide OE users who rated OE content as "good", the SIOR's surgeons, still provided comparable responses.

The OE user survey found that 60% of users felt that OE had allowed them to improve their patient care (OrthoEvidence, 2015). At the SIOR, only approximately 53% of surgeons, felt this was true for them. Though only 60% of worldwide OE users claimed to have changed a patient-related treatment decision as a result of an OE ACE report, 81% of surgeons at the SIOR enrolled in this research study claimed to have taken further action after reading an ACE report by engaging in an active discussion about a treatment plan with colleagues or patients.

Though the surgeons at the SIOR expressed a positive attitude towards OE and its ACE reports overall, the fact that they had trouble accessing it implies that it was not used to its full potential.

Usage Data from the SIOR vs. Worldwide OrthoEvidence Use

At the SIOR, the average open rate for the Intervention group receiving daily targeted mailers was 24.91% while the average open rate for the Control group receiving weekly mailers was 16.93% (see Appendix P, Table 8 for average open and click rates). The average click rate for the Intervention group was 12.76% while the average click rate for the Control group was 4.68%. Though the differences in open and click rates between

the two groups at the SIOR were not deemed to be statistically significant, they were still comparable to the Medical, Dental, and Healthcare industry's average open rate of 22.74% and average click rate of 2.52% according to MailChimp (2016) email marketing benchmarks. Again, regardless of location and culture, surgeons' usage of OE around the world can be considered to be comparable.

There was also no difference in usage rates at the SIOR between consultants and residents/visiting fellows. Thus, consultants were not engaging more often with OE as a result of their extensive experience in the orthopaedic field as was hypothesized.

Since the delivery of targeted daily mailers did not seem to enable more frequent usage of OE by surgeons in the Intervention group, the next phase of the study, the semi-structured interviews, allowed the researcher to understand the barriers that surgeons may have encountered in attempting to integrate evidence into practice using an online tool.

Discussion of Qualitative Interview Findings

The exploratory descriptive thematic analysis of the semi-structured interviews discussed the barriers and facilitators to incorporating evidence into practice through tools such as OE at the SIOR (Sandelowski, 2000; Sandelowski, 2010; Silverman, 2011; Thorne, 2008; Thorne et al., 1997; Thorne et al., 2004). Interviewees also explained how clinical practices were changing as a result of OE.

Barriers to keeping up with literature revolved around issues of accessing relevant literature and limited incentive to keep up with literature. Problems accessing relevant literature were a result of limited internet connection, lack of time to access information, and minimal access to medical journals. Limited incentive to keep up with literature was a

result of limited decision-making powers for patient-related care on the part of trainees, a text-book based residency curriculum, a lack of research methods knowledge, and limited context-specific research. These findings are in line with previous research studies from both developed and developing countries which have identified barriers to practising EBM as lack of time, inadequate skills and EBM training, inadequate access to appropriate resources, lack of research methods knowledge, and limited decision-making autonomy (Al-Almaie & Al-Baghli, 2004; Al Omari et al., 2009; Bhandari et al., 2003; Green & Ruff, 2005; Karthikeyan & Pais, 2010; Mittal & Perakath, 2010; Mozafarpour et al., 2011; O'Donnell, 2004; Prasad, 2013; Sadeghi-Bazargani et al., 2014; Tilburt, Goold, Siddiqui, & Mangrulkar, 2007; Van Dijk et al., 2010; Wilkinson et al., 1999; Zaidi et al., 2007).

Facilitators to using OE included the instruction and coaching provided by the researcher and the overall convenience of the pre-appraised ACE report summary format that was easily accessible through a mobile device. Similarly, previous research has found that convenience of access, reliability (high quality research), and applicability made information-seeking more likely to occur and be successful (Dawes & Sampson, 2003).

Interviewees provided numerous examples of practices specific to trauma care which were changing at the SIOR as a result of OE ACE reports. Such practices included a move towards surgical operation of clavicle fractures, non-surgical management of Achilles tendon ruptures, and a reassessment of post-operative care for tibia fracture patients. Most importantly, surgeons noted that there was more active discussion of new research amongst residents and consultants alike in the trauma department.

Both groups agreed that OE was applicable overall as a means to keep up to date with literature and as a teaching tool for residents. The majority of interviewees also believed that OE could be expanded to other regions of India or other countries with similar technological infrastructure as the SIOR.

Merged Findings and Key Recommendations

The majority of surgeons agreed that OE ACE reports were comprehensive, practical, useful, and applicable for clinical practice. They also improved efficiency and ability to keep up with new research while helping to inform and assist surgeons in making medical decisions. Interviewees described changing trauma practices as a result of information provided in OE ACE reports and active team discussions. Overall, these findings point towards the potential for knowledge dissemination portals that are easy to access, to help surgeons implement EBM in practice. Based on this study's findings, the practice of EBM and the use of point-of-care tools in India can be promoted in two key ways: (1) investments in adequate electronic infrastructure and (2) integration into training programs and surgical culture. Refer to Table 11 below for a summary of the quantitative, qualitative, and merged findings.

Investing in Adequate Electronic Infrastructure

Some of the barriers faced in accessing OE and keeping up with literature stem from an overall inability to connect to the internet at the SIOR. This finding has greater implications; it means that the use of any online tool will likely be limited as a result of the inability to access the internet within the hospital. Furthermore, it should be noted that the SIOR is a private hospital - one of the best facilities in the country for orthopaedic care.

Therefore, if surgeons at the SIOR were having difficulty connecting to online tools, healthcare facilities with fewer resources will likely have more difficulty. Investing in adequate electronic infrastructure to allow for reliable and fast internet are needed for online EBM tools to be accessed.

Currently, there are Indian tech companies which are attempting to uplift India out of its "digital poverty" such as Reliance Industries Ltd's (RIL) phone company, Jio (Choudhary, 2016). On March 30th, 2016, the company announced an initial investment at Rs150,000 crore (2.265 million USD). They have already begun setting up telecom infrastructure including telecom towers and fibre optic cables (Choudhary, 2016). In an interview, chairman of RIL, Mukesh Ambani, said,

> "Today, India is ranked 150th in the mobile Internet access rankings out of 230 countries in the world…To end this digital poverty, 1.3 billion Indians cannot be left behind as the world enters a new era…with the launch of Jio, India's rank will go up from 150 to among the top ten mobile Internet access (markets) in the world in the next few years," (Choudhary, 2016).

RIL is focusing on four key interventions including coverage, quality, data, and affordability (Choudhary, 2016). Current coverage (mobile internet access no matter one's location) of high-speed mobile internet in India is only between 15-20%; by the end of 2017, RIL's Jio will increase India's high speed mobile coverage to over 90% (Choudhary, 2016). Quality of mobile internet access depends on the speed and strength of the mobile broadband; the company will offer speeds that are 40-80 times faster than current speeds (Choudhary, 2016). Today, data consumption for an average Indian is 0.15 GB per annum,

but Jio's network is engineered to provide a capacity of over 10 GB per user (Choudhary, 2016). The company has pledged to make its mobile internet access affordable to consumers all over India, because otherwise, their advances in technology will be of no use (Choudhary, 2016). This affordable, high-quality coverage, mobile internet access network has the potential to change how we learn and communicate in the medical world within India.

EBM Integration into Training Programs and Surgical Culture

While investing in adequate electronic infrastructure is necessary, it is not sufficient. Appropriate training and integration of EBM practices into the surgical culture is needed: "A favourable EBM microclimate is one that fosters academic inquiry and shared learning" (Green & Ruff, 2005, p.181).

Necessity of EBM Training for Both Consultants and Residents

Training physicians in EBM concepts entails asking the appropriate clinical questions, acquiring the evidence, appraising the evidence, applying the evidence in decision-making, and then assessing the outcomes (Sackett et al., 2000). A study of physicians in Iran found that individuals with some understanding of research methodologies were more likely to use EBM in their practice (Mozafarpour et al., 2011). Salgotra (2012) explains that the best way to transform evidence into good clinical practice in India lies in training physicians to find and use rapidly accessible and reliable information for specific clinical problems. For physicians to successfully implement EBM, they must be informed about the EBM concept, then become educated in the basic

principles of EBM, and finally, motivated and trained to incorporate the latest evidence into their daily practice (Grol & Wensing, 2004).

Though it was concluded that there was no difference between OE usage rates of consultants and residents/visiting fellows, it was noted from interviews that if department heads were actively engaging with OE and felt favourably towards it, their team of residents were also more likely to engage with OE and incorporate its use into practice. This was seen in the trauma department as changes were implemented due to the positive attitude department heads expressed towards OE. The residents in the trauma department also expressed similar positive attitudes. Thus, if supervisors encourage the use of an EBM tool, then trainees are more likely to model this behaviour. Given these findings, it would be beneficial for hospitals to train both consultants and residents to implement EBM strategies.

Surgical cultures play a significant role in the adoption of EBM practices (Green & Ruff, 2005; Kitto et al., 2011). Clinician-teachers who do not possess adequate EBM knowledge, may not perceive acquiring these skills as a priority and may find it difficult to devote teaching time to demonstrate integration of EBM approaches (Hatala, Keitz, Wilson, & Guyatt, 2006; McAlister, Graham, Karr, & Laupacis, 1999; McColl, Smith, White, & Field, 1998). A study using a grounded theory approach to qualitative research on EBM uptake among Canadian surgical trainees noted that senior surgical staff's resistance to and disapproval of EBM was associated with limited availability and opportunity for residents to use EBM resources in practice (Bhandari et al., 2003).

During residency training, students are encouraged to internalize norms demonstrated by senior surgeons (Kitto et al., 2011). In a qualitative study on barriers and

facilitators to the implementation of EBM, some practitioners explained that the more authoritative or trustworthy the source of information, the more likely they were to listen: "'If someone very senior tells me about a treatment, I take it very seriously'" (Wilkinson et al., 1999, p.67). Therefore, the training of consultants would help to develop appropriate role models who actively practice EBM. It would be beneficial for residency EBM training to be led by individuals, such as senior consultants, who understand surgery and can focus on day-to-day case examples (Kitto et al., 2011; Kwaan & Melton, 2012).

Integration into Residency Curriculum

Many medical schools and residency programs are already teaching EBM strategies that critically evaluate the medical literature and integrate best evidence to encourage high-quality patient care (Kim et al., 2008; Slawson & Shaughnessy, 2005; Srinivasan et al., 2002). EBM teaching has the potential to considerably improve EBM knowledge and the use of evidence-based resources by residents (Kim et al., 2008). Targeted interactive interventions such as small-group discussion or case studies and computerized alerts or reminders, have been found to be effective in changing clinical behaviours (Bero et al., 1998; Schoenfeld, Cruess, & Peterson, 2000). A significant increase in knowledge and skills was also noted following an intensive 3-day course (Fritsche, Greenhalgh, Falck-Ytter, Neumayer, & Kunz, 2002). Early introduction of a one-month problem-based EBM short course on literature search and critical appraisal to preclinical medical students was feasible and practical in providing basic EBM skills (Srinivasan et al., 2002). However, it was the combined intervention strategies that resulted in long-term changes in physician

behaviour and health outcomes compared to individual interventions alone (Bero et al., 1998). Interventions must be carefully considered, structured, and delivered.

It makes sense that textbooks were found to be one of the most commonly used methods to keep up with new literature at the SIOR because the residency curriculum focuses most on textbook-based learning. Thus, there was limited incentive to seek and use evidence sources beyond textbooks. At the SIOR, an overall residency curriculum change would be necessary to integrate EBM into their training program. Residents at the SIOR do not receive any formal training in research methods or appraising the literature until the end of their three-year residency program. It would be more beneficial if this compulsory course took place at the beginning of their residency training program for the residents to develop skills to keep up with literature and apply their learnings during their residency training. Instilling habits early on into experientially based and culturally supported ways of learning can ensure that EBM is practiced successfully by individuals and surgical communities alike (Al-Almaie & Al-Baghli, 2004; Gorgon et al., 2013; Kitto et al., 2011; Scott et al., 2000; Wilkinson et al., 1999).

