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DOCTORAL THESIS

Challenges and Solutions for Educating Clinicians in Contemporary Evidence-Based Practice

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Challenges and Solutions for Educating Clinicians in Contemporary Evidence-Based Practice

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A thesis submitted in total fulfilment of the requirements of the degree of
Doctor of Philosophy (PhD)

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Thesis summary

Background

Evidence-based practice (EBP) provides a framework for integrating the best research evidence with clinical expertise and patient's unique values and preferences in the delivery of health care. EBP is necessary for improving the quality of health care as well as patient outcomes. EBP is commonly integrated into the curricula of undergraduate, postgraduate, and continuing professional development health programs. Despite the established interest in EBP as a core competency for clinicians, clinicians frequently do not use research evidence to inform clinical decisions in practice.

Aims

The overall aim of this thesis is to facilitate improved translation of EBP educational interventions into clinical and educational practice. To fulfil this objective, two main research issues were explored: (i) the quality of the current published EBP educational interventions; and (ii) efforts to improve the quality and the uptake of EBP education in practice.

Methods and Results

Five interrelated studies were conducted using a variety of research methods to investigate five specific research question to address the thesis main objective.

Firstly, a systematic review of controlled studies that had evaluated EBP educational interventions was conducted to examine the completeness of reporting of EBP educational intervention details in published studies (Study 1). A standardised template was used to assess the completeness of reporting of intervention details in included studies. This study found substantial deficiencies in the reporting of EBP educational interventions, with none of the included studies completely reporting all of the essential intervention details that are required for their replication and/or implementation. 'Intervention materials' was the most poorly reported item, with details provided in the original publication in only 4% of the included studies - this increased to 25% after study authors were contacted and asked to provide missing information.

The next study (Study 2) examined the differences in the EBP content covered and outcome measures used in evaluating the EBP educational interventions that were identified in the studies included in the review that was in Study 1. Data on the content of the intervention (i.e. the coverage of the five EBP steps: ask, acquire, appraise, apply, and assess), the outcome measures used, and the properties of instruments used in evaluating EBP educational interventions. This study found that the majority (74%) of the included studies focused on teaching critical appraisal of evidence (EBP step 3), often to the exclusion of other steps (EBP step 4: evidence implementation in particular). Furthermore, Study 2 found that only 25% of the instruments used in the included studies were high-quality (which was defined as having achieved ≥3 types of established validity evidence).

To overcome the previously shown variations in the EBP content covered in EBP educational interventions, Study 3 followed a rigorous multistage modified Delphi process to develop an international consensus set of EBP core competencies that clinicians should achieve and should inform the development of EBP curricula for clinicians. The set of 68 EBP core competencies was developed in four stages: (i) generation of an initial set of relevant EBP competencies derived from a systematic review of EBP education studies for clinicians; (2) a two-round, web-based Delphi survey of clinicians, selected using purposive sampling, to prioritise and gain consensus on the most essential EBP core competencies; (3) consensus meetings, both face-to-face and via video conference, to finalise the consensus on the most essential core competencies; and (4) feedback and endorsement from EBP experts.

Study 4 examined the types of the clinical questions asked by general practitioners (GPs) in a large professional social media network, along with whether evidence was cited in their answers. It comprised an analysis of the clinical questions (including the clinical topic and type of the questions) and answers (including if referred to a published relevant evidence resource) posted between January 20th and February 10th 2018 on a popular GP-restricted (Australia, New Zealand) Facebook group. A key finding of Study 4 is that most clinical questions asked were about a limited number of clinical topics and question types (i.e. treatment and diagnosis), which was useful to inform the development of the final study.

Finally, using the knowledge gained from the previous studies, a new approach to teaching EBP, which focuses on shared decision making (SDM) and the use of pre-appraised evidence was developed and piloted (Study 5). Skills in SDM and communicating evidence were assessed by audio-recording consultations between participant clinicians and standardised patients (immediately pre- and post-workshop) and rated by two independent assessors using standardised reliable tools (i.e. the OPTION, Observing Patient Involvement, 0-100 points; and ACEPP, Assessing Communication about Evidence and Patient Preferences, 0-5 points). This study showed that a half-day contemporary EBP workshop was feasible and associated with a small increase in clinicians' skills in SDM and communicating research evidence from pre to post the workshop (mean increase in OPTION score = 5.5, 95% CI 1.0 to 9.9; increase in ACEPP = 0.5, 95% CI, 0.02 to 1.06).

Conclusions and Implications

The findings of these studies highlight that inadequate reporting of EBP educational interventions, along with the inconsistent coverage of the EBP topics and infrequent use of high-quality instruments to measure the effect of EBP education in existing studies, presents a considerable challenge for translating evidence into practice. The consensus-based, contemporary set of EBP core competencies, that was developed as part of this thesis, will contribute to harmonising the variations in the content of EBP education with possible subsequent future effect on the outcomes that are measured. The results of the before-after pilot study suggest that a contemporary approach to EBP teaching, with a focus on teaching SDM skills and the interpretation of pre-appraised research evidence was feasible, acceptable to clinicians, and showed a small increase in clinicians' skills in SDM and communicating evidence.

The findings of this thesis also led to some recommendations for area needing improvement: (i) better reporting of intervention details in EBP educational studies in published studies; (ii) establishment of a repository of freely-available EBP learning resources; (iii) development of a set of core outcome measures for EBP educational studies; and (iv) integration of the set of EBP core competencies into EBP curricula for clinicians and student clinicians.

Although many challenges and gaps still remain, collective efforts in the research conducted as part of this thesis offer important recommendations that may facilitate the delivery of quality EBP education for clinicians.

Keywords

Evidence-based practice; shared decision making; evidence-based medicine; competency-based education; pre-appraised evidence; teaching materials, evidence implementation

Declaration by author

This thesis is submitted to Bond University in fulfilment of the requirements of the degree of Doctor of Philosophy by Research (PhD).

This thesis represents my own original work towards this research degree and contains no material that has previously been submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

Signed: Date:

Dr. Loai Albarqouni, MD, MSc, PhD candidate

Declaration of co-author contributions

Loai Albarqouni is the sole author of **Chapter 1** (General introduction), **Chapter 2** (Literature review), and **Chapter 8** (Discussion). The remaining chapters (listed below) are co-authored publications on which Loai Albarqouni was the lead author, with all other contributions acknowledged below. The design, conception, development and management of all studies; data collection and analysis; drafting and revision of manuscripts; and response to peer-reviewers was the primary responsibility of the PhD candidate. Co-authors provided assistance with study planning and design, interpretation of data, and critical revision of the manuscripts. None of the work submitted in this thesis was carried out before the PhD candidature.

Co-authored peer-reviewed journal publications

1. **Albarqouni L**, Glasziou P, Hoffmann T. Completeness of the reporting of evidence-based practice educational interventions: a review. *Med Educ* 2018;**52**(2):161-70. doi: 10.1111/medu.13410
   Statement of contributions: **LA 75%**, PG 10%, TH 15%
2. **Albarqouni L**, Hoffmann T, Glasziou P. Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured. *BMC Med Educ* 2018;**18**(1):177. doi: 10.1186/s12909-018-1284-1
   Statement of contributions: **LA 75%**, TH 10%, PG 15%
3. **Albarqouni L**, Hoffmann T, Straus S, et al. Core Competencies in Evidence-Based Practice for Health Professionals: Consensus Statement Based on a Systematic Review and Delphi Survey. *JAMA Netw Open* 2018;**1**(2):e180281. doi: 10.1001/jamanetworkopen.2018.0281
   Statement of contributions: **LA 60%**, TH 10%, SS 5%, NO 3%, TY 3%, DI 2%, TS 2%, BH 3%, GG 2%, PG 10%
4. **Albarqouni L**, Hoffmann T, McLean K, et al. Role of professional networks on social media in addressing clinical questions at general practice: a cross-sectional study of general practitioners in Australia and New Zealand. *BMC Fam Pract* 2019;**20**(1):43. doi: 10.1186/s12875-019-0931-x
   Statement of contributions: **LA 75%**, TH 10%, KM 2%, KP 3%, PG 10%
5. **Albarqouni L**, Glasziou P, Bakhit M, et al. Development of a contemporary evidence based practice workshop teaching pre-appraised research evidence which focus on shared decision making for health professionals: a before-after pilot study. S*ubmitted.*
   Statement of contributions: **LA 65%**, PG, 10%, MB 5%, CDM 5%, TH 15%

Research outputs arising from this thesis

Peer-reviewed journal publications

Albarqouni L, Glasziou P, Hoffmann T. Completeness of the reporting of evidence-based practice educational interventions: a review. *Med Educ* 2018;**52**(2):161-70. doi: 10.1111/medu.13410

Albarqouni L, Hoffmann T, Glasziou P. Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured. *BMC Med Educ* 2018;**18**(1):177. doi: 10.1186/s12909-018-1284-1

Albarqouni L, Hoffmann T, Straus S, et al. Core Competencies in Evidence-Based Practice for Health Professionals: Consensus Statement Based on a Systematic Review and Delphi Survey. *JAMA Netw Open* 2018;**1**(2):e180281. doi: 10.1001/jamanetworkopen.2018.0281

Albarqouni L, Hoffmann T, McLean K, et al. Role of professional networks on social media in addressing clinical questions at general practice: a cross-sectional study of general practitioners in Australia and New Zealand. *BMC Fam Pract* 2019;**20**(1):43. doi: 10.1186/s12875-019-0931-x

Peer-reviewed conference abstracts: oral presentations

Albarqouni L, Glasziou P, Hoffmann T. Completeness of the reporting of evidence-based practice educational interventions: a review. The annual higher degree research conference at Bond University in the Gold Coast.

Albarqouni L, Hoffmann T, Glasziou P. Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured. The annual higher degree research conference at Bond University in the Gold Coast.

Albarqouni L, Hoffmann T, McLean K, et al. Role of professional networks on social media in addressing clinical questions at general practice: a cross-sectional study of general practitioners in Australia and New Zealand. The Royal Australian College of General Practitioners (RACGP) 2018 conference in the Gold Coast.

Albarqouni L, Hoffmann T, Straus S, et al. Core Competencies in Evidence-Based Practice for Health Professionals: Consensus Statement Based on a Systematic Review and Delphi Survey. The 8th EBHC International conference in Italy.

Albarqouni L, Hoffmann T, Straus S, et al. Core Competencies in Evidence-Based Practice for Health Professionals: Consensus Statement Based on a Systematic Review and Delphi Survey. The 7th annual conference of the International Society for Evidence-Based Health Care in the UAE.

Albarqouni L, Hoffmann T, Straus S, et al. Core Competencies in Evidence-Based Practice for Health Professionals: Consensus Statement Based on a Systematic Review and Delphi Survey. The 2018 the Australian and New Zealand Association for Health Professional Educators conference in Tasmania. I have been awarded the 2018 Australian and New Zealand Association for Health Professional Educators post-graduate student awards for this research project.

Peer-reviewed conference abstracts: poster presentations

Albarqouni L, Hoffmann T, McLean K, et al. Role of professional networks on social media in addressing clinical questions at general practice: a cross-sectional study of general practitioners in Australia and New Zealand. The annual higher degree research conference at Bond University in the Gold Coast.

Ethics declaration

The research associated with **Chapters 5, 6, and 7** of this thesis received ethics approval from the Bond University Human Research Ethics Committee. Ethics application approval numbers, 15819, 16131, and LA03307, respectively.

Copyright declaration

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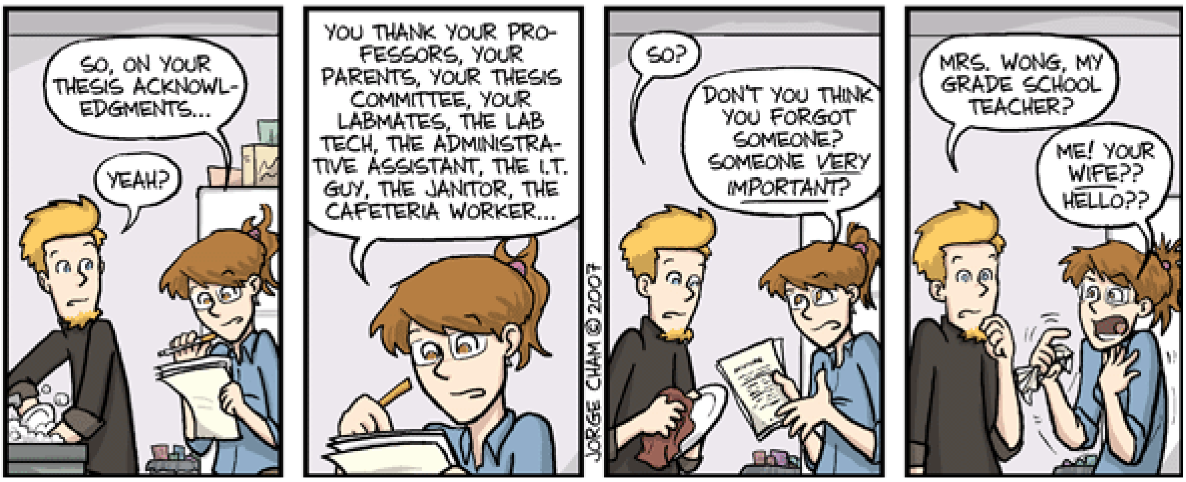

"Piled Higher and Deeper" by Jorge Cham
www.phdcomics.com

Eman, my soulmate, I would never forget you. Thank you for your endless patience and understanding, your selflessness and sacrifice, your love and care. Thank you from the bottom of my heart.

Loai Albarqouni
15th April 2019

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Abbreviations

Abbreviations included only in tables within the thesis are excluded from this list, as they are described in footnotes below each table.

ACEPP:	Assessing Communication about Evidence and Patient Preferences Tool
CONSORT:	Consolidated Standards of Reporting Trials
CREATE:	Classification Rubric for EBP Assessment Tools in Education framework
EBM:	Evidence Based Medicine
EBP:	Evidence Based Practice
EBPQ:	Evidence Based Practice Questionnaire
EQUATOR:	Enhancing the QUAlity and Transparency Of health research
GPs:	General Practitioners
GRADE	The Grades of Recommendation, Assessment, Development and Evaluation
GREET:	Guideline for Reporting Evidence-based practice Educational interventions and Teaching
IoM:	Institute of Medicine
ISEHC:	The International Society of Evidence-Based Healthcare
OPTION:	Observing Patient Involvement scale
PICO:	Population, Intervention, Comparison, Outcome
PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-analyses
RCT:	Randomised Controlled Trial
SDM:	Shared Decision Making
TIDieR:	Template for Intervention Description and Replication
USA:	United States of America

We do not learn from experience …
we learn from reflecting on experience

—John Dewey

1

Chapter 1
General Introduction

1.1 Background

Evidence-based practice (EBP) provides a framework for integrating the best research evidence with clinical expertise and patient values and preferences in the delivery of health care[1-3]. As the research base continually expands, EBP also emphasises how important it is that clinicians adopt lifelong learning skills.

Since it was coined in 1992, EBP has increasingly became a core component of the undergraduate, postgraduate, and continuing education health programs curricula worldwide for all health disciplines[4-6]. An evidence-based approach to health care is now commonly recognised by national and international health care communities and professional bodies as a core competency for clinicians necessary for the improvement of the quality and safety of health care[4,5,7-9].

Despite the established interest in EBP as a core competency for clinicians, clinicians frequently do not use research evidence to inform clinical decisions in practice[10,11]. The uptake of research evidence that should change practice is often slow, inconsistent, and incomplete, resulting in avoidable suffering of patients and inefficiencies in health systems[12,13].

Therefore, considerable efforts and resources have been focused on EBP education on the assumption that more effective EBP education may assist in improving the translation of evidence into practice. Although, this has resulted in a slow accumulation of the evidence for how to effectively teach EBP[6], the evidence evaluating the effect of EBP educational interventions remains suboptimal. Hatala and Guyatt highlighted this:

> "*the quantity and quality of the evidence for effectively teaching EBM are poor. Ironically, if one were to develop guidelines for how to teach EBM based on these results, they would be based on the lowest level of evidence*"[14].

Therefore, there is a need to examine the causes of, and potential solutions for, the inadequate uptake of EBP educational interventions in practice.

1.2 Objective of this thesis

The overall aim of this thesis is to facilitate improved translation of EBP educational interventions into practice. To fulfil this objective, this thesis explored two main research issues: (i) the quality of the current published EBP educational interventions; and (ii) efforts to improve the quality and the uptake of EBP education in practice.

1.3 Research Questions

This thesis sought to investigate the following five specific research question to address the thesis main objective.

1- *How complete is the reporting of intervention details in published EBP educational studies?*

2- *In studies which have evaluated EBP educational interventions, what EBP content is covered and what outcome measures are used?*

3- *What are the core competencies in EBP that clinicians should achieve and should be covered within that EBP educational interventions?*

4- *What are the types of clinical questions asked by general practitioners (GPs) in a large professional social media network and is evidence cited in their answers?*

5- *Is a new approach to teaching EBP, which focusses on shared decision making (SDM) and the use of pre-appraised evidence, feasible and acceptable to clinicians? and is it effective at improving clinicians' SDM and evidence communication skills?*

1.4 Outline of the thesis

This thesis consists of four parts. Part I (**Chapter 1**) contains the general introduction and thesis outline. Part II (**Chapter 2**) contains a thorough literature review of the evolution of EBP, discusses common criticism to EBP, and highlights the key gaps in the literature addressed in this thesis.

Part III (**Chapter 3-7**) contains five chapters, with each representing a research study investigating one of the five specific research questions. These five research studies are independent but interrelated studies. Four of these chapters (**Chapter 3-6**) comprise research studies which has already been published in peer-reviewed journals, and the remaining chapter (**Chapter 7**) contains a manuscript which is currently under review for publication in a peer-reviewed journal. Each of these chapters is prefaced by a statement highlighting the context of the study within the broader scope of the thesis.

Part IV (**Chapter 8**) is a general discussion, which summarises the main findings of this thesis and provides answers for the five specific research questions stated **Chapter 1**. In addition, practical recommendations and implications for future research are discussed.

Chapters outline

Chapter 2 introduces the definition of and rationale for EBP, discusses some of the common criticism of it, reviews the literature on EBP education, and highlights challenges and research gaps in EBP education.

Chapters 3 and **4** focus on analysing the current research evidence for EBP educational interventions. **Chapter 3** (Study 1) assesses the completeness of the reporting of EBP educational interventions in published studies. **Chapter 4** (Study 2) systematically evaluates the coverage of the five EBP steps (i.e. ask, acquire, appraise, apply, and assess), examines the outcome measures used, and assesses the properties of the instruments used in evaluating EBP educational interventions. **Chapter 5** (Study 3) describes the steps to develop a consensus statement of the most essential core competencies in EBP that should inform the development of EBP curricula for clinicians. **Chapter 6** (Study 4) characterises the clinical questions and evidence used in answers posted to a large well-used GP Facebook network. **Chapter 7** (Study 5) develops and pilots a new contemporary approach to teaching EBP, which has a focus on SDM and the use of pre-appraised evidence.

While a discussion of each individual study's findings can be found within each chapter, **Chapter 8** draws these findings together to address the original five research questions and overall objective of this thesis. It also situates these findings in the wider context of EBP education by providing recommendations for the practice of EBP education and suggesting future research questions and directions.

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The more you own, the more you know you don't own.

—Aristotle Onassis

2

Chapter 2
EBP and EBP Education
a review of current literature

This chapter is organised in three sections. Section I introduces the definition and history of EBP, discusses the rationale for EBP, and summarises some of the common criticisms of EBP. Section II reviews the published literature on EBP education including the effectiveness of and strategies for EBP education. Section III identifies the key challenges and research gaps in EBP education literature and concludes with this thesis research objectives.

2.1 Evidence-Based Practice

What is EBP?

"A NEW paradigm for medical practice is emerging. Evidence-based medicine de-emphasizes intuition, unsystematic clinical experience, and pathophysiologic rationale as sufficient grounds for clinical decision making and stresses the examination of evidence from clinical research. Evidence-based medicine requires new skills of the physician, including efficient literature searching and the application of formal rules of evidence evaluating the clinical literature." – Guyatt, 1992

This is the first paragraph of the paper entitled "Evidence-Based Medicine. A New Approach to Teaching the Practice of Medicine" that announced evidence-based medicine (EBM) to the wider medical community in 1992[1].

Although the term evidence-based medicine was first coined in an editorial in 1991[2], the idea and concept tracked back to at least 1970s, when Archie Cochrane, the then director of the Medical Research Council Epidemiology Research Unit in Cardiff, expressed these ideas in his book "Effectiveness and Efficiency: Random Reflections on Health Services"[3]. In 1980s, David Sackett and David Eddy developed initial evidence-based rules for guiding clinical decisions[4,5], and published a series of articles in the Canadian Medical Association Journal titled "How to read clinical journals"[6], which provide guidance on how to critically appraise clinical articles of various types such as treatment, diagnosis, and prognosis.

A decade after the launch of EBM, an international EBM working group updated the definition of EBM to: "Evidence-based medicine is the integration of the best research evidence with clinical expertise and patient values"[7]. Even though the definition proposed by David Sackett and his colleagues was originally directed to the medical profession, other health professions have adopted it in their professions. In 2003, international experts in evidence-based health care proposed the term evidence-based practice (EBP) to reflect the wide diverse of professions adopting the principles of EBP[8].

Components of EBP

There are three essential components of EBP (**Figure 2.1**):

1- **Best research evidence** refers to the most rigorous, patient-centred, and clinically relevant evidence that addresses a specific clinical question. Since not all evidence is the same, recent well-conducted systematic reviews and meta-analyses are at the top of the evidence pyramid and expert opinions and beliefs are at the bottom.

2- **Clinical expertise** refers to the clinicians' ability to use their cumulated experience, skills and education to identify the health status of each patient, search for and critically appraise the evidence, communicate the harms and benefits of any potential intervention, and engage each patient into decision-making process[9].

3- **Patient's values and preferences** refer to the unique preferences, concerns and expectations of each informed patient that should be considered as part of the clinical decision-making process[10].

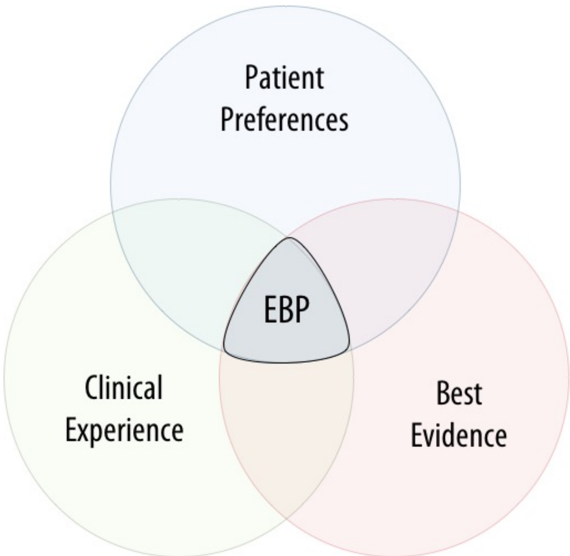

Figure 2.1. The components of evidence-based practice[9]

Why is EBP important?

Evidence to Practice Gaps

Clinicians frequently do not use research evidence to inform clinical decisions in practice[8,11], resulting in gaps between what is known (research findings) and what is practised (clinical practice)[12]. The presence of published research evidence is necessary but not sufficient alone to guarantee the translation of research evidence into practice[13]. The uptake of research evidence that should result in changes to practice is often slow, inconsistent, and incomplete, resulting in avoidable suffering of patients and inefficiencies in health systems[14,15]. This often results in three types of preventable inappropriate care: *underuse of high-value care* (i.e. the failure to deliver needed services); *overuse of low-value care* (i.e. continuing delivery of unnecessary services); and *misuse (or error) in delivering care*. There are many examples of the delay in evidence implementation – for example the discordance and delay between textbook recommendations and evidence from trials of treatment for cardiovascular diseases[16], and the advice to rest in bed for patients with any medical condition[18].

Glasziou and Haynes have described the path from research evidence to improved patient outcomes as a 'research-to-practice pipeline' (**Figure 2.2**)[14].

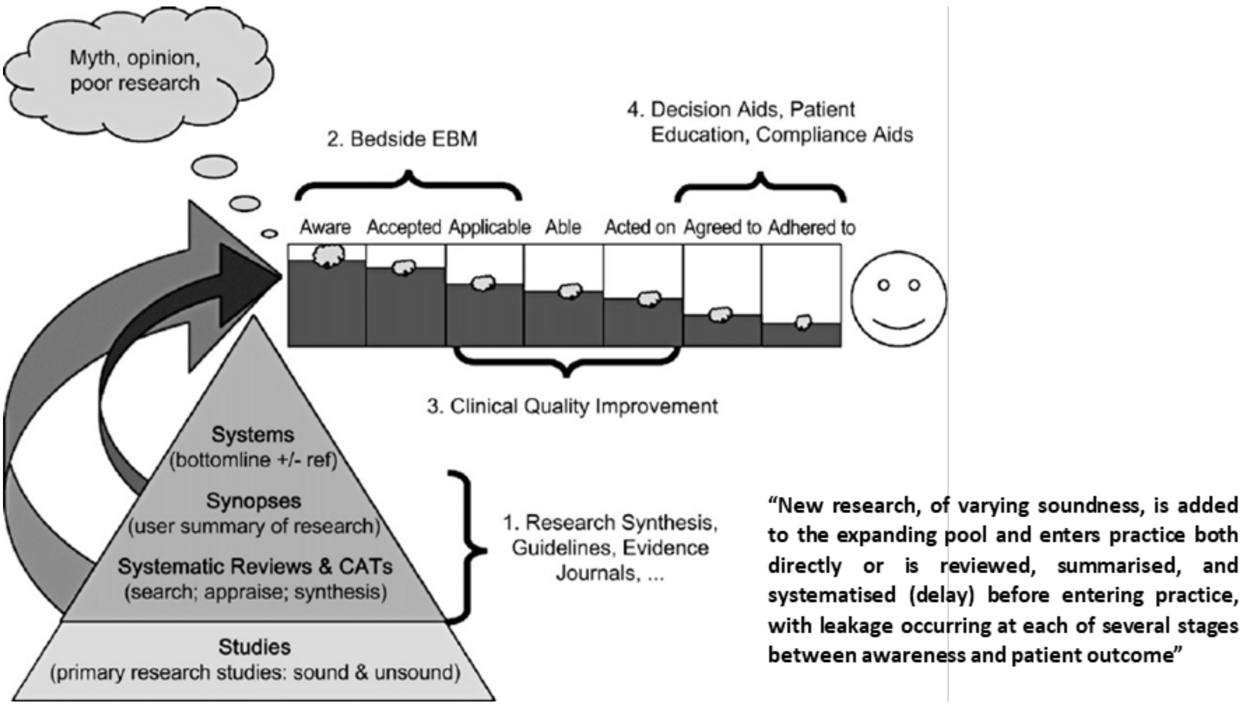

Figure 2.2. The leaky "evidence to practice" pipeline (Glasziou and Haynes's article[14])

Empirical vs. pathophysiological reasoning

EBP emphasises that clinical practice should be based on the best available empirical research evidence rather than pathophysiological theories and mechanisms (i.e. the underlying causes of health and pathophysiological mechanisms of diseases as the basis to claim the effectiveness of an intervention)[19,20]. The problem with mechanistic reasoning lies in the incomplete understanding of the pathophysiological mechanisms, and the complicated, even paradoxical, behaviour of most mechanisms[19]. There are many examples in which mechanistic reasoning has been discredited. One example is the advice about how to position babies at sleep time to prevent sudden infant death syndrome "SIDS" (a record-breaking bestseller 1960s book, 'Dr. Spock's Baby and Child Care', advised parents to put their babies to sleep prone to reduce the risk of sudden death, however, this might have led to thousands of avoidable sudden deaths[21]). Another is the use of antiarrhythmic drugs after heart attacks (antiarrhythmic drugs have been widely used to reduce sudden death after heart attacks based on the proposed pathophysiological mechanism of sudden death after a heart attack. However, empirical evidence found that antiarrhythmic drugs unexpectedly increase rather than decrease death after heart attack[22]).

The growth of medical information and clinicians' workload

There is an exponential growth of published biomedical literature with almost 3000 references being added to PubMed each day[23]. However, only a small fraction is considered relevant and valid enough to change the practice[24]. Clinicians would have to read an average of 19 journal articles every day to keep up-to-date in their specific field[25,26]. Thus, keeping up-to-date is a challenging task for already overloaded clinicians who cannot rely only on information they had learnt in medical schools to provide patients with optimal care. EBP instils a culture of lifelong learning through encouraging clinicians to seek out, critically analyse, and interpret the best research evidence for clinical decision making. Further, EBP supports clinicians by synthesising and summarising this flood of information into up-to-date point-of-care evidence summaries which can be accessed wherever and whenever it is needed.

EBP might improve patient outcomes

The most important rationale for the EBP is that it 'works' – that is, it improves patients' outcomes. In an observational study of the organisational changes of the internal medicine department in a Spanish hospital, Emperanza et al. reported reductions in both mortality rates and length of hospital stay in patients treated in an EBP unit compared to patients in a standard unit over 7 years (2004-2011)[27]. Further, the Academy of Medical Royal Colleges in the United Kingdom presented fifteen case studies (e.g. improving the quality of life of breast cancer patients, public health policy on smoking, and quicker recovery after surgeries)[28] to demonstrate that EBP is the basis for the extraordinary improvements in life expectancy and quality of life. Although these would be considered as 'weak' evidence to attest that EBP improves patient outcomes, EBP is considered a complex intervention (not a simple intervention) that cannot be evaluated in the same way as a pharmacological intervention, such as a tablet or injection[29].

Steps of EBP

There are three different modes of incorporating evidence into practice: (i) *Doing mode* (i.e. suitable for conditions encountered frequently with little or no time-constraints; clinicians complete all the aforementioned steps of EBP), (ii) *Using mode* (i.e. suitable for less common conditions or rushed clinical situations; clinicians use pre-appraised evidence and eliminate the appraisal step), and (ii) *Replicating mode* (i.e. clinicians replicate the practice of more trusted evidence-based practitioners)[30].

These are a number of main steps that a clinician needs to follow to deliver evidence-based healthcare as shown in **Figure 2.3**[8]:

1. *Recognise personal knowledge gap and uncertainties.* Without this very early step, clinicians can hardly engage in EBP. However, there is limited evidence about the best way to expose personal uncertainties and knowledge gaps (e.g. rewarding those who admit ignorance instead of treating it as a failure)[31].

2. *Step 1 (ASK): Convert uncertainties into an answerable structured clinical question. An* essential step in EBP is to convert a clinical problem or scenario into an answerable well-formulated clinical question. The 'PICO' framework is widely used to formulate

clear and focused clinical questions. The letters in the acronym stand for Patients (the patient/population or problem being addressed); Intervention (the intervention or exposure being considered); Comparison (the comparator intervention or exposure); and Outcome (the outcome of interest). A systematic review found that using the PICO approach helped learners to improve the quality of their clinical questions and subsequently practise EBP[32].

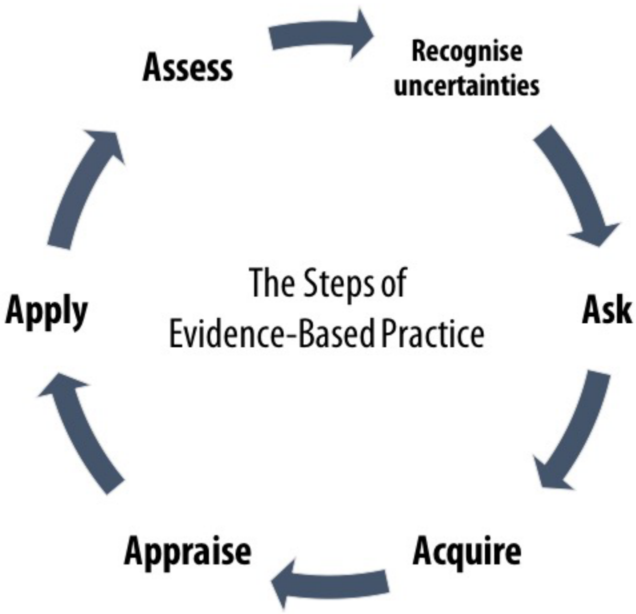

Figure 2.3. The steps of evidence based practice

3. *Step 2 (ACQUIRE): Find the best available evidence that is pertinent to the clinical question.* The next step after formulating a structured clinical question is tracking down the best research evidence that answers that specific question. There are several evidence-based resources and databases such as PubMed Clinical Queries. Advice from an information specialist or a librarian can be valuable in this step. A stepwise approach based on the hierarchy of evidence (6S Pyramid) is recommended to find the best available evidence. The evidence pyramid shown in **Figure 2.4** classifies evidence sources based on their quality and applicability into six levels: studies, synopses, synthesis, synopses of synthesis, summaries, and systems[33,34].