All nineteen interviewees agreed that reading journal articles should be "inculcated" into the residency curriculum as a fundamental component and that OE should be added to a resident's toolbox. When discussing how to integrate OE into the curriculum, one consultant explained that daily reports should continue and be sent to all residents to provide them with easy access. The majority of interviewees agreed that OE could be used as a reliable tool during journal club meetings to provide concrete evidence for surgeries being performed and as a learning tool during morning rounds and case presentations. A

recent study found that a weekly reading program improved orthopaedic residents' performance and exam performance (Weglein, Gugala, Simpson & Lindsey, 2015). A weekly reading program could be a valuable addition to the residency curriculum at the SIOR. Many residents at the SIOR explained that they would benefit from the integration of journal articles in their curriculum because it would help them stay updated in the world of orthopaedics and it would improve their patient care – they would become "good orthopaedic surgeons".

Consultants at the SIOR described propagating and promoting the use of EBM tools such as OE through residency training programs in India through state and national medical bodies. Institutes of medical education such as the SIOR should tell their residents and staff consultants that knowledge dissemination tools are available to them at the beginning of their training and orientation sessions. Incentives for learning EBM can be provided via scholarships or points for EBM based questions in final assessments (Agarwal et al., 2008). An administrative consultant at the SIOR said that they were planning on incorporating OE into the residency training program and explained their evaluation strategy as noted in the quote below.

> "What we will try to see now is that they incorporate OrthoEvidence as a tool in addition to other learning methods. And in our evaluations, we will include stuff from OrthoEvidence so that we will try to see and confirm that they have indeed read or referred to it. So some questions can be answered only if they have gone through OrthoEvidence…We will recommend it and we will also see if it is being followed." (Consultant).

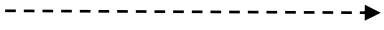
Overall, it would be beneficial for the SIOR's residency curriculum to provide a short research methods course at the beginning of their training to familiarize students with EBM concepts. Continued opportunities to incorporate EBM into practice through a weekly reading program and small-group learning at morning meetings should also be provided.

Table 11: Study's Merged Findings

Quantitative Findings	Qualitative Findings	Merged Findings
Common method to access medical literature = online + textbooks	Barriers = limited access to relevant literature (limited internet connection, lack of time, minimal access to medical journals)	Textbooks = common method to keep up with literature because residency curriculum focuses on textbook-based learning
Limited access to internet --> difficulty accessing OE	Barriers = limited incentive to keep up with literature (limited decision-making powers for residents, text-book based residency curriculum, lack of research methods knowledge, limited context-specific research)	Limited access to internet --> difficulty loading OE as an online tool --> difficulty using other point-of-care tools which require internet connection
Smartphones = preferred method to access OE	Facilitators = instruction and coaching, convenience of pre-appraised ACE summary format, easy access through mobile device.	
ACE reports = comprehensive, practical, useful, and applicable to practice	Changing trauma practices through active team discussion of research	Potential for knowledge dissemination portals with easy access to help surgeons implement EBM into practice
OE improves efficiency and ability to keep up with new research	OE has potential for greater applicability at the SIOR and beyond	
OE ACE reports help to inform and aid surgeons in making medical decisions		

No difference in OE usage rates for Intervention or Control groups

No difference in OE usage rates between consultants and residents/visiting fellows



Teaching EBM strategies is necessary at both levels (consultants and trainees) --> integrate into residency curriculum + surgical culture

Limitations of Study

Some limitations of this study should be noted. The small sample size of 44 surgeons enrolled in the study limited the generalizability of the findings. This study focused on a high-tech, private hospital in India and thus as a single-center study, it limited the ability to generalize findings beyond the context in which this study was conducted. Government hospitals in India are even more overloaded with patients and have very limited resources; they are at greater risk of being out of date with new practices and procedures (Prasad, 2013). The study's findings present the best-case scenario of the implementation, usability, and capability of an EBM knowledge dissemination tool such as OE because the SIOR possessed high-quality resources in comparison to other Indian hospitals.

A non-response bias may have affected the internal validity of the study. Surgeons enrolled in the study who did not complete the exit survey may have ignored it because they were not using OE at all. Those who agreed to an interview were mostly those who had accessed OE at least once. We are not sure about the views of the 25 surgeons in the trial who did not respond to an invitation for an interview.

There is also a possibility of contamination between Group 1 and Group 2 as the entire resident cohort had a WhatsApp group through which they may have shared ACE reports. If ACE reports were viewed this way, the open and click rates would not have been tracked for each participant because the data collection system did not allow for it; usage rates would have been underreported. Contamination through sharing of reports between the two groups may also have blurred any differences between the two groups in terms of OE usage.

There were limitations involved in conducting semi-structured interviews. Interviewer bias may have affected the validity of the results if the opinion of the interviewer was reflected in the interview process (Harrell & Bradley, 2009). To minimize potential bias, this study used interview guidelines that maintained neutrality – all questions to participants were asked using the same systematic approach to cover the same topics as recommended by Harrell and Bradley (2009). Moreover, since semi-structured interviews are verbal reports provided by interviewees, their contents are vulnerable to several weaknesses including recall bias and social desirability bias (Yin, 2009). During the semi-structured interviews, surgeons were asked to recollect specific interactions and discussions they had with other colleagues regarding OE. They may have suffered from a recall bias and may not have clearly remembered these experiences. Grimm (2010) describes a social desirability bias as being produced when subjects respond to questions in a manner that they assume the researcher wants to hear; thus, these may not be honest accounts of experiences. A self-reporting bias also existed for the surgeons filling out the surveys and responding to interview questions as they were asked to disclose their means of keeping up

with literature to improve their practice and usage of OE; surgeons may have exaggerated their use of OE, perception of OE, and changing practices as a result of OE ACE reports. To minimize these biases, this study employed a triangulation approach through which information was gathered from various independent sources to improve the validity of the research (Mays & Pope, 1995). In this case, perspectives from surgical residents, junior and senior consultants, and visiting fellows through surveys, interviews, and statistical data from the OE database, provided a more holistic understanding.

It also would have been beneficial to increase the study period to a minimum of three months as there was a learning curve involved in implementing and using OE at the SIOR. However, despite this issue, the interviewees provided positive initial feedback on the potential of an EBM knowledge dissemination portal such as OE.

CHAPTER VII: CONCLUSION

Health services research has consistently revealed a gap between best practice as determined by scientific evidence and its implementation in clinical care; this has led to poorly informed clinical decision-making and adverse outcomes for patients worldwide (Grimshaw et al., 2012; Grol & Wensing, 2004; Prasad, 2013). As a result, in an attempt to improve physicians' informed decision-making and healthcare quality for patients, EBM has been deemed an international and national priority (Adily & Ward, 2005; Dawes et al., 2005; Plsek, 2001; Prasad, 2013; Sadeghi-Bazargani et al., 2014). Although point-of-care tools, evidence summaries, and decision aids are available, their utilisation and impact in developing countries has rarely been studied (Goodyear-Smith et al., 2008; Lang et al., 2007; Sprague et al., 2015; Van Dijk et al., 2010).

This study, which provided free, online access to OE at a private orthopaedic hospital in India, helped to explore the feasibility of using such a knowledge dissemination tool in a non-Western context. Though it was hypothesized that sending daily targeted evidence summaries specific to the SIOR's practice would enable more frequent use of the OE service, no difference in usage was actually found between the Intervention and Control groups. However, there was a consensus among surgeons that OE and its pre-appraised ACE report summaries were comprehensive, practical, useful and applicable in clinical practice. Yet, similar to previous research in the field, limited internet connection, lack of time, minimal access to medical journals, limited decision-making powers for residents, textbook-based residency curriculum, lack of research methods knowledge, and limited context-specific research, were described by surgeons as major barriers to keeping up with

medical literature and using OE. Despite the issues described by surgeons, there was more active discussion amongst surgeons on the trauma team about topics on OE ACE reports; as a result, trauma practices at the SIOR began to change.

Action Plan to Move Forward with Research

Current research on the diffusion and adoption of guidelines for practice does not take into account the effects of differing contexts and practice circumstances on these processes (Grimshaw et al., 2005). Some interviewees at the SIOR explained that sometimes, OE ACE reports were not applicable to their practice. If the surgeons did not have the resources to make evidence-based changes to their practice, the change was less likely be implemented. Best evidence must be tailored to the characteristics and context of the patient population and resources for providers (Haynes, 2007). Though it is beyond the scope of this study, context-specific research should be conducted and disseminated for EBM point-of-care resources to be applicable in developing countries (Chinnock et al., 2005; Salgotra, 2012; Swingler et al., 2003; Zaidi et al., 2007). However, there is an inherent issue that is circular in nature about conducting context-specific research that is sometimes overlooked; some say that research is not context-specific in developing countries, but yet it is the educational institutions that do not necessarily provide the means, resources, and training for physicians to conduct research that is meaningful to them.

The way forward to promote EBM practice in India is two-fold:

1) Identifying the current state of EBM and how it is practiced at specific hospitals is necessary. Similar to Mittal and Perakath's (2010) study in India, attitudes towards EBM and barriers to its practice can be determined and validated using

the McColl questionnaire and the BARRIERS scale. Given India's complex healthcare delivery model with public and private institutions, each hospital and healthcare clinic possesses its own unique culture. Physicians working within these institutions must identify a need for EBM practices; they must take some ownership of its implementation since top-down approaches are likely to be ineffective.

2) Once a need to implement EBM practices is identified, and a commitment to doing so is made by the physicians within the healthcare institution, a collaborative twinning project can be developed. Twinning initiatives between institutions in high and low-income countries are the foundation upon which local capacity can be built and sustainability can be encouraged. Twinning initiatives can strengthen participating organizations through a process of capacity building by transferring skills and knowledge (World Health Organization [WHO], 2001). Exchange of best practices can be enhanced through twinning by providing opportunities to identify policies, techniques and interventions that have worked and spreading the word (WHO, 2001). Effectiveness of an initiative is improved because twinning involves collaboratively working towards a common goal; stronger relationships between institutions are also built (WHO, 2001). To promote EBM, a twinning project between the healthcare institution (university and/or specific hospital's residency program) in India and a university such as McMaster which has already demonstrated its leadership in the realm of EBM practice, can be

established. McMaster currently offers Evidence-Based Clinical Practice Workshops for clinicians to improve their clinical practice by enhancing skills in reading, interpreting, and applying the medical literature, and to clinician educators interested in teaching the principles of evidence-based practice (McMaster University, 2016). Through a twinning partnership, these workshops can be adapted to the Indian context. Some aspects of the twinning project to be considered include:

a. Securing funding to cover the cost of human resources and EBM tools necessary to develop and sustain the program.
b. Putting together a team with a purpose to develop a context-specific EBM training program for both residents and consultants at the Indian institution. The team should include a chief resident responsible for representing the needs of resident trainees at the Indian institute, a senior consultant to advocate for consultants and residents alike, an administrator from the Indian institution to help implement the program, and a project manager from the Canadian institute who understands the Indian culture and can communicate effectively to oversee coordination of the project. Twinning exchanges to be organized for the Canadian project manager to travel to India to engage in ongoing collaboration and project set-up. All stakeholders including residents, consultants, administrators, and project coordinators, should have a clear

understanding of the project's long-term goals, task descriptions, action plans, and time frames.

c. The EBM curriculum for the initial training courses and/or workshops should be developed as a team to ensure that it is applicable to the Indian context (Bero et al., 1998; Fritsche et al., 2002; Kim et al., 2008; Schoenfeld et al., 2000; Slawson & Shaughnessy, 2005; Srinivasan et al., 2002). An introduction to an EBM workshop can be conducted to learn the basics of EBM: asking the question → acquiring the evidence → appraising evidence → applying the evidence to individuals' care → evaluating the effectiveness and impact of the process (Sackett et al., 2000). A subsequent weekly reading program can be developed and integrated into residency curriculums to continue the practice of EBM (Weglein et al., 2015). The reading program would include the dissemination of one high-impact article to the residents and consultants every week which would be followed by small group discussions and a larger group discussion to make the system more inclusive. For example, journal clubs at the SIOR are currently led by the senior consultants; providing an opportunity for the residents to lead these meetings may foster greater learning, inclusivity, and collaboration.

d. Ensuring affordable access to point-of-care EBM resources such as Cochrane (free to individuals residing in India), ACP Journal Club, PubMed, OE, etc.

e. Encouraging opinion leaders to post on social media such as Facebook and WhatsApp groups about innovative, interesting, and applicable research in their respective fields to engage colleagues and resident trainees.
f. Assessing the impact and outcomes of the EBM workshop and training program at the Indian institution.

Key Take-Away Message

It can be concluded that though surgeons expressed positive attitudes towards OE as a knowledge-dissemination portal, it was not used to its full potential given the many barriers that surgeons faced. With limited accessibility to this online application, it is likely that other online point-of-care resources will face similar challenges. The capacity to use point-of-care mobile applications such as OE within high-tech centers like the SIOR is available; however, without adequate investments in high-speed internet, the full potential of such programs cannot be attained. Useful information sources for clinicians must be easy to access and implement (Maheshwari & Maheshwari, 2012).

While providing appropriate evidence based resources through adequate online internet access is necessary, a paradigm shift in methods of training future surgeons is crucial. Suitable training and integration of EBM practices into the Indian surgical culture are needed; there must be a focus on developing senior role models as well. Like Hatala and colleagues (2006) said, "Helping our residents become effective evidence users will require a sustained effort on the part of residents, faculty, and their educational institutions" (p.541). If we want to see practices changing, there needs to be a concentrated effort in

teaching, integrating, and implementing EBM learning into residency training programs. Future research should be geared towards developing solutions collaboratively in order to help implement EBM resources that are context-specific.

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APPENDICES

Appendix A: Break-down of an ACE™ Report

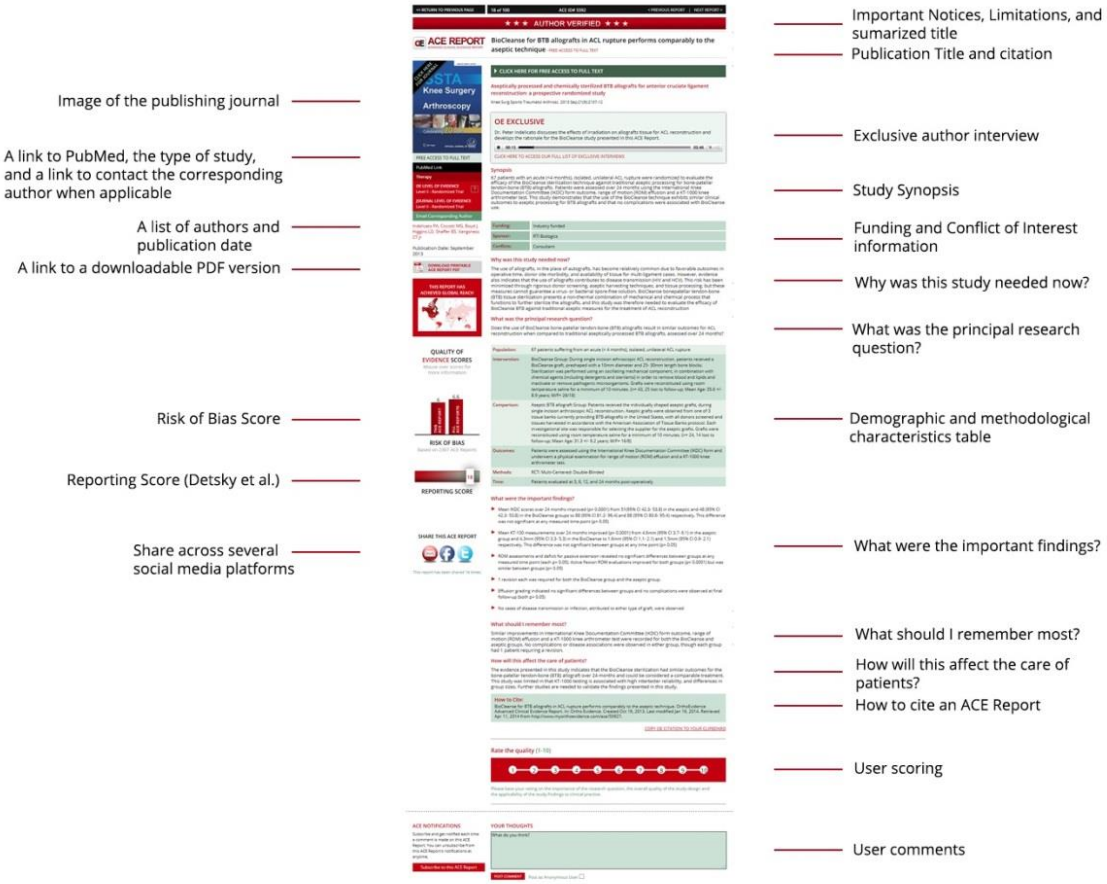
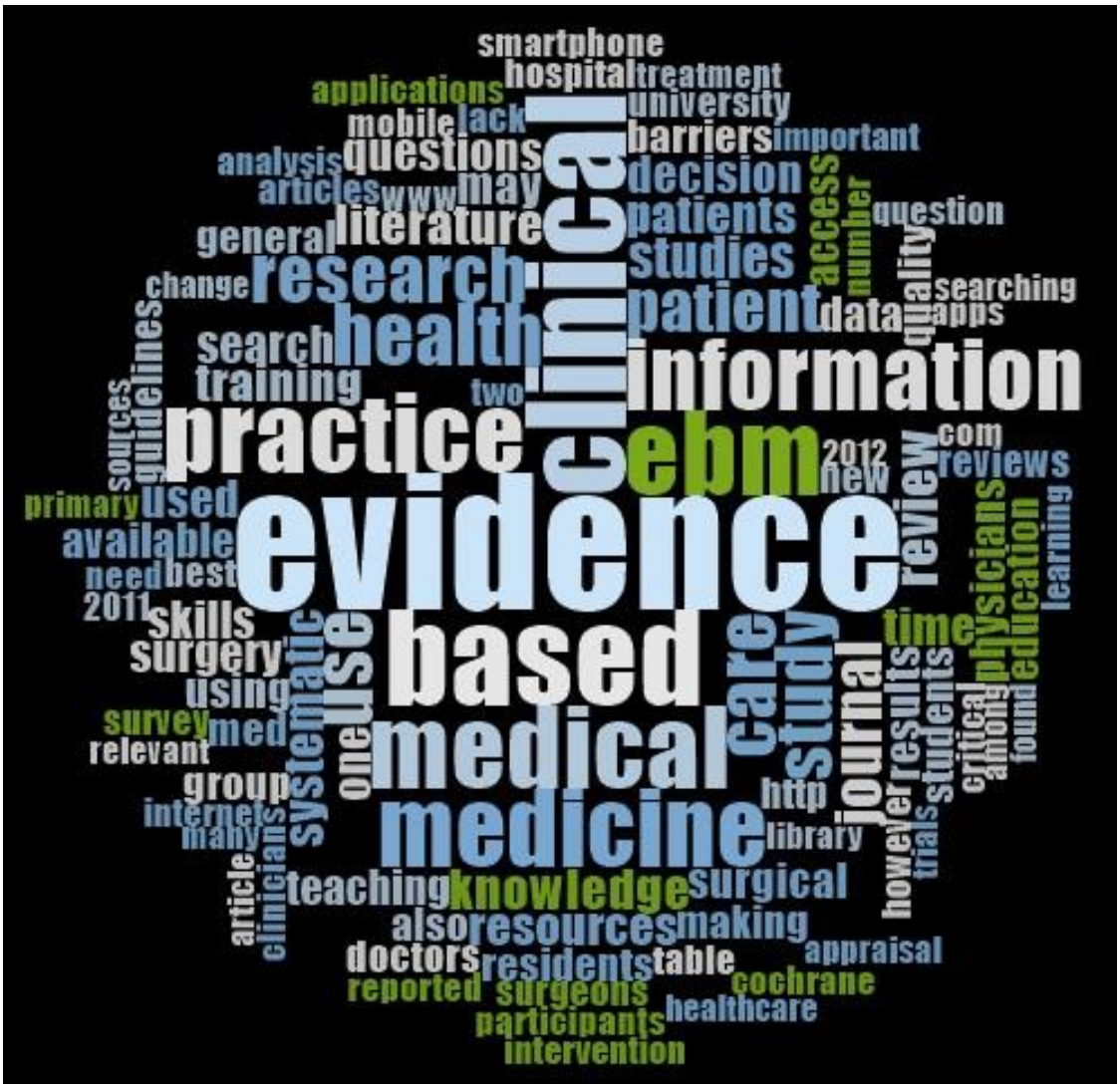


Image retrieved from: Sprague, S., Smith, C., & Bhandari, M. (2015). OrthoEvidenceTM: a clinical resource for evidence-based orthopedics. *Orthopedic Reviews*, *7*(2).

Appendix B: Word Cloud of 100 Most Frequent Words From Literature Review Articles



Appendix C: Email Recruitment Script

E-mail Subject Line: McMaster Study – ***Exploring the Perceived Value of OrthoEvidence and its Daily Targeted Reports for Orthopaedic Doctors at the Sancheti Institute of Orthopaedics and Rehabilitation in Pune, India***

Dear Madam or Sir,

There is a widespread adoption of mobile devices by health care practitioners motivated by a desire for more accurate and accessible communication and information resources such as medical literature, at the point of care. While mobile technology is making a difference in health care practices around the world, testing the perceived value of mobile applications and knowledge dissemination portals for health care providers in India has not fully been explored.

OrthoEvidence is a private, for-profit knowledge dissemination portal which gathers the most relevant, high-impact literature articles, summarizes them and sends out Advanced Clinical Evidence (ACE) reports to subscribers via email or a new mobile app. As part of the graduate program in Global Health at McMaster University, we are carrying out a mixed methods study to understand whether targeted evidence summaries, as produced by OrthoEvidence in the form of ACE reports, would improve the confidence of orthopaedic doctors when making decisions. As an orthopaedic resident, fellow, or consultant at the Sancheti Institute of Orthopaedics and Rehabilitation, you have been invited to participate. Please find attached the letter of information including further details of the project. We are inviting you to complete a brief 25-question online survey that will take about 10-15 minutes to complete. The following link will lead you to the online survey:

https://docs.google.com/forms/d/1Zba4b0rs4VBgTz4oIo3Q06knOlXUHzelMKIpQc7Uqwg/viewform?usp=send_form

You do not need to answer questions that you do not want to answer or that make you feel uncomfortable. Please complete the survey by Sunday, May 27th, 2015 at midnight.

We would like to thank you in advance for your time and consideration. After a few days, we will send you a follow-up reminder.

This study has been reviewed by the Hamilton Integrated Research Ethics Board (HIREB). The HIREB 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, Hamilton Integrated Research Ethics Board at 905.521.2100 x 42013.

Sunita Kheterpal, BSc,
Master's Candidate in Science
Department of Global Health
McMaster University, Hamilton Ontario
Tel: 905-525-9140 Ext: 22045
kheters@mcmaster.ca

Appendix D: Letter of Information

Exploring the Perceived Value of OrthoEvidence and its Daily Targeted Reports for Orthopaedic Doctors at the Sancheti Institute of Orthopaedics and Rehabilitation in Pune, India

Principal Investigator:
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Purpose of the Study:

While mobile technology is making a difference in health care practices around the world, testing the value of mobile applications and knowledge dissemination portals for health care providers in India has not fully been explored. You are invited to take part in this study on mobile health applications used by orthopaedic doctors at the Sancheti Institute of Orthopaedics and Rehabilitation. This study aims to understand whether orthopaedic doctors receiving evidence summaries on a regular basis, perceive greater confidence in making decisions. Please note, this research is being conducted for the completion of a Master's in Science thesis.

Procedures involved in the Research:

OrthoEvidence is a private, for-profit knowledge dissemination portal which gathers the most relevant, high-impact literature articles, summarizes them and sends out Advanced Clinical Evidence (ACE) reports to subscribers via email or a new mobile app. The project will employ a mixed methods approach gathering qualitative surveys obtained from the residents, consultants, and fellows, and quantitative data from the OrthoEvidence database and MailChimp.