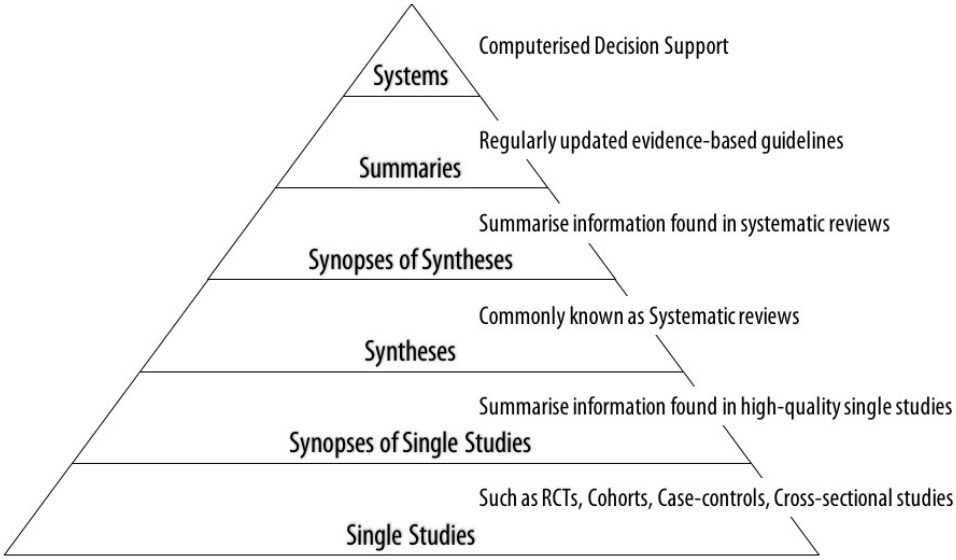

Figure 2.4. One example of a hierarchy of the evidence: The 6s Evidence Pyramid[34]

4. *Step 3 (APPRAISE): Critically appraise the retrieved evidence for validity, clinical relevance, and applicability.* After obtaining the evidence, the next step is to critically appraise the evidence to determine the trustworthiness and applicability of the results to inform the clinical practice. Several checklists (e.g. *RAMbo* for randomised controlled trials, RCTs[35]) have been developed to help clinicians appraise the evidence and determine if the evidence is good enough to help in the clinical decision.

5. *Step 4 (APPLY): Apply the appraised evidence to the patient in clinical practice.* Once evidence has been appraised and found to be relevant, valid, and important, then the question is whether this evidence applies to the individual patient. The patient's values and circumstances should be taken into account during the decision-making process. Evidence regarding the benefit and harms of the various available options should be clearly communicated to and discussed with the patient so that he/she can be supported to make an informed decision - this process is known as shared decision making (SDM).

6. Step 5 (ASSESS): Evaluate the efficiency and performance with which the abovementioned steps were carried out and strategies to improve. It is important for the clinician to evaluate their performance of the EBP process at frequent intervals to identify which of these steps are being performed well and which need to be refined.

Common criticisms of EBP

In the decades following the conception of EBP, persistent criticism and polarised debates have occurred over a few issues, but never against the use of reliable evidence in effective decision making[11,36]. Straus et al classified the most common criticism of EBP as limitations either universal to the practice of medicine or unique to EBP and misperceptions of it[36] (**Table 2.1**).

Table 2.1 Classification of the common criticism of EBP[36].

Limitations
Universal to the practice of medicine
Limited availability of coherent consistent scientific evidence.
Difficulties in applying evidence to the care of individual patients
Barriers to the practice of high-quality medicine
Unique to the practice of EBP
The need to develop new skills related to EBP
Limited time and resources
Misperceptions
EBP ignores patient's values and preferences
EBP promotes a cookbook approach to medicine
EBP leads to therapeutic nihilism in the absence of high-quality evidence from RCTs
EBP denigrates clinical experience

Reductionism of the definition of evidence and evidence hierarchy

EBP opponents argue that the definition of evidence in EBP is narrow and simplistic. For instance, it has been argued that evidence from RCTs is not always superior to evidence derived from observational studies regarding the effect of a treatment (i.e. small-scale biased RCT versus large-scale well-controlled observational study)[37,38]. EBP proponents acknowledge the limitations of the proposed hierarchies of evidence which largely focus on study design, and have admitted that RCTs are not immune to bias, and therefore should not automatically be labelled as high-quality evidence without quality assessment[39]. This has led to the development of a new approach for rating the quality of evidence and the strength of recommendations – GRADE (The Grades of Recommendation, Assessment, Development and Evaluation)[40]. GRADE provides a more sophisticated framework that not only allows for the limitations in the evidence derived from RCTs but also recognises the potential for observational studies to provide high-quality evidence (e.g. definitive casual evidence between smoking and lung cancer)[41].

Overemphasis on following algorithmic rules 'cookbook medicine'

Opponents argue that EBP emphasises on the use of research evidence (e.g. algorithmic clinical rules) and clinical practice guidelines. Opponents believe that the incentivisation for clinicians to strictly adhere to these guidelines (e.g. using quality metrics derived from guideline recommendations to judge the quality of care[42,43]) has resulted in neglect of the personal humanistic nature of healthcare and a shift in focus away from individuals[11]. Further, arguments have been that applying evidence derived from RCTs to individual patients remains problematic (for example, because of the increasing prevalence of multi-morbidity and ageing population)[44]. EBP proponents rebut that EBP puts great emphasis on individuals and patients, which can be clearly manifested by championing the development and progress of shared decision making (i.e. the process of the clinician and patient jointly participating in a health decision after discussing the options, the benefits and harms, and considering the patient's values, preferences, and circumstances)[45].

Distortion of the 'evidence-based' brand by vested interest

Another criticism of EBP is that it has been hijacked by vested interests. For example, vested interests can influence setting the agenda of health research through medicalising conditions (e.g. 'female sexual arousal disorder' and promoting sildenafil as a treatment for it[46]) and creating pre-disease states (e.g. low bone density 'osteoporosis' and advertising for a treatment for it - 'alendronate'[47]). EBP opponents also argue that the majority of influential clinical trials were conducted by researchers with vested interests, which may be resulted in biased findings, due to: (i) overpowering clinical trials to ensure that even small clinically, not important, differences are statistically significant; (ii) devising the eligibility criteria to ensure the maximum response to the treatment; (iii) using short-term surrogate outcomes; (iv) selective reporting of trials with positive findings, and (v) spinning the message such as using relative risk reduction to show a very small effect as a major practice-change finding. EBP advocates acknowledge this criticism, but argue that EBP had provided clear guidance for critically appraising studies to detect misleading study designs and interpretations[41].

Barriers to EBP

Recent systematic reviews have identified that the sub-optimal practice of EBP can be attributed to various barriers including clinician-related, system-related, patient-related, and research-related barriers[15,48,49].

Clinician-related

Lack of EBP knowledge and skills has been commonly reported as the main barrier to the use of EBP in practice[48]. Clinicians frequently report that they have insufficient EBP training, and lack of skills in searching and appraising research evidence[48]. Further, clinicians' negative attitudes towards EBP can influence the use of it. This can include negative beliefs about the usefulness of EBP, threats to professional autonomy, the rigidity of the evidence, and lack of motivation to change behaviour. Swennen et al. conducted a systematic review and thematic analysis of 30 qualitative studies which had explored the medical doctors' perception and use of EBP[50]. An identified barrier is clinicians' perception of EBP as 'evidence-dominated clinical decisions' with little attention to their clinical expertise, autonomy, or professional reputation[50].

System-related

Inadequate infrastructure for information retrieval (e.g. limited access to research evidence or decision support tools), high patient and office workload (e.g. due to workforce shortage), and lack of mentors and clinical role models are frequently reported organisational barriers to the use of EBP[50]. Lack of time is one of the most commonly reported barriers to the implementation of EBP since clinicians feel that searching and critically appraising the best evidence is a time-consuming task and they are already busy with clinical practice routine[51]. Clinicians also express that short consultation duration is an important barrier to the implementation of research evidence with each patient[52]. The systematic review mentioned above (by Swennen et al.) identified that respectful safe communication and a culture of shared learning across career stages and medical disciplines are important facilitators of EBP. Medical doctors have also reported that a strong hierarchical order may create a barrier to the ability to change clinical routines, which is a prerequisite for the implementation of EBP[50].

Patient-related

Patients' values and preferences are one of the core components of EBP, however, they can also be one of the barriers to the use of the best available evidence. This happens when patients are disengaged with clinicians. Therefore, clinicians find it difficult to reconcile patient preferences with the best available evidence[49].

Research evidence related

"Research evidence" itself can also be a barrier to the implementation of EBP. This can be through lack of sound evidence or evidence of adequate quality, contradictions in the findings of the available evidence, and issues related to the applicability and generalisability of research findings)[48].

Although, EBP education (or lack thereof) is just one of numerous barriers to evidence translation (as described previously), the focus of this thesis is on EBP education with the assumption that more effective EBP education may assist in improving the translation of evidence into practice.

2.2 EBP education

The need for EBP teaching

Clinical knowledge is thought to accumulate over time and with experience. However, a systematic review of 62 studies found that clinical performance and competencies deteriorated over time[53]. A commitment to lifelong learning and keeping up-to-date must be an integral foundation of ethical clinical practice. Given the phenomenal growth of the biomedical literature, skills in separating the trusted evidence "wheat" from the unreliable "chaff" have become as essential as being able to use a stethoscope [54].

> *"the search engine is now as essential as the stethoscope ...*
> *... a 21st century clinician who cannot critically read a study is as unprepared as one who cannot take a blood pressure or examine the cardiovascular system"*[54]

The Lancet commission report "Education of health professionals for the 21st century" emphasised the need for transformative healthcare education and called for a shift "*from memorisation of facts to critical reasoning that can guide the capacity to search, analyse,* *assess and synthesise information for decision-making*", which aligns with the principles and steps of EBP[55]. The USA National Academy of Medicine (formerly the Institute of Medicine), an independent, non-governmental, non-profit organisation that provides advice, counsel, and independent research on major topics in health care, has also recognised the great potential role of EBP in improving the quality and safety of health care[56] and endorsed EBP as one of the main five competencies that every clinician needs[57]. Health professional bodies and accreditation councils (e.g. Accreditation Council for Graduate Medical Education and Association of American Medical Colleges in the United States, and General Medical Council and Academy of Medical Royal Colleges in the United Kingdom) have called for the integration of EBP in the curricula of undergraduate, postgraduate, and continuing healthcare education and require all health professionals to be competent in EBP for accreditation and licencing purposes[58,59]. The influence of EBP has been widely recognised both in academia (as one of the 15 modern medicine's greatest milestones and intellectual achievements since 1840[60,61]) and beyond (as one of best ideas of the year 2001 in the New York Times[62]).

EBP offers evolving heuristic principles for optimising clinical practice that can address the challenges presented in **Section 2.1**[63]: (i) evidence (defined as any empirical observation or report of a symptom or mental state constitutes potential evidence, whether systematically collected or not[64]) is not all equal and clinical decisions should be informed by the best available evidence; (ii) clinical decisions are best informed by evaluating the totality of the evidence (e.g. systematic reviews); and (iii) evidence is necessary, but not sufficient alone, for clinical decisions which require the integration of patients' values and preferences as well as the consideration of the circumstances of the health system (e.g. whether the intervention is available and affordable or not).

EBP education: What is effective?

In response to the need for EBP training, medical and health science faculties and postgraduate training programs have increasingly integrated EBP teaching in their healthcare curricula[65,66]. EBP educators offer workshops, educational meetings, and courses to cover the increasing demands for EBP learning opportunities.

However, despite the widespread popularity of teaching EBP, little is known about the effectiveness of different EBP educational interventions[67]. An overview of 16 systematic reviews which assessed the effectiveness of EBP teaching included a total of 81 primary studies: 34 studies included student clinicians and 47 clinicians; 34 were RCTs, 22 non-randomised controlled trials, and 34 were before-after studies[68]. Authors of the overview found that multifaceted clinically integrated EBP educational interventions (i.e. which include a combination of lectures, small group discussions, journal clubs, real clinical scenarios, and computer lab sessions) were more likely to improve EBP knowledge, skills, attitude and behaviour than a single stand-alone intervention. However, this was based on studies of varied methodological quality. Similar, Coomarasamy and Khan reviewed 23 studies which compared the effect of standalone versus clinically integrated EBP teaching for postgraduates. They found that standalone teaching improved knowledge but not skills, attitudes, or perceived behaviour, while clinically integrated teaching improved all[69]. However, a cluster RCT of 82 general practitioner trainees to evaluate a clinically integrated EBP educational intervention, found that a clinically integrated EBP educational intervention, compared to a standalone intervention, did not improve the EBP behaviour (i.e. guideline adherence and information-seeking behaviour), attitude, or knowledge of trainees[70].

Do EBP educational interventions change clinicians' behaviour and improve patients' outcomes?

Few studies have evaluated the impact of EBP educational interventions on the behaviour of practising clinicians, let alone patient outcomes. Straus et al evaluated the effect of a multicomponent EBP educational intervention (including EBP training, EBP textbook, and provision of evidence-based resources) on the EBP behaviour and the uptake of research evidence (i.e. interventions proven to be beneficial in RCTs or systematic reviews) among 47 medical doctors in a general hospital. They found that the intervention improved the EBP behaviour and increased the uptake of research evidence (i.e. 62% of interventions given to 239 patients in the month after the EBP intervention were evidence-based compared to 49% to 244 patients in the month before the intervention)[71]. However, Shuval et al. conducted a controlled before-and-after trial to examine the impact of an EBP educational intervention on 70 family doctors' test ordering performance and drug utilization by their patients. Unlike Straus et al, they did not find an improvement in clinicians' EBP behaviour (i.e. test ordering performance and patients' drug utilisation - which are quality of care indicators)[72,73], which might be attributed to the difference in the nature of the interventions. A recent systematic review of 15 studies evaluated the effect of EBP teaching on medical doctors had found that EBP teaching can lead to short-term improvement in EBP knowledge and skills. However, there is a little research evidence about long-term effect on improvement in EBP knowledge, skills, and behaviour, as well as patient outcomes[74]. Similar, a systematic review of 13 studies evaluating the effect of EBP educational interventions among health professionals found that EBP educational interventions improved EBP implementation behaviours, however, this behaviour was self-reported, and thus the objective impact of EBP educational interventions was not measured[75].

Strategies for teaching EBP

Interactive vs. didactic EBP educational interventions

EBP educational interventions can be delivered in didactic sessions (i.e. a teacher-centred approach where a teacher gives a lecture and students are mostly passive listeners), interactive (i.e. a student-centred approach which may involve small-group discussion or exercises, role play, practical skills), or mixed sessions. A systematic review of the methods of EBP teaching identified that there were no major differences across different teaching approaches including interactive, didactic, workshops, small-group discussion, and self-directed learning[76]. Buchanan et al. conducted an RCT to evaluate the effect of an interactive EBP educational intervention compared to a didactic intervention on the EBP knowledge, attitude, and behaviour of 56 occupational therapists[77]. Authors found that an interactive EBP educational intervention had a similar effect to a didactic intervention[77]. However, a systematic review and a meta-analysis of the impact of 17 educational interventions on clinicians' behaviour or health care outcomes, found that interactive and mixed, but not didactic, educational interventions were effective in changing behaviour[78].

E-learning vs. face-to-face EBP educational interventions

E-learning technologies are increasingly used in health education since it potentially allows learners to have control over the time, place, order, pace and depth of the educational materials to fulfil their educational needs[79]. Two RCTs comparing the effectiveness of e-learning and face-to-face EBP educational interventions reported no significant differences between e-learning only programs and face-to-face EBP training on EBP knowledge, skills and attitude [80-82]. This was also shown in a recent systematic review of EBP teaching methods[76]. Online (or blended) health educational interventions were found to be as effective as face-to-face interventions in some systematic reviews in nursing[83], allied health professionals[84,85], and medical professionals[79,86,87]. Further, online (or blended) educational interventions have been found to have higher satisfaction rates among trainees[88].

Are Journal clubs effective in EBP education?

A journal club is a well-organised interactive strategy to keep up-to-date with relevant evidence. It was started by Sir William Osler in 1875 and defined as "a group of individuals who meet regularly to discuss the clinical applicability of articles in current medical journals"[89]. Despite its widespread popularity as a mean of continuous education and keeping up-to-date with advances in knowledge, the effectiveness of journal clubs in improving the dissemination of EBP concepts has not yet been established. A systematic review of 18 studies which evaluated the impact of journal clubs in supporting evidence-based decision-making showed that journal clubs might improve the reading behaviour, critical appraisal skills and application of research findings in clinical practice, however, the evidence is heterogeneous (e.g. assessment measures, components of interventions, size and frequency of journal club) and of low quality (e.g. studies inadequately designed and poorly conducted, and intervention details inadequately reported)[90]. A recent cluster RCT exploring the impact of implementing structured journal clubs for allied health professionals found that journal clubs had a positive self-perceived influence on clinical practice and the role of an academic facilitator and the consistent use of critical appraisal tools were appreciated[91]. However, the long-term sustainability of journal clubs is dependent on many factors (e.g. individual and organisation level factors)[92,93]. This was also highlighted by a systematic review of seven studies evaluating EBP educational interventions (involving journal clubs) among surgery residents, which found that the use of critical appraisal checklists and review of methodological/epidemiological articles are appreciated activities within journal clubs[94]. Therefore, journal clubs may need to be integrated with other implementation strategies to enhance behaviour changes in practice[95].

Hierarchy of effective EBP educational interventions

Kahn and Coomarasamy developed a hierarchy of effective EBP educational interventions based on evidence from a systematic review combined with some theoretical considerations[96]. The hierarchy, shown in **Figure 2.5**, has interactive and clinically integrated activities at the top, then the interactive but classroom-based activities, followed by didactic but clinically integrated activities, and finally at the bottom, didactic classroom or standalone teaching.

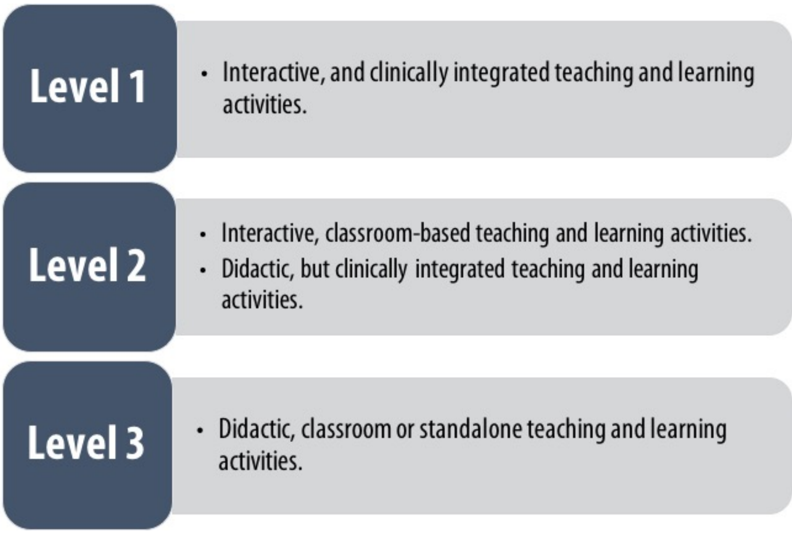

Figure 2.5. Hierarchy of EBP teaching

2.3 EBP education: Challenges and research gaps

Since the development of the principles of EBP in the 1990s, EBP has been widely disseminated to clinicians, incorporated into both undergraduate and postgraduate health education curriculum, and become a core competency needed by clinicians. However, evidence for the effectiveness of EBP educational interventions lacks in many ways[97]. Hatala and Guyatt described this as:

> *"Although evaluation of the quality of research evidence is a core competency of EBM, the quantity and quality of the evidence for effectively teaching EBM are poor. Ironically, if one were to develop guidelines for how to teach EBM based on these results, they would be based on the lowest level of evidence."*[65]

Below we describe several challenges facing the progress of EBP education and research gaps in EBP education literature.

Challenges in the research evidence evaluating EBP educational interventions

As shown in **Section 2.2**, there is a large body of research investigating the impact of EBP educational interventions. However, the findings of these studies are inconsistent and non-conclusive[68]. The evidence generated by these studies is hampered by at least two important problems: (i) incomplete reporting of educational intervention details and (ii) heterogeneity in the outcome measures.

(i) Reporting of interventions details in EBP educational studies

Demonstrating the effectiveness of an intervention does not guarantee the translation of its findings into practice. Inadequate reporting of an intervention's details hinders the ability of clinicians and patients to use the intervention in real-life situations[98], hampers the synthesis of primary studies into systematic reviews and meta-analysis, and limits the understanding and the interpretation of primary studies and its synthesis[98,99]. Lack of adequate reporting of intervention details also contributes to avoidable waste in health research evidence[100].

Several studies have shown that the quality of reporting of health-related interventions is generally inadequate in primary studies and in systematic reviews[24,99,101], which is much more evident in non-pharmacological interventions (e.g. intervention details were accurately reported in 67% of pharmacological trials compared to only 29% in non-pharmacological trials[98]). Hoffmann et al. evaluated the completeness of descriptions of 137 non-pharmacological interventions reported in a sample of 133 randomised trials[102]. Only 39% of interventions were adequately reported, but partially remediable (this increased to 59% by using responses from contacting authors)[102]. Intervention materials were the most frequently missing component (in 53% of interventions)[102]. Therefore, an international group of experts and stakeholders developed the Template for Intervention Description and Replication (TIDieR) checklist to improve the completeness of reporting, and ultimately the replicability, of interventions[103].

The problem of inadequate reporting of the intervention in EBP educational trials has been discussed in several systematic reviews examining the effect of EBP educational interventions[68,69,76]. For instance, Hecht et al. conducted a systematic review of 13 studies and found that the effect of EBP educational interventions could not be determined due to the poor reporting of included studies[75]. Further, inadequate reporting of EBP educational intervention details results in huge variations in the definition of the elements of EBP educational interventions. For example, Kortekaas et al. conducted a cluster RCT comparing an integrated EBP educational intervention to standalone one and pointed out that the use of clinical scenarios in their standalone intervention had been considered 'a clinically integrated intervention' by other studies[70]. Inadequate reporting of intervention details has not only contributed to the observed inconsistent findings of EBP educational studies but also impeded the translation of best available evidence regarding EBP education into practice. This gap in the literature has been addressed in **Chapter 3** (thesis **research question 1**) which examined the completeness of reporting of EBP educational interventions in published studies.

(ii) Heterogeneity in the outcomes measures used to evaluate EBP educational interventions

Despite the established interest in teaching EBP as a core competence for clinicians, measuring clinicians' competence in EBP remains a challenge. It is unclear what the most important outcomes that should be measured in EBP educational interventions (i.e. core outcomes) are, and how to measure them (i.e. with which instruments). For instance, Shaneyfelt et al showed in a systematic review of 104 instruments used to evaluate EBP educational interventions that despite the apparent abundance of instruments evaluating EBP educational interventions, only a few were of high quality (11 out of 104 instruments; based on the type, extent, methods, and results of psychometric testing and the suitability for different evaluation purposes). In addition, they highlighted that patient-related outcomes were rarely measured as an outcome of EBP educational interventions[104]. Therefore, there is a need to harmonise the use of reliable outcome measures to allow for evaluating the most important outcomes of EBP educational interventions and determining its impact on clinical practice and quality of care[105].

Tilson et al. developed the Classification Rubric for EBP Assessment Tools in Education (CREATE) framework (**Figure 2.6**), which provides directions for the evaluation and design of EBP learning outcome assessment tools[106]. The CREATE framework is an internationally agreed taxonomy for classifying outcome measures used to measure EBP educational interventions that considers the assessment category (i.e. patient outcomes, behaviour, skills, knowledge, self-efficacy, attitudes, and reaction to the educational experience), type of assessment (i.e. patient-oriented outcomes, activity monitoring, performance assessment, cognitive testing, and self-report/opinion), and steps of EBP (i.e. ask, search, appraise, integrate, evaluate)[106].

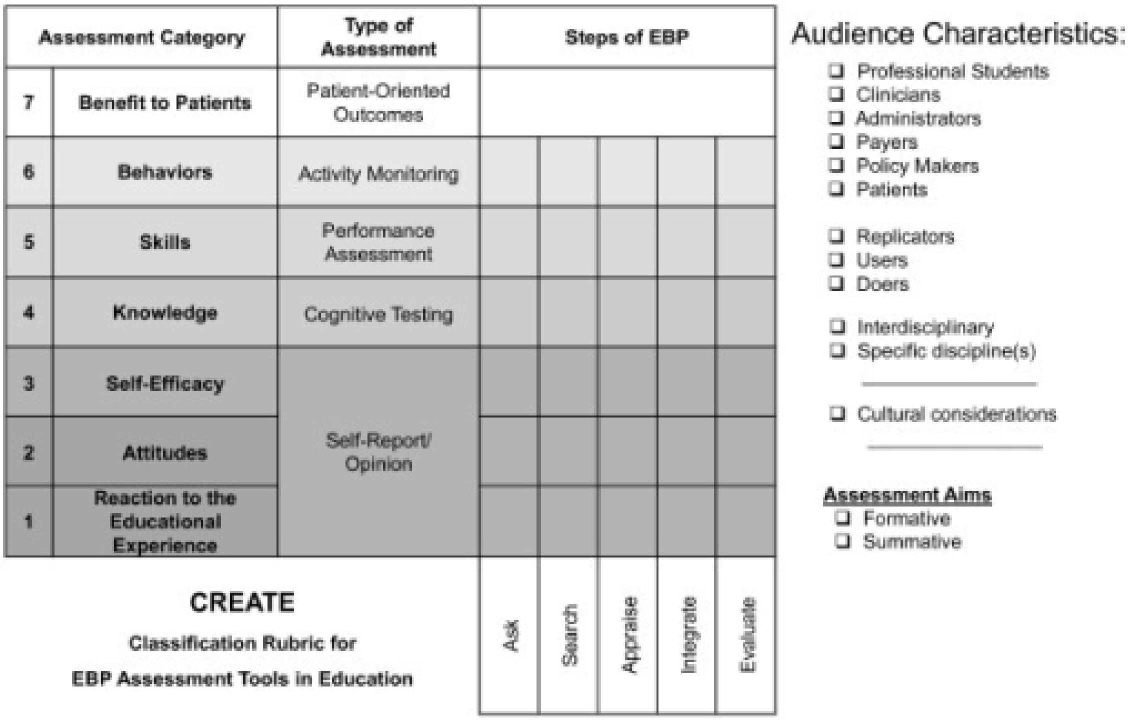

Figure 2.6. The Classification Rubric for EBP Assessment Tools in Education (CREATE) framework (adapted from the Sicily statement)

Despite the abundance of outcome measures that have been developed to evaluate EBP educational interventions (with an overlap in measuring specific domains), Tilson et al suggested that there is also a need to develop new outcome measures that measure specific neglected outcome domains (e.g. behaviour, patient outcomes) and focus on specific populations (e.g. health disciplines)[106]. This gap in the literature has been addressed in **Chapter 4** (thesis **research question 2**) which examined the differences in the outcome measures used in evaluating EBP educational interventions.

Variations in EBP educational interventions and the need for core competencies

Despite the increasing recognition and integration of EBP as a core element in both undergraduate and postgraduate education curriculum, lack of EBP knowledge and skills is frequently reported as a barrier to EBP implementation in practice[48,49]. A potential contributor to this is an inconsistency in the quality and content of EBP educational interventions. For example, Meats et al. surveyed 20 (of all 32) undergraduate medical schools in the UK about EBP teaching and assessment (including details of the content of the EBP curriculum) and found considerable variation in the content and methods of EBP teaching[107]. Meats et al. suggested the development of a national EBP curriculum detailing the content that should be covered in undergraduate level[107]. Similar, Blanco et al. surveyed the deans of 115 (of 149) the United States and Canadian medical schools about the content of EBP curriculum and barriers to EBP training in medical schools and found similar inconsistency in the content of EBP curricula[108]. Blanco et al. also reported that the development of a national agreement on the required EBP competencies was rated most frequently (by 41% of participating deans) as extremely helpful in overcoming barriers to EBP implementation[108].

The Institute of Medicine has endorsed the development of core competencies (i.e. defined as 'the essential minimal set of a combination of attributes, such as applied knowledge, skills, and attitudes, that enable an individual to perform a set of tasks to an appropriate standard efficiently and effectively'[109]) and promoted competency-based education as a promising way of reforming health education and ultimately improving quality of care[57]. A standardised set of minimum core competencies in EBP that clinicians should meet has the potential to standardise and improve EBP educational interventions. Therefore, a standardised set of core competencies in EBP for clinicians is needed to harmonise the development of EBP curriculum, learning objectives, and assessment strategies. This gap in the literature has been addressed in **Chapter 5** (thesis **research question 3**) which used a multi-method Delphi study to develop core competencies in EBP.

Clinicians' EBP learning needs: the role of social media networks

As discussed earlier, the exponential and scattered growth of health literature over the last few decades is an increasing hinderance to clinicians' capacity to keep up with research evidence[25,110]. Despite the huge amount of information available, clinicians frequently face personal knowledge gaps, ask clinical questions about patient care, and have many unanswered questions (i.e. information paradox)[111,112]. Del Fiol et al. systematically reviewed 72 studies that examined clinical questions raised or observed by clinicians and found that clinicians ask about one question for every two patients[113]. However, for more than half of the generated questions, answers are never pursued, and if they were, they were often not answered satisfactorily[113,114]. This represents a missed opportunity to address clinicians' learning needs. Ely et al. analysed the barriers to answering 1062 clinical questions raised by clinicians and found a lack of time and clinicians' doubt about the existence and usefulness of available answers to be frequently reported barriers[113,115]. Clinicians often consult colleagues to answer clinical questions and to overcome information overload[110,112]. Thus, understanding clinicians' use of social media networks to address clinical questions that are generated from patient care and personal knowledge gaps and learning needs is warranted to optimise learning and teaching programs. This gap in the literature has been addressed in **Chapter 6** (thesis **research question 4**) which examined questions asked in a large well-used GP Facebook network.

Shared decision making focusing on pre-appraised evidence: Is it an opportunity for training busy clinicians in EBP?

Shared decision making

SDM is a consultation process where a clinician and patient jointly participate in making a health decision, having discussed the available options and their benefits and harms, and having considered the patient's values, preferences, and circumstances[10,45]. There is an increasing recognition of the importance of sharing clinical decisions with patients to achieve quality patient-centred, value-based care[116]. However, there is a lack of clear guidance about how best to implement SDM in practice, and generally low levels of SDM implementation in clinical practice[117]. A systematic review of 38 studies of health professionals' perceived barriers and facilitators to implementing SDM in practice, found that time constraints, perceived lack of applicability of SDM, and clinicians' attitudes are major barriers[118]. A Cochrane review of interventions for increasing the uptake of SDM found that training clinicians in SDM can improve its use in practice[119]. Further, an environmental scan of 148 training programs in SDM for clinicians found that training appears to be effective in addressing frequently reported barriers to SDM implementation[120,121]. However, SDM training programs vary widely in how and what they deliver[120] and evidence about how best to teach SDM is scarce[120,122]. Many existing SDM training interventions are disease-specific[123-127], and very few have evaluated general SDM training[128-130]. Therefore, training programs that teach busy clinicians a set of SDM skills to enable them to engage patients in the decision-making process may be appreciated by clinicians and an opportunity to foster the uptake of research evidence in practice.