To understand your orthopaedic background and schooling, use of mobile technology, current methods of staying up-to-date in the research realm, perception of the availability of technology and internet at the Sancheti Institute, an initial survey will be sent out in May. Upon completion of the initial survey, you will be given a username and password to access OrthoEvidence. You will be randomly chosen to receive daily targeted OrthoEvidence ACE reports based on morning rounds, or to be a part of the group with open access to OrthoEvidence.

You will be asked to fill out weekly confidential surveys about how you are using OrthoEvidence in your daily medical practice. The survey will also ask about the number of articles you reviewed and the time spent on OrthoEvidence.

The quantitative data obtained from the OrthoEvidence database and MailChimp will provide information on the actual time you spend on the mobile app, the types of articles most frequently being accessed, and usage trends. These statistics will be reviewed on a weekly basis.

Finally, some of you will be asked to take part in a one-on-one interview. The purpose of these interviews will be to: understand the experiences you had with OrthoEvidence at the Sancheti Institute; evaluate whether knowledge from OrthoEvidence ACE reports has increased your confidence in making decisions; and identify perceived barriers to implementing OrthoEvidence at the Sancheti Institute. Interviews will be audio-recorded with your permission and handwritten notes will be taken.

Potential Harms, Risks or Discomforts:

Risks for you to participate in the study are minimal. Reading additional information on the OrthoEvidence app every day may be inconvenient. You may feel uncomfortable about investing time in the OrthoEvidence intervention by providing answers to surveys or interview questions. To reduce potential harm, surveys and interview data will be kept confidential and all information will be de-identified. You do not need to answer questions that you do not want to answer or that make you feel uncomfortable. We describe below the steps taken to protect your privacy.

Potential Benefits:

We hope to learn more about how targeted evidence summaries help orthopaedic doctors to increase their confidence in patient care decision-making. What is learned as a result of this study may help OrthoEvidence to reach orthopaedic health care providers and patients around the world by providing critical information access. Furthermore, the findings of this study will provide support for other similar mobile applications targeting physicians to come to market to enhance quality health care.

Confidentiality:

Every effort will be made to protect your confidentiality and privacy. We will not use your names or any information that would allow you to be identified. However, it is possible that you may be identified by your peers based on the experiences you share about how you used OrthoEvidence in your day-to-day practice.

The information/data you provide will be kept in a locked desk/cabinet where only the study team will have access to it. Information kept on a computer will be protected by a password. Once the study is complete, an archive of the data, without identifying

information, will be maintained until the end of the study. The supervisor will keep an encrypted electronic copy for a period of three years.

Participation and Withdrawal:

Your participation in this study is voluntary. However, once you have submitted your survey, your responses cannot be withdrawn from the study because we will not be able to identify which responses are yours.

Conversely, you may withdraw from the interview for whatever reason, even after signing the consent form or part-way through the study or up until approximately ***July 2015*.** In cases of withdrawal from the interview, any data you have provided will be destroyed unless you indicate otherwise.

Information about the Study Results:

We expect to have this study completed by approximately ***October 2015***. If you would like a brief summary of the results, please let me know how you would like it sent to you.

Questions about the Study:

If you have questions or need more information about the study itself, please contact me at:

kheters@mcmaster.ca

This study has been reviewed by the Hamilton Integrated Research Ethics Board (HIREB). The HIREB 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, Hamilton Integrated Research Ethics Board at 905.521.2100 x 42013.

Appendix E: Initial Survey Sent to All Doctors at the SIOR

Instructions: Please choose the option that applies best to you while answering the survey as honestly as possible.

1. Do you identify as a:
    a. Male
    b. Female
    c. I do not wish to identify.
2. What position do you hold at the Sancheti Institute of Orthopaedics and Rehabilitation?
    a. Orthopaedic Resident
    b. Junior Consultant
    c. Senior Consultant
    d. Fellow
    e. Other
3. Do you work:
    a. Full-time
    b. Part-time
4. How many years have you practiced in the field of orthopaedics?
    a. 1 – 5
    b. 6 – 10
    c. 11 – 15
    d. 16 – 20
    e. 21 – 25
    f. 26 – 30
    g. 31+
5. What is your age range?
    a. 20 – 25
    b. 26 – 30
    c. 31 – 35
    d. 36 – 40
    e. 41 – 45
    f. 46 – 50
    g. 51+
6. If you are a resident, what year of residency are you currently pursuing?
    a. 1
    b. 2
    c. 3
    d. Not applicable
7. If you are a resident, what stream are you following?

   a. Master of Surgery in Orthopaedics (MS Ortho)
   b. Diploma of Orthopaedics (DO)
   c. Not applicable
8. Is there a specialty which you are more interested in pursuing or are more focused on currently? (Please select all that apply.)
   a. Arthroplasty
   b. Foot & ankle
   c. General orthopaedics
   d. Hand & wrist
   e. Metabolic disorders
   f. Osteoarthritis
   g. Pediatric orthopaedics
   h. Physical therapy & rehabilitation
   i. Shoulder & elbow
   j. Spine
   k. Sports medicine
   l. Trauma
   m. Tumour
   n. Other (please specify)
9. Do you use a mobile device such as a laptop, tablet, or cellular mobile phone?
   a. Yes
   b. No
10. Do you own and use a smart phone?
   a. Yes
   b. No
11. If you own and use a smart phone, does it use:
   a. an Android operating system
   b. an IOS operating system
   c. Not applicable because I do not own a smart phone
12. Do you use your smart phone within the Sancheti Institute?
   a. Yes
   b. No
   c. Not applicable because I do not own a smart phone
13. Do you currently have a data plan on your mobile device?
   a. Yes
   b. No
14. Do you connect your phone to the internet and browse websites while in the Sancheti Institute?
   a. Yes, I load and browse websites with ease.
   b. Sometimes, depending on my connection and my location in the building(s).

c. Never, my connection is too slow to browse the web.

15. Do you connect to mobile apps within the Sancheti Institute?
    a. Yes, I load my mobile apps with ease.
    b. Sometimes, depending on my connection and my location in the building(s).
    c. Never, my connection is too slow to connect to my mobile apps.
16. Do you have access to computers connected to the internet within Sancheti?
    a. Yes
    b. No
17. Are you able to browse the internet on the computers within the Sancheti Hospital?
    a. Yes, I am able to load and browse websites with ease.
    b. Sometimes, depending on my connection and the computer I am using.
    c. Never, my connection is too slow to browse the web or the computers do not have internet access.
18. Where do you access medical literature? (Please select all that apply.)
    a. At home
    b. Within the Sancheti Institute
    c. University
    d. Other (please specify)
19. How do you access medical literature? (Please select all methods which apply.)
    a. I read journals in paper form.
    b. I read literature online.
    c. I read textbooks.
    d. Other (please specify)
20. How often do you read medical literature articles?
    a. Every day
    b. Every couple of days
    c. Weekly
    d. Monthly
    e. Never
21. How many scholarly journal articles do you read in a week?
    a. 0
    b. 1-3
    c. 4-6
    d. 7-9
    e. 9+
22. Do you believe that your current method of staying up to date with new research is efficient?
    a. Yes
    b. No

23. Do you believe that your current method of staying up to date with new research improves your patient care?
    a. Yes
    b. No
24. If you use the internet to review medical literature, what services do you currently access to stay up to date? (Please select all that apply.)
    a. Electronic medical journals
    b. ACP Journal Club
    c. Up-to-Date
    d. OrthoEvidence
    e. First Consult
    f. Clinical Evidence
    g. Dynamed
    h. PIER
    i. Other (please specify)
25. Please enter your email address below if you consent to receiving full access to OrthoEvidence and to take part in the study.

Appendix F: Email Templates Sent to Participants Enrolled in Each Arm of Study

Email Template for Participants Receiving Daily Newsletters

Dear Dr. _____,

Thank you for consenting to take part in the McMaster study. You now have full access to the OrthoEvidence web portal. To login, please follow this link http://www.myorthoevidence.com/login. Your login username is [insert each participant's unique email address] and the password is *Sancheti1*. You may change the password by clicking on "My Profile" in the top right-hand corner.

You will be receiving a daily newsletter with Advanced Clinical Evidence reports related to Trauma, Hip, Knee, Spine, Pediatric Orthopaedics, Hand, Shoulder, Tumour, and Arthroscopy. Please ensure that you check the "Promotions" tab of your Gmail account as the newsletter will be sent directly from the OrthoEvidence website. Please keep an eye out for these as we will be asking for your feedback.

To learn more about OrthoEvidence and its functionalities, please watch their 2-minute introduction video here: https://youtu.be/Olr0qxNnqVc

If you have any questions or concerns, please do not hesitate to contact me.

Kind Regards,

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Email Template for Participants Receiving Weekly Newsletters

Dear Dr. _____,

Thank you for consenting to take part in the McMaster study. You now have full access to the OrthoEvidence web portal. To login, please follow this link http://www.myorthoevidence.com/login. Your login username is [insert each participant's unique email address] and the password is *Sancheti1*. You may change the password by clicking on "My Profile" in the top right-hand corner.

You will be receiving a weekly newsletter with Advanced Clinical Evidence reports related to Arthroplasty, Foot & Ankle, General Orthopaedics, Hand & Wrist, Metabolic Disorders, Osteoarthritis, Pediatric Orthopaedics, Physical Therapy & Rehab, Shoulder & Elbow, Spine, Sports Medicine, Trauma, and Tumours. Please be sure to check your "Promotions" tab in Gmail as the emails will be sent from the OrthoEvidence sender. Please keep an eye out for these as we will be asking for your feedback.

To learn more about OrthoEvidence and its functionalities, please watch their 2-minute introduction video here: https://youtu.be/Olr0qxNnqVc

If you have any questions or concerns, please do not hesitate to contact me.

Kind Regards,

Sunita Kheterpal, BSc.
MSc Candidate in Global Health
Department of Global Health
McMaster University, Hamilton, Ontario

Tel: +91 99 8012 7794
kheters@mcmaster.ca

Appendix G: Example of a Daily Targeted Newsletter Sent to Group 1 (Intervention)

Sunita,

Today's ACE reports include the most relevant and recent evidence for all orthopaedic specialties at the Sancheti Institute of Orthopaedics and Rehabilitation. Please take a moment to view them by clicking the links below.

Sincerely,

The Team at OrthoEvidence

Arthroplasty

No significant differences in results between high-flexion and standard PS TKA
READ THE FULL ACE REPORT

General anaesthesia versus spinal anaesthesia for fast-track total hip arthroplasty
READ THE FULL ACE REPORT

Displaced femoral neck fractures in the elderly: arthroplasty vs. internal fixation
READ THE FULL ACE REPORT

Foot & Ankle

PLOS ONE

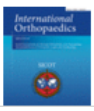
Safety, efficacy of early weight-bearing and mobilization after ORIF for ankle fractures
READ THE FULL ACE REPORT

Hand & Wrist

Endoscopic CT release may lead to improved short-term results compared to open release
READ THE FULL ACE REPORT

Clinical & economic effects of K-wire & volar locking-plate fixation for radial fractures
READ THE FULL ACE REPORT

Spine

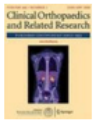


Kyphoplasty offers benefit in radiographic outcome and safety vs. vertebroplasty for OVCF
READ THE FULL ACE REPORT

Spine

Kyphoplasty offers benefit in radiographic outcome and safety vs. vertebroplasty for OVCF
READ THE FULL ACE REPORT

Trauma



Network Meta-Analyses: Unreamed nailing best treatment for open tibial shaft fractures
READ THE FULL ACE REPORT

Possible advantage with intramedullary vs plate fixation in treatment of clavicle fracture
READ THE FULL ACE REPORT

Appendix H: Break-down of ACE Reports Sent to Group 1 (Intervention)

	Total Number of ACE Reports Sent in Category
Arthroplasty	23
Foot & Ankle	10
General Orthopaedics	16
Hand & Wrist	9
Osteoarthritis	7
Pediatric Orthopaedics	19
Physical Therapy & Rehab	5
Shoulder & Elbow	28
Spine	26
Sports Medicine	15
Trauma	28
Tumour	3
Total Reports Sent	189

Appendix I: Methodological Quality Assessment

Image retrieved from: Sprague, S., Smith, C., & Bhandari, M. (2015). OrthoEvidenceTM: a clinical resource for evidence-based orthopedics. *Orthopedic Reviews*, *7*(2).
Originally adapted from: Higgins, J. P., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., ... & Sterne, J. A. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*, *343*, d5928.