EBP educational interventions are often focused on teaching detailed critical appraisal skills often to the exclusion of other steps (i.e. the application of evidence using SDM skills in particular)[45,107,131]. Integrating SDM training with EBP training maybe a valuable opportunity for both SDM (owing to the lack of standardised SDM training[120]) and EBP (because of the infrequent focus on applying research evidence[107]) to capitalise on closely aligning the two approaches, which has been frequently advocated[45,116]. Although SDM is important to the application of evidence to practice, by integrating research evidence with patients' values and preferences, it is usually not taught as part of EBP. EBP has mostly been taught according to the traditional approach which follows the five EBP steps: ask, acquire, appraise, apply, and assess. Therefore, this is an ideal opportunity to integrate SDM training within EBP training to highlight the connection between the two approaches. Hoffmann et al. described this as "*Without SDM, EBM can turn into evidence tyranny. Without SDM, evidence may poorly translate into practice and improved outcomes*"[45]. It may also increase clinicians interest in the clinical relevance of EBP and hence its uptake.

Pre-appraised evidence

Years of efforts in teaching EBP to clinicians has revealed that only a few clinicians would ever master the skills—and those with the skills would seldom have time—to conduct a detailed critical appraisal of the evidentiary basis of their practice[132]. Therefore, there is increasing interest in using pre-appraised evidence to help clinical decision making at the point of care[41]. Pre-appraised evidence (i.e. evidence-based sources that are vetted by experts and updated regularly to accommodate the newest evidence) represents a partial solution to busy clinicians by providing timely condensed updated summaries of the best research evidence[133]. As was discussed in **Section 2.1**, Straus et al. discerned the 'using' mode (i.e. use of pre-appraised evidence to inform clinical practice) from the 'doing' mode of practising EBP (i.e. conduct detailed critical appraisal of individual studies)[30]. Although a major advancement in the science of producing trustworthy pre-appraised resources has occurred, EBP educational interventions mainly focus on teaching detailed critical appraisal skills (i.e. 'doing' mode)[65]. For example, a multicentre study that evaluated the preferences and understanding of pre-appraised evidence of 248 clinicians (working primarily in general internal medicine or family medicine in 10 different countries) suggested that strategies to increase clinicians' competencies in EBP to better understand or interpret pre-appraised evidence are still needed[134]. In addition, the use of pre-appraised evidence might improve the implementation of SDM - by providing timely availability of unbiased, balanced, and reliable evidence to support patient-clinician discussion about the benefits and harms[135]. Therefore, there is a need to focus on the use of pre-appraised evidence in EBP educational interventions and also to teach clinicians how to interpret and clearly communicate the findings presented in pre-appraised evidence – which might also be a motivation for clinicians to learn more about the critical appraisal of research evidence. This gap in the literature has been also addressed in **Chapter 7** (thesis **research question 5**) which examined an integrated SDM and EBP teaching approach with a focus on using pre-appraised evidence.

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When one teaches … two learn

—Robert Heinlein

3

Chapter 3
Reporting of Interventions

Reporting of interventions details in EBP educational studies

Completeness of the reporting of evidence-based practice educational interventions: a review

Loai Albarqouni, Paul Glasziou, Tammy Hoffmann

Medical Education, 2018, 52: 161-170.

Preamble

In the previous chapter (**Chapter 2**), we noted that previous studies have highlighted deficiencies in the reporting of a range of non-pharmacological interventions. We also observed that inadequate reporting of intervention details frequently hinders the synthesis of primary studies examining the effect of EBP educational interventions. However, despite the frequent acknowledgment of this problem and its implications, a careful examination of the completeness of reporting of intervention details in studies that evaluated EBP educational interventions have not been conducted.

This chapter contains an article entitled "*Completeness of the reporting of evidence-based practice educational interventions: a review*", published in Medical Education on November 2017. It examines reporting of EBP educational interventions in published studies and explores whether missing information about intervention details could be obtained.

Work arising from this chapter was also presented in oral form at the annual higher degree research conference at Bond University.

3.1 Abstract

Context

Complete reporting of intervention details in trials of evidence-based practice (EBP) educational interventions is essential to enable clinical educators to translate research evidence about interventions that have been shown to be effective into practice. In turn, this will improve the quality of EBP education.

Objectives

This study was designed to examine the completeness of reporting of EBP educational interventions in published studies and to assess whether missing details of educational interventions could be retrieved by searching additional sources and contacting study authors.

Methods

A systematic review of controlled trials that had evaluated EBP educational interventions was conducted using a citation analysis technique. Forward and backward citations of the index articles were tracked until March 2016. The TIDieR (template for intervention description and replication) checklist was used to assess the completeness of intervention reporting. Missing details were sought from: (i) the original publication; (ii) additional publicly available sources, and (iii) the study authors.

Results

Eighty-three articles were included; 45 (54%) were randomised controlled trials (RCTs) and 38 (46%) were non-RCTs. The majority of trials (n = 62, 75%) involved medical professionals. None of the studies completely reported all of the main items of the educational intervention within the original publication or in additional sources. However, details became complete for 17 (20%) interventions after contact with the respective authors. The item most frequently missing was 'intervention materials', which was missing in 80 (96%) of the original publications, in additional sources for 77 (93%) interventions, and in 59 (71%) studies after

contact with the authors. Authors of 69 studies were contacted; 33 provided the details requested.

Conclusions

The reporting of EBP educational interventions is incomplete and remained so for the majority of studies, even after study authors had been contacted for missing information. Collaborative efforts involving authors and editors are required to improve the completeness of reporting of EBP educational interventions.

3.2 Introduction

Evidence-based practice (EBP) provides a framework for the integration of the best available research evidence and clinical expertise with patients' values to optimise clinical decision making and patient care[1,2]. Evidence-based practice emphasises how important it is that clinicians adopt lifelong learning skills. Since the phrase 'evidence-based medicine' was coined over two decades ago, it has been widely embraced by national and international health care communities and professional bodies. An evidence-based approach to health care is recognised internationally as a core competency for clinicians and has become a standard required by many health professions[3-6].

Consequently, tremendous effort and resources have been focused on EBP education and there has been slow but steady progress in the accumulation of evidence for the effectiveness of EBP educational interventions[7]. In a recent overview of systematic reviews that evaluated the effects of teaching EBP to clinicians, 16 systematic reviews, which included more than 80 primary studies (25 were randomised controlled trials [RCTs]), were identified. The review found that multifaceted, clinically integrated EBP interventions with assessment were more likely to improve EBP knowledge, skills and attitudes than standalone interventions or no intervention[8].

However, a recent systematic review investigating the barriers to EBP found that lack of knowledge, skills, resources and time remain major barriers to EBP from the clinician's perspective[9,10], highlighting a gap in the uptake of evidence about effective EBP educational interventions in practice. Evidence of the effectiveness of an intervention alone is not enough to guarantee the translation of research evidence into practice. Without the complete reporting of intervention details, an intervention cannot be implemented[11]. For instance, training materials (both those provided to participants and those used by the intervention provider) are often a major component of an educational intervention. However, without a detailed description of these materials, readers will not be able to use the intervention.

Evidence-based practice educational interventions, like other health professional educational interventions, are complex interventions in which many components interact, and are conducted in various settings[12]. Health education research should aim to find out not only about whether an intervention is effective, but also about what the intervention is; this requires the intervention to be reported with sufficient detail[13]. Guidance for researchers that aims to increase accuracy, consistency, completeness and transparency in the reporting of interventions has been developed recently[14,15].

The quality of the reporting of RCTs in health professional education is suboptimal[16,17]. For instance, a recent systematic review that examined the completeness of reporting of health professional educational trials using the Consolidated Standards of Reporting Trials (CONSORT) checklist found that most checklist items were reported in fewer than 50% of studies[17]. In addition, although incomplete reporting of EBP educational interventions has been mentioned as a problem in systematic reviews of these interventions[8,18-21], these studies examined the methodological quality and reporting quality of the general characteristics of these trials. They did not conduct a detailed assessment of the reporting of the interventions in these trials.

The completeness of the reporting of EBP educational interventions has not been comprehensively assessed using a specifically designed intervention reporting checklist, and the issue of whether missing details can be obtained from authors has not been explored. This study aimed to examine the completeness of reporting of intervention details in published trials of EBP educational interventions. To use research evidence, readers and researchers often search for missing intervention details in additional resources provided by the original authors or by contacting the study authors. Thus, we also aimed to assess whether missing intervention details can be retrieved by searching additional sources and contacting study authors.

3.3 Methods

Study design

We conducted a systematic review of studies that have evaluated the effects of EBP educational interventions. As far as possible, this systematic review was reported in accordance with the PRISMA (preferred reporting items for systematic reviews and meta-analyses) statement. **Supplementary material 3.1** shows supporting information for the completed PRISMA checklist. However, a few items (n = 7) related to the synthesis of the results, risk for bias across studies and additional analysis were not relevant to our review, and hence are not reported.

Search strategy

We used the citation analysis technique to identify studies about EBP educational interventions. The index articles for our citation analysis were studies in the recent overview of the effect of EBP teaching[8], both the systematic reviews included and the primary studies included that had investigated the effects of EBP education. We tracked the forward and backward citations of these index articles using the Web of Science database until March 2016. Citation analysis can efficiently elude the time-consuming and complex nature of traditional search strategies with an acceptable rate of accuracy[22-24]. Further, citation analysis does not depend on the use of specific keywords and search terms, which may be advantageous, particularly in disciplines in which there is inconsistent terminology[25,26]. However, this may also carry risk for the missing of a few relevant studies. The highly sensitive Cochrane search filter for identifying randomised trials (sensitivity-maximising version; 2008) was applied[27]. We identified additional eligible studies by reviewing the reference lists of the studies included. No language restrictions were applied.

Eligibility criteria

Types of study

Studies were required to be controlled trials that included a separate group for the purposes of comparison (e.g. RCTs or non-RCTs).

Types of participant

Participants could be any health professionals, irrespective of discipline or level of training (in undergraduate or postgraduate education or in continuous professional development).

Types of intervention

Interventions could involve any format or mode of EBP educational intervention (e.g. workshop, course, journal club) that aimed to teach at least one component of the main steps of EBP (ask, acquire, appraise, apply and assess).

Types of comparator

Comparators might involve no intervention or another intervention (e.g. comparing different methods of EBP training).

Types of outcome measure

Outcome measures included any measure of EBP knowledge, skills, attitudes, behaviours or practice. There were no language or publication year restrictions.

Selection of studies

Studies were assessed for eligibility by an initial screening of titles and abstracts and the subsequent examination of the full text by one review author (LA). Any concerns about study eligibility were discussed by the authors and resolved through consensus.

Data extraction

Details of the study characteristics and components of the EBP intervention were extracted from each study using a piloted data extraction form (**Table 3.1**). The data extraction form was adapted from the TIDieR (template for intervention description and replication) checklist[14], which aims to improve the reporting of interventions and is an extension of the CONSORT guidance[15], and the GREET (guideline for reporting evidence-based practice educational interventions and teaching)[28].

The completeness of the reporting of each checklist item describing the intervention core items (items 3–8) as reported in the original publication was assessed, after searches for additional sources and after e-mail contact with the respective authors[29]. Each checklist item (items 3–8) was rated as 'complete' if the component of the intervention was clearly described or as 'incomplete' if this component was not reported or was poorly described. In addition, the overall reporting of each included article was assessed as 'complete' when all the checklist items (items 3–8) were rated as complete and otherwise as 'incomplete'. The other TIDieR items (items 9–12), which record the modifications to and fidelity of the intervention, were not assessed as they are less relevant to the aim of our study. At the beginning of the data extraction phases, data from a random sample of 20 articles (23%) were extracted by all three authors, who independently assessed the completeness of reporting in these articles. Ratings were discussed after every five articles in a process that continued until consensus rating had been attained and the data extraction tool was being used consistently.

Table 3.1 Checklist of the items that have been extracted from the reports of EBP educational interventions

	Item	Description/Details
Study Characteristics	Journal/article	a. Journal name b. Title c. Year of publication d. Citation details (PMID) e. Registration details
	Authors	a. Authors names b. Corresponding author's contact details (email)
	Setting	a. Country b. Language
	Study design	c. Randomisation d. Sample size calculation
Participants	Learners	a. Number (sample size) b. The level of education (students, professionals) c. professional discipline d. previous EBP exposure e. age
Intervention[1]	1. Brief name	A name or a phrase which describes the intervention
	2. Why	Describes the rationale, theory, or goal of the elements essential to the intervention: a. Theory: describe the educational theory (ies), concept or approach used in the intervention. b. Learning objectives: describe the learning objectives for all groups involved in the educational intervention. c. EBP content: list the foundation steps of EBP (ask, acquire, appraise, apply, assess) included in the educational intervention.
	3. What: materials	Describes any physical or informational materials provided to participants used in intervention delivery or in the training of intervention providers a. Materials provided to participants: workbook/handbook/manual or checklist/ EBP references b. Materials used in training: presentations/tasks/articles for discussions c. EBP concepts covered
	4. What: procedure	Describes each of the procedures, activities, and processes used in the intervention, including any enabling or support activities a. Pre-intervention any readings/activities required/prerequisites b. During the intervention: any task/activity required (group projects ...etc.). c. Post-intervention: activities required/assessments/assignments

	5. Provider	Describes the intervention provider (number) and their expertise, background/professional discipline, and any specific training given/incentives
	6. How	Describes the modes of delivery (e.g. face-to-face) of the intervention a. Teaching strategy (e.g. tutorial, lectures, small-group, blended, interactive, didactic, mixed) b. Mode of delivery (face-face or online) c. Group size, trainer-to-trainee ratio
	7. Where	Describes the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features/facilities (e.g. conference, university lecture theatre, hospital ward, community)
	8. When and How Much	Describes the dose/schedule of the intervention a. The schedule (duration of entire program, fixed or flexible) b. How frequent each session c. Duration of each session d. Timing of each session)
	9. Tailoring	Describes the what, why, when, and how of intervention titration, personalization, or progression Did the educational intervention require specific adaptation for the learners? If yes, please describe the adaptations made for the learner(s) or group(s).
	10. Modification	Describes any modifications to the intervention during the course of the study Was the educational intervention modified during the course of the study? If yes, describe the changes (what, why, when, and how).
	11. How well: planned	Describes strategies used to maintain or improve fidelity (how and by whom) a. Attendance: Describe the learner attendance, including how this was assessed and by whom. Describe any strategies that were used to facilitate attendance.
	12. How well: actual	Describes the extent to which the intervention was delivered as planned (if adherence or fidelity was assessed) a. Describe any processes used to determine whether the materials and the teaching strategies used in the educational intervention were delivered as originally planned. b. Describe the extent to which the number of sessions, their frequency, timing, and duration of the educational intervention was delivered as scheduled
Evaluation	Outcomes	a. Measured outcomes b. Assessment methods/ instruments used

[1]Adapted from TIDier and GREET reporting checklist

For each study, additional intervention information from other sources (such as reference lists, article citations, and by tracking the authors' relevant publications) was obtained where available. If further details about the intervention were still missing, an attempt to contact the corresponding authors of the original study with specific questions related to the missing information was made. (**Supplementary material 3.2** shows an example of an e-mail to an author.) Contact e-mail addresses were searched for in the included article or in the corresponding authors' most recent publications or workplace staff directories. Up to three reminders, each 3 weeks apart, were sent to authors. If current e-mail addresses were unavailable, one of the co-authors was contacted. When additional information was obtained (from either the other sources or the authors), relevant items were re-rated. In addition, the accessibility of the intervention materials was assessed and categorised as: already freely accessible; available by agreement with the study authors to be freely accessible in an open database[30], or not freely accessible (i.e. free accessibility was declined). The methodological quality (risk for bias) of the included studies was not assessed as this is unlikely to affect the completeness of intervention reporting.

Data analysis

Microsoft Access Version 2013 X.X (Microsoft Corp., Redmond, WA, USA) was used to compile details about each item, to track the completion of missing items, to search for additional sources and to follow up with the study authors. Data were analysed using descriptive statistics.

3.4 Results

The search yielded 1682 articles for the screening of titles and abstracts. Of these, 286 full-text articles were obtained for full-text review and 83 of these articles were included (**Figure 3.1**). Of these, 45 (54%) were RCTs and 38 (46%) were non-RCTs.

The trials were published between 1986 and 2015, and about half (51%) were published in the last decade. Except for one Spanish article, all articles were written in English. Thirty-five (42%) studies were conducted in the USA, nine (11%) in the UK, seven (8%) in each of Australia and Canada, and the remainder in other countries (the Netherlands, Norway, Mexico, China, Croatia, Philippines, Iran, Israel, Taiwan, Spain, Italy, Saudi Arabia, South Africa). In 62 (75%) of the studies included, the participants were medical professionals, whereas the remainder were conducted in nurses, physiotherapists, occupational therapists and other allied health professionals. Fifty studies (60%) included postgraduate-level participants, 32 studies (39%)

included undergraduate students, and one study (1%) included participants in both levels of education. **Supplementary material 3.3** shows details of the characteristics of the included studies and **Supplementary material 3.4** shows details of the intervention discussed in each study.

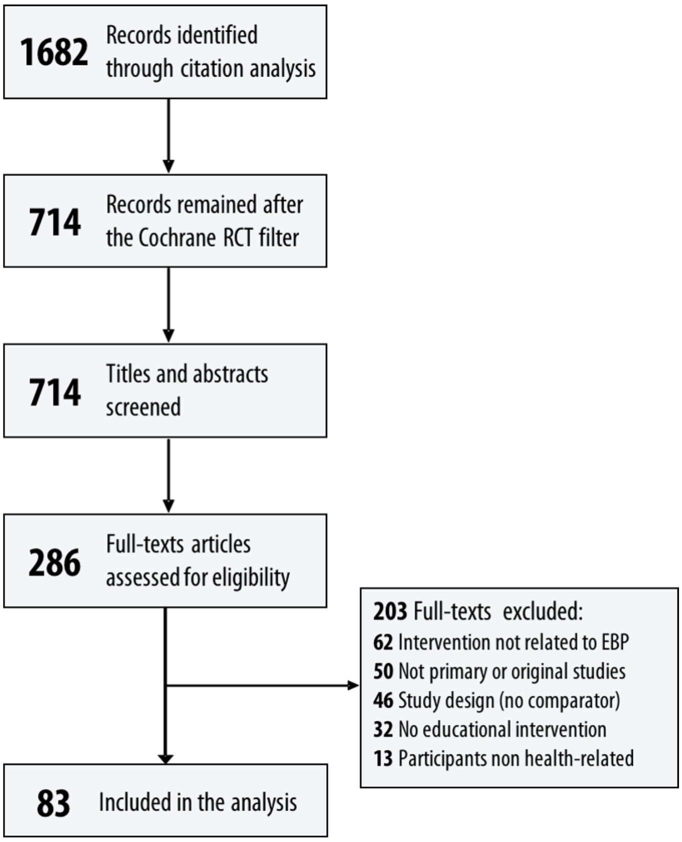

Figure 3.1. PRISMA (preferred reporting items for systematic reviews and meta-analyses) -based flow diagram showing study selection. EBP, evidence-based practice; RCT, randomised controlled trial

Across the 83 studies, 14 corresponding authors were not contactable because contact details could not be found. Of the 69 corresponding authors contacted, 27 did not respond after reminders. Of the 42 who did reply, 33 provided the intervention details requested (18 provided materials and other details; 15 provided only other intervention details) (**Figure 3.2**).

Completeness of reporting of the EBP educational intervention

In the original publication or in additional sources, none of the 83 included studies completely reported all the checklist items. However, after author contact, 17 articles (20%) were then rated as complete in all checklist items.

The item most frequently rated as incompletely reported was 'intervention materials' (item 3). Details were missing in 80 (96%) of the original publications, in 77 (93%) after searching additional sources, and in 59 (71%) after author contact. Items 6a and 6b (details describing the 'teaching strategy' and 'mode of delivery') were the most completely reported items (**Figure 3.3**). After contact with corresponding authors, the completeness of reporting was most improved (by 30%) for item 5 ('intervention providers') and least improved (by 10%) for item 6b ('mode of delivery').

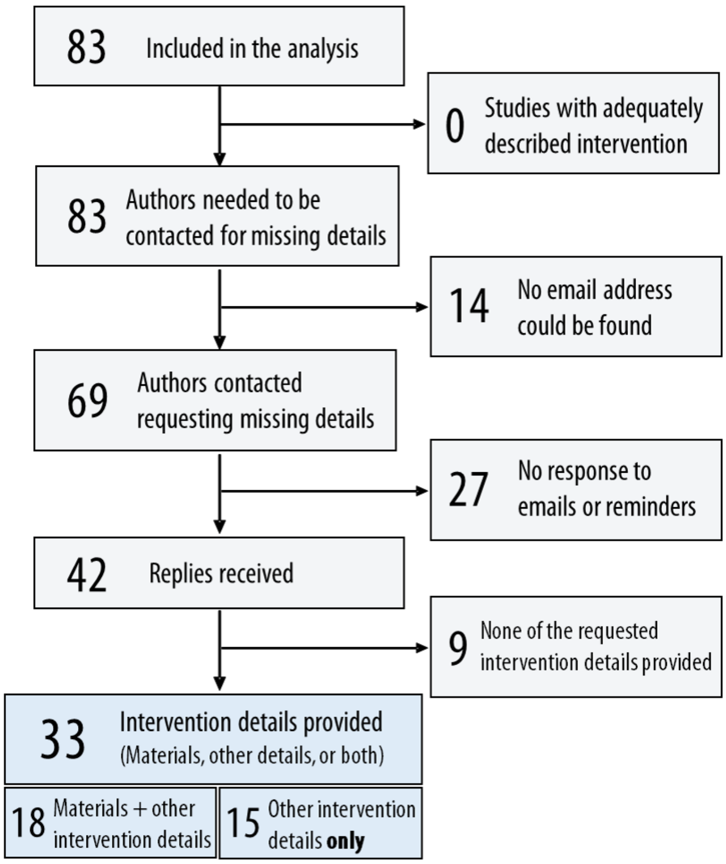

Figure 3.2. Process of contacting study authors for missing information

The completeness of reporting of interventions improved over time. Eleven of the 27 studies (41%) published between 2010 and 2016 were rated as complete (including details from the original publication, additional sources and author contact), whereas only two of the 39 (5%) studies published before 2005 and four of the 17 (24%) studies published between 2005 and 2009 were rated as complete after author contact.

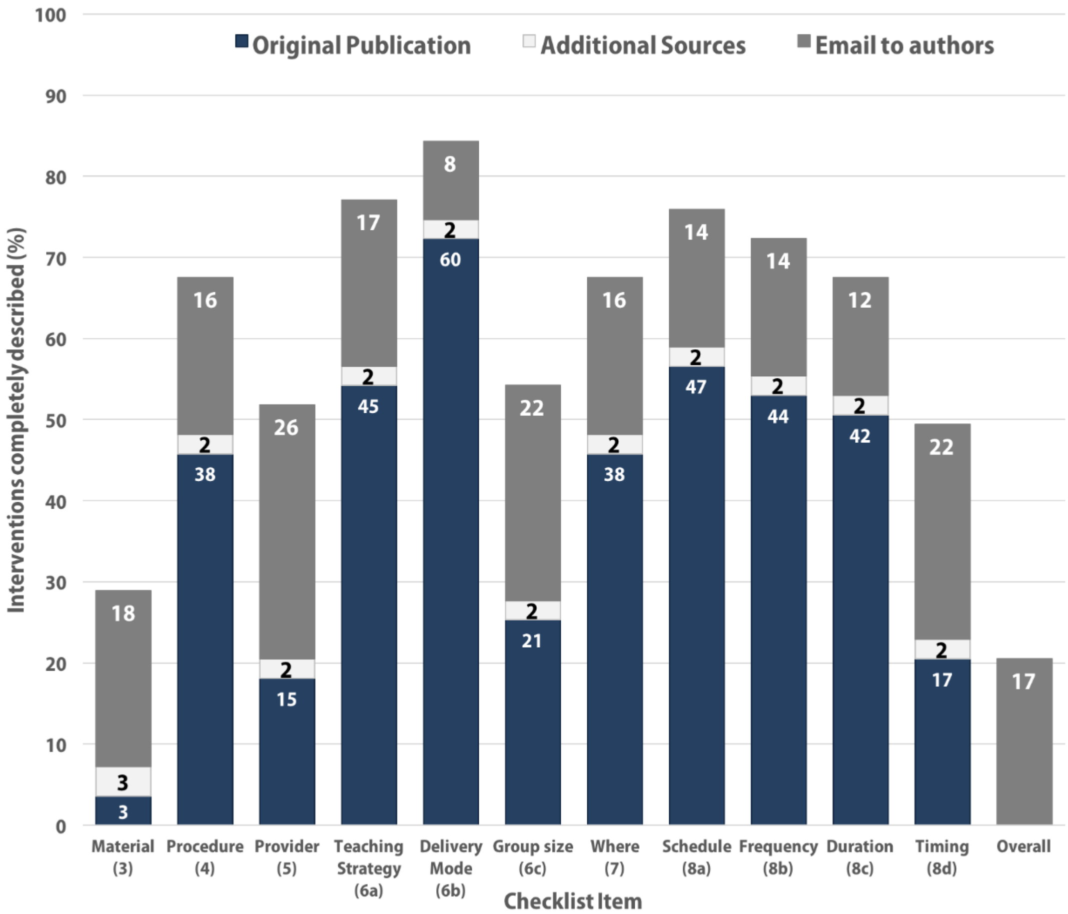

Figure 3.3. Percentages (numbers in bars) of interventions in evidence-based practice educational trials rated as completely described for each checklist item (items 3–8 in **Table 3.1**), in 83 original publications, with additional sources and after contacting authors

Materials used in the educational interventions

Materials used in the educational intervention were provided in the original publications for three studies, and in additional sources for a further three studies. Requests for the material (and other intervention details) used in delivering the intervention were sent to 69 authors, of whom 42 replied, but only 18 provided the requested materials (along with other intervention details) (**Figure 3.2**). Of the 24 sets of materials retrieved (six from the original publication or additional sources plus 18 supplied by study authors), 18 were either already publicly available or the authors agreed to make them publicly available. The most common reasons for an author's refusal to make materials publicly available were that the materials were outdated or that organisational permissions were perceived to be required. A total of 112 sets of documents were provided, ranging from one to 30 documents per responding author. The types of materials most commonly provided were slides of presentations (n = 33), but materials also included handouts (n = 22), tutorial manuals (n = 13), workbooks, exercises or case studies (n = 16), assignments (n = 9), and lists of further resources or readings or website/Internet resources (e.g. a video or discussion forum) (n = 19).

3.5 Discussion

We found that EBP educational interventions in 83 published controlled trials were incompletely reported in the majority of the studies. None of the studies included had completely reported all of the main elements of the educational intervention, including the intervention materials. Following author contact[17], study authors were able to supply all missing information. The most frequently incompletely reported items were: intervention materials; providers of the intervention, and details of the frequency, duration and timing of the intervention.

These findings resonate with the results of a systematic review of 61 studies that described the reporting of EBP educational interventions and found that instructor details and the schedule of the intervention were among the least consistently reported items in EBP educational interventions[18]. However, this previous study did not comprehensively assess the completeness of reporting of EBP educational interventions using a specifically designed checklist and the authors of the relevant studies were not contacted to determine whether it was possible to obtain missing intervention details[18]. Our finding of incomplete reporting of intervention details aligns with previous reports investigating the completeness of the reporting of other basic and methodological elements (i.e. not intervention details) of health professional education studies[17], which have found that most of the essential reporting items (e.g. randomisation, blinding, participant flow and sampling) were missing in more than 50% of included studies[16,17,31,32].

The problem of incomplete reporting of intervention details has been observed in many areas of clinical interventions. Hoffmann et al.[29] evaluated the completeness of descriptions of non-pharmacological interventions in a sample of randomised trials and assessed whether the study authors were able to provide the missing details. They found complete descriptions in original publications for about one-third of the interventions (39%), which increased to almost two-thirds (59%) after information was obtained from trial authors. They also found that 'intervention materials' was the most frequently missing item (missing in 53% of studies reporting interventions)[29]. A systematic examination of cardiac rehabilitation interventions also found that intervention details were completely reported in only 8% of trials and that contact with the study authors increased this percentage to 43%[33]. Analysis of a random sample of 200 reports of randomised trials in the context of physiotherapy showed that 23% of the included interventions scored poorly on at least half of the checklist items[34].

'Intervention materials' was the most poorly reported item, with only 4% of studies providing the materials in the original publication. This improved to 29% when study authors were contacted. The accessibility of intervention materials is an important prerequisite for widespread knowledge translation, which is why we assessed the availability of materials. Three-quarters (75%) of the retrieved materials were either freely accessible or their authors agreed to make them freely accessible in an open-access database[30]. The most common reason for declining to make the materials freely accessible was copyright concerns about the article. Hoffmann et al.[29] found that about half of the websites that contained further intervention information or the materials themselves were freely accessible, and concern about copyright or intellectual property was the main reason given for the unavailability of study intervention materials. Phillips et al.[18] found that the materials used in EBP educational interventions were reported in about three-quarters of studies; however, this refers to materials being described in articles rather than being provided in sufficient detail to facilitate replication.

In the present study, the observed improvement in the completeness of reporting of intervention details over time may reflect our inability to locate the contact details for the authors of some older trials, as well as the development and use of reporting guidelines (e.g. CONSORT[15]) over time. A previous study of the completeness of the reporting of health professional educational studies also observed improvement in reporting completeness over time[17]. However, Abell et al.[33] did not find an increase in the completeness of reporting of intervention details in published cardiac rehabilitation trials over time.

Strengths and limitations

One potential limitation of this review concerns the risk that relevant articles were not detected by using citation analysis as a search strategy. However, the accuracy rate of citation analysis has been found to be acceptable[22,24]. For instance, using this technique, Janssens and Gwinn[25] identified 94% (range: 75–100%) of all articles included in 10 different meta-analyses that were originally retrieved using traditional search strategies, whereas only 10% as many articles were screened using a traditional search strategy. Even if a few potentially eligible studies were missed, it is unlikely that our overall results and conclusions were affected as we aimed to assess the completeness of intervention reporting rather than the effectiveness of the educational interventions. Another limitation refers to the fact that although we used a checklist to assess completeness, some elements may still be missing when other researchers or educators attempt to use the educational intervention. This may mean that we underestimated the extent to which the descriptions were completely reported.

Implications for practice and research

The incomplete reporting of research is a major problem that contributes to the overall waste in health research[11]. The incomplete provision of intervention details impedes research into the reproducibility of findings, results synthesis, and translation into practice. Without complete details of interventions, EBP educators will be unable to translate interventions shown to be effective into practice, which, in turn, will impede the delivery of quality EBP education. Authors of trial reports are encouraged to follow relevant reporting guidelines, such as those of TIDieR[14] and GREET[28]. In order to enhance the availability of materials relevant to EBP, we will upload the materials retrieved in the course of the current analysis (which the respective authors have agreed to make publicly available) in the Critical thinking and Appraisal Resource Library (CARL)[30].

3.6 Conclusions

The majority of EBP educational interventions remained incompletely reported and unusable even after the original study authors had been contacted for missing information. Collaborative efforts involving authors, editors and EBP educators are needed to improve the quality of the reporting of EBP educational interventions.

3.7 Declarations

Contributors

All authors contributed to the design of the study. LA drafted the original manuscript. All authors contributed to the revision of the paper and approved the final manuscript for submission.

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Conflicts of interest

PG and TH sat on the steering committee that developed the TIDieR (template for intervention description and replication) guide and checklist and are both authors of that publication. There are no financial relationships or other conflicts that might have influenced the results of this research.

Ethical approval

Not required.

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3.9 Supplementary materials 3

Published with article presented in **Chapter 3**

Supplementary material 3.1

PRISMA checklist published with the article presented in **Chapter 3**

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	P1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	P2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	P3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	P4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	NA
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	P5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	P5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	P5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	P5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	P5-6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	P6

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	P6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	P6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	NA
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	P6-7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	P7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	P7-8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	P7-8
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA

DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	P8
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	P10
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	P10
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	P11

Supplementary material 3.2

An example of an e-mail to an author published with the article presented in **Chapter 3**

An Example of the email sent to the author requesting for missing information about the details of the EBP interventions

Dear Dr xxxxxx,

We have read your 20xx article*, the title of the article* (PDF attached), with great interest and will include it in a study looking at how evidence-based practice educational interventions are reported in published studies.

For your study, could you please provide us with some further information and/or resources about the educational intervention?

You described a brief and interactive EBM workshop aimed to enhance the EBM knowledge, literature searching skills among postgraduate residents. Could you please tell us about:

1- **Materials:** We wonder if the materials that (a) have been given to the participants and (b) used in delivering the training are still available. If so, where from? If not, could you please provide us with the materials?

2- **Teachers:** You have described that the workshops conducted by one faculty member and one Librarian. Were there any other facilitators? If so, how many EBP teachers were involved? What was their experience in EBP? Had they received any specific training in EBP?

3- **Delivery:** Could you please describe how you delivered your intervention: what was the ratio of teachers to students?

4- **Schedule:** Could you please provide us with more details about the schedule of the workshop? How many sessions? And how long did each session last?

5- **Changes:** Were any changes made to the educational intervention throughout the duration of the trial? If yes, please describe the changes (what, why, when, and how).

Thank you for taking the time to provide this information.

Sincerely,

Loai Albarqouni, Paul Glasziou and Tammy Hoffmann

Supplementary material 3.3

Details of the characteristics of the included studies published with the article presented in **Chapter 3**

Table S1. Baseline characteristics of the included trials

Author, date	Country, language of intervention	Study Design	Participants (number, profession, education level)
Akl 2004[1]	US, English	CT	40 medical students and residents rotating with the general internal medicine team at a university hospital.
Al-Baghali 2013[2]	Saudi Arabia, English	RCT	59 medical doctors in primary health care centres
Badgett 2001[3]	US, English	CT	157 third-year medical students
Balajic 2012[4]	Croatia, Croatian	CT	1232 medical students in 3 medical schools.
Bazarian 1999[5]	US, English	CT	32 emergency medicine residents
Bennett 1987[6]	Canada, English	CT	79 final-year medical students
Bradley 2002 [7]	US, English	RCT	10 residents in neonatal care unit
Bradley 2005[8]	Norway,	RCT	175 tenth-semester medical students
Brettle 2013[9]	UK, English	RCT	77 first-year undergraduate pre-registration diploma nursing students
Buchanan 2014[10]	South Africa, English	RCT	56 practising occupational therapists
Cabell 2001[11]	US, English	RCT	48 internal medicine resident physicians
Campbell 2013[12]	Australia, English	RCT	135 allied health professionals from four regions in Australia.
Carlock 2007[13]	US, English	CT	90 junior first-semester nursing students
Cheng 2003[14]	China,	RCT	800 healthcare clinicians (medical doctors, nurses, allied health professionals)
Cheng 2012[15]	Taiwan, Mandarin	RCT	94 final-year medical students
Davis 2007[16]	UK, English	RCT	179 first medical students
Davis 2008[17]	UK, English	RCT	55 newly qualified foundation year doctors
Dizon 2014[18]	Philippines,	RCT	54 practising physical therapists
Edwards 2001[19]	UK, English	CT	482 third-year medical students
Eldredge 2013[20]	US, English	RCT	71 first-year medical students
Erickson 1998[21]	US, English	RCT	31 residents in obstetrics and gynaecology
Feldstein 2010[22]	US, English	RCT	48 internal medicine residents
Fernandez 2014[23]	Australia and Hong Kong, English	CT	186 postgraduate nursing students
Forsetlund 2003[24]	Norway,	RCT	148 public health physicians
Frasca 1992[25]	US, English	CT	92 third-year medical students
Fu 1999[26]	Canada, English	CT	12 residents in psychiatry
Gardois 2011[27]	Italy, Italian	RCT	22 paediatric residents and interns
Ghali 2000[28]	Canada, English	CT	60 third-year medical students
Green 1997[29]	US, English	CT	34 second- and third-year internal medicine residents
Griffin 1992[30]	US, English	CT	57 occupational therapy students

Gruppen 2005[31]	US, English	CT	92 fourth-year medical students
Haas 2012[32]	US, English	CT	339 chiropractic doctoral students
Hadley 2010[33]	UK, English	RCT	237 postgraduate medical trainee at foundation or internship level
Haynes 1993[34]	Canada, English	RCT	392 physicians and physicians-in-training
Hugenholtz 2008[35]	Netherlands,	RCT	98 occupational physicians
Ilic 2015[36]	Australia, English	CT	61 second-year medical students
Ilic 2013[37]	Australia and Malaysia	RCT	147 medical students
Ilic 2012[38]	Australia, English	RCT	121 third-year medical students
Jalali-Nia 2011[39]	Iran,	RCT	41 undergraduate nursing students
Johnston 2009[40]	China,	RCT	129 second-year medical students
Kim 2008[41]	US, English	RCT	50 residents in internal medicine
Kim 2009[42]	US, English	CT	208 senior fourth-year nursing students
Kitchens 1989[43]	Canada, English	CT	83 residents in internal medicine
Kok 2013[44]	Netherland,	RCT	132 insurance physicians
Krueger 2006[45]	US, English	RCT	77 third-year osteopathic medical students
Kulier 2009[46]	Netherland and UK,	RCT	61 postgraduate trainees in obstetrics and gynaecology
Kulier 2012[47]	7 LMICs,	RCT	204 postgraduate trainees (residents, registrars and postgraduate clinical trainees) in obstetrics and gynaecology
Landry 1994[48]	US, English	CT	146 third-year medical students
Langkamp 1992[49]	US, English	CT	27 residents in Paediatrics
Lee 2007[50]	China,	RCT	132 final-year medical students
Linzer 1988[51]	US, English	CT	85 residents in internal medicine
Linzer 1987[52]	US, English	RCT	44 medical interns
MacAuley 1999[53]	UK, English	RCT	99 GP trainers
Macrae 2004[54]	Canada, English	RCT	81 general surgeons
Major-Kincade 2001[55]	US, English	CT	64 paediatrics house staff
McLeod 2010[56]	US, English	RCT	443 residents in general surgery
Mills 2002[57]	Canada, English	CT	83 Naturopathic interns
Olsen 2015[58]	Norway,	CT	37 clinical instructors in Physiotherapy
Radack 1986[59]	US, English	CT	33 medical students
Ramos-Morcillo 2015[60]	Spain, Spanish	CT	109 registered nurse
Riegelman 1986[61]	US, English	CT	292 medical students
Romm 1989[62]	US, English	RCT	108 medical students

Rosenberg 1998[63]	UK, English	RCT	108 medical students
Ross 2003[64]	US, English	CT	48 residents in family practice
Sanchez-Mendiola 2004[65]	Mexico, Spanish	CT	131 medical students
Sanchez-Mendiola 2012[66]	Mexico, Spanish	RCT	289 fifth-year medical students
Schaafsma 2007[67]	Netherland,	CT	125 occupational health physicians and insurance physicians
Schilling 2006[68]	US, English	RCT	238 third-year medical students
Schoonheim-Klein 2012[69]	Netherland,	CT	62 working group of dental students
Seelig 1993[70]	US, English	CT	44 practising internists and residents
Shorten 2001[71]	Australia, English	CT	143 nursing students
Shuval 2007[72]	Israel	RCT	75 primary care doctors
Smith 2000[73]	US, English	CT	55 first-year residents in internal medicine
Stark 2007[74]	US, English	RCT	77 second- and third-year residents in internal medicine
Stevenson 2004[75]	UK, English	RCT	30 musculoskeletal physiotherapists
Stevermer 1999[76]	US, English	RCT	59 residents in family practice
Taylor 2004[77]	UK, English	RCT	145 healthcare professionals (general practitioners, hospital physicians, professions allied to medicine, and healthcare managers/administrators)
Thomas 2005[78]	US, English	CT	46 residents in internal medicine
Verhoeven 2000[79]	Netherland,	RCT	103 healthcare professionals (general practitioners and others)
Viniegra 1986[80]	Mexico, Spanish	CT	20 residents in internal medicine
Vrdoljak 2015[81]	Croatia, Croatian	CT	98 mentors in general practice
Wallen 2010[82]	US, English	CT	159 nurses participating in leading/mentoring activities
Welch 2014[83]	US, English	RCT	175 professional athletic training students, graduate students, clinical preceptors, educators, and clinicians.

Abbreviations: RCT: randomised controlled trial; CT: controlled trial; P: postgraduate; U: undergraduate

Supplementary material 3.4

Details of the intervention discussed in each of the included studies published with the article presented in **Chapter 3**

Table S2. Characteristics of the intervention details of included trials

Author, date	Summary of the intervention	Intervention format (teaching strategy), mode of delivery	Length/ frequency, duration of intervention, schedule	Teachers/facilitators, group size, location
Akl 2004[1]	EBM elective rotation within the internal medicine residency program in three teaching hospitals (one as an intervention group and the other two as a control group).	Interactive small-group sessions (critical appraisal) On-the-ward feedback about the evidence-based answers for problematic issues (through the application of EBM steps)	A two-week rotation including two 45-minute interactive lectures on the 2nd and 5th day about the basic concepts of EBM.	The EBM residents are senior internal medicine residents within the general internal medicine ward team (one attending physician, one or two 2nd or 3rd year residents, two interns, and one or two medical students)
Al-Baghali 2013[2]	EBM workshops vs. other primary healthcare activities.	-	Each EBM workshop lasted for 7 hours per day for 3 consecutive days.	The workshops were conducted at Primary Health Administration Centre.
Badgett 2001[3]	The intervention had two parts: (1) providing computers and this automated search internet-site and (2) delivering of a course about how to find and appraise medical evidence using these resources.	A face-to-face and interactive course about searching medical evidence and developing an internet site that automates searching for medical evidence (SUMSearch).	Four sessions (three 90-minute each and one 60-minute) were delivered over four weeks.	Two teachers (a medical doctor and a medical librarian; each had an experience of 5-10 years). Two teachers to 10-12 students.
Balajic 2012[4]	A vertical course on research in biomedicine and health as part of the medical curricula in three medical schools.	These courses on research methodology were adjusted to the students' needs (1st year students learned about types of research studies vs. 6th year students who learned practical advanced skills to prepare undergraduate thesis)	This course lasted through the entire 6-year medical curriculum. In each rotation, each student had to answer two clinical questions by applying the EBM steps.	-
Bazarian 1999[5]	Journal clubs using EBM approach.	Highly structured EBM journal club containing three elements: case-based presentation, structured critical appraisal of an article, and close faculty supervision.	Journal clubs were conducted monthly over 12 months. Each journal club lasted for one hour and preceded by 60-90 minutes of preparation and supervision.	Each presenting resident was closely supervised by one of the investigators.

Bennett 1987[6]	The introduction of special training for tutors and the critical appraisal educational packages for students.	Critical appraisal educational packages including common patients' scenarios, relevant articles, and guide of the expected methodological standards.	Two-hour weekly tutorials were conducted over eight weeks (a group of 4-5 students on the same rotation who meet with their faculty tutor). Special tutor training sessions (4-5 hours in total)	Clinical epidemiologists with an average of three years' experience in teaching critical appraisal skills. Tutors were specialists in the same discipline as students' rotation.
Bradley 2002[7]	Active instruction on EBM search techniques and to review basic EBM searching.	Interactive, face-to-face, individualised active instructions based on the nature of the question and the searcher's level of skill.	A librarian was available two to three days per week for a month. Each session lasted approximately 15-30 minutes.	Three experienced medical librarians were responsible for 10 residents.
Bradley 2005[8]	Directed vs. self-directed EBM educational intervention.	Directed (as workshops) vs. self-directed (computer-assisted).	Five half-day sessions over two weeks.	
Brettle 2013[9]	Online vs. face-to-face tutorial sessions about information literacy skills.	Online interactive sessions compared to face-to-face sessions.	Two sessions (introductory and follow-up; one hour each) were delivered one month apart.	The same nursing subject librarian delivered both the face-to-face and online sessions.
Buchanan 2014[10]	Interactive vs. didactic EBP educational intervention.	Didactic presentations vs. small group interactive sessions. all face-to-face.	Two sessions were delivered one week apart (1st session: 4 hours, 2nd session: 2 hours).	Sessions were facilitated by two experienced EBP teachers (> 10-year experience). Teacher-to-student ratio varied between 1:3 to 1:18.
Cabell 2001[11]	Simple educational intervention of the well-built clinical question formulation.	The intervention consisted of 3 components: 1-hour didactic sessions, well-built clinical question cards and practical experience building questions.	The 1-hour weekly sessions over 6-8 weeks.	The teachers received specific training in EBM. Teacher-to-student ratio about 1:8.
Campbell 2013[12]	Knowledge translation intervention to improve EBP behaviour.	The intervention (online + face-to-face) included three-day interactive skills training workshop (role-playing and reflection) and multifaceted workplace supports.	Two 3-day workshops.	These workshops conducted by the investigators and senior clinician.
Carlock 2007[13]	Educational intervention to teach EBP searching skills.	Lecture/hands-on instruction (included introduction to CINAHL, keyword search, subject heading search) were delivered.	Two 30-minute sessions (small-group lectures and practical hands-on sessions).	A librarian delivered the sessions, with about 15 students in each session.

Cheng 2003[14]	Educational workshop (with supervised hands-on practice) to improve information-seeking skills and attitude.	The training workshop included live demonstrations, hands-on practice, exercises to formulate answerable questions and search appropriate databases.	Three-hour workshops in four 20-30 minute sessions.	
Cheng 2012[15]	Two strategies to integrate EBM into the undergraduate medical curriculum.	EBP structured case conference vs. didactic lectures about EBP. Both had face-to-face and online components.	Two weekly 1-hour session over two weeks.	Three experienced teachers (with more than 4 years of EBM teaching experience and 10 years of clinical experience; received 12-hour faculty development program focusing on teaching EBM). Each group had about 4-10 students.
Davis 2007[16]	Computer-based sessions vs. traditional lectures at postgraduate level within medicine.	Computer-based sessions or an equivalent lecture in EBM and systematic review.	Forty-minute sessions.	The same tutor at all the centres.
Davis 2008[17]	Two methods of teaching EBM.	Computer-based teaching vs. face-to-face, lecture-based teaching of EBM.	Seven 40-minute sessions were delivered.	The same tutor delivered both the computer-based and lecture-based teaching.
Dizon 2014[18]	EBP training program to improve EBP knowledge, skills, and behaviour.	Face-to-face training (in the form of lectures and practical sessions) with online support.	Six lectures with four practical sessions in-between.	Material on website.
Edwards 2001[19]	Teaching critical appraisal using journal clubs and letter writing exercises.	Small groups of students appraised a recently published article, presented it to their peers in a journal club and write a letter to the journal editor.	Four half-day sessions with a total contact time of 5 hours with 4.5 hours of directed self-study.	Each group was about 15-20 students.
Eldredge 2013[20]	Student peer assessment in EBM searching skills training.	An introductory didactic lecture and an interactive practical session about PubMed searching skills. Students were instructed to assess other students' assignments using predetermined criteria.	A one-hour introductory lecture and one-hour practical lab delivered once.	A faculty librarian delivered the lecture and practical sessions.
Erickson 1998[21]	Individual training sessions on use of Medline.	Individual training session, including hands-on instruction on how to design and perform the search.	One-hour training session.	Health science librarians

Feldstein 2010[22]	A brief interactive EBM workshop	An interactive EBM workshop with practical hands-on training.	The workshop lasted 4 hours.	A faculty member and a librarian delivered the workshop, which was conducted in the computer lab. The teacher-to-student ratio was about 1:11-12
Fernandez 2014[23]	Four teaching methods on EBP skills.	Four methods of teaching EBP were compared: interactive, self-directed standard distance learning; computer laboratory teaching; EBP-DVD teaching; and didactic classroom teaching.	Standard distance teaching: needs 15 weeks (10 hours/week) to be completed; computer lab: three 2-hour practical sessions; didactic: four 3.25-hour lectures and two 2.25-hour tutorials.	Computer laboratory sessions were delivered by a senior lecturer with extensive experience in EBP.
Forsetlund 2003[24]	An educational intervention to diffuse evidence-based health practice.	The intervention consisted of: workshop in evidence-based public health, a newsletter, access to a specially designed information service, relevant databases, and electronic discussion list. This included face-to-face and online webpage components.	Eleven workshops (each 1-5 days) were delivered over 1.5 years.	Two public health physicians and two librarians delivered the training programme.
Frasca 1992[25]	A collaborative course in teaching library and critical appraisal skills.	Two main components of this intervention: critical appraisal skills and searching skills.	Weekly 1.5-hour sessions over ten weeks.	The course was delivered by medicine and library faculty.
Fu 1999[26]	Teaching critical appraisal through journal clubs.	Journal clubs run weekly. Sessions about basic statistical concepts were also provided.	Weekly journal clubs, each lasting 1.5 hours, over 12 weeks. Four 45-minute sessions were also delivered.	A professor of psychiatry led the journal club and residents were responsible for facilitating the discussion.
Gardois 2011[27]	Assistance of biomedical librarians in bibliographic searches.	Interactive face-to-face refresher sessions about EBM basics was delivered along with the assistance provided to students.	EBM refresher sessions (over 2 days/ total 12 hours)	A librarian with 5 years of biomedical search experience had delivered the intervention.
Ghali 2000[28]	A mini-course of EBM.	Four interactive face-to-face sessions reflected the four steps of EBM (including group discussion of factual scenarios).	Four weekly 90-minute sessions.	Course was attended by 4-8 students at a time.
Green 1997[29]	Evidence-based medicine curriculum	A typical interactive face-to-face tutorial included: case presentation,	Seven, weekly, 1-hour tutorials.	Each tutorial was attended by 5-14 residents, directed by a resident

		clinical question, search results, critical appraisal of an article, and interpretation of the results.		and facilitated by a general medicine faculty member.
Griffin 1992[30]	Educational intervention to improve information retrieval.	Instructional booklet and supervised interactive hands-on practice.	One practical session lasting an hour.	The course instructor and several librarians delivered the intervention.
Gruppen 2005[31]	A single brief instructional intervention on EBM.	This intervention was the introductory session (the use of Medline in EBM) of a whole elective course in EBM. Sessions were both didactic and interactive.	A single two-hour session within a 4-week EBM elective.	Experienced medical librarians who had received training on EBP.
Haas 2012[32]	The integration of EBP curriculum in a chiropractic doctoral program.	The curriculum included three parts: 4 core EBP courses (face-to-face and interactive): 2 didactic and 2 journal clubs; critical learning modules dealing with EBP; and other program-related courses.	Four EBP courses: two were 20 contact hours and the other were 10 contact hours.	MDs with EBM background and a statistician delivered the courses. Teacher-to-student ratio varied from 1:120 to 1:10-15.
Hadley 2010[33]	A clinically integrated e-learning course for teaching EBM	An interactive online e-learning self-directed training sessions.	The e-learning course was intended to be completed in six weeks.	-
Haynes 1993[34]	Individualised feedback to improve Medline searching skills.	An introductory basic training in EBP was delivered then individualised feedback from a librarian on ten searches.	The basic training was for 2 hours (1-hour small group session and 1-hour individual practical session).	Teachers with extensive experience in Medline searching.
Hugenholtz 2008[35]	EBM course in combination with case method learning sessions.	The EBP training program consisted of didactic EBP course and ten Case Method Learning Sessions (CMLSs).	EBM training program lasted for four months: EBM course (three half-day over two weeks) and CMLSs (every other week, lasting for 1-1.5 hours).	Each CMLS peer group was 6-8 persons.
Ilic 2015[36]	A blended learning educational EBM intervention.	Blended learning approach integrated classroom activities (lecture/tutorial) with online and mobile learning.	The intervention consisted of a one-day workshop and ten 2-hour tutorial sessions.	-
Ilic 2013[37]	A blended-learning approach vs a didactic approach to learn EBM.	One-day block workshop (two tutorial sessions), the remaining eight sessions	Ten 2-hour tutorial sessions.	

		were small-group discussions about patient-based EBM scenarios.		
Ilic 2012[38]	A single workshop in EBM searching skills.	An EBM literature searching skills workshop, which included formal presentation, interactive computer-based searching session and self-directed learning tasks.	Single 2-hour workshop.	A subject librarian delivered the presentation.
Jalali-Nia 2011[39]	Evidence-based approach to nursing education	The intervention included four phases: EBP training for tutors, EBP workshop, courses based on EBP approach, evaluation of the intervention.	EBP training for tutors: two 3-day and 2-day workshops, 14 days apart. The EBP workshop was a one-day workshop.	-
Johnston 2009[40]	Problem-based learning (PBL) method for teaching EBM.	Small-group interactive sessions using PBL case format.	Two 2-hour sessions per body system block.	Faculty tutors (clinical or non-clinical) facilitated small-group (9-10 students).
Kim 2008[41]	EBM curriculum on critical appraisal of evidence and the use of electronic resources.	Interactive small-group sessions delivered and led by residents.	Six 2-hour workshop sessions for a over a month (12 hours in total).	A medical librarian and a general internist with extensive training in medical education led the sessions. There were 3-7 residents in each session.
Kim 2009[42]	EBP-focused interactive teaching strategy.	The intervention consisted of three phases: problem identification and evidence synthesis; EBP implementation strategies; and dissemination, delivered through interactive, face-to-face sessions.	Introductory 2-hour session. Each group had weekly clinical hours with their supervisors. At the end of the semester, two “sharing day” events were held.	A group of 4-5 students worked together on their EBP projects, closely supervised by their Clinical Practice instructor as well as their professors.
Kitchens 1989[43]	A curriculum in critical appraisal and clinical epidemiology.	The curriculum consisted of 17 sessions each where they discussed two articles: one clinical epidemiology (methodology) article and clinically related article.	Weekly 30- to 45-minute session for 17 weeks.	
Kok 2013[44]	A clinically integrated training program in EBM.	Mixed didactic and interactive small group-sessions were delivered.	5 contact days over a six-month period.	Two experienced tutors (who were knowledgeable in EBM and epidemiology) per group of 12 students.

Krueger 2006[45]	Teaching critical appraisal to undergraduate osteopathic students.	An interactive face-to-face teaching program including lectures, discussions, reading literature, and journal clubs.	A daily series of group workshops and lectures (6 hours of faculty time) over 6 weeks.	Each group of 8-10 students was taught entirely by one tutor.
Kulier 2009[46]	Clinical integrated e-learning course in EBM.	Self-directed online EBM teaching program with clinically related activities.	Delivered over 4-6 weeks.	
Kulier 2012[47]	Clinical integrated e-learning course in EBM.	The course was blended with face-to-face teaching and learning with a clinical trainer. Five recorded videos about the basic EBM knowledge.	Total duration was 8 weeks. The online components lasted for 2-3 hours and about 20 hours for assessment, feedback, and assignments.	A senior staff member preferably a specialist in obstetrics and gynaecology who is knowledgeable about basic EBM principles was facilitating the course.
Landry 1994[48]	A seminar about the use of medical literature.	Interactive seminars about different study designs and their distinguishing features.	Two 90-minute interactive seminars over two weeks.	-
Langkamp 1992[49]	Medical journal clubs to improve knowledge about clinical epidemiology and biostatistics.	Two didactic sessions on research designs, clinical epidemiology followed by eight journal clubs.	Monthly journal clubs at lunch time over eight months.	Two paediatric faculty members with training in epidemiology and biostatistics facilitated the journal clubs.
Lee 2007[50]	Integrated teaching intervention on clinical decision analysis.	Teaching session consisting of three lectures about the principles of clinical decisions, followed by two workshops: the critical appraisal of a cost-effectiveness paper, and economic analysis.	Three 40-minute lectures and two 1-hour workshops (total 4 hours) over two weeks.	Ten students were allocated to one tutor trained in clinical decision analysis.
Linzer 1988[51]	Medical journal clubs on critical appraisal skills.	The journal club discussed the presented topics, the methodological and epidemiological aspects of the selected article, and then the clinical utility of the suggested article.	Weekly journal club sessions; 2-3 hours of preparation.	The journal club was presented by a resident or intern and facilitated by a faculty member.
Linzer 1987[52]	Comparing two formats of medical journal club.	Journal clubs directed by faculty member interested in epidemiology and critical appraisal compared to journal clubs lead by subspecialists.	Weekly journal clubs over two years.	Group one: general medicine faculty member with special interest in clinical epidemiology, and critical appraisal; Group two: A chief medical resident with invited

				subspecialist interested in the topic.
MacAuley 1999[53]	Critical appraisal using the READER method.	A teaching session on the READER method of critical appraisal and then practical critical appraisal of two papers.	A 30-minute teaching session.	-
Macrae 2004[54]	A curriculum in critical appraisal skills with an internet-based journal club.	A curriculum in critical appraisal skills which included a clinical and methodological article, a listserv discussion, and clinical and methodological critiques.	Eight 1-month packages: 1-week for reading the articles; one-week discussion, comments and feedback provided; another one-week discussion and comments.	Surgeons with training in clinical epidemiology and content experts moderated the discussions.
Major-Kincade 2001[55]	Educational intervention in evidence-based ethics.	Small group interactive group discussions started with a case presentation.	40- or 60-minute group discussions held late in the afternoon.	A senior resident and two neonatologists with an interest in epidemiology and ethics delivered the intervention.
McLeod 2010[56]	Educational intervention comparing internet vs. moderated journal clubs.	Eight training packages, each contained a methodological and clinical article. A clinical scenario relevant to each package discussed in a listserv and a comprehensive review followed.	Each of the 8 packages had to be completed within a month, so the intervention lasted eight months.	Clinical and methodological experts had facilitated the discussion.
Mills 2002[57]	Teaching critical appraisal to complementary and alternative medicine students.	A didactic training session about question formulation, level of evidence and critical appraisal.	A 3.5-hour workshop on EBM.	
Olsen 2015[58]	A multifaceted clinically integrated training program in EBP.	Workshops, assignments, supervision, and exams. Workshops were a mixture of lectures (didactic sessions) and small-group interactive activities.	Four half-day workshops over six months.	Five physiotherapists from both academic and clinical positions, and with a range of expertise in EBP, physiotherapy, higher education, and research.
Radack 1986[59]	Teaching critical appraisal and application of medical literature.	Small group discussion seminars approaching specific areas through critical appraisal and problem-based learning.	Weekly 50-minute sessions over five weeks.	Each group had four to seven clinical students, supervised by one teacher.

Ramos-Morcillo 2015[60]	A brief basic EBM course for clinical nurses.	Training included two face-to-face sessions and online learning.	Two 5-hour sessions and weekly online learning activities (total of 30 hours).	Teacher to student ratio was 1:10.
Riegelman 1986[61]	Teaching skills to read medical literature.	Lectures on critical appraisal with practical supervised seminars.	12 hours of lectures and four hours of supervised seminars.	-
Romm 1989[62]	Teaching clinical epidemiology and appraisal skills.	Introductory session and then seven sessions. Participants divided into: small-group discussion vs. lecture based learning groups.	8 sessions.	Groups of 16-20 students each.
Rosenberg 1998[63]	Training in formulating questions and searching databases.	Small group training sessions.	A 3-hour training session.	Two experienced librarians facilitated the small group sessions (4-7 students each group).
Ross 2003[64]	EBM curriculum in family medicine residency.	Ten-session EBM interactive workshop series introduced to the curriculum.	10 sessions, each 1-2 hours (brief lecture: 30-40 minutes followed by practical sessions).	
Sanchez-Mendiola 2004[65]	Teaching EBM.	Sessions to guide the students through the EBM process.	14 two-hour sessions.	
Sanchez-Mendiola 2012[66]	Teaching EBM to medical students.	A one-semester EBM course included: large group interactive sessions, small-group problem-solving activities, individual and group assignments, and informatics laboratory sessions	Fourteen, 2-hour weekly sessions.	The course faculty were six professors trained in EBM teaching, all board- certified physicians with clinical practice experience.
Schaafsma 2007[67]	Training in literature searching skills	EBM introduction course then a practical hands-on training in literature searching and critical appraisal of the literature.	A 4-day course.	-
Schilling 2006[68]	A web-based curriculum on EBM	An interactive, web-based curriculum on key aspects of EBM including discussion of actual patients.	A 6-week course, with 40-60 minutes commitment each week.	A faculty member moderated the discussion.
Schoonheim-Klein 2012[69]	Evidence based dental medicine course.	The intervention included the implementation of a community of learners within the course to discuss the application of evidence in practice.	Each session was 1.5 hours over six months.	Researchers and senior scientists advised students about their progress.

Seelig 1993[70]	Educational intervention in critical appraisal.	An interactive seminar about practical approaches for keeping up with literature and critical appraisal skills.	A 1-hour seminar.	-
Shorten 2001[71]	A curriculum-integrated program on searching skills.	A series of lectures and laboratory/ tutorial sessions.	-	The faculty librarian and the members of the teaching team.
Shuval 2007[72]	EBM educational intervention.	Three workshops and six sessions, which were integrated and interactive.	Three workshops over 6 months and six sessions over 10 months.	Thirteen family doctors with teaching experience of EBM and who attended a 12-hour course focusing on EBM teaching delivered the intervention.
Smith 2000[73]	Teaching EBM skills.	Two weekly sessions: one didactic lecture and the other interactive seminar.	Two weekly 2-hour sessions over seven weeks.	Three senior faculty members, and six chief medical residents.
Stark 2007[74]	Searching tutorial for residents.	Each resident did a brief oral case presentation and structured clinical questions and search results.	Six 1-hour weekly sessions.	A medical research librarian and 1–3 faculty members had supervised the intervention.
Stevenson 2004[75]	Evidence-based educational programme.	Interactive sessions included: teaching, discussion, reflective thinking, active experimentation, and peer group teaching.	Two 2.5-hour sessions.	
Stevermer 1999[76]	Academic detailing intervention.	One-to-one academic detailing intervention with residents.	29 15-minute sessions over two weeks.	-
Taylor 2004[77]	Critical appraisal skill training for health professionals.	Workshops based on the critical appraisal skills programme (CASP).	A half-day workshop (three 60-minute sessions)	Three to four individuals, each of whom had formal training in health services research methods and were experienced in delivering CASP workshops.
Thomas 2005[78]	Conferences vs. discussion group to teach EBM.	Each conference had two presentations. Small group discussions were interactive.	Four weekly 45-minute conferences vs. four weekly 1-hour small-group discussions.	Chief medical resident as facilitator for EBM small-group discussions.
Verhoeven 2000[79]	Citation retrieval methods for general practitioners.	The intervention included an introductory lecture and on-site training.	15 one-day training sessions were delivered (included 2-hour lecture).	A professional librarian delivered the intervention.

Viniegra 1986[80]	Critical appraisal course.	The course involved the selection of 25 published reports of clinical research.		
Vrdoljak 2015[81]	Academic detailing to improve EBM knowledge and skills.	Students (academic detailers) had reported and discussed with their monitors two EBM case presentations.	Over two weeks.	
Wallen 2010[82]	A structured multi-faceted mentorship program.	An intensive EBP workshop followed by ongoing mentorship skill-building activities.	A 2-day workshop.	
Welch 2014[83]	EBP educational intervention for athletic trainers.	Web-based interactive learning.	Self-pacing, each module need 20-25 minutes to be completed.	Website contents were developed by five EBP subject-matter experts who had experience in EBP education and research.

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When one teaches … two learn
Asking the right questions takes as much skill as giving the right answers.

—Robert Heinlein

4

Chapter 4
EBP Content and Measures

Heterogeneity in the outcome measures used to evaluate EBP educational interventions

Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured

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Preamble

In our review of the current literature on EBP education (**Chapter 2**), we observed that the inadequate reporting of intervention details in EBP educational studies (that was discussed in **Chapter 3**) was not the only challenge facing the research evidence evaluating EBP education. One major challenge is the differences in the content of EBP educational interventions and the outcome measures used to evaluate these interventions. We have collected a large proportion of missing intervention details, intervention materials in particular, in the previous chapter. Therefore, we were able to use this information to examine the differences in the coverage of the five EBP steps as well as the domains of outcomes measured in published studies evaluating EBP educational interventions.

This chapter contains an article entitled "*Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured*", published in BMC Medical Education on August 2018. It systematically examines the differences in the EBP content covered, describes the outcome domains measured, and evaluates the psychometric properties of the instruments used in evaluating EBP educational interventions.

Work arising from this chapter was also presented in oral form at the annual higher degree research conference at Bond University.

4.1 Abstract

Background

Despite the established interest in evidence-based practice (EBP) as a core competence for clinicians, evidence for how best to teach and evaluate EBP remains weak. We sought to systematically assess coverage of the five EBP steps, review the outcome domains measured, and assess the properties of the instruments used in studies evaluating EBP educational interventions.

Methods

We conducted a systematic review of controlled studies (i.e. studies with a separate control group) which had investigated the effect of EBP educational interventions. We used citation analysis technique and tracked the forward and backward citations of the index articles (i.e. the systematic reviews and primary studies included in an overview of the effect of EBP teaching) using Web of Science until May 2017. We extracted information on intervention content (grouped into the five EBP steps), and the outcome domains assessed. We also searched the literature for published reliability and validity data of the EBP instruments used.