Appendix J: Quality of Reporting Assessment

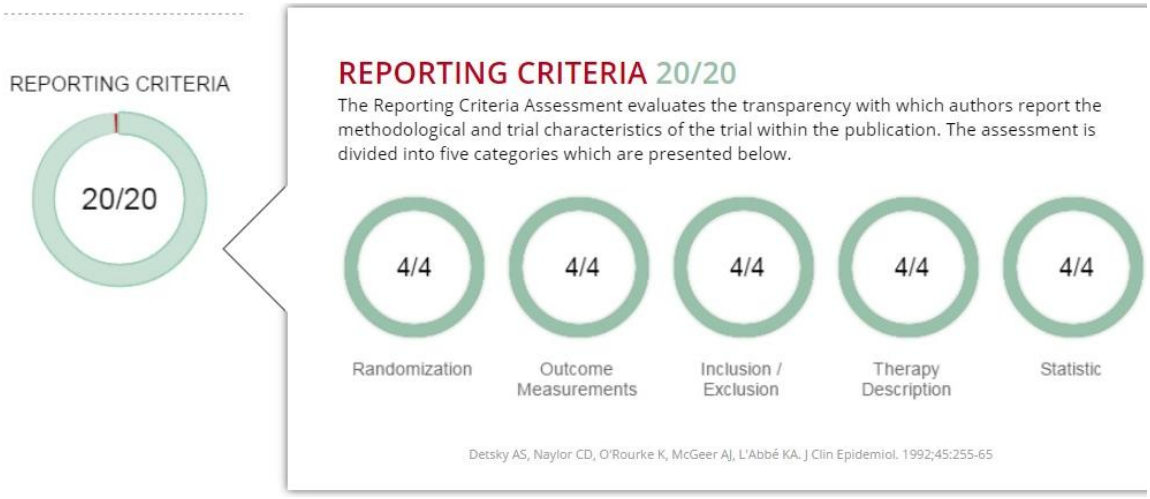


Image retrieved from: Sprague, S., Smith, C., & Bhandari, M. (2015). OrthoEvidenceTM: a clinical resource for evidence-based orthopedics. *Orthopedic Reviews*, *7*(2).

Appendix K: Exit Survey for all Study Participants

1. Please enter your email address.
2. How much time, on average, do you usually spend reviewing medical literature in online journals (including the time it takes you to look up publications through web portals such as PubMed, and to read the articles)?
    a. 30 minutes or less
    b. 30-60 minutes
    c. 1-2 hours
    d. 2-3 hours
    e. 3-4 hours
    f. 4-5 hours
    g. 5+ hours
    h. Not applicable because I do not read medical literature online.
3. How have you accessed OrthoEvidence and the ACE reports? (Please select all that apply).
    a. Smartphone
    b. Laptop
    c. Tablet
    d. Desktop Computer
    e. I do not access OrthoEvidence and the ACE reports.
    f. Other (please specify)
4. How easily can you load the OrthoEvidence website on your mobile device?
    a. I load and browse OrthoEvidence with ease regardless of my location.
    b. Sometimes I can load the OrthoEvidence website easily but it depends on my connection and/or my location in the building.
    c. I can rarely load the OrthoEvidence website because my connection is usually too slow.
    d. I have not tried to load the OrthoEvidence website on my mobile device.
5. How often have you read the ACE reports sent to you over the last three weeks?
    a. Every day
    b. Every couple of days
    c. Weekly
    d. Never
6. How much time, on average, do you spend on the OrthoEvidence website weekly?
    a. 30 minutes or less
    b. 30 – 60 minutes
    c. 1 -2 hours
    d. 2-3 hours
    e. 3-4 hours

   f. 4-5 hours
   g. 5+ hours
   h. Not applicable because I have not spent time on the OrthoEvidence website.
7. How many ACE reports do you read on average per week?
   a. 0
   b. 1-3
   c. 4-6
   d. 7-9
   e. 9+
8. Please indicate when you would prefer to receive the OrthoEvidence ACE reports. Why? (Please provide a reason).
   a. Morning
   b. Afternoon
   c. Evening
   d. No preference
   e. Never
9. Which types of articles have you accessed on OrthoEvidence? (Please select all that apply).
   a. Arthroplasty
   b. Foot & ankle
   c. General orthopaedics
   d. Hand & wrist
   e. Metabolic disorders
   f. Osteoarthritis
   g. Pediatric orthopaedics
   h. Physical therapy & rehabilitation
   i. Shoulder & elbow
   j. Spine
   k. Sports medicine
   l. Trauma
   m. Tumour
   n. Other (please specify)
10. ACE reports are COMPREHENSIVE in enhancing knowledge by providing additional and updated information to the available orthopaedic textbooks. (Please choose the response that best applies to you).
   a. Strongly agree
   b. Agree
   c. Neither agree or disagree
   d. Disagree
   e. Strongly disagree

11. ACE reports are PRACTICAL tools to enhance knowledge by providing additional and updated information to the available orthopaedic textbooks. (Please choose the response that best applies to you).
    a. Strongly agree
    b. Agree
    c. Neither agree or disagree
    d. Disagree
    e. Strongly disagree
12. ACE reports are USEFUL in enhancing knowledge by providing additional and updated information to the available orthopaedic textbooks. (Please choose the response that best applies to you).
    a. Strongly agree
    b. Agree
    c. Neither agree or disagree
    d. Disagree
    e. Strongly disagree
13. OrthoEvidence's ACE reports have improved my efficiency and ability to keep up with new research. (Please choose the response that best applies to you).
    a. Strongly agree
    b. Agree
    c. Neither agree or disagree
    d. Disagree
    e. Strongly disagree
14. I am better informed to make medical decisions as a result of knowledge gained from the OrthoEvidence ACE reports. (Please choose the response that best applies to you).
    a. Strongly agree
    b. Agree
    c. Neither agree or disagree
    d. Disagree
    e. Strongly disagree
15. I read one or more ACE reports and (please select all that apply)
    a. made an informed patient care decision based on the information I read
    b. changed a patient care decision
    c. discussed some part of what I read with another orthopaedic doctor
    d. discussed some part of what I read with a physician, physiotherapist, or nurse
    e. discussed some part of what I read with my patient
    f. learned how my decision would differ from the consultant's patient care decision
    g. did not take further action

16. I believe that the patient care that I provide has improved as a result of the knowledge gained from ACE reports. (Please choose the response that best applies to you).
    a. Strongly agree
    b. Agree
    c. Neither agree or disagree
    d. Disagree
    e. Strongly disagree
17. How applicable is the evidence from ACE reports to your medical practice in India given available resources?
    a. Very applicable
    b. Somewhat applicable
    c. Not applicable
    d. Other (please explain)
18. Please provide one or more examples of how you used the knowledge gained from an ACE report in your practice or indicate "not applicable" if you have not used knowledge from an ACE report in your practice. (Example: Enabled me to critically examine the practice of other physicians.)

Appendix L: Semi-Structured Interview Guide

Information about these interview questions: Interviews will be one-on-one and will be open-ended (not just "yes or no" answers). The exact wording of each question may change during the course of the interview. Sometimes I will use other short questions to make sure I understand what you have said to me or if I need more information when we are talking such as: "*So, you are saying that …?*), to get more information ("*Please tell me more?"),* or to learn what you think or feel about something ("*Why do you think that is…?").*

1) Information about you:
    a. Are you a resident, fellow, or consultant?
    b. If you are a resident, what year of residency are you in?
    c. For all interviewees, what is your specialty?
2) Please tell me about your experience with OrthoEvidence.
    a. Did you receive daily reports? Were you able to open and review them in full?
    b. Can you please describe for me how receiving evidence summaries and having access to a large database of orthopaedic evidence (ie OrthoEvidence) has or has not made a difference in your daily work-life?
        i. Describe how you have used knowledge gained from ACE reports to improve your patient care, if at all.
        ii. Describe how, if at all, the use of ACE reports has influenced your confidence when providing care to patients.
        iii. Describe how, if at all, OrthoEvidence and its ACE reports have influenced your knowledge about orthopaedics and/or your specialty. Please explain.
        iv. Describe the impact of OrthoEvidence on your practice (ie level of understanding of current evidence in the field, impact on decisions, patient care).
        v. Describe any barriers that you encountered when trying to use OrthoEvidence.
        vi. Describe any facilitators that helped you to use OrthoEvidence.
3) Can you describe for me a time in the last few weeks where you either discussed something you read in an ACE report with a colleague, or used your newfound knowledge to change a decision, or to make a decision? How did the knowledge gained from OrthoEvidence influence the discussion?
4) Describe how you believe OrthoEvidence can be used as a reliable tool at Sancheti in the future? Please explain.
    a. What strategies should/could be put in place to promote the uptake of OrthoEvidence amongst residents, fellows, and consultants?
5) Do you believe that OrthoEvidence can be expanded to other regions of India or other countries with similar technological infrastructure? Please explain.

END

Appendix M: Interviewees' Informed Consent Form

Exploring Perceptions of Physicians Accessing OrthoEvidence and Daily Targeted Reports: Improving Patient Care at the Sancheti Institute of Orthopaedics and Rehabilitation in Pune, India

Principal Investigator:
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E-mail: *kheters@mcmaster.ca*

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Purpose of the Study:

While mobile technology is making a difference in health care practices around the world, testing the value of mobile applications to health care providers in India has not fully been explored. You are invited to take part in this study on mobile health applications used by orthopaedic physicians at the Sancheti Institute of Orthopaedics and Rehabilitation. This study aims to understand whether physicians receiving evidence summaries on a regular basis, perceive greater confidence in making decisions. Please note, this research is being conducted for the completion of a Master's in Science thesis.

Procedures Involved in the Research:

OrthoEvidence is a private, for-profit knowledge dissemination portal which gathers the most relevant, high-impact literature articles, summarizes them and sends out Advanced Clinical Evidence (ACE) reports to subscribers via email or a new mobile app. The project will employ a mixed methods approach gathering qualitative surveys obtained from the residents, consultants, and fellows, and quantitative data from the OrthoEvidence database and MailChimp.

As a participant in the study you are asked to take part in a one-on-one interview. The purpose of these interviews is to: understand your experience with OrthoEvidence at Sancheti; evaluate whether knowledge from OrthoEvidence ACE reports has increased your confidence in making decisions; and identify perceived barriers to implementing OrthoEvidence at the Sancheti Institute. Interviews will be audio-recorded with your permission and handwritten notes will be taken. Questions asked will include:

i) If you received targeted ACE reports – do you believe that OrthoEvidence has made any type of difference in your daily life in terms of access to relevant and targeted evidence? Have you used knowledge gained from ACE reports to improve your patient care? If yes, please explain and/or provide an example.

ii) If you simply had access to OrthoEvidence – do you believe that your peers were better equipped to improve their patient care with targeted access to OrthoEvidence? Please explain.
iii) Did you encounter any barriers while using OrthoEvidence?
iv) Do you believe that OrthoEvidence can be used as a reliable tool at the Sancheti Institute of Orthopaedics and Rehabilitation in the future? Please explain.
v) Do you believe that OrthoEvidence has the potential to be expanded throughout India or another country with similar technological infrastructure? Please explain.

Potential Harms, Risks or Discomforts:

You may feel uncomfortable about investing time in the OrthoEvidence intervention by providing answers to interview questions. To reduce potential harm, interview data will be kept confidential and all information will be de-identified. You do not need to answer questions that you do not want to answer or that make you feel uncomfortable. We describe below the steps taken to protect your privacy.