Results

Of 1831 records identified, 302 full-text articles were screened, and 85 included. Of these, 46 (54%) studies were randomised trials, 51 (60%) included postgraduate level participants, and 63 (75%) taught medical professionals. EBP Step 3 (critical appraisal) was the most frequently taught step (63 studies; 74%). Only 10 (12%) of the studies taught content which addressed all five EBP steps. Of the 85 studies, 52 (61%) evaluated EBP skills, 39 (46%) knowledge, 35 (41%) attitudes, 19 (22%) behaviours, 15 (18%) self-efficacy, and 7 (8%) measured reactions to EBP teaching delivery. Of the 24 instruments used in the included studies, 6 were high-quality (achieved ≥3 types of established validity evidence) and these were used in 14 (29%) of the 52 studies that measured EBP skills; 14 (41%) of the 39 studies that measured EBP knowledge; and 8 (26%) of the 35 studies that measured EBP attitude.

Conclusions

Most EBP educational interventions which have been evaluated in controlled studies focus on teaching only some of the EBP steps (predominantly critically appraisal of evidence) and did not use high-quality instruments to measure outcomes. Educational packages and instruments which address all EBP steps are needed to improve EBP teaching.

4.2 Background

Evidence-Based Practice (EBP) is the integration of the best available research evidence with clinical expertise and patient's unique values and preferences (i.e. personal concerns, expectations, cultural influences and individual characteristics during the clinical encounter)[1]. The Institute of Medicine (IOM), accreditation councils and health professional bodies consider EBP as a core competency needed for health professionals[2-4]. Hence, EBP has become an integral part of undergraduate, postgraduate, and continuing health professional education curricula[5].

Despite the established interest in evidence-based practice (EBP) as a core competency for clinicians, evidence for how to effectively teach it remains suboptimal. Fifteen years ago, Hatala and Guyatt highlighted this: "the quantity and quality of the evidence for effectively teaching EBM are poor. Ironically, if one were to develop guidelines for how to teach EBM based on these results, they would be based on the lowest level of evidence"[6]. The disproportionate focus on critical appraisal compared to the other four steps in the EBP process (question formulation, searching, applying, and self-assessment) is a major shortcoming of the current literature for teaching EBP[6-8]. A review of 20 EBP educational interventions for undergraduate medical students found that these interventions stressed certain EBP steps (asking clinical question, acquire evidence, and critical appraisal) but pay less attention to others (apply, and assess and reflect)[9]

In addition, the lack of high-quality validated instruments to establish the effect of an educational intervention is also a shortcoming[6]. In 2006, Shaneyfelt et al systematically identified 104 unique instruments for evaluating EBP teaching, the majority (90%) of which were not high quality instruments[10]. High quality instruments were those with established inter-rater reliability, objective outcome measures, and three or more types of established validity[10]. The 'Fresno test of competence in evidence based medicine'[11] and the Berlin Questionnaire[12] were the only high-quality instruments identified as evaluating EBP knowledge and skills across 3 of the 5 EBP steps[10]. In 2011, a classification rubric for EBP instruments in education (the CREATE framework) was developed to help EBP educators identify the best available EBP instruments for their educational needs[13].

Whether progress has been made to address these shortcomings (focus on EBP Step 3 and lack of high quality EBP instruments) is unclear. Therefore, we sought to systematically assess coverage of the five EBP steps in educational interventions, review the domains of outcomes measured in EBP educational interventions, and assess the psychometric properties of the instruments used in studies evaluating EBP educational interventions.

The review question was: "What are the contents of EBP educational interventions and how are the effects of EBP educational interventions measured?"

4.3 Methods

We updated the search of a previously conducted systematic review of studies which evaluated the effect of EBP educational interventions (searched until March 2017)[14] to find additional studies and extract additional information on content, outcome domains and EBP instruments.

Eligibility Criteria

We included studies that were: controlled (studies with a separate control group, e.g. randomised controlled trials or non-randomised controlled trials); investigated the effect of EBP educational intervention which aimed to teach at least one component of the main EBP steps (of any format or mode - e.g. workshop, course, journal club); among health professionals (irrespective of the discipline or the level of training - undergraduate, postgraduate, or continuous professional education).

Search strategy

We used a forward and backward citation analysis technique using the Web of Science database (until May 2017), with no language or publication year restrictions. Citation analysis can be used to identify all the articles that cited ("forward citation") or were cited by ("backward citation") the index articles. The index articles were the systematic reviews and primary studies included in an overview of systematic reviews of the effect of EBP teaching[15]. The Cochrane highly sensitive search filter for identifying controlled trials was applied[16]. In addition, the reference lists of included studies were also reviewed, and additional eligible studies were included for full-text assessment. Further, we searched the literature in Web of Science for published reliability and validity data of the EBP instruments reported in the included studies – using terms including the reference cited in the included article, the name of tool, and the authors involved in the development of the tool.

Study selection

Titles and abstracts were screened to identify potentially eligible studies, and the full texts of these were assessed for inclusion by one of the authors (LA). Any concerns about study eligibility were discussed and resolved by all authors.

Data extraction and analysis

We extracted data on study characteristics including publication year, country, sample size, design, and population. We extracted information on intervention content (EBP steps covered in the educational intervention) and categorised it into the five EBP steps[17]. We also extracted information on the outcome domains measured and organised them into the 7 categories according to Tilson et al[13]: (i) Reaction to the EBP educational experience; (ii) Attitudes about EBP; (iii) Self-efficacy for conducting EBP; (iv) Knowledge about EBP principles; (v) Skills for performing EBP; (vi) Behaviour congruent with EBP as part of patient care; and (vii) Benefit to Patients associated with EBP. All three authors independently extracted data from a random sample of 20 articles and discussed extractions until consensus achieved. Data from the remaining articles were extracted by one of the authors (LA).

We also extracted information on the reliability and validity of the EBP instruments reported in the included studies – either from the included studies or retrieved articles from our search. The methods to evaluate the quality of instruments were based on those used by Shaneyfelt et al[10] – high quality instruments should be supported by established interrater reliability (if applicable), objective (non–self-reported) outcome measures, and multiple (≥3) types of established validity evidence (including evidence of discriminative validity). Instruments that did not meet the criteria of high quality instruments were labelled low quality instruments. We considered the reliability and validity of an instrument as "established" if the corresponding statistical test was significant (e.g. quantitative assessment of the reliability and validity of an instrument was not enough).

4.4 Results

Of 1831 records retrieved by our search, 962 titles and abstracts were screened for eligibility. Of these, 302 full-text articles were screened for inclusion, and 217 articles were excluded (**Figure 4.1** shows the PRISMA flow chart). Of 85 included articles, 46 (54%) were randomized trials, 51 (60%) included postgraduate level participants, and 63 (75%) taught medical professionals. **Table 4.1** shows characteristics of the included studies (See also **Supplementary material 4.1** for a detailed description of each included study).

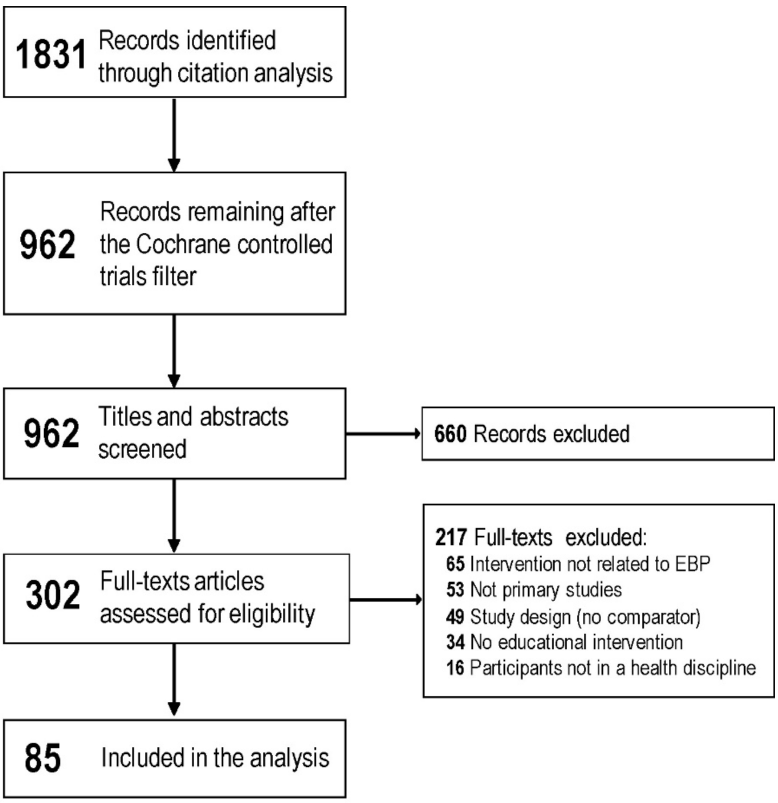

Figure 4.1. PRISMA flow chart of the systematic review

Content coverage of EBP steps in included studies

EBP step 3 (critical appraisal of evidence) was the step taught most frequently in EBP educational interventions (n=63; 74%), followed by step 2 (acquiring the evidence; n= 52; 63%) and step 1 (asking a clinical question; n=51; 61%) (**Figure 4.2**). About one-third of the studies (n=30; 36%) covered only one of the five EBP steps, most commonly step 3 (critical appraisal of evidence). Only 10 (12%) studies covered all five EBP steps. However, the proportion of studies which taught all five steps increased over time - from 1 study (of 39; 3%) in years before 2004 to 6 studies (of 27; 22%) in 2010-2016, with a particular increase in coverage of steps 4 and 5.

Table 4.1 Characteristics of the 85 included studies of EBP educational interventions

Characteristics	No. (%)
Location	
USA	35 (41%)
Europe	27 (32%)
Australia	7 (8%)
Canada	7 (8%)
Others	9 (11%)
Publication year	
< 2000	21 (25%)
2000-2004	18 (21%)
2005-2009	17 (20%)
≥ 2010	29 (34%)
Health disciplines	
Medical	63 (74%)
Nursing	8 (9%)
Allied health professions	14 (17%)
Training level	
Undergraduate	32 (38%)
Postgraduate	51 (60%)
Both	2 (2%)
Study design	
Randomised controlled trials	46 (54%)
Non-randomised controlled trials	39 (46%)

Outcome domains measured and quality of EBP instruments

Of the 85 included studies, 52 (61%) evaluated EBP skills, 39 (46%) knowledge, 35 (41%) attitudes, 19 (22%) behaviours, 15 (18%) self-efficacy, and 7 (8%) measured students' reaction to the educational experience. None measured benefits to patients associated with EBP.

High-quality instruments (achieved ≥3 types of established validity evidence) were used across: 14 (29%) of 52 studies that measured EBP skills; 14 (41%) out of 39 studies that measured EBP knowledge; and 8 (26%) out of 35 studies that measured EBP attitude. None of the instruments used to measure EBP self-efficacy and behaviour were of high quality. **Table 4.2** shows the overall outcome domains measured and quality of EBP instruments used in the included studies.

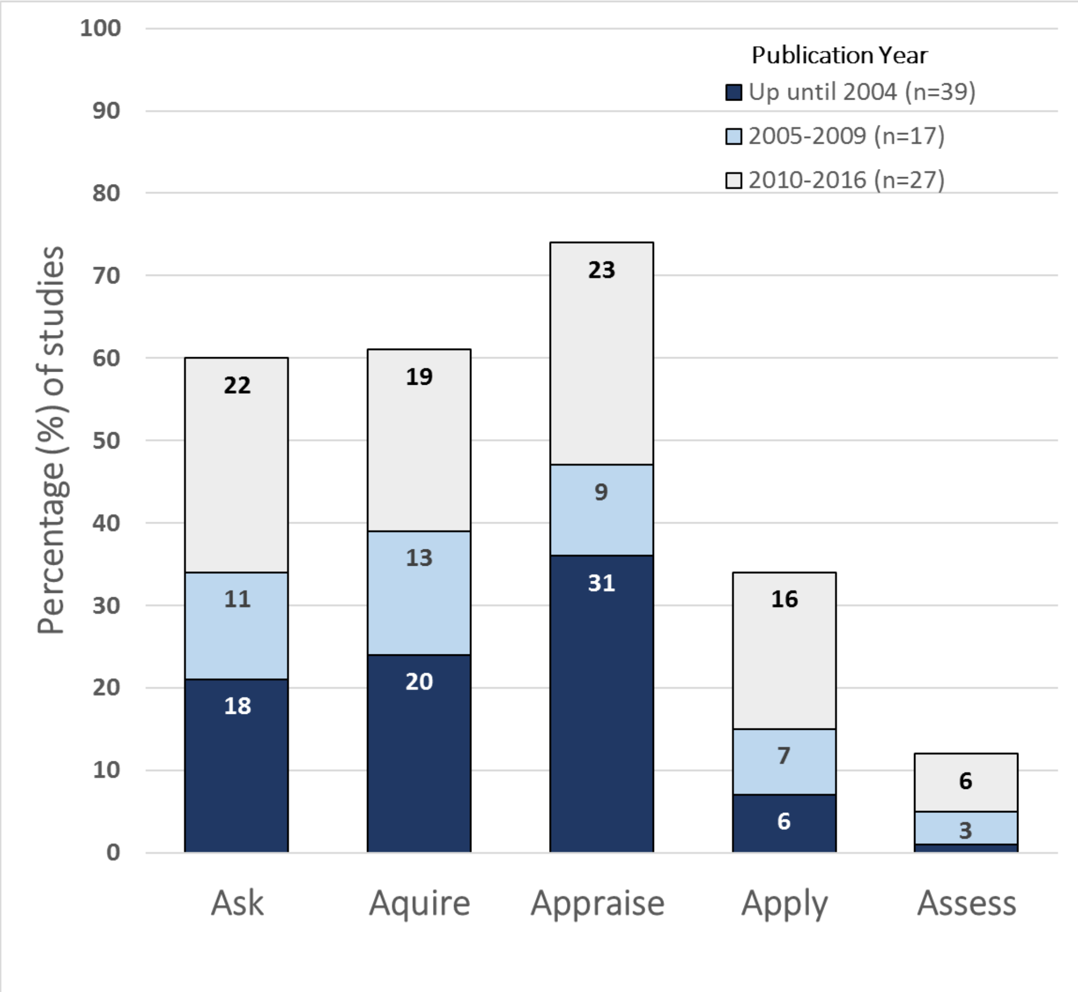

Figure 4.2. Percentage (numbers in bars) of studies which teach each of the 5 EBP steps (1: ask; 2: acquire; 3: appraise; 4: apply; 5: assess), grouped by publication year

High-quality instruments used in EBP educational studies

Of the 24 previously developed instruments that were used across all included studies, 6 (25%) instruments were rated as high quality (**Table 4.3**). Four of these (Fresno Test[11], Berlin Questionnaire[12], Taylor et al[18], and Assessing Competency in EBP "ACE" tool[19]) were used to measure both EBP knowledge and skills. The other two were used to measure either EBP knowledge[20] or skills[21]. The Fresno Test, Berlin Questionnaire, and Assessing Competency in EBP "ACE" tool evaluated three of the five EBP steps (ask, acquire, and appraise and interpret). Taylor et al evaluated EBP step 2 and 3 (acquire, and appraise and interpret), Utrecht questionnaire evaluated EBP step 3 and 4 (appraise and interpret, apply)[20], and MacRae et al evaluated EBP step 3 only[21]. **Table 4.3** summarises high-quality instruments used in EBP educational interventions.

Table 4.2 Outcome domains and psychometric properties of instruments used in studies of EBP educational interventions (n=85). Presented as number (%) of included studies within each measured outcome domain

	Reaction to EBP Teaching Delivery	Attitude	Self-efficacy	Knowledge	Skills	Behaviours	Patient Benefit
Of 85 included studies, number measuring this outcome domain	7	35	15	39	52	19	0
Studies using previously developed instruments	0/7 (0)	24/35 (69)	5/15 (33)	24/39 (62)	20/52 (38)	7/19 (37)	0/0 (0)
Participant self-reported measure	7/7 (100)	35/35 (100)	15/15 (100)	0/39 (0)	0/52 (0)	18/19 (95)	0/0 (0)
Published/reported psychometric properties							
Inter-rater reliability†	0/7 (0)	0/35 (0)	0/15 (0)	8/39 (21)	15/52 (38)	2/19 (11)	0/0 (0)
Content validity†	0/7 (0)	12/35 (34)	2/15 (13)	19/39 (49)	15/52 (38)	2/19 (11)	0/0 (0)
Internal validity†	0/7 (0)	20/35 (57)	5/15 (33)	26/39 (67)	17/52 (44)	8/19 (42)	0/0 (0)
Responsive validity†	0/7 (0)	8/35 (23)	1/15 (7)	11/39 (28)	10/52 (26)	1/19 (5)	0/0 (0)
Discriminative validity†	0/7 (0)	9/35 (26)	4/15 (27)	15/39 (38)	16/52 (41)	0/19 (0)	0/0 (0)
Criterion validity†	0/7 (0)	4/35 (11)	1/15 (7)	2/39 (5)	1/52 (3)	2/19 (11)	0/0 (0)
Instrument ≥ 3 types of established validity†	0/7 (0)	8/35 (23)	0/15 (0)	14/39 (36)	14/52 (27)	0/19 (0)	0/0 (0)

† considered 'established' and counted if the corresponding statistical test was significant. Abbreviation: EBP, Evidence-based practice.
Definitions: inter-rater reliability, the degree to which the measurement is free from measurement error; content validity, external review of the instrument by EBP experts; internal validity, includes both internal consistency (i.e. the degree of the interrelatedness among the items) and dimensionality (i.e. factor analysis to determine if the instrument measured a unified latent construct); responsive validity, ability to detect the impact of EBP ; discriminative validity, ability to discriminate between participants with different levels of EBP ; criterion validity, the relationship between the instrument scores and participants' scores on another instrument with established psychometric properties.

Table 4.3 High quality instruments (achieved ≥3 types of established validity evidence) used in some of the included studies.

Source instrument name and date	Instrument development	Outcome domain	EBP steps*	Instrument Description	Type of validity/ reliability evidence
Ramos et al 2003[11] (Fresno Test)	43 Family practice residents and faculty members, 53 experts in EBM, and 19 family practice teachers (US).	Knowledge and skills	1,2,3	The Fresno test was originally developed and validated to assess medical professionals' knowledge and skills in EBP, however, it has been adapted for use in other health disciplines (e.g. occupational therapy[22], physical therapy[23], and pharmacy[24]) and in other languages (e.g. Brazilian-Portuguese version[25]). It consists of two clinical scenarios with 12 open-ended questions. It needs about 40-60 minutes to complete and 10-15 minutes to mark using standardised grading rubrics (scores ranged from 0–21).	Content Internal consistency Discriminative Inter-rater reliability
Fritsche et al 2002[12]; Akl et al 2004[26] (Berlin Questionnaire)	43 experts in EBM, 20 medical students, 203 participants in EBP course (Germany); 49 Internal medicine residents in Non-randomized controlled trial of EBP curriculum (US)	Knowledge and skills	1,2,3	The Berlin questionnaire was developed and validated to assess EBP knowledge and skills in medicine, but has been translated and validated in other languages (e.g. Dutch[27]). It consists of two separate sets of 15 multiple choice questions with 5 response option each, which mainly focus on epidemiological knowledge and skills (scores ranged from 0-15).	Content Internal consistency Discriminative Responsive
Ilic et al. 2014[19] (ACE tool)	342 medical students: 98 EBM-novice, 108 EBM-intermediate and 136 EBM advanced (Australia).	Knowledge and Skill	1,2,3	ACE tool was also developed and validated to assess EBP knowledge and skills in medicine and consists of 15 dichotomous-choice (yes or no) questions, based on a short patient scenario, a relevant search strategy and a hypothetical article extract (Scores ranged from 0-15).	Content Internal consistency Discriminative Responsive Inter-rater reliability
Taylor et al. 2001[18]; Bradley et al 2005[28]; Sánchez-	152 health care professionals (UK); 175 medical students	Attitude, knowledge, skill	2,3	Part I: 6 multiple-choice questions each with three items, with 3 potential answers, each requiring a true, false, or "don't know" response; the range of scores is -18 to 18.	Content Internal consistency Discriminative

Mendiola et al 2012[29] (Spanish version)	(Norway); 289 medical students (Mexico)			Part II: 7 statements related to the use of evidence in practice, and each scored using a five-point Likert scale; the range of scores is 7 to 35.	Responsive
Kortekaas et al 2017[20] (Utrecht questionnaire "U-CEP") in Dutch	219 general practice (GP) trainees, 20 hospital trainees, 20 GP supervisors, and 8 expert academic GPs or clinical epidemiologists (The Netherlands)	Knowledge	3,4	Two formats: two sets of 25 comparable questions (6 open-ended and 19 multiple-choice questions) and a combined set of 50 questions. Multiple-choice question scored 1 for correct and 0 for incorrect answer. Open-ended questions scored 0 to 3. Scores ranged from 0-33 for set A and 0-34 for set B.	Content Internal consistency Discriminative Responsive Inter-rater reliability
MacRae et al 2004[21]	44 Surgery residents (Canada)	Skill	3	3 Journal articles, each followed by a series of short-answer questions and 7-point scales to rate the quality of elements of the study design; short-answer questions based on cards from an EBP textbook (Evidence-Based Medicine: How To Practice And Teach It)	Internal consistency Discriminative Responsive

3.5 Discussion

Our systematic review of controlled studies of EBP educational interventions found that only 12% of interventions taught content that covered all five EBP steps. Over half of the 85 EBP educational studies did not use a high quality instrument to measure their outcomes of interest. Only six high quality EBP instruments were used in the included studies, but none were designed to evaluate all five EBP steps.

Although few of interventions taught content that covered all five EBP steps, increasing recognition of the importance of the "apply" step of EBP through processes such as shared decision making may account for increased coverage of the fourth step in more recent years[30].

This is the first systematic review that we are aware of to evaluate the instruments used in EBP educational studies. However, there are a number of previous systematic reviews that have identified and evaluated all available EBP instruments (whether used in controlled educational studies or not), and these also found only a small number of high quality instruments. Shaneyfelt et al identified 104 unique instruments for evaluating the effectiveness of EBP training, the majority of which were developed or tested with medical students or trainees. Seven of the 104 instruments identified in Shaneyfelt and colleagues' review were recognised as high quality instruments (i.e. supported by established inter-rater reliability, objective outcome measures, and three or more types of established validity)[10].

Thomas et al found that only the Fresno test has been assessed with more than one group of family physician residents and reported a full set of validity and reliability measures[31]. Leung et al identified 24 different instruments for measuring EBP knowledge, skills and attitude among nurses, and found that only one (the revised EBPQ[32]) had adequate validity for measuring knowledge, skills and attitudes in EBP[33]. Oude et al found that of 160 EBP instruments for assessing EBP behaviour (i.e. only one of the seven outcome domains that we addressed) among health professionals, no instruments have established validity and reliability that assessed all five EBP steps[34].

The CREATE framework proposed guidance for developing new EBP instruments by purposively classifying the assessment domains (e.g. self-efficacy, knowledge, skills) and types (e.g. self-report, performance assessment) within the five EBP steps[13]. Development and agreement on a core set of valid and reliable recommended instruments to measure outcome domains is essential to reliably establish the effectiveness of EBP educational interventions. This would include evaluation of previously developed validated EBP instruments (e.g. Fresno test, Berlin Questionnaire) across health disciplines, and translation of these tools into other languages using standardised methods. EBP instruments measuring the clinicians' use of EBP processes in practice (e.g. frequency of search for evidence) are needed. Innovative new approaches to evaluate EBP teaching (e.g. objective structured clinical examination[35], use of standardised patients within the context of a performance-based examination[36], use of audio-recording in clinics[37]) that balance robustness with feasibility should be explored. Despite the ultimate goal of EBP education being to improve the quality of care and patient outcomes, it is nearly impossible to measure this[38]. In a systematic review of 599 research articles published in three major medical education journals, patient outcomes accounted in only 0.7% of all articles[39]. Some of the factors that can impede measuring the impact of EBP education on the quality of care and patient outcomes include: the impact of educational interventions is often latent and distant; and the dominant role of the overarching team and health care system on quality of care and patient outcomes[40,41].

Similar to previous studies[7,8], we found that the majority of evaluated EBP educational interventions focus on critically appraising evidence (EBP Step 3), often to the exclusion of other steps (i.e. apply and reflect). If EBP educational interventions remain mostly focused on teaching how to locate and appraise evidence, research evidence may be poorly translated into clinical practice. Instead, greater emphasis should be placed on teaching learners how to apply and the evidence in collaboration with individual patients such as through shared decision making. An International consensus statement of core competencies in EBP for health professionals has been recently developed and includes 68 core competencies that should be taught in EBP educational programs[42]. This may help to harmonise the content of EBP educational interventions, and with possibly flow-on effect to the measured outcomes.

This systematic review has a number of limitations. We may have missed some relevant studies by using citation analysis as the searching method. However, the accuracy rate of citation analysis has been found to be acceptable[43,44]. For instance, using this technique, Janssens and Gwinn identified 94% [75-100%] of all articles included in 10 systematic reviews that were originally used the conventional search strategy[43]. Therefore, overall conclusions are unlikely to be affected. Screening and data extraction were performed by one author, and multiple researchers independently extracted data from only a random sample of 20 articles. Another limitation is that we might have inaccurately rated the psychometrics properties of EBP instruments as for some instruments this judgement was limited by inadequate reporting of the results of psychometric testing.

Our findings have a number of implications for health educators and researchers. EBP educators should identify specific assessment tools (for formative and summative use) that provide accurate, reliable, and timely evaluation of the EBP education being provided and map these assessment tools to the EBP domains targeted. If necessary, educators may need to develop appropriate assessment tools designed specifically to evaluate the identified gaps in EBP assessment tools (e.g. EBP step 4: apply), and recognise the need to evaluate the psychometric properties of any tools developed.

4.6 Conclusions

After over two decades of EBP teaching which has spread across professions and clinical settings, the majority of evaluated EBP educational interventions remain focussed on critically appraising evidence (EBP Step 3), often to the exclusion of other steps (i.e. apply and reflect). There are few validated instruments that have been developed and utilised in EBP educational intervention studies; and these predominantly focus on certain domains (i.e. knowledge and skills) and EBP steps (i.e. appraise). This might limit the ability to evaluate the impact of EBP educational interventions.

4.7 Declarations

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

LA, TH, and PG contributed to the design of the study. LA drafted the original manuscript. LA, TH, and PG contributed to the revision of the paper and approved the final manuscript for submission.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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4.9 Supplementary materials 4

Published with article presented in **Chapter 4**

Supplementary material 4.1

Detailed description of each included study the systematic review of EBP educational studies presented in **Chapter 4**

Study	Location, language, and participants	Summary of the intervention
Akl 2004	40 medical students and residents rotating with the general internal medicine team at a university hospital.	EBM elective rotation within the internal medicine residency program in three teaching hospitals (one as an intervention group and the other two as a control group). Interactive small-group sessions (critical appraisal); On-the-ward feedback about the evidence-based answers for problematic issues (through the application of EBM steps). A two-week rotation including two 45-minute interactive lectures on the 2nd and 5th day about the basic concepts of EBM. The EBM residents are senior internal medicine residents within the general internal medicine ward team (one attending physician, one or two 2nd or 3rd year residents, two interns, and one or two medical students)
Al-Baghali 2013	Saudi Arabia, English; 59 medical doctors in primary health care centres	EBM workshops vs. other primary healthcare activities. Each EBM workshop lasted for 7 hours per day for 3 consecutive days. The workshops were conducted at Primary Health Administration Centre.
Badgett 2001	US, English; 157 third-year medical students	The intervention had two parts: (1) providing computers and this automated search internet-site and (2) delivering of a course about how to find and appraise medical evidence using these resources. A face-to-face and interactive course about searching medical evidence and developing an internet site that automates searching for medical evidence (SUMSearch). Four sessions (three 90-minute each and one 60-minute) were delivered over four weeks. Two teachers (a medical doctor and a medical librarian; each had an experience of 5-10 years). Two teachers to 10-12 students.
Balajic 2012	Croatia, Croatian; 1232 medical students in 3 medical schools.	A vertical course on research in biomedicine and health as part of the medical curricula in three medical schools. These courses on research methodology were adjusted to the students' needs (1st year students learned about types of research studies vs. 6th year students who learned practical advanced skills to prepare undergraduate thesis). This course lasted through the entire 6-year medical curriculum. In each rotation, each student had to answer two clinical questions by applying the EBM steps.
Bazarian 1999	US, English; 32 emergency medicine residents	Journal clubs using EBM approach. Highly structured EBM journal club containing three elements: case-based presentation, structured critical appraisal of an article, and close faculty supervision. Journal clubs were conducted monthly over 12 months. Each journal club lasted for one hour and preceded by 60-90 minutes of preparation and supervision. Each presenting resident was closely supervised by one of the investigators.
Bennett 1987	Canada, English; 79 final-year medical students	The introduction of special training for tutors and the critical appraisal educational packages for students. Critical appraisal educational packages including common patients' scenarios, relevant articles, and guide of the expected methodological standards. Two-hour weekly tutorials were conducted over eight weeks (a group of 4-5 students on the same rotation who meet with their faculty tutor); Special tutor training sessions

		(4-5 hours in total); Clinical epidemiologists with an average of three years' experience in teaching critical appraisal skills; Tutors were specialists in the same discipline as students' rotation.
Bradley 2002	US, English 10 residents in neonatal care unit	Active instruction on EBM search techniques and to review basic EBM searching. Interactive, face-to-face, individualised active instructions based on the nature of the question and the searcher's level of skill. A librarian was available two to three days per week for a month. Each session lasted approximately 15-30 minutes. Three experienced medical librarians were responsible for 10 residents.
Bradley 2005	Norway; 175 tenth-semester medical students	Directed vs. self-directed EBM educational intervention. Directed (as workshops) vs. self-directed (computer-assisted). Five half-day sessions over two weeks.
Brettle 2013	UK, English; 77 first-year undergraduate pre-registration diploma nursing students	Online vs. face-to-face tutorial sessions about information literacy skills. Online interactive sessions compared to face-to-face sessions. Two sessions (introductory and follow-up; one hour each) were delivered one month apart. The same nursing subject librarian delivered both the face-to-face and online sessions.
Buchanan 2014	South Africa, English; 56 practising occupational therapists	Interactive vs. didactic EBP educational intervention. Didactic presentations vs. small group interactive sessions. all face-to-face. Two sessions were delivered one week apart (1st session: 4 hours, 2nd session: 2 hours). Sessions were facilitated by two experienced EBP teachers (> 10-year experience). Teacher-to-student ratio varied between 1:3 to 1:18.
Cabell 2001	US, English; 48 internal medicine resident physicians	Simple educational intervention of the well-built clinical question formulation. The intervention consisted of 3 components: 1-hour didactic sessions, well-built clinical question cards and practical experience building questions. The 1-hour weekly sessions over 6-8 weeks. The teachers received specific training in EBM. Teacher-to-student ratio about 1:8.
Campbell 2013	Australia, English; 135 allied health professionals from four regions in Australia.	Knowledge translation intervention to improve EBP behaviour. The intervention (online + face-to-face) included three-day interactive skills training workshop (role-playing and reflection) and multifaceted workplace supports. Two 3-day workshops. These workshops conducted by the investigators and senior clinician.
Carlock 2007	US, English; 90 junior first-semester nursing students	Educational intervention to teach EBP searching skills. Lecture/hands-on instruction (included introduction to CINAHL, keyword search, subject heading search) were delivered. Two 30-minute sessions (small-group lectures and practical hands-on sessions). A librarian delivered the sessions, with about 15 students in each session.
Cheng 2003	China; 800 healthcare clinicians (medical doctors, nurses, allied health professionals)	Educational workshop (with supervised hands-on practice) to improve information-seeking skills and attitude. The training workshop included live demonstrations, hands-on practice, exercises to formulate answerable questions and search appropriate databases. Three-hour workshops in four 20-30-minute sessions.

Cheng 2012	Taiwan, Mandarin; 94 final-year medical students	Two strategies to integrate EBM into the undergraduate medical curriculum. EBP structured case conference vs. didactic lectures about EBP. Both had face-to-face and online components. Two weekly 1-hour session over two weeks. Three experienced teachers (with more than 4 years of EBM teaching experience and 10 years of clinical experience; received 12-hour faculty development program focusing on teaching EBM). Each group had about 4-10 students.
Davis 2007	UK, English; 179 first medical students	Computer-based sessions vs. traditional lectures at postgraduate level within medicine. Computer-based sessions or an equivalent lecture in EBM and systematic review. Forty-minute sessions. The same tutor at all the centres.
Davis 2008	UK, English; 55 newly qualified foundation year doctors	Two methods of teaching EBM. Computer-based teaching vs. face-to-face, lecture-based teaching of EBM. Seven 40-minute sessions were delivered. The same tutor delivered both the computer-based and lecture-based teaching.
Dizon 2014	Philippines; 54 practising physical therapists	EBP training program to improve EBP knowledge, skills, and behaviour. Face-to-face training (in the form of lectures and practical sessions) with online support. Six lectures with four practical sessions in-between. Material on website.
Edwards 2001	UK, English; 482 third-year medical students	Teaching critical appraisal using journal clubs and letter writing exercises. Small groups of students appraised a recently published article, presented it to their peers in a journal club and write a letter to the journal editor. Four half-day sessions with a total contact time of 5 hours with 4.5 hours of directed self-study. Each group was about 15-20 students.
Eldredge 2013	US, English; 71 first-year medical students	Student peer assessment in EBM searching skills training. An introductory didactic lecture and an interactive practical session about PubMed searching skills. Students were instructed to assess other students' assignments using predetermined criteria. A one-hour introductory lecture and one-hour practical lab delivered once. A faculty librarian delivered the lecture and practical sessions.
Erickson 1998	US, English; 31 residents in obstetrics and gynaecology	Individual training sessions on use of Medline. Individual training session, including hands-on instruction on how to design and perform the search. One-hour training session. Health science librarians
Feldstein 2010	US, English; 48 internal medicine residents	A brief interactive EBM workshop; An interactive EBM workshop with practical hands-on training. The workshop lasted 4 hours. A faculty member and a librarian delivered the workshop, which was conducted in the computer lab. The teacher-to-student ratio was about 1:11-12
Fernandez 2014	Australia and Hong Kong, English; 186 postgraduate nursing students	Four teaching methods on EBP skills. Four methods of teaching EBP were compared: interactive, self-directed standard distance learning computer laboratory teaching; EBP-DVD teaching; and didactic classroom teaching. Standard distance teaching: needs 15 weeks (10 hours/week) to be completed; computer lab: three 2-hour practical sessions; didactic: four 3.25-hour lectures and two 2.25-hour tutorials. Computer laboratory sessions were delivered by a senior lecturer with extensive experience in EBP.

Forsetlund 2003	Norway; 148 public health physicians	An educational intervention to diffuse evidence-based health practice. The intervention consisted of: workshop in evidence-based public health, a newsletter, access to a specially designed information service, relevant databases, and electronic discussion list. This included face-to-face and online webpage components. Eleven workshops (each 1-5 days) were delivered over 1.5 years. Two public health physicians and two librarians delivered the training programme.
Frasca 1992	US, English; 92 third-year medical students	A collaborative course in teaching library and critical appraisal skills. Two main components of this intervention: critical appraisal skills and searching skills. Weekly 1.5-hour sessions over ten weeks. The course was delivered by medicine and library faculty.
Fu 1999	Canada, English; 12 residents in psychiatry	Teaching critical appraisal through journal clubs. Journal clubs run weekly. Sessions about basic statistical concepts were also provided. Weekly journal clubs, each lasting 1.5 hours, over 12 weeks. Four 45-minute sessions were also delivered. A professor of psychiatry led the journal club and residents were responsible for facilitating the discussion.
Gardois 2011	Italy, Italian; 22 paediatric residents and interns	Assistance of biomedical librarians in bibliographic searches. Interactive face-to-face refresher sessions about EBM basics was delivered along with the assistance provided to students. EBM refresher sessions (over 2 days/ total 12 hours); A librarian with 5 years of biomedical search experience had delivered the intervention.
Ghali 2000	Canada, English; 60 third-year medical students	A mini-course of EBM. Four interactive face-to-face sessions reflected the four steps of EBM (including group discussion of factual scenarios). Four weekly 90-minute sessions. Course was attended by 4-8 students at a time.
Green 1997	US, English; 34 second- and third-year internal medicine residents	Evidence-based medicine curriculum; A typical interactive face-to-face tutorial included: case presentation, clinical question, search results, critical appraisal of an article, and interpretation of the results. Seven, weekly, 1-hour tutorials. Each tutorial was attended by 5-14 residents, directed by a resident and facilitated by a general medicine faculty member.
Griffin 1992	US, English; 57 occupational therapy students	Educational intervention to improve information retrieval. Instructional booklet and supervised interactive hands-on practice. One practical session lasting an hour. The course instructor and several librarians delivered the intervention.
Gruppen 2005	US, English; 92 fourth-year medical students	A single brief instructional intervention on EBM. This intervention was the introductory session (the use of Medline in EBM) of a whole elective course in EBM. Sessions were both didactic and interactive. A single two-hour session within a 4-week EBM elective. Experienced medical librarians who had received training on EBP.
Haas 2012	US, English; 339 chiropractic doctoral students	The integration of EBP curriculum in a chiropractic doctoral program. The curriculum included three parts: 4 core EBP courses (face-to-face and interactive): 2 didactic and 2 journal clubs critical learning modules dealing with EBP and other program-related courses. Four EBP courses: two were 20 contact hours and the

		other were 10 contact hours. MDs with EBM background and a statistician delivered the courses. Teacher-to-student ratio varied from 1:120 to 1:10-15.
Hadley 2010	UK, English; 237 postgraduate medical trainees at foundation or internship level	A clinically integrated e-learning course for teaching EBM. An interactive online e-learning self-directed training session.; The e-learning course was intended to be completed in six weeks.
Haynes 1993	Canada, English; 392 physicians and physicians-in-training	Individualised feedback to improve Medline searching skills.; An introductory basic training in EBP was delivered then individualised feedback from a librarian on ten searches.; The basic training was for 2 hours (1-hour small group session and 1-hour individual practical session).; Teachers with extensive experience in Medline searching.
Hugenholtz 2008	Netherlands; 98 occupational physicians	EBM course in combination with case method learning sessions.; The EBP training program consisted of didactic EBP course and ten Case Method Learning Sessions (CMLSs).; EBM training program lasted for four months: EBM course (three half-day over two weeks) and CMLSs (every other week, lasting for 1-1.5 hours).; Each CMLS peer group was 6-8 persons.
Ilic 2012	Australia, English; 121 third-year medical students	A single workshop in EBM searching skills.; An EBM literature searching skills workshop, which included formal presentation, interactive computer-based searching session and self-directed learning tasks.; Single 2-hour workshop.; A subject librarian delivered the presentation.
Ilic 2013	Australia and Malaysia; 147 medical students	A blended-learning approach vs a didactic approach to learn EBM.; One-day block workshop (two tutorial sessions), the remaining eight sessions were small-group discussions about patient-based EBM scenarios.; Ten 2-hour tutorial sessions.;
Ilic 2015	Australia, English; 61 second-year medical students	A blended learning educational EBM intervention.; Blended learning approach integrated classroom activities (lecture/tutorial) with online and mobile learning.; The intervention consisted of a one-day workshop and ten 2-hour tutorial sessions.; -
Jalali-Nia 2011	Iran; 41 undergraduate nursing students	Evidence-based approach to nursing education; The intervention included four phases: EBP training for tutors, EBP workshop, courses based on EBP approach, evaluation of the intervention.; EBP training for tutors: two 3-day and 2-day workshops, 14 days apart. The EBP workshop was a one-day workshop.; -
Johnston 2009	China; 129 second-year medical students	Problem-based learning (PBL) method for teaching EBM.; Small-group interactive sessions using PBL case format.; Two 2-hour sessions per body system block.; Faculty tutors (clinical or non-clinical) facilitated small-group (9-10 students).
Kim 2008	US, English; 50 residents in internal medicine	EBM curriculum on critical appraisal of evidence and the use of electronic resources.; Interactive small-group sessions delivered and led by residents.; Six 2-hour workshop sessions for an over a month (12 hours in total).; A medical librarian and a general internist with extensive training in medical education led the sessions. There were 3-7 residents in each session.

Kim 2009	US, English; 208 senior fourth-year nursing students	EBP-focused interactive teaching strategy.; The intervention consisted of three phases: problem identification and evidence synthesis; EBP implementation strategies; and dissemination, delivered through interactive, face-to-face sessions.; Introductory 2-hour session. Each group had weekly clinical hours with their supervisors. At the end of the semester, two "sharing day" events were held.; A group of 4-5 students worked together on their EBP projects, closely supervised by their Clinical Practice instructor as well as their professors.
Kitchens 1989	Canada, English; 83 residents in internal medicine	A curriculum in critical appraisal and clinical epidemiology.; The curriculum consisted of 17 sessions each where they discussed two articles: one clinical epidemiology (methodology) article and clinically related article.; Weekly 30- to 45-minute session for 17 weeks.;
Kok 2013	Netherland; 132 insurance physicians	A clinically integrated training program in EBM.; Mixed didactic and interactive small group-sessions were delivered.; 5 contact days over a six-month period.; Two experienced tutors (who were knowledgeable in EBM and epidemiology) per group of 12 students.
Krueger 2006	US, English; 77 third-year osteopathic medical students	Teaching critical appraisal to undergraduate osteopathic students.; An interactive face-to-face teaching program including lectures, discussions, reading literature, and journal clubs.; A daily series of group workshops and lectures (6 hours of faculty time) over 6 weeks.; Each group of 8-10 students was taught entirely by one tutor.
Kulier 2009	Netherland and UK; 61 postgraduate trainees in obstetrics and gynaecology	Clinical integrated e-learning course in EBM.; Self-directed online EBM teaching program with clinically related activities.; Delivered over 4-6 weeks.;
Kulier 2012	7 LMICs; 204 postgraduate trainees (residents, registrars and postgraduate clinical trainees) in obstetrics and gynaecology	Clinical integrated e-learning course in EBM.; The course was blended with face-to-face teaching and learning with a clinical trainer. Five recorded videos about the basic EBM knowledge.; Total duration was 8 weeks. The online components lasted for 2-3 hours and about 20 hours for assessment, feedback, and assignments.; A senior staff member preferably a specialist in obstetrics and gynaecology who is knowledgeable about basic EBM principles was facilitating the course.
Landry 1994	US, English; 146 third-year medical students	A seminar about the use of medical literature.; Interactive seminars about different study designs and their distinguishing features.; Two 90-minute interactive seminars over two weeks.; -
Langkamp 1992	US, English; 27 residents in Paediatrics	Medical journal clubs to improve knowledge about clinical epidemiology and biostatistics.; Two didactic sessions on research designs, clinical epidemiology followed by eight journal clubs.; Monthly journal clubs at lunch time over eight months.; Two paediatric faculty members with training in epidemiology and biostatistics facilitated the journal clubs.

Lee 2007	China; 132 final-year medical students	Integrated teaching intervention on clinical decision analysis.; Teaching session consisting of three lectures about the principles of clinical decisions, followed by two workshops: the critical appraisal of a cost-effectiveness paper, and economic analysis.; Three 40-minute lectures and two 1-hour workshops (total 4 hours) over two weeks.; Ten students were allocated to one tutor trained in clinical decision analysis.
Linzer 1987	US, English; 44 medical interns	Comparing two formats of medical journal club.; Journal clubs directed by faculty member interested in epidemiology and critical appraisal compared to journal clubs lead by subspecialists.; Weekly journal clubs over two years.; Group one: general medicine faculty member with special interest in clinical epidemiology, and critical appraisal; Group two: A chief medical resident with invited subspecialist interested in the topic.
Linzer 1988	US, English; 85 residents in internal medicine	Medical journal clubs on critical appraisal skills.; The journal club discussed the presented topics, the methodological and epidemiological aspects of the selected article, and then the clinical utility of the suggested article.; Weekly journal club sessions; 2-3 hours of preparation.; The journal club was presented by a resident or intern and facilitated by a faculty member.
MacAuley 1999	UK, English; 99 GP trainers	Critical appraisal using the READER method.; A teaching session on the READER method of critical appraisal and then practical critical appraisal of two papers.; A 30-minute teaching session.; -
Macrae 2004	Canada, English; 81 general surgeons	A curriculum in critical appraisal skills with an internet-based journal club.; A curriculum in critical appraisal skills which included a clinical and methodological article, a listserv discussion, and clinical and methodological critiques.; Eight 1-month packages: 1-week for reading the articles; one-week discussion, comments and feedback provided; another one-week discussion and comments.; Surgeons with training in clinical epidemiology and content experts moderated the discussions.
Major-Kincade 2001	US, English; 64 paediatrics house staff	Educational intervention in evidence-based ethics.; Small group interactive group discussions started with a case presentation.; 40- or 60-minute group discussions held late in the afternoon.; A senior resident and two neonatologists with an interest in epidemiology and ethics delivered the intervention.
McLeod 2010	US, English; 443 residents in general surgery	Educational intervention comparing internet vs. moderated journal clubs.; Eight training packages, each contained a methodological and clinical article. A clinical scenario relevant to each package discussed in a listserv and a comprehensive review followed.; Each of the 8 packages had to be completed within a month, so the intervention lasted eight months.; Clinical and methodological experts had facilitated the discussion.
Mills 2002	Canada, English; 83 Naturopathic interns	Teaching critical appraisal to complementary and alternative medicine students.; A didactic training session about question formulation, level of evidence and critical appraisal.; A 3.5-hour workshop on EBM.;
Olsen 2015	Norway; 37 clinical instructors in Physiotherapy	A multifaceted clinically integrated training program in EBP.; Workshops, assignments, supervision, and exams. Workshops were a mixture of lectures (didactic sessions) and small-group interactive activities.; Four half-day workshops over six months.; Five physiotherapists from both academic and clinical positions, and with a range of expertise in EBP, physiotherapy, higher education, and research.

Radack 1986	US, English; 33 medical students	Teaching critical appraisal and application of medical literature.; Small group discussion seminars approaching specific areas through critical appraisal and problem-based learning.; Weekly 50-minute sessions over five weeks.; Each group had four to seven clinical students, supervised by one teacher.
Ramos-Morcillo 2015	Spain, Spanish; 109 registered nurses	A brief basic EBM course for clinical nurses.; Training included two face-to-face sessions and online learning.; Two 5-hour sessions and weekly online learning activities (total of 30 hours).; Teacher to student ratio was 1:10.
Riegelman 1986	US, English; 292 medical students	Teaching skills to read medical literature.; Lectures on critical appraisal with practical supervised seminars.; 12 hours of lectures and four hours of supervised seminars.; -
Romm 1989	US, English; 108 medical students	Teaching clinical epidemiology and appraisal skills.; Introductory session and then seven sessions. Participants divided into: small-group discussion vs. lecture-based learning groups.; 8 sessions.; Groups of 16-20 students each.
Rosenberg 1998	UK, English; 108 medical students	Training in formulating questions and searching databases.; Small group training sessions.; A 3-hour training session.; Two experienced librarians facilitated the small group sessions (4-7 students each group).
Ross 2003	US, English; 48 residents in family practice	EBM curriculum in family medicine residency.; Ten-session EBM interactive workshop series introduced to the curriculum.; 10 sessions, each 1-2 hour (brief lecture: 30-40 minutes followed by practical sessions).;
Sanchez-Mendiola 2004	Mexico, Spanish; 131 medical students	Teaching EBM.; Sessions to guide the students through the EBM process.; 14 two-hour sessions.;
Sanchez-Mendiola 2012	Mexico, Spanish; 289 fifth-year medical students	Teaching EBM to medical students.; A one-semester EBM course included: large group interactive sessions, small-group problem-solving activities, individual and group assignments, and informatics laboratory sessions; Fourteen, 2-hour weekly sessions.; The course faculty were six professors trained in EBM teaching, all board- certified physicians with clinical practice experience.
Schaafsma 2007	Netherland; 125 occupational health physicians and insurance physicians	Training in literature searching skills; EBM introduction course then a practical hands-on training in literature searching and critical appraisal of the literature.; A 4-day course.; -
Schilling 2006	US, English; 238 third-year medical students	A web-based curriculum on EBM; An interactive, web-based curriculum on key aspects of EBM including discussion of actual patients.; A 6-week course, with 40-60 minutes commitment each week.; A faculty member moderated the discussion.
Schoonheim-Klein 2012	Netherland; 62 working group of dental students	Evidence based dental medicine course.; The intervention included the implementation of a community of learners within the course to discuss the application of evidence in practice.; Each session was 1.5 hours over six months.; Researchers and senior scientists advised students about their progress.
Seelig 1993	US, English; 44 practising internists and residents	Educational intervention in critical appraisal.; An interactive seminar about practical approaches for keeping up with literature and critical appraisal skills.; A 1-hour seminar.; -

Shorten 2001	Australia, English; 143 nursing students	A curriculum-integrated program on searching skills.; A series of lectures and laboratory/ tutorial sessions.; -; The faculty librarian and the members of the teaching team.
Shuval 2007	Israel; 75 primary care doctors	EBM educational intervention.; Three workshops and six sessions, which were integrated and interactive.; Three workshops over 6 months and six sessions over 10 months.; Thirteen family doctors with teaching experience of EBM and who attended a 12-hour course focusing on EBM teaching delivered the intervention.
Smith 2000	US, English; 55 first-year residents in internal medicine	Teaching EBM skills.; Two weekly sessions: one didactic lecture and the other interactive seminar.; Two weekly 2-hour sessions over seven weeks.; Three senior faculty members, and six chief medical residents.
Stark 2007	US, English; 77 second- and third-year residents in internal medicine	Searching tutorial for residents.; Each resident did a brief oral case presentation and structured clinical questions and search results.; Six 1-hour weekly sessions.; A medical research librarian and 1–3 faculty members had supervised the intervention.
Stevenson 2004	UK, English; 30 musculoskeletal physiotherapists	Evidence-based educational programme.; Interactive sessions included: teaching, discussion, reflective thinking, active experimentation, and peer group teaching.; Two 2.5-hour sessions.;
Stevermer 1999	US, English; 59 residents in family practice	Academic detailing intervention.; One-to-one academic detailing intervention with residents.; 29 15-minute sessions over two weeks.; -
Taylor 2004	UK, English; 145 healthcare professionals (general practitioners, hospital physicians, professions allied to medicine, and healthcare managers/administrators)	Critical appraisal skill training for health professionals.; Workshops based on the critical appraisal skills programme (CASP).; A half-day workshop (three 60-minute sessions); Three to four individuals, each of whom had formal training in health services research methods and were experienced in delivering CASP workshops.
Thomas 2005	US, English; 46 residents in internal medicine	Conferences vs. discussion group to teach EBM.; Each conference had two presentations. Small group discussions were interactive.; Four weekly 45-minute conferences vs. four weekly 1-hour small-group discussions.; Chief medical resident as facilitator for EBM small-group discussions.
Verhoeven 2000	Netherland; 103 healthcare professionals (general practitioners and others)	Citation retrieval methods for general practitioners.; The intervention included an introductory lecture and on-site training.; 15 one-day training sessions were delivered (included 2-hour lecture).; A professional librarian delivered the intervention.
Viniegra 1986	Mexico, Spanish; 20 residents in internal medicine	Critical appraisal course.; The course involved the selection of 25 published reports of clinical research.

Vrdoljak 2015	Croatia, Croatian; 98 mentors in general practice	Academic detailing to improve EBM knowledge and skills.; Students (academic detailers) had reported and discussed with their monitors two EBM case presentations.; Over two weeks.;
Wallen 2010	US, English; 159 nurses participating in leading/mentoring activities	A structured multi-faceted mentorship program.; An intensive EBP workshop followed by ongoing mentorship skill-building activities.; A 2-day workshop.;
Welch 2014	US, English; 175 professional athletic training students, graduate students, clinical preceptors, educators, and clinicians.	EBP educational intervention for athletic trainers.; Web-based interactive learning.; Self-pacing, each module need 20-25 minutes to be completed.; Website contents were developed by five EBP subject-matter experts who had experience in EBP education and research.

Competence, like truth, beauty, and contact lenses, is in the eye of the beholder

— Laurence Peter

5

Chapter 5
EBP Core Competencies

Variations in EBP educational interventions and the need for core competencies

Core Competencies in Evidence-Based Practice for Health Professionals: Consensus Statement Based on a Systematic Review and Delphi Survey

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Preamble

The previous chapter showed considerable differences in the EBP content covered and outcome measures used in EBP educational interventions, with the majority focus on critically appraising evidence often to the exclusion of other steps. The findings of the study presented in this chapter offer avenue to overcome the previously described challenges, by developing a consensus-based, contemporary set of EBP core competencies that may benchmark standards for EBP teaching and harmonise the content of EBP educational interventions.

This chapter contains an article entitled "*Core Competencies in Evidence-Based Practice for Health Professionals: Consensus Statement Based on a Systematic Review and Delphi Survey*", published in JAMA Network Open on June 2018. It develops a consensus set of minimum core competencies in EBP that health professionals should achieve.

Work arising from this chapter was also presented in oral form at the 8th EBHC International Conference in Italy, the 7th annual Conference of the International Society for Evidence-Based Health Care in the UAE, and at the 2018 the Australian and New Zealand Association for Health Professional Educators conference in Tasmania. I have been awarded the 2018 Australian and New Zealand Association for Health Professional Educators post-graduate student awards for this research project.

5.1 Key Points

Question What are the core competencies in evidence-based practice (EBP) that health professionals should meet?

Findings In this systematic, multistage, modified Delphi survey study, a contemporary set of 68 core competencies in EBP grouped into the main EBP domains was developed.

Meaning This consensus statement of the core competencies in EBP should inform the development of EBP curricula for health professionals.

5.2 Abstract

Importance

Evidence-based practice (EBP) is necessary for improving the quality of health care as well as patient outcomes. Evidence-based practice is commonly integrated into the curricula of undergraduate, postgraduate, and continuing professional development health programs. There is, however, inconsistency in the curriculum content of EBP teaching and learning programs. A standardised set of minimum core competencies in EBP that health professionals should meet has the potential to standardise and improve education in EBP.

Objective

To develop a consensus set of core competencies for health professionals in EBP.

Evidence

Review For this modified Delphi survey study, a set of EBP core competencies that should be covered in EBP teaching and learning programs was developed in 4 stages: (1) generation of an initial set of relevant EBP competencies derived from a systematic review of EBP education studies for health professionals; (2) a 2-round, web-based Delphi survey of health professionals, selected using purposive sampling, to prioritise and gain consensus on the most essential EBP core competencies; (3) consensus meetings, both face-to-face and via video conference, to finalise the consensus on the most essential core competencies; and (4) feedback and endorsement from EBP experts.

Findings

From an earlier systematic review of 83 EBP educational intervention studies, 86 unique EBP competencies were identified. In a Delphi survey of 234 participants representing a range of health professionals (physicians, nurses, and allied health professionals) who registered interest (88 [61.1%] women; mean [SD] age, 45.2 [10.2] years), 184 (78.6%) participated in round 1 and 144 (61.5%) in round 2. Consensus was reached on 68 EBP core competencies. The final set of EBP core competencies were grouped into the main EBP domains. For each key competency, a description of the level of detail or delivery was identified.

Conclusions and Relevance

A consensus-based, contemporary set of EBP core competencies has been identified that may inform curriculum development of entry-level EBP teaching and learning programs for health professionals and benchmark standards for EBP teaching.

5.3 Introduction

The term evidence-based medicine was first developed in the field of medicine in the early 1990s, but as its use expanded to include other health disciplines, it became known as evidence-based practice (EBP). Evidence-based practice provides a framework for the integration of research evidence and patients' values and preferences into the delivery of health care[1,2]. Implementation of EBP principles has resulted in major advances in improving the quality of delivered health care as well as patient outcomes. The last 20 years have seen EBP increasingly integrated as a core component into the curriculum of undergraduate, postgraduate, and continuing education health programs worldwide[3,4]. Many national registration bodies and accreditation councils (e.g. the Accreditation Council for Graduate Medical Education in the United States) expect that all clinicians (i.e. health professionals and learners of any discipline) should be competent in EBP[5]. The National Academy of Medicine (formerly the Institute of Medicine), an independent, nongovernmental, nonprofit organisation that provides advice, counsel, and independent research on major topics in health care, has recognised EBP as one of the core competencies necessary for continuous improvement of the quality and safety of health care[6].

Although many teaching strategies have been used and evaluated, a lack of EBP knowledge and skills is still one of the most commonly reported barriers to practicing EBP[7,8]. One of the potential explanations is the inconsistency in the quality and content of the EBP teaching programs[9] (also L.A., P.G., T.H., unpublished data, 2018). A standardised set of core competencies in EBP for clinicians and students may therefore improve EBP teaching and learning programs as well as EBP knowledge and skills[10].

Core competencies have been defined as the essential minimal set of a combination of attributes, such as applied knowledge, skills, and attitudes, that enable an individual to perform a set of tasks to an appropriate standard efficiently and effectively[11]. Core competencies offer a common shared language for all health professions for defining what all are expected to be able to do to work optimally.

Recognising it as a promising way of reforming and managing medical education and ultimately improving quality of care[12,13], the Institute of Medicine report Health

Professions Education: A Bridge to Quality endorsed competency-based education across the health professions[4]. Implementation of competency-based education involves the identification of core competencies, designing curricula and teaching programs that clearly articulate the attributes underpinning each core competency, and developing assessment tools that provide a valid and reliable evaluation of these core competencies[14].

A clear outline of core competencies is critical in any health care education setting, as it informs the blueprinting of a curriculum, including learning outcomes, assessment strategies, and graduate attributes[15-17]. Therefore, defining core competencies is a priority in health care education[11,18-22]. Unaware of any systematically derived set of core competencies in EBP, we set out to remedy this deficiency. The objective of this study was to develop a consensus-based set of core EBP competencies that EBP teaching and learning programs should cover.

5.4 Methods

We conducted a multistage, modified Delphi study, in which we (1) generated, from a systematic review, an initial set of potential competencies to be considered for inclusion in the EBP core competencies set; (2) conducted a 2-round modified Delphi survey to prioritise and gain consensus on the most essential EBP core competencies; (3) held a meeting to finalise the consensus on the set of EBP core competencies; and (4) sought feedback and endorsement from EBP experts and planned for dissemination.

Generation of an Initial Set of Relevant EBP Competencies

We previously completed a systematic review of EBP educational studies, following Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guidelines. Studies were eligible if they were controlled (that is, had a separate group for comparison) and had investigated the effect of EBP education among clinicians (irrespective of the level of training, profession, or intervention format). Of 1682 articles identified, we screened 714 titles and abstracts for eligibility. Of these, 286 full-text articles were obtained for review, and 83 articles proved eligible. Results of the review, rather than competencies, are reported elsewhere[23]. We reviewed included studies to identify EBP competencies addressed in these studies. In addition, EBP curricula and key statements (e.g. Sicily statement on EBP[24], Institute of Medicine reports[4], and the Informed Health Choice key concepts[25,26]) were identified by contacting experts in this field and reviewing suggested documents. These were reviewed for relevant EBP competencies, which were defined as "attributes such as applied knowledge, skills and attitudes that enable an individual to perform a set of tasks to an appropriate standard efficiently and effectively."[11] Three of us (L.A., T.H., and P.G.) independently extracted EBP competencies from a random sample of 20 articles and continued discussion until consensus was attained. Afterward, one of us (L.A.) extracted EBP competencies from the rest of the included articles. These authors reviewed this set of initial EBP competencies for duplication, overlap, and clarity, leaving uniquely specified competencies. The same 3 authors grouped these competencies into the relevant EBP steps (introductory, ask, acquire, appraise and interpret, apply, and evaluate). **Supplementary material 5.1** presents detailed methods of this stage.

Two-Round Delphi Survey

We used a modified 2-round Delphi survey to obtain the input of a broad range of experts and stakeholders on the most essential EBP core competencies[27-30]. We used a purposive and snowball sampling approach to invite clinicians who had significant experience in teaching and/or practicing EBP to register their interest in participating in our Delphi survey (February 2017). We sent email invitations to the evidence-based health care listserv and other networks of national and international evidence-based health societies and posted announcements on social media (e.g. Twitter and Facebook).

Figure 5.1 illustrates the process of the modified Delphi survey. The round 1 survey (March-April 2017) consisted of 86 competencies grouped into EBP steps (introductory, ask, acquire, appraise and interpret, apply, and evaluate). We invited participants who responded and registered their interest to participate in round 1. Participants rated the relative importance of each competency as "omitted: is not a priority to be included in an EBP teaching program," "mentioned: should be just mentioned in an EBP teaching program (i.e. provide common knowledge of the competency)," "explained: should be briefly explained in an EBP teaching program (i.e. provide understanding of the competency but without practical exercises)," or "practiced with exercises: should be practiced with exercises in an EBP teaching program (i.e. provide a detailed understanding of the competency, enhanced with practical exercises).” We chose this rating scale to reflect the desired learning outcome and clinical competence (i.e. Miller’s Pyramid of Clinical Competence[31]) and the required level of detail and time commitment to be delivered. For round 2, we retained EBP competencies that attained a predefined consensus level of at least 70% of participants per competency or a combined rating of greater than or equal to 85% across 2 rating categories (e.g. combined rating of mentioned and explained ≥85%).

Participants who responded and completed the round 1 survey were invited to participate in round 2 (May-June 2017). For this round, we revised the retained competencies based on feedback from participants and arranged them into 5 groups (**Figure 5.1**). Group A included competencies that a predefined consensus (≥70%) agreed should be practiced with exercises or explained or mentioned; participants were advised that these would be included in the final set of core competencies unless strong objection was received in that round. Groups B, C, and D were competencies that did not achieve the predefined consensus level in round 1, but most (≥85%) agreed should be practiced with exercises or explained; explained or mentioned; or mentioned or omitted, respectively. Participants in round 2 were asked to rate whether these competencies should be practiced with exercises or explained, explained or mentioned, or mentioned or omitted. Group E included new competencies that were suggested by round 1 participants, who then rated them omitted, mentioned, explained, or practiced with exercises.

Survey Monkey, a web-based survey service, provided the platform for the surveys. In both rounds, participants were given a chance to suggest additional competencies, argue for or against proposed competencies, and comment on competency wording and comprehension. We obtained ethics approval for this study from the Human Research Ethics Committee at Bond University. Participants were informed that consent was assumed if they responded to the survey. Detailed methods of the Delphi survey are presented in **Supplementary materials 5.2** through **5.4**.