Potential Benefits:

We hope to learn more about how targeted evidence summaries help physicians to increase their confidence in patient care decision-making. What is learned as a result of this study may help OrthoEvidence to reach orthopaedic health care providers and patients around the world by providing critical information access. Furthermore, the findings of this study will provide support for other similar mobile applications targeting physicians to come to market to enhance quality health care.

Confidentiality:

Every effort will be made to protect your confidentiality and privacy. We will not use your names or any information that would allow you to be identified. However, it is possible that you may be identified by your peers based on the experiences you share about how you used OrthoEvidence in your day-to-day practice.

The information you provide will be kept in a locked desk/cabinet where only the study team will have access to it. Information kept on a computer will be protected by a password. Once the study is complete, an archive of the data, without identifying information, will be maintained until the end of the study. The supervisor will keep an encrypted electronic copy for a period of three years.

Participation and Withdrawal:

You may withdraw from the interview for whatever reason, even after signing the consent form or part-way through the study or up until approximately ***July 2015.*** If you decide to withdraw, there will be no consequences to you. In cases of withdrawal from the interview, any data you have provided will be destroyed unless you indicate otherwise. If you do not wish to answer some of the questions you do not have to, but you may still be in the study.

Information about the Study Results:

We expect to have this study completed by approximately ***October 2015***. If you would like a brief summary of the results, please let me know how you would like it sent to you.

Questions about the Study:

If you have questions or need more information about the study itself, please contact me at:

kheters@mcmaster.ca

This study has been reviewed by the Hamilton Integrated Research Ethics Board (HIREB). The HIREB 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, Hamilton Integrated Research Ethics Board at 905.521.2100 x 42013.

CONSENT

- I have read the information presented in the information letter about a study being conducted by **Sunita Kheterpal** of McMaster University.
- I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested.
- I understand that if I agree to participate in this study, I may withdraw from the study at any time or up until approximately ***July 2015.***
- I have been given a signed copy of this form.
- I agree to participate in the study.

Signature: _____ Date: _____
Name of Participant (Printed) _____

1. I agree that the interview can be audio recorded.
… Yes.
… No.
2. …Yes, I would like to receive a summary of the study's results.
Please send them to me at this email address _____
Or to this mailing address: _____
_____
_____
… No, I do not want to receive a summary of the study's results.

3. I agree to be contacted about a follow-up interview, and understand that I can always decline the request.
... Yes. Please contact me at: _____
... No.

Appendix N: Initial Survey Demographic Information

Table 1: Study Participants' Demographic Information

	Receiving Daily Mailers (Intervention)	**Receiving Weekly Mailers (Control)**	**Total n (%)**	**P - Value**
Age Range				
20 to 25	5 (22.73%)	9 (40.91%)	14 (31.82%)	**p = 0.337**
26 to 30	10 (45.45%)	7 (31.82%)	**17 (38.64%)**	
Above the age of 30	7 (31.82%)	6 (27.27%)	13 (29.54%)	
Total	22 (100.00%)	22 (100.00%)	44 (100%)	
Years of Practice				
1 to 5	16 (72.73%)	15 (68.18%)	**31 (70.45%)**	**p = 0.744**
More than 5 years	6 (27.27%)	7 (31.82%)	13 (29.55%)	
Total	22 (100.00%)	22 (100.00%)	44 (100%)	

Table 2: Access and Ability to Browse Internet through Computers or Smartphones

	Receiving Daily Mailers (Intervention)	**Receiving Weekly Mailers (Control)**	**Total n (%)**	**P- Value**
Access to computers connected to the internet in the SIOR				
Yes	14 (63.64%)	14 (63.64%)	**28 (63.64%)**	**p = 0.911**
No	7 (31.82%)	8 (36.36%)	15 (34.09%)	
No Response	1 (4.54%)	0 (0.00%)	1 (2.27%)	
Total	22 (100.00%)	22 (100.00%)	44 (100%)	
Ability to browse the internet on computers within the SIOR				
Yes with ease	8 (36.36%)	7 (31.82%)	15 (34.09%)	**p = 0.922**
Sometimes or never	13 (59.09%)	15 (68.18%)	**28 (63.64%)**	
No Response	1 (4.55%)	0 (0.00%)	1 (2.27%)	
Total	22 (100.00%)	22 (100.00%)	44 (100%)	
Connect smartphone to internet and browse websites within the SIOR				
Yes with ease	9 (40.91%)	9 (40.91%)	18 (40.91%)	**p = 1.000**
Sometimes or never	13 (59.09%)	13 (59.09%)	**26 (59.09%)**	
Total	22 (100.00%)	22 (100.00%)	44 (100%)	
Connect smartphone to mobile apps within the SIOR				
Yes with ease	7 (31.82%)	10 (45.45%)	17 (38.64%)	**p = 0.359**
Sometimes or never	15 (68.18%)	12 (54.55%)	**27 (61.36%)**	
Total	22 (100.00%)	22 (100.00%)	44 (100%)	

Table 3: Keeping up to Date with Medical Literature

	Receiving Daily Mailers (Intervention)	Receiving Weekly Mailers (Control)	Total n (%)	P-Value
Form of Accessing Medical Literature				
I read journals in paper form.	8 (36.36%)	9 (40.91%)	17 (38.64%)	**p = 0.532**
I read literature online.	17 (77.27%)	16 (72.73%)	**33 (75.00%)**	
I read textbooks.	13 (59.09%)	14 (63.64%)	**32 (72.73%)**	
Frequency of reading medical literature				
Every day	3 (13.64%)	2 (9.09%)	5 (11.36)	**p = 0.919**
Every couple of days	4 (18.18%)	5 (22.73%)	9 (20.46)	
Weekly	11 (50.00%)	12 (54.54%)	**23 (52.27%)**	
Monthly	4 (18.18%)	3 (13.64%)	7 (15.91%)	
Total	22 (100.00%)	22 (100.00%)	44 (100.00%)	
Number of Scholarly Journal Articles Read in Week				
0	1 (4.55%)	5 (22.73%)	6 (13.64%)	**p = 0.075**
1 to 3	15 (68.18%)	14 (63.63%)	**29 (65.91%)**	
More than 4	6 (27.27%)	3 (13.64%)	9 (20.45%)	
Total	22 (100.00%)	22 (100.00%)	44 (100.00%)	
Is current method of staying up to date with new research efficient?				
Yes	6 (27.27%)	10 (45.45%)	16 (36.36%)	**p = 0.215**
No	16 (72.73%)	12 (54.55%)	**28 (63.64%)**	
Total	22 (100.00%)	22 (100.00%)	44 (100.00%)	
Is current method of staying up to date with new research improving patient care?				
Yes	17 (77.27%)	16 (72.73%)	**33 (75.00%)**	**p = 0.731**
No	5 (22.73%)	6 (27.27%)	11 (25.00%)	
Total	22 (100.00%)	22 (100.00%)	44 (100.00%)	

Appendix O: Exit Survey Responses

Table 4: Average Time Spent Reviewing Literature in Online Journals

	Receiving Daily Mailers (Intervention)	**Receiving Weekly Mailers (Control)**	**Total n (%)**	**P-Value**
Average Time Spent Reviewing Literature in Online Journals				
30 minutes or less	**9 (50.00%)**	**10 (52.63%)**	**19 (51.35%)**	**p = 0.753**
30 to 60 minutes	5 (27.78%)	6 (31.58%)	11 (29.73%)	
1 to 2 hours	2 (11.11%)	2 (10.53%)	4 (10.82%)	
More than 2 hours	1 (5.56%)	1 (5.26%)	2 (5.40%)	
Not applicable because I do not read medical literature online.	1 (5.55%)	0 (0.00%)	1 (2.70%)	
Total	18 (100.00%)	19 (100.00%)	37 (100.00%)	

Table 5: Accessibility of OrthoEvidence

	Receiving Daily Mailers (Intervention)	**Receiving Weekly Mailers (Control)**	**Total n (%)**	**P-value**
Method of Accessing OrthoEvidence and ACE Reports				
Smartphone	**11 (61.11%)**	**16 (84.21%)**	**27 (72.97%)**	**p = 0.991**
Laptop	8 (44.44%)	5 (26.31)	13 (35.14%)	
Tablet	2 (11.11%)	2 (10.53%)	4 (10.81%)	
Desktop Computer	0 (0.00%)	4 (21.05%)	4 (10.81%)	
I do not access OrthoEvidence and the ACE reports.	1 (5.55%)	1 (5.26%)	2 (5.41%)	
Loading of OrthoEvidence Website on Mobile Device				
Yes with ease	5 (27.78%)	3 (15.79%)	8 (21.62%)	**p = 0.443**
Sometimes but with difficulty	**12 (66.67%)**	**14 (73.68%)**	**26 (70.27%)**	
I have not tried	1 (5.55%)	2 (10.53%)	3 (8.11%)	
Total	18 (100.00%)	19 (100.00%)	37 (100.00%)	

Table 6: Usage of OrthoEvidence Based on Exit Survey Responses

	Receiving Daily Mailers (Intervention)	**Receiving Weekly Mailers (Control)**	**Total n (%)**	**P-value**
Frequency of Reading ACE Reports Sent Over the Week				
Every day	4 (22.22%)	0 (0.00%)	4 (10.81%)	**p = 0.142**
Every couple of days	5 (27.78%)	4 (21.05%)	9 (24.32%)	
Weekly	**6 (33.33%)**	**12 (63.16%)**	**18 (48.65%)**	
Never	3 (16.67%)	3 (15.79%)	6 (16.22%)	
Total	18 (100.00%)	19 (100.00%)	37 (100.00%)	
How much time, on average, do you spend on the OrthoEvidence website weekly?				
30 minutes or less	**10 (62.50%)**	**6 (37.50%)**	**16 (50.00%)**	**p = 0.287**
30 to 60 minutes	3 (18.75%)	**6 (37.50%)**	9 (28.13%)	
More than 1 hour	3 (18.75%)	4 (25.00%)	7 (21.87%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	
How many ACE reports do you read on average per week?				
0	2 (12.50%)	0 (0.00%)	2 (6.25%)	**p = 0.724**
1 to 3	**9 (56.25%)**	**14 (87.50%)**	**23 (71.88%)**	
4 or more	5 (31.25%)	2 (12.50%)	7 (21.88%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	

Table 7: Surgeons' Perceptions of ACE Reports

	Receiving Daily Mailers (Intervention)	Receiving Weekly Mailers (Control)	Total n (%)	P-Value
ACE reports are COMPREHENSIVE				
Agree	**12 (75.00%)**	**15 (93.75%)**	**27 (84.38%)**	**p = 0.361**
Neither agree nor disagree	3 (18.75%)	1 (6.25%)	4 (12.50%)	
Disagree	1 (6.25%)	0 (0.00%)	1 (3.12%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	
ACE reports are PRACTICAL tools				
Agree	**10 (62.50%)**	**13 (81.25%)**	**23 (71.88%)**	**p = 0.341**
Neither agree nor disagree	5 (31.25%)	3 (18.75%)	8 (25.00%)	
Disagree	1 (6.25%)	0 (0.00%)	1 (3.12%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	
ACE reports are USEFUL				
Agree	**12 (75.00%)**	**16 (100.00%)**	**28 (87.50%)**	**p = 0.239**
Neither agree nor disagree	3 (18.75%)	0 (0.00%)	3 (9.38%)	
Disagree	1 (6.25%)	0 (0.00%)	1 (3.12%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	
OE's ACE reports have improved my efficiency and ability to keep up with new research.				
Agree	**12 (75.00%)**	**12 (75.00%)**	**24 (75.00%)**	**p = 0.956**
Neither agree nor disagree	3 (18.75%)	4 (25.00%)	7 (21.88%)	
Disagree	1 (6.25%)	0 (0.00%)	1 (3.12%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	
I am better informed to make medical decisions as a result of knowledge gained from the OE ACE reports.				
Agree	**8 (50.00%)**	**11 (68.75%)**	**19 (59.38%)**	**p = 0.402**
Neither agree nor disagree	7 (43.75%)	4 (25.00%)	11 (34.37%)	
Disagree	1 (6.25%)	1 (6.25%)	2 (6.25%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	
I believe that the patient care that I provide has improved as a result of the knowledge gained from ACE reports.				
Agree	7 (43.75%)	**10 (62.50%)**	**17 (53.13%)**	**p = 0.381**
Neither agree nor disagree	**9 (56.25%)**	6 (37.50%)	15 (46.87%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	

How applicable is the evidence from ACE reports to your medical practice in India given available resources?				
Applicable	**13 (81.25%)**	**15 (93.75%)**	**28 (87.50%)**	**p = 0.539**
Not applicable	2 (12.50%)	1 (6.25%)	3 (9.38%)	
No Response	1 (6.25%)	0 (0.00%)	1 (3.12%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	
I read one or more ACE reports and…				
Took further action	**10 (62.50%)**	**13 (81.25%)**	**23 (71.88%)**	**p = 0.341**
Did not take further action	5 (31.25%)	3 (18.75%)	8 (25.00%)	
No Response	1 (6.25%)	0 (0.00%)	1 (3.12%)	
Total	16 (100.00%)	16 (100.00%)	32 (100.00%)	

Appendix P: Usage Rates (Open and Click Rates) of OE Newsletters

Table 8: Comparison of Open and Click Rates Between Intervention and Control Groups

		Receiving Daily Mailers (Intervention)	Receiving Weekly Mailers (Control)	Total
Average Daily Mailer Rates (Intervention) vs. Average Weekly Mailer Rates (Control)				
Open Rate (%)	Mean	24.91%	16.93%	21.01%
	N	22	21	43
	Std. Deviation	30.39%	30.58%	30.39%
	Median	**14.29%**	**0.00%**	9.52%
	P-Value	**p = 0.132**		
Click Rate (%)	Mean	12.76%	4.68%	8.81%
	N	22	21	43
	Std. Deviation	20.82%	10.12%	16.80%
	Median	**5.51%**	**0.00%**	0.00%
	P-Value	**p = 0.053**		

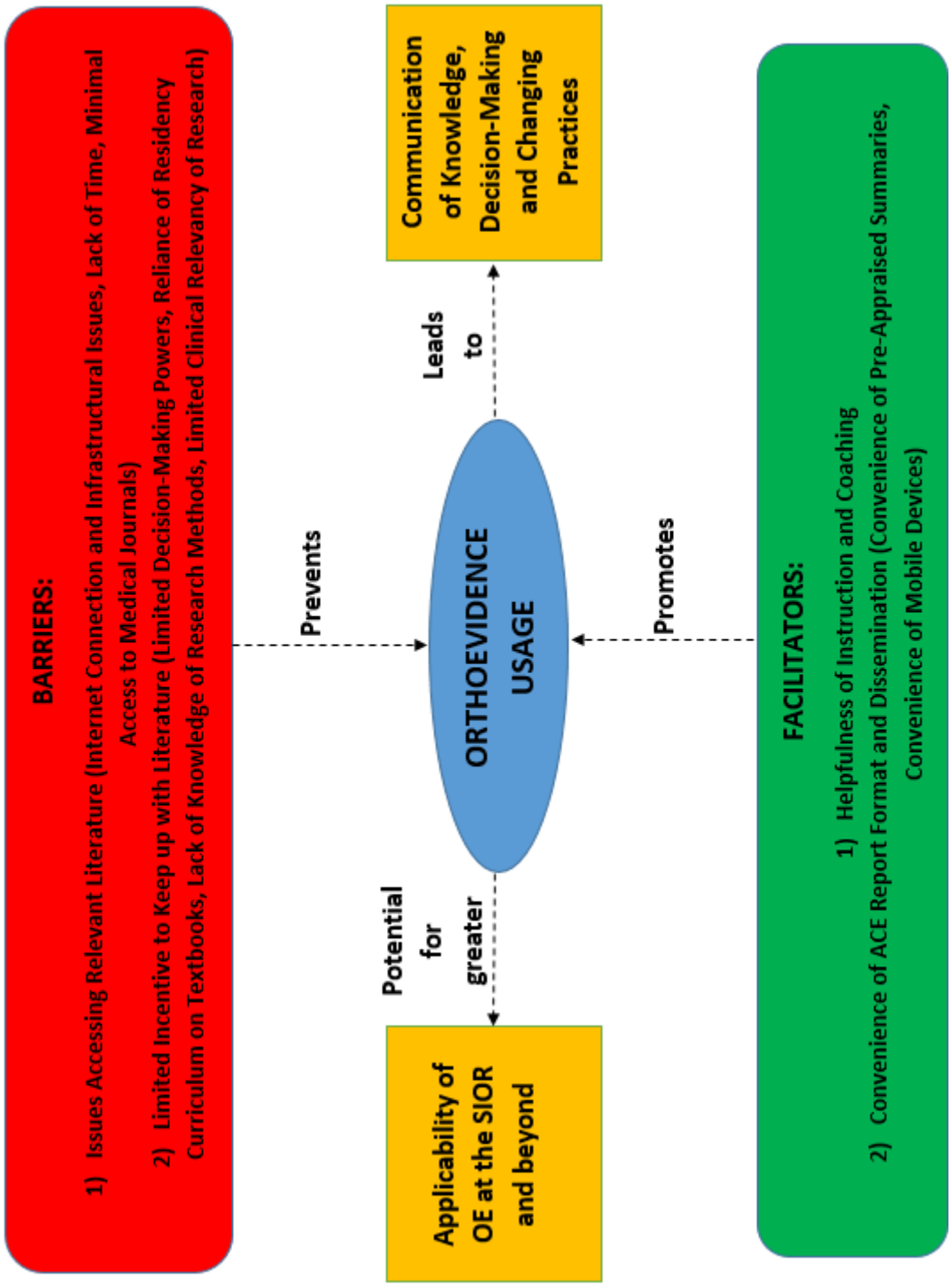
Table 9: Within Group Analysis of Open and Click Rates

		Consultants	Residents/Visiting Fellows	Total
Consultants vs. Residents/Visiting Fellows in Intervention Group				
Open Rate (%)	N	7	15	22
	Std. Deviation	39.77%	25.83%	30.39%
	Median	**14.29%**	**9.52%**	14.29%
	P-Value	**p = 0.783**		
Click Rate (%)	N	7	15	22
	Std. Deviation	18.17%	22.39%	20.82%
	Median	**9.52%**	**4.76%**	5.51%
	P-Value	**p = 0.332**		
Consultants vs. Residents/Visiting Fellows in Control Group				
Open Rate (%)	N	6	15	21
	Std. Deviation	38.25%	28.02%	30.58%
	Median	**10.70%**	**0.00%**	0.00%
	P-Value	**p = 0.424**		
Click Rate (%)	N	6	15	21
	Std. Deviation	16.63%	5.91%	10.12%
	Median	**0.00%**	**0.00%**	0.00%
	P-Value	**p = 0.677**		

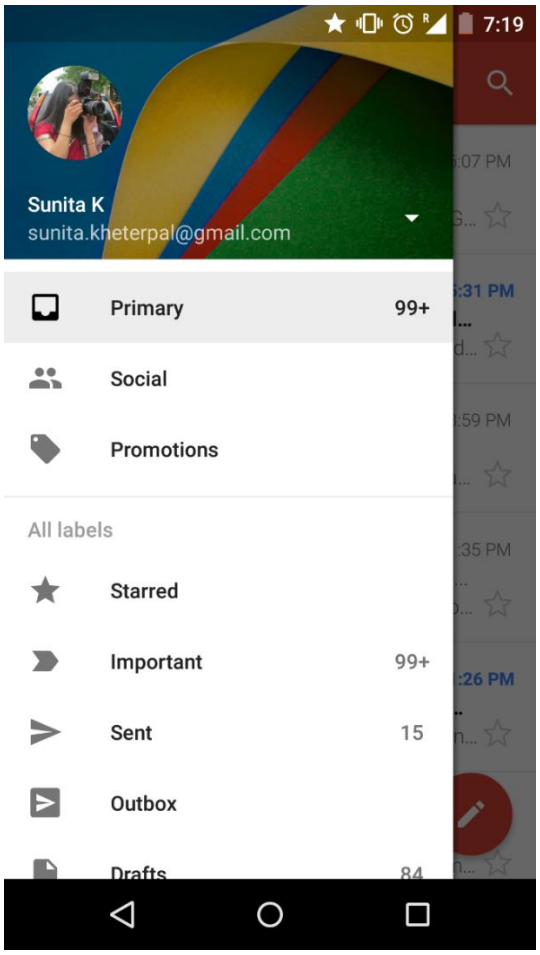
Table 10: Stratified Analysis of Open and Click Rates

		Receiving Daily Mailers (Intervention)	Receiving Weekly Mailers (Control)	Total
Consultants in Intervention Group vs. Consultants in Intervention Group				
Open Rate (%)	N	7	6	13
	Std. Deviation	39.77%	38.25%	37.68%
	Median	**14.29%**	**10.70%**	14.29%
	P-Value	**p = 0.836**		
Click Rate (%)	N	7	6	13
	Std. Deviation	18.17%	16.63%	17.10%
	Median	**9.52%**	**0.00%**	4.76%
	P-Value	**p = 0.366**		
Residents/Visiting Fellows vs. Residents/Visiting Fellows in Control Group				
Open Rate (%)	N	15	15	30
	Std. Deviation	25.83%	28.02%	26.73%
	Median	**9.52%**	**0.00%**	8.33%
	P-Value	**p = 0.148**		
Click Rate (%)	N	15	15	30
	Std. Deviation	22.40%	5.91%	16.66%
	Median	**4.76%**	**0.00%**	0.00%
	P-Value	**p = 0.161**		

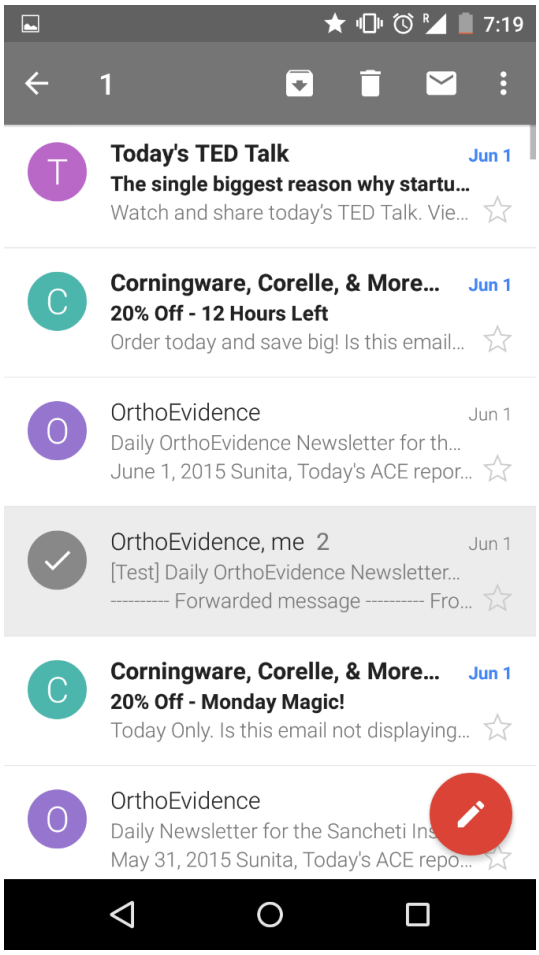
Appendix Q: Summary of Themes from Qualitative Semi-Structured Interviews