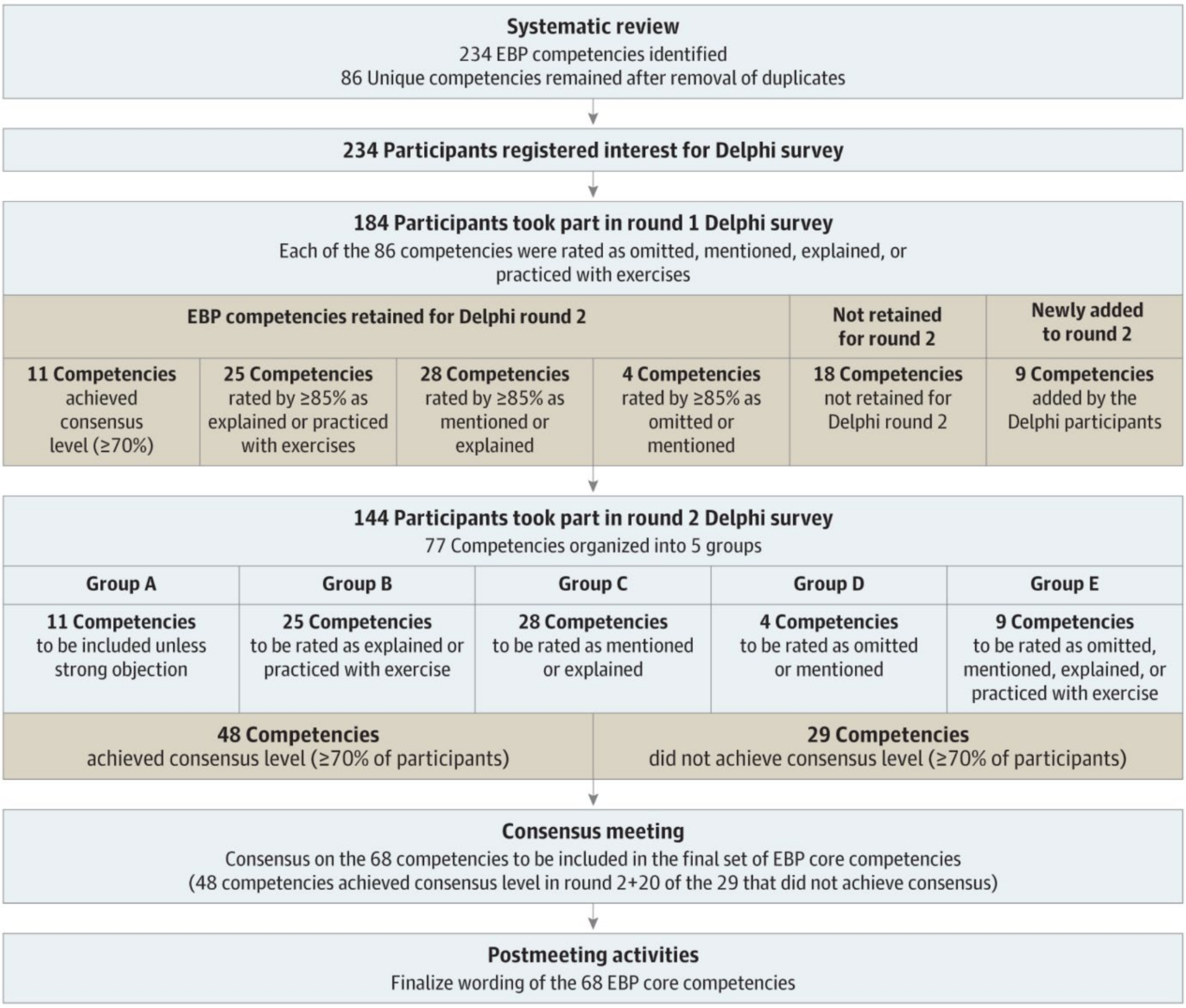

Figure 5.1. Flow Diagram of the Process of Developing the Set of Evidence-Based Practice (EBP) Core Competencies

Participants in the 2-round Delphi survey rated the relative importance of each competency as "omitted: is not a priority to be included in an EBP teaching program," "mentioned: should be just mentioned in an EBP teaching program (i.e. provide common knowledge of the competency)," "explained: should be briefly explained in an EBP teaching program (i.e. provide understanding of the competency but without practical exercises)," or "practiced with exercises: should be practiced with exercises in an EBP teaching program (i.e. provide a detailed understanding of the competency, enhanced with practical exercises)."

Consensus Meeting and Postmeeting Activities

A 2-day consensus meeting (July 10-11, 2017) was organised by the Centre for Research in Evidence-Based Practice (L.A., T.H., and P.G.) and involved 10 participants purposively chosen to represent a range of health professions, experience in teaching EBP, geographical locations, and representation of EBP societies and organisations. We presented the results of the systematic review and the 2-round Delphi survey. Following presentation of the results, the group participated in focused discussions addressing the proposed set of core competencies and made final decisions on the inclusion of each competency and its wording and description. To ensure that the consensus set of competencies reflected the decisions made, participants reviewed a document presenting the consensus set of competencies after the meeting. To ensure the validity, applicability, utility, and clarity of the competencies, we sent the final set of EBP core competencies for external feedback to 15 EBP experts (purposively identified to represent different EBP organisations and societies, including the International Society for Evidence-Based Health Care board members). Based on feedback from EBP experts, we further revised the wording and explanation of the competencies. All coauthors were emailed the draft document and provided minor wording suggestions.

5.5 Results

Generation of an Initial Set of Relevant EBP Competencies

We identified 234 EBP competencies, which decreased to 86 unique competencies after removal of duplicates. **Supplementary materials 5.5**, **5.6** and **5.7** present details.

Delphi Survey and Consensus Meeting

Of the 234 individuals who registered their interest (88 [61.1%] women; mean [SD] age, 45.2 [10.2] years), 184 (78.6%) participated in round 1 of the Delphi survey, and 144 participated in round 2 (61.5%, or 78.3% of round 1 participants). Of the 144 round 2 participants, 88 (61.1%) were women, 63 (43.8%) were 30 to 44 years old, 60 (41.7%) were 45 to 59 years old, and 115 (79.9%) currently taught EBP, with a mean (SD) of 10.9 (7.4) years of EBP teaching experience. Participants were from 28 different countries. In total, 59 participants (41.0%) were medical professionals (not including nurses, who were categorised separately) and 56 (38.9%) were allied health professionals. More than one-third of participants (n = 54 [37.5%]) had both clinical and academic (teaching or research) roles. The majority (n = 118 [81.9%]) were working in a university setting, and 53 participants (36.8%) worked in hospitals (**Table 5.1**).

Table 5.1. Characteristics of Participants in Each Stage of Modified Delphi Survey. Values are number (%) unless otherwise indicated

Characteristics	No. (%) Registration of interest (n = 234)	Delphi Round 1 (n = 184)	Delphi Round 2 (n = 144)
Age, mean (SD), y	45.2 (10.2)	NA	NA
<30	NA	4 (2.2)	4 (2.8)
30-44	NA	83 (45.1)	63 (43.8)
45-59	NA	75 (40.8)	60 (41.7)
60+	NA	22 (12.0)	17 (11.8)
Female	141 (60.3)	110 (59.8)	88 (61.1)
Countries and continents	36 countries (12 Europe, 13 Asia, 4 Africa, 6 Americas, and Australia)	32 countries (11 Europe, 12 Asia, 3 Africa, 5 Americas, and Australia)	28 countries (11 Europe, 10 Asia, 2 Africa, 4 Americas, and Australia)
Australia	57 (24.4)	59 (32.1)	45 (31.3)
United Kingdom	55 (23.5)	41 (22.3)	31 (21.5)
United States	27 (11.5)	21 (11.4)	22 (15.3)
Others	95 (40.6)	59 (32.1)	46 (31.9)
Health discipline			
Medicine	80 (34.2)	75 (40.8)	59 (41.0)
Nursing	33 (14.1)	26 (14.1)	18 (12.5)
Allied health	66 (28.2)	72 (39.1)	56 (38.9)
Others	56 (23.9)	13 (7.1)	11 (7.6)
Current Role[a]			
Teaching	178 (76.1)	145 (78.8)	112 (77.8)
Clinical	160 (68.4)	140 (76.1)	110 (76.4)
Research	106 (45.3)	68 (37.0)	50 (34.7)
Setting or Institution[a]			
University	NA	148 (80.4)	118 (81.9)
Hospital	NA	69 (37.5)	53 (36.8)
Others (e.g. governmental)	NA	21 (11.4)	15 (10.4)
Currently teaching EBP	183 (78.2)	147 (79.9)	115 (79.9)
EBP teaching experience, mean (SD), y	NA	10.5 (7.4)	10.9 (7.4)
Clinical experience, mean (SD), y	21.2 (10.8)	NA	NA

Abbreviations: EBP, evidence-based practice; NA, not available.
[a] Participants could choose more than 1 option.

After round 1, 11 competencies attained the predefined consensus level (≥70%) (group A); 25 competencies were rated by the majority (≥85%) practiced with exercises or explained (group B); 28 were rated by the majority (≥85%) explained or mentioned (group C); 4 were rated by the majority (≥85%) mentioned or omitted (group D); and 9 new competencies were suggested by participants (group E). After round 2, 48 competencies had achieved the consensus level (≥70%): 20 competencies were rated as practiced with exercises; 20 as explained; and 8 as mentioned. In total, 29 competencies did not achieve the a priori consensus level and were retained for further discussion at the consensus meeting; 20 were subsequently included. **Figure 5.1** illustrates the results of the modified Delphi survey. **Supplementary materials 5.8** and **5.9** present detailed results of rounds 1 and 2.

Core Competencies in EBP

After the 2 rounds of Delphi survey and the consensus meeting, a total of 68 competencies achieved consensus for inclusion in the final set of EBP core competencies. **Table 5.2** presents the final set of EBP core competencies (**Supplementary material 5.10** includes the set and an elaboration of each competency). The final set of EBP core competencies are grouped into the main EBP domains: introductory (n = 5); ask (n = 3); acquire (n = 4); appraise and interpret (n = 9); apply (n = 4); and evaluate (n = 2). We also provide a description of each key competency and the level of detail or delivery for each one (a proxy of the time that should be dedicated to teaching each competency—M, mentioned; E, explained; and P, practiced with exercise). We found that most of the core competencies could be classified within the 5-step model of EBP, which is also used by the Sicily statement[24], except for the introductory competencies, which we therefore retained.

Table 5.2. Final Set of EBP Core Competencies Grouped Into the Main EBP Domains

EBP Core Competencies	Rating
0. Introductory	
0.1 Understand EBP defined as the integration of the best research evidence with clinical expertise and patient's unique values and circumstances[a]	**E**
0.2 Recognise the rationale for EBP	**M**
This competency includes the need to recognise	
The daily clinical need for valid information to inform decision making, and the inadequacy of traditional sources for this information	M
The disparity between diagnostic skills and clinical judgment, which increase with experience, and up-to-date knowledge and clinical performance, which decline with age and experience	M
Lack of time to find and assimilate evidence as a clinician	M
The gaps between evidence and practice can lead to suboptimal practice and quality of care.	M
The potential discordance between a pathophysiological and empirical approach to thinking about whether something is effective[a]	M
0.3 For each type of clinical question, identify the preferred order of study designs, including the pros and cons of the major study designs[a]	**E**
This competency includes	
Classify the major study designs for each type of clinical question	E
0.4 Practice the 5 steps of EBP: ask, acquire, appraise and interpret, apply, and evaluate[a]	P
0.5 Understand the distinction between using research to inform clinical decision making vs conducting research[a]	M
1. Ask	
1.1 Explain the difference between the types of questions that cannot typically be answered by research (background questions) and those that can (foreground)[a]	**E**
1.2 Identify different types of clinical questions, such as questions about treatment, diagnosis, prognosis, and aetiology[a]	**P**
1.3 Convert clinical questions into structured, answerable clinical questions using PICO[a]	**P**
This competency includes	
Recognise the importance of and strategies for identifying and prioritising uncertainties or knowledge gaps in practice	M
Understand the rationale for using structured clinical questions	E
Identify the elements of PICO questions and use variations of it when appropriate (e.g. PICOT, PO, PECO-Exposure) to structure answerable clinical questions	P
2. Acquire	
2.1 Outline the different major categories of sources of research information, including biomedical research databases or databases of filtered or preappraised evidence or resources[a]	**E**
This competency includes:	
Outline the advantages of using filtered or preappraised evidence sources and recognise relevant resources	E

Indicate the differences between the hierarchy of evidence, level of processing of evidence, and types of EBM resources[a]	E
2.2 Construct and carry out an appropriate search strategy for clinical questions[a]	**P**
This competency includes	
Know where to look first to address a clinical question	P
When necessary, construct a search strategy that reflects the purpose of the search[a]	P
Apply a general search strategy including the use of search terms, and the role of Boolean operators; truncation; and search filters for more efficient searches[a]	E
2.3 State the differences in broad topics covered by the major research databases	**M**
2.4 Outline strategies to obtain the full text of articles and other evidence resources[a]	**E**

3. Appraise and Interpret	
3.1 Identify key competencies relevant to the critical evaluation of the integrity, reliability, and applicability of health-related research	**E**
This competency includes	
Understand the difference between random error and systematic error (bias)[a]	E
Identify the major categories of bias and the impact of these biases on the results[a]	E
Interpret commonly used measures of uncertainty, in particular, confidence intervals[a]	P
Recognize that association does not imply causation and explain why[a]	E
Recognise the importance of considering conflict of interest/funding sources	M
Recognise the uses and limitations of subgroup analysis and how to interpret its results[a]	M
3.2 Interpret different types of measures of association and effect, including key graphical presentations[a]	**P**
This competency includes	
Identify the basic types of data such as categorical and continuous[a]	E
Recognise the meaning of some basic frequency measures	M
Identify the difference between "statistical significance" and "importance", and between a lack of evidence of an effect and 'evidence of no effect'[a]	E
3.3 Critically appraise and interpret a systematic review[a]	**P**
This competency includes	
Recognise the difference between systematic reviews, meta-analyses, and non-systematic reviews[a]	M
Identify and critically appraise key elements of a systematic review	P
Interpret presentations of the pooling of studies such as a forest plot and summary of findings table	P
3.4 Critically appraise and interpret a treatment study[a]	**P**
This competency includes	
Identify and appraise key features of a controlled trial	P
Interpret the results including measures of effect	P
Identify the limitations of observational studies as treatment studies, and recognise the basics of adjustment methods and its limitations	E
3.5 Critically appraise and interpret a diagnostic accuracy study[a]	**P**
This competency includes	
Identify and appraise key features of a diagnostic accuracy study	P
Interpret the results including interpret measures to evaluate diagnostic accuracy[a]	P
Recognise the purpose and use of clinical prediction rules	M

3.6 Distinguish evidence-based from opinion-based clinical practice guideline[a]	**P**
3.7 Identify the key features of, and be able to interpret, a prognostic study	**E**
This competency includes	
Identify and appraise key features of a prognostic study	E
Interpret the results including measures of effect (e.g., Kaplan Meier survival curves) and uncertainty	E
Recognise the purpose and use of clinical prediction rules	M
3.8 Explain the use of harm/aetiologies study for (rare) adverse effects of interventions[a]	**E**
This competency includes	
Indicate that common treatment harms can usually be observed in controlled trials, but some rare or late harms will only be seen in observational studies	E
3.9 Explain the purpose and processes of a qualitative study	**E**
This competency includes	
Recognise how qualitative research can inform the decision making process	M
4. Apply	
4.1 Engage patients in the decision making process, using shared decision making, including explaining the evidence and integrating their preferences[a]	**P**
This competency includes	
Recognise the nature of the patient's dilemma, hopes, expectations, fears, and values and preferences	M
Understand and practice shared decision making	P
Recognise how decision support tools such as patient decision aids can assist in shared decision making	M
4.2 Outline different strategies to manage uncertainty in clinical decision making in practice	**E**
This competency includes	
Recognise professional, ethical, and legal components/dimensions of clinical decision making, and the role of clinical reasoning	M
4.3 Explain the importance of baseline risk of individual patients when estimating individual expected benefit	**E**
This competency includes:	
Recognise different types of outcome measures (surrogate vs composite endpoints measures)	M
4.4 Interpret the grading of the certainty in evidence and the strength of recommendations in health care	**E**
5. Evaluate	
5.1 Recognise potential individual-level barriers to knowledge translation and strategies to overcome these	**M**
This competency includes:	
Recognise the process of reflective clinical practice.	M
5.2 Recognise the role of personal clinical audit in facilitating EBP	**M**

Abbreviations: E, explained; EBP, evidence-based practice; M, mentioned; P, practiced with exercises; PECO, population, exposure, comparison, outcome; PICO, patient, intervention, comparison, outcome; PICOT, patient, intervention, comparison, outcome, time; PO, patient, outcome.

[a] indicates core competencies that achieved the consensus level in Delphi round 2.

5.6 Discussion

This study was a rigorous process, which involved integrating evidence from a systematic review, conducting a modified Delphi survey, holding a consensus meeting, and receiving external feedback from EBP experts, to achieve consensus on the most essential core competencies that should be taught in EBP educational programs for clinicians and students. The final consensus set includes 68 core competencies.

A previous study has developed a set of EBP competencies, but it was limited to a single discipline (nursing) and country (United States) and did not use a systematic review to inform the Delphi survey[32]. Some competencies appear in this previously identified set (e.g. critical appraisal of a research article, formulate a clinical question using PICO [patient, intervention, comparison, outcome]). However, our competencies are more specific and extend to include the application of evidence, including through shared decision making, and evidence implementation at the individual clinical level. The set of EBP core competencies highlights the required level of detail needed (i.e. mentioned, explained, and practiced with exercises) for each EBP competency as a proxy for the amount of time that should be dedicated to each. Additionally, we view this set of EBP core competencies as a contemporary and dynamic set. As the field matures, new competencies will undoubtedly need to be added, and others removed. For instance, shared decision making and the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach are 2 recent competencies that were not taught in EBP curricula previously. We plan to review this set periodically and welcome any feedback.

With the increased availability of trustworthy preappraised evidence resources, clinicians can practice EBP without being fully competent in detailed critical appraisal of individual studies. What they must know, however, is how to critically interpret and apply the results presented in these preappraised sources[33,34]. This full understanding is necessary to trade off desirable and undesirable consequences, particularly when they are closely balanced. Furthermore, shared decision making requires clearly communicating about the trade-offs with patients. However, clinicians may still sometimes need to critically appraise individual studies (for example, when there are no trusted preappraised resources that answer a clinical question, or when a new study challenges their current practice). In addition, skills in critical appraisal are helpful in determining the trustworthiness of preappraised evidence.

The core competencies should be suitable to inform the curricula for an introductory course in EBP for clinicians of any level of education and any discipline. The competencies provide building blocks for EBP educators to use to develop their own curriculum, tailored to local learning needs, time availability, discipline, and the previous EBP experience of the learners. Competencies are unlikely to be exhaustive or tailored to the specific needs of any one discipline. However, some of the competencies might be more relevant to one discipline than another (e.g. diagnosis is more relevant to the discipline of medicine than to others). The order of the EBP core competencies in the set does not reflect the order of their importance or sequence in teaching. Educators can modify their approach to teaching these competencies based on case-based scenarios or articles, and it is likely that optimal communication of competencies will require teaching in more than one setting using a number of different scenarios and/or articles. For example, a teaching session can be initiated using an equivocal risk-benefit balance case scenario and teaching the shared decision-making skills needed, providing patient decision aids where possible. Then, teachers can explain the evidence incorporated into the decision aids and the derivation and interpretation of quantities, such as absolute risk difference and number needed to treat or harm.

Educators and curriculum developers in EBP are encouraged to evaluate the content of their current curriculum and integrate these competencies into it. Educators may find mapping core competencies to existing curricula will allow identification of any gaps in the coverage of essential content. Programs can address other additional advanced competencies (e.g. implementation science, economic analysis) depending on the needs and desires of their learners.

This set of core competencies in EBP represents just one of several needed steps for the implementation of competency-based EBP education. Dissemination and integration of this set of core competencies in academic and clinical practice may assist in delivering a more uniform and harmonised education to EBP learners. Open access online databases of learning resources (e.g. the Critical Thinking and Appraisal Resource Library [CARL])[35] represent an important resource to enhance the sharing and accessibility of learning resources relevant for the EBP core competencies.

The development of appropriate assessment tools to evaluate the identified EBP competencies is challenging but useful for monitoring learners' progress in each of the competencies or evaluating the effectiveness of different teaching methods. A systematic review of 85 studies evaluating EBP educational interventions found that more than half of the included studies did not use a psychometrically robust, high-quality instrument to measure their outcomes (L.A., P.G., T.H., unpublished data, 2018). Therefore, EBP education researchers should identify, and if necessary develop, specific assessment tools (both formative and summative) that provide accurate, reliable, and timely evaluation of the EBP competencies of learners. Future work should also focus on defining core competencies needed for each training level and comparing different modalities (including the sequence) when teaching these competencies.

Limitations

A key strength of the study is the systematic review and Delphi survey approach to achieving international consensus about a contemporary set of core competencies in EBP curricula. Although we selected Delphi participants to represent a diverse range of health professions and expertise, they may not adequately represent the full spectrum of views held by individuals within a single profession.

5.7 Conclusions

Based on a systematic consensus process, a set of core competencies in EBP to inform the development of EBP curricula for health professional learners has been developed and described.

5.8 Declarations

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Author Contributions

Drs Albarqouni and Hoffmann had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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Acquisition, analysis, or interpretation of data: Albarqouni, Hoffmann, Straus, Young, Ilic, Shaneyfelt, Haynes, Guyatt, Glasziou.

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Supervision: Hoffmann, Glasziou.

Conflict of Interest Disclosures

Dr Albarqouni reported grants from the Australian Government Research Training Program Scholarship during the conduct of the study. Dr Hoffmann reported personal fees from Elsevier outside the submitted work. Dr Glasziou reported membership on the board of the International Society for Evidence-Based Health Care. No other disclosures were reported.

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The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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5.10 Supplementary materials 5

Published with article presented in **Chapter 5**

Supplementary material 5.1

eMethods 1 Detailed methods of the systematic review of EBP educational studies for health professionals presented in **Chapter 5**.

Background and Objectives

Evidence-Based Practice (EBP) has the potential to improve the quality of healthcare as well as the patients' outcomes. Thus, EBP is integrated in the curricula of undergraduate, postgraduate, and continuing healthcare education. However, there are huge variations in the content of EBP training programs and curricula. There is no agreement on the most essential core competencies in EBP that clinicians should learn in order to achieve the ultimate potential benefits of practicing EBP. We previously conducted a systematic review of studies which had evaluated the effect of EBP educational interventions. For this study, we identified EBP competencies addressed in included studies.

Eligibility criteria (Study design, population, intervention, and outcomes)

Design: controlled trials (must have had a separate group for comparison, e.g. randomized controlled trials or non-randomized controlled trials);

Population: any health professionals irrespective of the discipline or the level of training (undergraduate, postgraduate, or continuous professional development);

Intervention: any format or mode of EBP educational intervention (e.g. workshop, course, journal club) which aimed to teach at least one component of the main EBP steps (ask, acquire, appraise, apply and assess), compared to either no intervention or other intervention (e.g. comparing different methods of EBP training);

Outcomes: any measure of EBP knowledge or skills or attitudes or behaviors or practice.

Search strategy

We used the citation analysis technique to identify the studies of EBP educational interventions (until March 2017). Citation analysis is an alternative to the time-consuming and the complex nature of the standard search strategies, and has an acceptable accuracy rate. The index articles for our citation analysis were studies in a recent overview of the effect of EBP teaching - both the included systematic reviews and the included primary studies investigating the effect of evidence-based practice. We tracked forward and backward citations of these index articles using the Web of Science database. No language restrictions were applied. The Cochrane highly sensitive search filter for identifying controlled trials (sensitivity-maximizing version; 2008) was applied. In addition, the reference lists of included studies were also reviewed and additional eligible studies were included for full text assessment.

Selection of studies

Titles and abstracts were screened by one review author to identify potentially eligible studies and the full texts of these were assessed for inclusion. Any concerns about study eligibility were discussed by the authors and resolved by discussion.

Data extraction

Details of the study characteristics including authors, publication year, title, journal, country, sample size, design, population, intervention, and outcomes were extracted from each study. We contacted the corresponding author of the original study requesting further information regarding the EBP educational intervention including any teaching materials. We reviewed the original publications, any other additionally relevant resources (searching reference list, and tracking the author's relevant publications), and provided information and materials (by contacting the authors) to identify all EBP competencies delivered in these EBP educational interventions based on the most completed data available for each study. Three authors independently extracted EBP competencies from a random sample of 20 articles, and continued discussion until consensus was attained. We did not assess the risk of bias in included studies.

Results

Of 1682 articles identified by our search, 714 titles and abstract were screened for eligibility. Of these, 286 full text articles were obtained for review, 203 articles were excluded; 83 articles were included (**eFigure 1**). 42 (51%) studies were published after 2005 (ranged from 1986-2015), 35 (42%) were conducted in United States (the remainder were conducted in 16 different countries in all continents), and 45 (54%) were randomized controlled trials. 50 (60%) included postgraduate level participants, and 62 (75%) taught medical professionals. **eTable 1** shows details about the characteristics of the included studies.

We identified 234 EBP competencies in included studies and other additional EBP curricula and key statements (Sicily statement on EBP, and informed health choice key concepts). The initial list of EBP competencies were reviewed for duplication, consistency, and comprehension; and eventually reduced to 86 competencies. We grouped/organized these competencies into the relevant EBP steps (Introductory, ask, acquire, appraise and interpret, apply, and reflect) (**eTable 2**).

Supplementary material 5.2

eMethods 2 Detailed methods of the modified Delphi Survey presented in **Chapter 5**.

Background and Objectives

Core competencies have been defined as "the essential minimal set of a combination of attributes such as applied knowledge, skills and attitudes which enable an individual to perform a set of tasks to an appropriate standard efficiently and effectively". Core competencies offer a common shared language for all healthcare professions for defining what all clinicians are expected to be able to do in order to work optimally. Clearly specified core competencies can significantly enhance the individual learning performance, and provide an impetus for consistent quality healthcare education. Evidence-Based Practice (EBP) has the potential to improve the quality of healthcare as well as the patients' outcomes, thus, it has been widely integrated into curricular educational activities and practised by clinicians from different healthcare disciplines working in various settings. However, there is a lack of clarity about the essential core competencies in EBP that clinicians should meet in order to achieve the ultimate potential benefits of practising EBP. We used a modified Delphi technique to achieve a consensus from a diverse group of international experts on the most essential core competencies in EBP.

Methods

Modified Delphi survey is a common approach used to solicit the opinions of experts through a series of structured iterative questionnaires (called rounds) which aim to obtain group consensus. A modified Delphi survey utilises pre-existing literature (e.g. systematic review) to develop the initial questionnaire rather than starting the first round with open-ended questions. We used a modified Delphi technique to achieve a consensus from a diverse group of international experts. Our Delphi study consisted of two sequential rounds of questionnaires.

Participants

The diverse range of expertise within the Delphi participants is an important quality criterion and should reflect the population that is intended to use the EBP core competencies set. To facilitate the dissemination and implementation of the EBP core competencies set we have been inclusive of relevant healthcare professions, organisations or institutions, countries, research disciplines, and stakeholders. The ideal participant is a healthcare clinician who has a significant experience in teaching and practising EBP (both academic and practitioner). However, we also included participants who: (1) have a significant research contribution to the field of EBP (e.g. authors of EBP educational trials); (2) have a significant experience in practising EBP in the clinical practice; and (3) EBP teachers who have extensive experience in teaching EBP.

Selection of the participants

We used purposive and snowball sampling approach to select participants for the Delphi survey. We invited eligible participants to register their interests in our Delphi Survey by posting announcements in social media (e.g. Twitter, and Facebook), sending email invitations to EBHC listserv and other networks of national and international evidence-based societies, and personal invitations to a list of EBP experts (have credibility in this field, e.g. ISEHC board members, Sicily statements group members). National and international evidence-based societies that have been approached included: (1) International Society of Evidence Based Healthcare (ISEHC); (2) The German Network of Evidence based Medicine Society (Deutsches Netzwerk Evidenzbasierte Medizin DNEbM) – Germany; (3) Taiwan Evidence-based Medicine Association (TEBMA) – Taiwan; (4) Iranian Center for Evidence-Based Medicine – Iran; (5) Centre Evidence Based Medicine – Oxford, UK; (6) Italian partner for evidence –based health care (GIMBE) – Italy; (7) Centre for Evidence-based Health Care – South Africa; (8) Center for Clinical Epidemiology and Evidence-Based Medicine (CEEBM) – Indonesia; (9) Chinese Cochrane Centre – China; and (10) Johns Hopkins Evidence-based Practice Center – US.

Sample size

There is no best practice guidance regarding the sample size of Delphi survey, however, having more participants will increase the reliability of group judgment. In addition, diversity among participants is important to ensure all views are considered in the consensus. We, therefore, undertook a broad approach to ensure there is a diverse and sufficient participation in this Delphi study. We aimed to invite a minimum of 120-150 participants for the first round.

Recruitment of participants and Delphi Procedures

We sent an email to invite all eligible participants who registered their interest in our Delphi. The invitation email included a clear explanatory statement outlining the objective of the Delphi survey, the procedure of the Delphi surveys (e.g. an estimate of the amount of time required to complete each questionnaire) and the importance of completing all Delphi rounds. Participation in the survey was optional and informed consent was assumed if a participant responded to the survey.

Attrition bias is a common problem in Delphi surveys which might overestimate the degree of consensus in the final results. Strategies to minimise attrition bias included providing reminders to participants and ensuring that each round is concise and easy to complete with minimal time commitment. Participants were encouraged to complete each Delphi Round within 4-6 weeks. Reminder emails have been sent at the end of week two, three, and four to prompt the completion of the survey.

All participants were allocated a unique identification number to allow the identification of individual responses and enable the tracking of attrition at each round. All participants who completed the first round of the Delphi were invited to participate in the second round. We used the web-based SurveyMonkey software to conduct the Delphi survey.

Data has been collected and analysed following each Delphi round using Microsoft Excel 2016. Additional items listed by participants were reviewed by the research team to ensure they represent new unique competencies.

Round 1 Delphi questionnaire

The Delphi questionnaire for the first round included three main sections: (i) introduction: a statement describing the main aims of the Delphi survey, the procedures, and timeline; (ii) the main questionnaire: based on the items generated from the systematic review and other sources (as described in **eMethods 1**); (iii) information about the participants (e.g. age group, country of residence, place of employment, their professional background and their level of experience in EBP).

EBP competencies were organised into 6 domains to reflect the main EBP steps (introductory, ask, acquire, appraise and interpret, apply, assess). Participants were asked to rate the relative importance of each competence item listed as “omitted”, “mentioned”, “explained”, or “practised (with exercises)”. Participants had the opportunity to suggest any other competencies that they believe should be added. Participants were also encouraged to comment on any of the competencies, and suggest possible rephrasing of any of them. The final draft of this questionnaire was piloted to ensure the feasibility, clarity of the competencies and rating format. **eMethods 3** shows the round 1 Delphi questionnaire.

Round 2 Delphi questionnaire

EBP competencies from the first round were amended and merged, and those remained were organised into five groups for the second round. The first group included competencies attained the pre-defined consensus level (≥70%) at the same rating level (e.g. “explained”), and participants were advised that these would be included in the list of core competencies unless strong objection was received in the second round. The second group included competencies that did not achieve the consensus level but positively rated as “practised with exercises or explained” by the majority (≥85%). Participants were asked to rate competencies in this group as “practised with exercises” or “explained”; third group included competencies that did not achieve the consensus level but positively rated as “explained or mentioned” by the majority (≥85%). Participants were asked to rate competencies in this group as “explained” or “mentioned”; fourth group included competencies that did not achieve the consensus level but positively rated as "mentioned or omitted" by the majority (≥85%). Participants were asked to rate competencies in this group as "mentioned" or "omitted"; fifth Group included competencies that were suggested by participants, and they were asked to rate each competence as "omitted", "mentioned", "explained", or "practised with exercises".

Participants were also encouraged to suggest any other competencies that they believe should be added, comment on any of the competencies, and suggest possible rephrasing of any of them. The final draft of this questionnaire was piloted to ensure the feasibility, clarity of the competencies and rating format. **eMethods 4** shows the round 2 Delphi questionnaire.

Results

A total of 234 participants have registered their interest to participate in our Delphi survey and were invited to round 1 Delphi questionnaire. Of those, 184 participants (79%) had participated in round 1 Delphi survey, and were invited for round 2 Delphi survey. 144 participants (78%) participated in round 2 Delphi questionnaire. Characteristics of participants in "registration of interest", Delphi round 1, and Delphi round 2 are shown in **eTable 3**.

Delphi round 1 and 2 results

Of the 86 EBP competencies included in round 1 Delphi questionnaire, 11 reached the consensus level (≥70%) at the same rating level (e.g. "explained"); 27 were rated as "practised with exercises or explained" by the majority (≥85%); 28 were rated as "explained or mentioned" by the majority (≥85%); 4 were rated as "mentioned or omitted" by the majority (≥85%); and 9 additional competencies were identified in the first round and added to the questionnaire of the second round. **eTable 4** shows summary of round 1 Delphi questionnaire results.

After second round, 48 EBP competencies had achieved the consensus level (>70%): 20 EBP competencies were rated as "practised with exercises"; 20 as "explained"; and 8 as "mentioned". 29 EBP competencies did not achieve the consensus level, and were retained for further discussion at the consensus meeting. **eTable 5** shows summary of round 2 Delphi questionnaire results.

Supplementary material 5.3

Round 1 Delphi Survey presented in **Chapter 5**.

eMethods 3. Round 1 Delphi survey

Developing a core set of EBP concepts - Delphi survey round 1

Background

What are the core concepts of Evidence-Based Practice (EBP)?