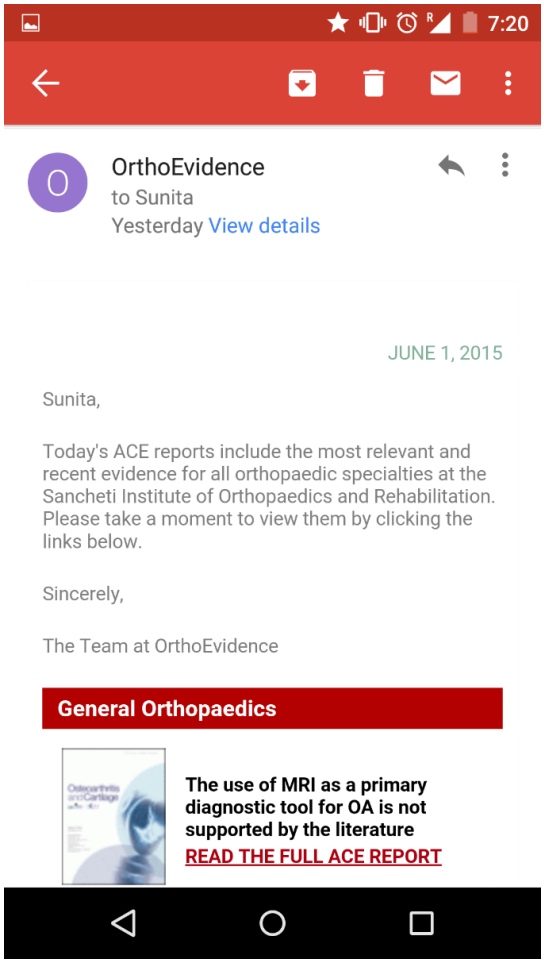
Appendix R: Screenshots of Presentation on "How to Access OE"



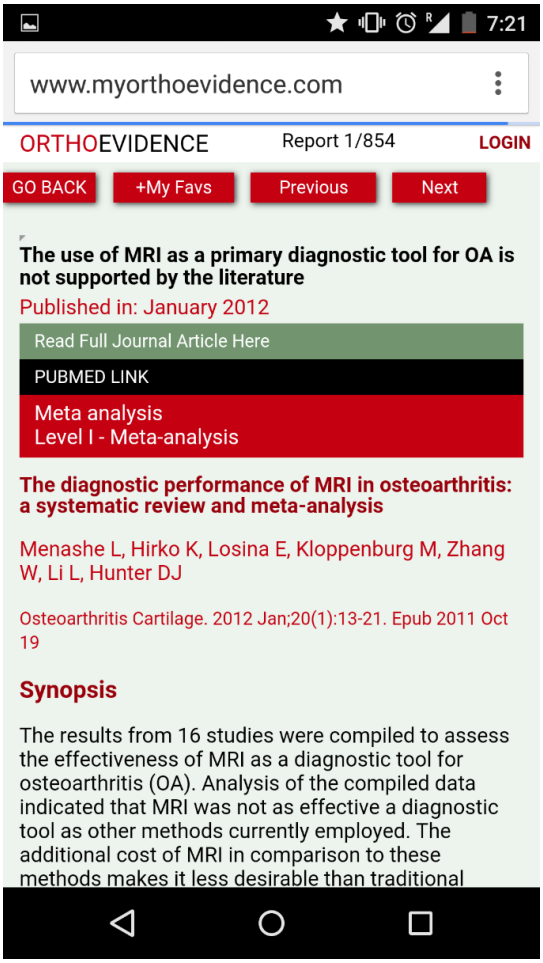
Screenshot 1



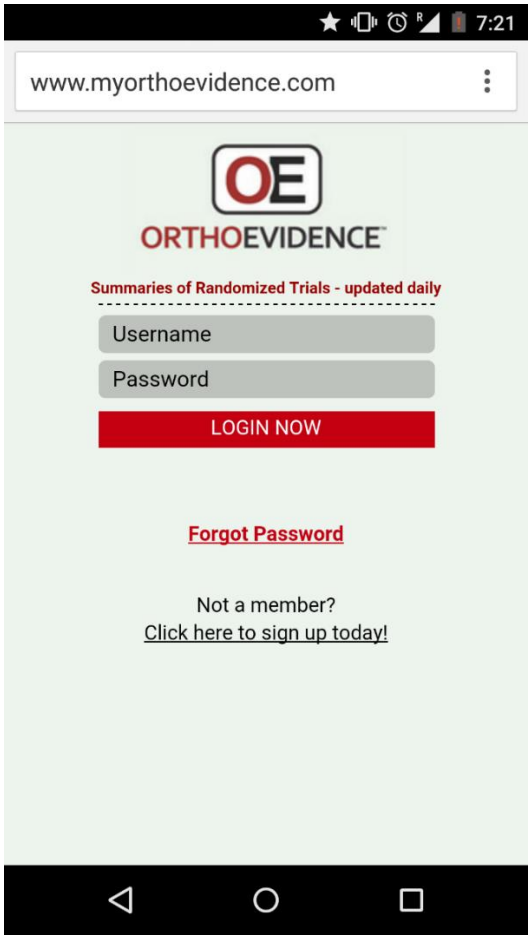
Screenshot 2



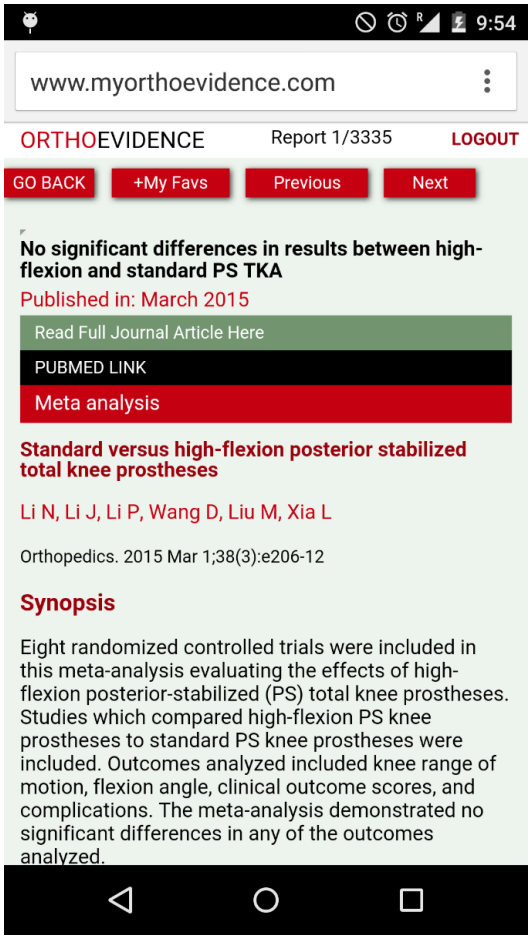
Screenshot 3



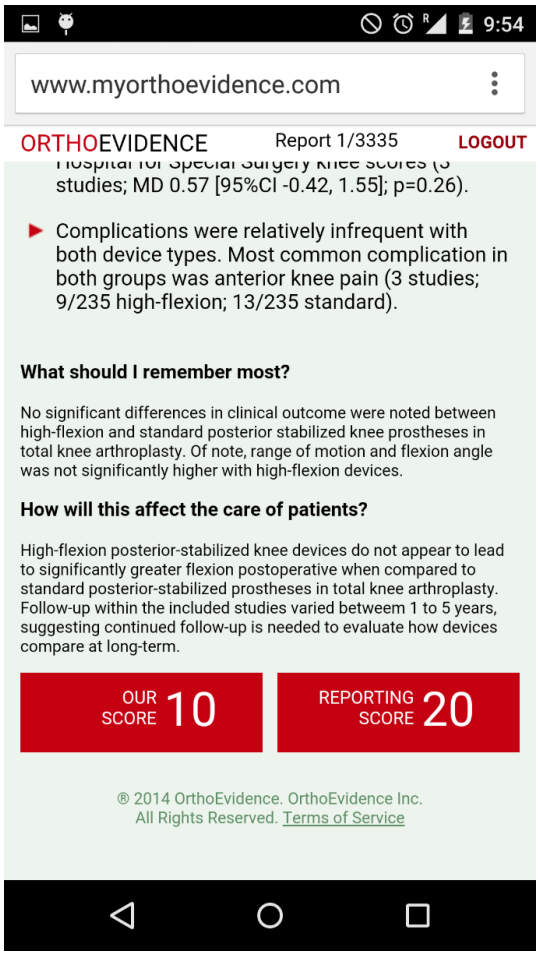
Screenshot 4



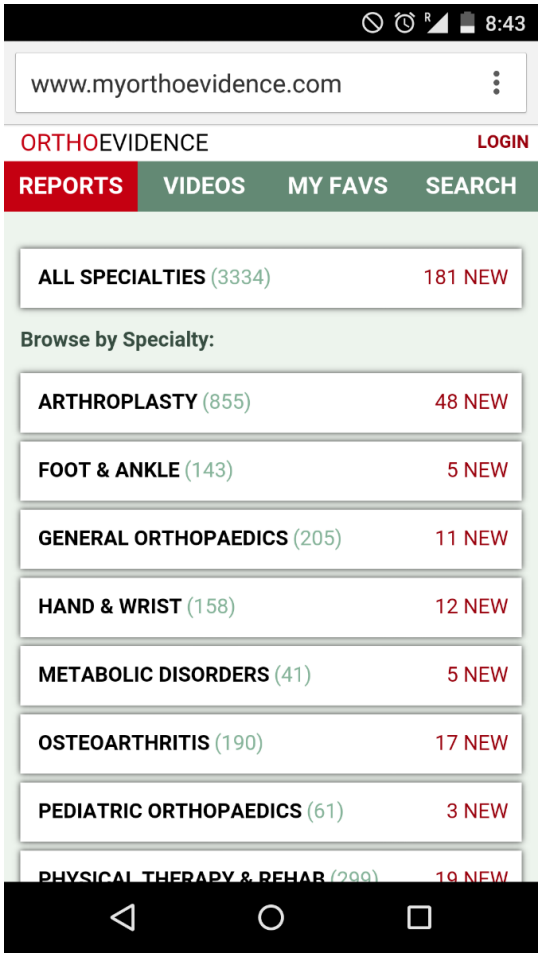
Screenshot 5



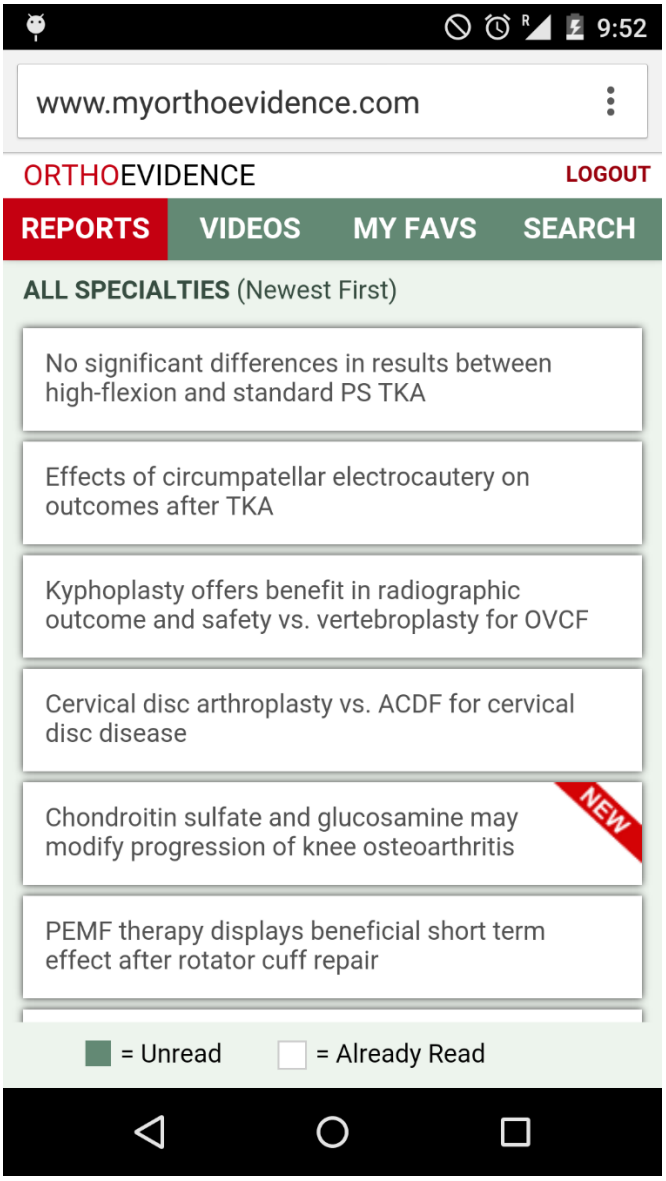
Screenshot 6



Screenshot 7



Screenshot 8



Screenshot 9