Thank you for agreeing to participate in this Delphi survey on the core evidence-based practice (EBP) concepts. The goal of this two-round Delphi survey (and a third, if necessary) is to achieve consensus about the core concepts that should be delivered in EBP training programs.

Concept-based learning is being endorsed and required by major medical and health education entities; however, no previous systematic attempt has been made to develop a list of the core concepts that a clinician needs to learn in EBP. This list will contain the most essential EBP concepts that should be taught to any health discipline (e.g. medicine, nursing, allied health, pharmacy) as well as to any education level (e.g. undergraduate, postgraduate, or continuous professional education).

We hope that you will participate in both rounds (approximately 4-6 weeks apart). Each survey should take you about 15 minutes to complete. The structure of this questionnaire is based on the main five steps of EBP:

1. **Ask**: asking a clear clinical question.
2. **Acquire**: acquiring the best evidence which is relevant to our question.
3. **Appraise**: a) Critically appraising the evidence for its validity and usefulness; b) Interpretation of the results.
4. **Apply**: applying the evidence to the clinical practice.
5. **Assess**: assessing the performance of this process.

In these surveys, you will be asked your opinion on priorities of teaching various EBP concepts.

Please rate whether each concept in this survey should be included in a core set of EBP teaching concepts.

For each of the numbered concepts, please check the basic box that corresponds to your rating.

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

Where appropriate, a textbox is also provided for you to comment on the reasons for your responses, suggestions for the precise wording, and description of the concepts. Suggestions of new concepts are also welcome, but please first consider the concepts already listed at the end of this survey. These are concepts that have been covered in published education interventions and EBP curriculum statements, but were not included in the main survey questions.

Thank you
Loai Albarqouni, Paul Glasziou, Tammy Hoffmann, Dragan Ilic, Taryn Young and Nina Rydland Olsen

Developing a core set of EBP concepts - Delphi survey round 1

Introductory and Background Concepts

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

Introductory and Background Concepts

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. The definition of evidence-based practice (EBP): "the integration of the best research evidence with our clinical expertise and our patient's unique values and circumstances[1]".**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. The distinction between the mechanistic vs. empiricism approach of dealing with what is effective (a common example is Dr. Spock's advice to put infants on fronts to sleep to avoid chocking on vomit [mechanistic] while this led to avoidable cot death (empiric evidence)**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. Hierarchy of levels of evidence (i.e. hierarchy for each clinical question type, primary research vs. secondary research).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 4. The history and origin of EBP**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 5. The rationale for EBP (e.g. there is a huge amount of literature that clinicians cannot read all: an expanding amount of publications vs. clinicians' workload and the need to keep up-to-date).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 6. The five steps of EBP: ask, acquire, appraise, apply and assess.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 7. The distinction between using research (that is, search for pre-appraised evidence to apply in practice or follow the five steps of EBP) vs. conducting research (that is, conducting primary or secondary research).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 8. New, brand-named, or more expensive treatments are not necessarily better than current alternatives.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 9. Earlier detection of disease is not necessarily better.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

10. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

11. Are there any suggestions you would like to make on the wording or content of the concepts?

[1] Straus S, Glasziou W, Richardson S, Haynes RB. Evidence Based Medicine: How to Practice and Teach it. 4th Ed. 2010. Churchill Livingstone, Edinburgh, UK.

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 1: Ask

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 1: Ask

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. How to identify and prioritise personal uncertainties or knowledge gaps in practice**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. The difference between background and foreground questions (e.g. "What is myocardial infarction?" versus "In adult patients with myocardial infarction, does aspirin intake improve patients' survival?").**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. Type of foreground clinical question (Frequency vs. Aetiology vs. Therapeutic vs. Prognosis vs. Diagnosis).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 4. Using PICO to structure answerable clinical questions (includes: PICO elements, how to translate clinical problems into structured clinical questions, advantages of structured clinical questions).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

5. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

6. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 2: Acquire

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 2: Acquire

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. 5S/(or)6S model/pyramid of evidence resources.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. Categories of sources of information (original primary databases vs. filtered resources vs. pre-appraised clinical evidence).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. The difference in topic covered between databases (e.g. PubMed: medical, CINAHL: nursing and allied health, PsycINFO: psychiatry and mental health).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 4. How to use different databases (e.g. PubMed, EMBASE, and Cochrane).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 5. General search strategy: How to develop one (e.g. search terms: free text vs. Key words or MeSH terms) and Boolean operations: e.g. AND, OR, NOT.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 6. Role of search filters (e.g. limit to language, human, year or study design).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 7. The importance of designing a search strategy that reflects the purpose of the search (e.g. a narrow "the best" search for answering a quick clinical question vs. a broad search "everything" for conducting a systematic review.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 8. How to find full text articles.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

9. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

10. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 3: Appraise – Epidemiological

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 3: Appraise – Epidemiological

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

* **1. Randomisation (the importance and methods of randomisation).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* **2. Allocation concealment.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* **3. Blinding.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* **4. Loss to follow up/Attrition.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* **5. Intention-To-Treat analysis (vs. Per Protocol analysis).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* **6. The difference between Causation and Association.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* **7. Confounding (methods to detect and adjust for confounders).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 8. The definition and calculation of incidence and prevalence.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 9. The importance of considering conflict of interest/ funding sources in appraising articles.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

10. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

11. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 3: Appraise – Appraisal

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 3: Appraise – Appraisal

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. The anatomy of a scientific paper (IMRD: Introduction, Methods, Results, and Discussion, identifying the "must read" sections).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. Classifications of study designs: e.g. Interventional vs. observational; systematic reviews, RCTs, Non-RCTs, cohort, case-control, cross-sectional, etc.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. The Pros & Cons of each study design for different types of research questions.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 4. Systematic reviews & Meta-analysis (definitions and their importance).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 5. Level of evidence and grade of recommendations (GRADE).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 6. How to critical appraise a systematic review.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 7. How to critical appraise a treatment study.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 8. How to critical appraise a diagnostic study.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 9. How to critical appraise a prognostic study.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 10. How to critical appraise a harm study.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 11. How to critical appraise a qualitative study.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 12. How to critical appraise a clinical practice guideline.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

13. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

14. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 3: Appraise – Statistical

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 3: Appraise – Statistical

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. The importance of the reporting quality of studies: EQUATOR Network reporting guidelines (e.g. STROBE, CONSORT, and PRISMA) and how to assess the quality of reporting of an article.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. Classifications of the types of data: categorical (dichotomous, nominal, ordinal) vs. continuous data**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. P-values: what they are and how to interpret.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 4. Confidence Intervals: what they are and how to interpret.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 5. The difference between clinical and statistical significance.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 6. The difference between random error and systematic error (Bias).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 7. Classifications of the types bias (sources, types and how to deal with): e.g. performance bias; reporting bias; detection bias; recall bias; selection bias; publication bias (funnel plot, egger's test).

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 8. Meaning and types of validity (internal vs. external validity).

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 9. Sensitivity analysis: what is it and how to interpret its results.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 10. Subgroup analysis: what is it and how to interpret its results.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 11. Meta-analysis: what is it and how to interpret its results.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

* 12. Heterogeneity: what is it, methods to detect it and how to interpret it.

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

13. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

14. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 3: Appraise – Results Interpretation

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 3: Appraise – Results Interpretation

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. Types of measures of association and effect for binary outcomes (how to interpret): e.g. effect size in general, odds ratio, relative risk reduction/increase, absolute risk difference, relative risk /risk ratio, hazard ratio, NNT/NNH.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. Measures for continuous outcomes (how to interpret): e.g. difference of means, ratio of means.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. A 2x2 or contingency table (how to interpret and construct).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 4. Measures to evaluate diagnostic accuracy (how to interpret): e.g. sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratio.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

5. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

6. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 4: Apply

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 4: Apply

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. Clinical Decision Making (its components, application of the concepts of decision anatomy in the analysis of a clinical problem, and the barriers for objective decision making).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. Management of uncertainty in decision making in clinical practice.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. The purpose and use of clinical prediction rules.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 4. Shared decision making (importance of and strategies including communicating benefit and harms to patients, and sharing decision with patients) and the role of decision support tools.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 5. Baseline risk of individual patient affects expected benefit (and calculation of individual expected benefit).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 6. Barriers of knowledge translation: individual versus organizational level and strategies to overcome these barriers.**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

7. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

8. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

EBP Step 5: Assess

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

EBP Step 5: Assess

Which of the following concepts should be included in a priority set of core EBP teaching concepts?

*** 1. The leaky evidence pipeline (aware, accept, decide, do, recall, adhere, agree with patient, done).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 2. Clinical Audit (its importance and how to conduct).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

*** 3. Reflective clinical practice (what is it and how to practice it).**

○ Omitted ○ Mentioned ○ Explained ○ Practiced (with exercises)

4. Are there any other concepts relevant to the introduction and background of EBP that you think should be included?

5. Are there any suggestions you would like to make on the wording or content of the concepts?

Developing a core set of EBP concepts - Delphi survey round 1

Additional concepts

This is a list of additional concepts that have been also addressed in published education interventions and EBP curriculum statements. However, the steering committee have not included these additional concepts in the main survey questions. If you feel strongly, that one or more of these should be included in the next round, please indicate which and give a brief justification. Please review this list before suggesting new concepts.

Additional concepts

1- ACQUIRE

- ○ Citations tracking (forward/backward).

2- APPRAISE

- ○ Types of outcome measures (surrogate vs. composite end points measures).
- ○ Types of summary measures (proportion, mean, mode, median, SD, range, IQ ranges).
- ○ Graphical presentation of data (e.g. scatter plot, distribution curve, Kaplan-Meier curve, Bland-Altman plot, forest plot).
- ○ Tabular presentation of data (e.g. summary of finding tables in Cochrane reviews).
- ○ Clinical Practice Guidelines (development, sources, advantages and limitations).
- ○ Critical appraisal of cost-effectiveness paper + economic analysis.
- ○ Type I & Type II Error.
- ○ Sampling: techniques (probability vs. non-probability sampling) and sample size calculation.
- ○ Descriptive vs. Inferential statistical tests.
- ○ Parametric vs. Non-parametric tests.
- ○ Regression analysis: types (logistic, linear), independent vs. dependent variables.
- ○ Survival analysis (life table).
- ○ Random vs. Fixed effect models.
- ○ Equivalence vs. Non-inferiority vs. Superiority trials.
- ○ Reliability: reliability coefficients (e.g. intra-class correlation coefficient, kappa statistics).

3- APPLY

- ○ Cultural competence.

4- ASSESS

- ○ Academic detailing.
- ○ Supervision and training EBP to students.

5- Please give a reason for each concept you believe should be included in the next round.

6- Any other additional concepts that have not been mentioned anywhere in this survey.

Developing a core set of EBP concepts - Delphi survey round 1

About You

1- What is your age?

- ○ Under 18
- ○ 18 - 29
- ○ 30 - 44
- ○ 45 - 59
- ○ 60+

2- What is your gender?

- ○ Female
- ○ Male

3- In what country do you live?

4- Please indicate your health discipline

- ○ Medicine
- ○ Nursing
- ○ Allied health (e.g. physiotherapy, occupational therapy)
- ○ Pharmacy
- ○ Other (please specify)

5- Please indicate which of the following describes your place of employment (more than one may apply)

- ○ Hospital
- ○ Private health practice
- ○ University
- ○ Non-profit organisation (e.g. non-governmental organisation, charity)
- ○ Governmental organisation
- ○ For-profit organisation (e.g. pharmaceutical or training company)
- ○ Other (please specify)

6- **Please indicate which of the following describes your role or position (more than one may apply)**

- ○ Teaching role
- ○ Clinical role
- ○ Research role
- ○ Other (please specify)

7- **Are you currently responsible for teaching EBP**

- ○ Yes
- ○ No

8- **Please indicate the number of years of EBP teaching experience.**

9- **Please indicate here if you do NOT want to participate in the next round of the survey**

- ○ I do NOT want to participate

10- **At what email address would you like to be contacted?**

Developing a core set of EBP concepts - Delphi survey round 1
Thank you
Thank you very much for your participation

Supplementary material 5.4

Round 2 Delphi Survey presented in **Chapter 5**

eMethods 4. Round 2 Delphi survey

Developing a core set of EBP concepts - Delphi survey round 2

Background

Thank you for your participation in the first round of this modified Delphi survey on the core evidence-based practice (EBP) concepts. This is the second round and hopefully the final one. We are aiming to develop a **minimum** list of the core concepts that a clinician needs to learn in EBP.

Based on your responses to the first round, the potential EBP core concepts have been divided into 5 main parts:

Part 1 (DEFINITELY INCLUDE): concepts that will be **included** in the list of EBP core concepts unless strong objection is received in this round.

Part 2 (POSSIBLY INCLUDE – PRACTISED): concepts that were positively rated as should be '**Practised with exercise**' by the **majority** but did not reach the predefined level of consensus.

Part 3 (POSSIBLY INCLUDE – EXPLAINED): concepts that were positively rated as should be '**Explained**' by the **majority** but did not reach the predefined level of consensus.

Part 4 (POSSIBLY INCLUDE – MENTIONED): concepts that were positively rated as should be '**Mentioned**' by the **majority** but did not reach the predefined level of consensus.

Part 5 (ADDITIONAL): concepts that were either on the additional list or suggested by participants.

Thank you for the many free-text comments from Round 1. We have incorporated those comments into this round where applicable, or added them to the agenda for discussion at the consensus meeting.

This round of the survey should take 10 minutes to complete and will close on **4th June 2017**.

Thank you for your participation.

Loai Albarqouni, Paul Glasziou, Tammy Hoffmann, Dragan Ilic, Taryn Young and Nina Rydland Olsen

Developing a core set of EBP concepts - Delphi survey round 2

Part 1: DEFINITELY INCLUDE

Part 1 These are concepts that reached the predefined level of consensus and will be included in the EBP core concepts list, unless strong objection is received in this round. You do not need to rate these items again, but can provide comment.

1.1. The five steps of EBP: ask, acquire, appraise, apply and assess.**(Practised)**

1.2. Using PICO to structure answerable clinical questions (includes: PICO elements, how to translate clinical problems into structured clinical questions, advantages of structured clinical questions). **(Practised)**

1.3. How to use different databases (e.g. PubMed, EMBASE, Cochrane).**(Practised)**

1.4. General search strategy: How to develop one (e.g. search terms: free text vs. Key words or MeSH terms) and Boolean operators: e.g. AND, OR, NOT. **(Practised)**

1.5. Systematic reviews & Meta-analysis (definitions and their importance).**(Explained)**

1.6. Critical appraisal of a systematic review. **(Practised)**

1.7. Critical appraisal of a treatment study. **(Practised)**

1.8. Critical appraisal of a clinical practice guideline.**(Practised)**

1.9. Critical appraisal of a diagnostic study. **(Practised)**

1.10. How to interpret measures of effect for binary outcomes: e.g. effect size in general, odds ratio, relative risk reduction/increase, absolute risk difference, relative risk /risk ratio, hazard ratio, NNT/NNH. **(Practised)**

1.11. The history and origin of EBP.**(Mentioned)**

1. Are there any suggestions you would like to make on the wording or content or incorporation of any of these concepts?

Developing a core set of EBP concepts - Delphi survey round 2

Part 2: POSSIBLY INCLUDE – PRACTISED

Part 2 These are concepts that were rated as should be 'Practised with exercise' by the **majority**, but did not reach the predefined level of consensus.

Please rate each concept as to whether it should be *'Practised with exercise' or 'Explained'*. These concepts are mapped to the concepts in part 1.

Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

*** 1. Additional concepts relevant to concept 1.1: "The five steps of EBP: ask, acquire, appraise, apply and assess."**

	Practised with exercise	Explained
Shared decision making (importance of and strategies including communicating benefit and harms to patients, and sharing decision with patients) and the role of decision support tools.	○	○

*** 2. Additional concepts relevant to concept 1.2: "Using PICO to structure answerable clinical questions (includes: PICO elements, how to translate clinical problems into structured clinical questions, advantages of structured clinical questions)."**

	Practised with exercise	Explained
Types of clinical questions (e.g. frequency, aetiology, therapeutic)	○	○
Major types of study designs: e.g. Interventional vs. observational; systematic reviews, RCTs, Non-RCTs, cohort, case-control, cross-sectional, etc.	○	○
Hierarchy of levels of evidence (i.e. hierarchy for each clinical question type, primary research vs. secondary research).	○	○
The pros & cons of major study designs for different types of research questions.	○	○

*** 3. Additional concepts relevant to concept 1.3: "How to use different databases (e.g. PubMed, EMBASE, Cochrane)."**

	Practised with exercise	Explained
How to find full text articles.	○	○
Role of search filters (e.g. limit to language, human, year or study design).	○	○
The importance of designing a search strategy that reflects the purpose of the search (e.g. a narrow "the best" search for answering a quick clinical question vs. a broad search "everything" for conducting a systematic review.)	○	○

*** 4. Additional concepts relevant to concept 1.6: "Critical appraisal of a systematic review."**

	Practised with exercise	Explained
Heterogeneity: what it is, methods to detect it and how to interpret it.	○	○
A 2x2 or contingency table (how to interpret and construct).	○	○
Meta-analysis: what is it and how to interpret its results.	○	○

*** 5. Additional relevant to concept 1.7: "Critical appraisal of a treatment study."**

	Practised with exercise	Explained
Allocation concealment.	○	○
Blinding.	○	○
Intention-To-Treat analysis (vs. Per Protocol analysis).	○	○
Randomisation (the importance and methods of randomisation).	○	○
Loss to follow up/Attrition.	○	○
The difference between causation and association.	○	○

*** 6. Additional relevant to concept 1.9: "Critical appraisal of a diagnostic study."**

	Practised with exercise	Explained
How to interpret measures to evaluate diagnostic accuracy: e.g. sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratio.	○	○

*** 7. Concepts relevant to concept 1.10: "How to interpret measures of effect for binary outcomes"**

	Practised with exercise	Explained
The difference between clinical and statistical significance.	○	○
Confidence Intervals: what they are and how to interpret.	○	○
How to interpret measures of effect for continuous outcomes: e.g. difference of means, ratio of means.	○	○
P-values: what they are and how to interpret.	○	○

*** 8. Unmapped**

	Practised with exercise	Explained
Critical appraisal of a prognostic study.	○	○
Critical appraisal of a harm study.	○	○
Critical appraisal of a qualitative study.	○	○

9. Are there any suggestions you would like to make on the wording or content or incorporation of any of these concepts?

Developing a core set of EBP concepts - Delphi survey round 2

Part 3: POSSIBLY INCLUDE – EXPLAINED

Part 3 These are concepts that were rated as should be **'Explained'** by the **majority**, but did not reach the predefined level of consensus.

Please rate each concept as to whether it should be *'Explained' or 'Mentioned'* . Some of the concepts where possible, have been mapped to the concepts in part 1.

Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).

*** 1. Additional concepts relevant to concept 1.1: "The five steps of EBP: ask, acquire, appraise, apply and assess."**

	Explained	Mentioned
The definition of evidence-based practice (EBP): "e.g. the integration of the best research evidence with our clinical expertise and our patient's unique values and circumstances [1]".	○	○
How to identify and prioritise personal uncertainties or knowledge gaps in practice	○	○
Management of uncertainty in decision making in clinical practice.	○	○

*** 2. Additional concepts relevant to concept 1.2: "Using PICO to structure answerable clinical questions (includes: PICO elements, how to translate clinical problems into structured clinical questions, advantages of structured clinical questions)."**

	Explained	Mentioned
The difference between background and foreground questions (e.g. "What is myocardial infarction?" versus "In adult patients with myocardial infarction, does aspirin improve patients' survival?").	○	○

*** 3. Additional concepts relevant to concept 1.3: "How to use different databases (e.g. PubMed, EMBASE, Cochrane)."**

	Explained	Mentioned
Categories of sources of information (e.g. original primary databases vs. filtered resources vs. pre-appraised evidence).	○	○
5S (or) 6S model of evidence resources (i.e. studies, syntheses, synopses, summaries, systems): what it is and the advantages and disadvantages of resources at each level [2].	○	○

*** 4. Additional concepts relevant to concept 1.6: "Critical appraisal of a systematic review."**

	Explained	Mentioned
The difference between random error and systematic error (Bias).	○	○
Classifications of the type of bias (sources, types and how to deal with): e.g. performance bias; reporting bias; detection bias; recall bias; selection bias; publication bias (funnel plot, egger's test).	○	○
Types of validity (internal vs. external validity).	○	○
Sensitivity analysis: what is it and how to interpret its results.	○	○
Subgroup analysis: what is it and how to interpret its results.	○	○
The Grading of Recommendations Assessment, Development and Evaluation (GRADE) - Level of evidence.	○	○
Baseline risk of individual patient affects expected benefit (and calculation of individual expected benefit).	○	○

*** 5. Additional relevant to concept 1.7: "Critical appraisal of a clinical practice guideline."**

	Explained	Mentioned
The Grading of Recommendations Assessment, Development and Evaluation (GRADE) - Strength of Recommendations	○	○

*** 6. Additional relevant to concept 1.9: "Critical appraisal of a diagnostic study."**

	Explained	Mentioned
The purpose and use of clinical prediction rules.	○	○

*** 7. Concepts relevant to concept 1.10: "How to interpret measures of effect for binary outcomes"**

	Explained	Mentioned
Classifications of types of data: categorical (dichotomous, nominal, ordinal) vs. continuous data.	○	○

*** 8. Additional concepts relevant to concept 1.11: "The history and origin of EBP"**

	Explained	Mentioned
The distinction between the mechanistic vs. empiricism approach of dealing with what is effective (e.g. Dr. Spock's advice to put infants on fronts to sleep to avoid choking on vomit [mechanistic] while this led to avoidable cot death [empirical]	○	○

	Explained	Mentioned
The distinction between using research (that is, search for pre-appraised evidence to apply in practice or follow the five steps of EBP) vs. conducting research (that is, conducting primary or secondary research).	○	○
The rationale for EBP (e.g. there is a huge amount of literature that clinicians cannot read all: an expanding amount of publications vs. clinicians' workload and the need to keep up-to-date).	○	○

*** 9. Unmapped**

	Explained	Mentioned
The importance of the reporting quality of studies: EQUATOR Network of reporting guidelines (e.g. STROBE, CONSORT, and PRISMA) and how to assess the quality of reporting of an article.	○	○
Clinical Decision Making (its components, application of the concepts of decision anatomy in the analysis of a clinical problem, and the barriers for objective decision making).	○	○
Barriers of knowledge translation: individual versus organizational level and strategies to overcome these barriers.	○	○
Clinical audit (its importance and how to conduct).	○	○
Reflective clinical practice (what is it and how to practice it).	○	○
The definition and calculation of incidence and prevalence.	○	○
The importance of considering conflict of interest/ funding sources in appraising articles.	○	○
The anatomy of a scientific paper (IMRD: Introduction, Methods, Results, and Discussion, identifying the "must read" sections).	○	○
Confounding (methods to detect and adjust for confounders).	○	○

10. Are there any suggestions you would like to make on the wording or content or incorporation of any of these concepts?

Developing a core set of EBP concepts - Delphi survey round 2

Part 4: POSSIBLY INCLUDE – Mentioned

Part 4 These are concepts that were rated as should be 'Mentioned' by the **majority**, but did not reach the predefined level of consensus.

Please rate each concept as to whether it should be *'Mentioned' or 'Omitted'*. Some of the concepts where possible, have been mapped to the concepts in part 1.

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).

*** 1. Additional concepts relevant to concept 1.3: "How to use different databases (e.g. PubMed, EMBASE, Cochrane)."**

	Mentioned	Omitted
The difference in topics covered between databases (e.g. PubMed: medical, CINAHL: nursing and allied health, PsycINFO: psychiatry and mental health).	○	○

*** 2. Unmapped**

	Mentioned	Omitted
Earlier detection of disease is not necessarily better.	○	○
The leaky evidence pipeline (aware, accept, decide, do, recall, adhere, agree with patient, done) [1].	○	○
New, brand-named, or more expensive treatments are not necessarily better than current alternatives.	○	○

3. Are there any suggestions you would like to make on the wording or content or incorporation of any of these concepts?

Developing a core set of EBP concepts - Delphi survey round 2

Part 5: ADDITIONAL

Part 5 These are concepts that were either on the additional list in Round 1 or from participants' comments.

Please rate each concept as whether it should be *'Practised with exercise', 'Explained', 'Mentioned', or 'Omitted'.*

Omitted: a concept that is not a priority to be included in an EBP training program.
Mentioned: a concept that should be just mentioned in an EBP training program (i.e. provide common knowledge about this concept).
Explained: a concept that should be briefly explained in an EBP training program (i.e. provide understanding of the concept but without practical exercises).
Practised (with exercises): a concept that should be practised with exercises in an EBP training program (i.e. provide a detailed understanding of the concept, enhanced with practical exercises).

*** 1. Additional concepts relevant to concept 1.10: "How to interpret measures of effect for binary outcomes "**

	Practice with exercise	Explained	Mentioned	Omitted
Types of outcome measures (surrogate vs. composite end points measures).	○	○	○	○

*** 2. Unmapped**

	Practice with exercise	Explained	Mentioned	Omitted
Graphical presentation of data (e.g. scatter plot, Kaplan-Meier curve, Bland-Altman plot).	○	○	○	○
Mixed-method research: how to appraise and interpret.	○	○	○	○
Type I & Type II Error.	○	○	○	○
Cultural competence (including the workplace context).	○	○	○	○
Qualitative research: how to appraise.	○	○	○	○
Summary of Findings (SoF) tables: how to interpret.	○	○	○	○
Patient decision aids: what they are, role in EBP, and how to use.	○	○	○	○
Clinician decision support tools: role in EBP.	○	○	○	○

3. Are there any suggestions you would like to make on the wording or content or incorporation of any of these concepts?

Developing a core set of EBP concepts - Delphi survey round 2

Thank you

Thank you very much for your participation

Supplementary material 5.5

Characteristics of included studies in the systematic review presented in **Chapter 5**.

eTable 1. Characteristics of included studies in the systematic review

Author, date	Country, language of intervention	Participants (number, profession, education level)
Randomized Controlled Trials		
Buchanan 2014	South Africa, English	56 practising occupational therapists
Dizon 2014	Philippines	54 practising physical therapists
Welch 2014	US, English	175 professional athletic training students, graduate students, clinical preceptors, educators, and clinicians.
Al-Baghali 2013	Saudi Arabia, English	59 medical doctors in primary health care centres
Brettle 2013	UK, English	77 first-year undergraduate pre-registration diploma nursing students
Campbell 2013	Australia, English	135 allied health professionals from four regions in Australia.
Eldredge 2013	US, English	71 first-year medical students
Ilic 2013	Australia and Malaysia	147 medical students
Kok 2013	Netherland	132 insurance physicians
Cheng 2012	Taiwan, Mandarin	94 final-year medical students
Ilic 2012	Australia, English	121 third-year medical students
Kulier 2012	7 LMICs	204 postgraduate trainees (registrars and residents trainees) in obstetrics and gynaecology
Sanchez-Mendiola 2012	Mexico, Spanish	289 fifth-year medical students
Gardois 2011	Italy, Italian	22 paediatric residents and interns
Jalali-Nia 2011	Iran	41 undergraduate nursing students
Feldstein 2010	US, English	48 internal medicine residents
Hadley 2010	UK, English	237 postgraduate medical trainee at foundation or internship level
McLeod 2010	US, English	443 residents in general surgery
Johnston 2009	China	129 second-year medical students
Kulier 2009	Netherland and UK	61 postgraduate trainees in obstetrics and gynaecology
Davis 2008	UK, English	55 newly qualified foundation year doctors
Hugenholtz 2008	Netherlands	98 occupational physicians
Kim 2008	US, English	50 residents in internal medicine
Davis 2007	UK, English	179 first medical students
Lee 2007	China	132 final-year medical students
Shuval 2007	Israel	75 primary care doctors
Stark 2007	US, English	77 second- and third-year residents in internal medicine
Krueger 2006	US, English	77 third-year osteopathic medical students
Schilling 2006	US, English	238 third-year medical students
Bradley 2005	Norway	175 tenth-semester medical students
Macrae 2004	Canada, English	81 general surgeons
Stevenson 2004	UK, English	30 musculoskeletal physiotherapists
Taylor 2004	UK, English	145 healthcare professionals (general practitioners, hospital physicians, professions allied to medicine, and healthcare managers/administrators)

Cheng 2003	China	800 healthcare clinicians (medical doctors, nurses, allied health professionals)
Forsetlund 2003	Norway	148 public health physicians
Bradley 2002	US, English	10 residents in neonatal care unit
Cabell 2001	US, English	48 internal medicine resident physicians
Verhoeven 2000	Netherland	103 healthcare professionals (general practitioners and others)
MacAuley 1999	UK, English	99 GP trainers
Stevermer 1999	US, English	59 residents in family practice
Erickson 1998	US, English	31 residents in obstetrics and gynaecology
Rosenberg 1998	UK, English	108 medical students
Haynes 1993	Canada, English	392 physicians and physicians-in-training
Romm 1989	US, English	108 medical students
Linzer 1987	US, English	44 medical interns
Non-Randomized Controlled Trials		
Ilic 2015	Australia, English	61 second-year medical students
Olsen 2015	Norway	37 clinical instructors in Physiotherapy
Ramos-Morcillo 2015	Spain, Spanish	109 registered nurse
Vrdoljak 2015	Croatia, Croatian	98 mentors in general practice
Fernandez 2014	Australia and Hong Kong, English	186 postgraduate nursing students
Balajic 2012	Croatia, Croatian	1232 medical students in 3 medical schools.
Haas 2012	US, English	339 chiropractic doctoral students
Schoonheim-Klein 2012	Netherland	62 working group of dental students
Wallen 2010	US, English	159 nurses participating in leading/mentoring activities
Kim 2009	US, English	208 senior fourth-year nursing students
Carlock 2007	US, English	90 junior first-semester nursing students
Schaafsma 2007	Netherland	125 occupational health physicians and insurance physicians
Gruppen 2005	US, English	92 fourth-year medical students
Thomas 2005	US, English	46 residents in internal medicine
Akl 2004	US, English	40 medical students and residents rotating with the general internal medicine team at a university hospital.
Sanchez-Mendiola 2004	Mexico, Spanish	131 medical students
Ross 2003	US, English	48 residents in family practice
Mills 2002	Canada, English	83 Naturopathic interns
Badgett 2001	US, English	157 third-year medical students
Edwards 2001	UK, English	482 third-year medical students
Major-Kincade 2001	US, English	64 paediatrics house staff
Shorten 2001	Australia, English	143 nursing students
Ghali 2000	Canada, English	60 third-year medical students
Smith 2000	US, English	55 first-year residents in internal medicine

Bazarian 1999	US, English	32 emergency medicine residents
Fu 1999	Canada, English	12 residents in psychiatry
Green 1997	US, English	34 second- and third-year internal medicine residents
Landry 1994	US, English	146 third-year medical students
Seelig 1993	US, English	44 practising internists and residents
Frasca 1992	US, English	92 third-year medical students
Griffin 1992	US, English	57 occupational therapy students
Langkamp 1992	US, English	27 residents in Paediatrics
Kitchens 1989	Canada, English	83 residents in internal medicine
Bennett 1987	Canada, English	79 final-year medical students
Linzer 1988	US, English	85 residents in internal medicine
Radack 1986	US, English	33 medical students
Riegelman 1986	US, English	292 medical students
Viniegra 1986	Mexico, Spanish	20 residents in internal medicine

Abbreviations: RCT: randomised controlled trial; CT: controlled trial; P: postgraduate; U: undergraduate

Supplementary material 5.6

EBP competencies identified from included studies in the systematic review presented in **Chapter 5**.

eTable 2. EBP competencies identified from included studies in the systematic review

Introductory
The definition of evidence-based practice (EBP): "the integration of the best research evidence with our clinical expertise and our patient's unique values and circumstances".
The distinction between the mechanistic vs. empiricism approach of dealing with what is effective (a common example is Dr. Spock's advice to put infants on fronts to sleep to avoid chocking on vomit [mechanistic] while this led to avoidable cot death (empiric evidence)
Hierarchy of levels of evidence (i.e. hierarchy for each clinical question type, primary research vs. secondary research).
The history and origin of EBP.
The rationale for EBP (e.g. there is a huge amount of literature that clinicians cannot read all: an expanding amount of publications vs. clinicians' workload and the need to keep up-to-date).
The five steps of EBP: ask, acquire, appraise, apply and assess.
The distinction between using research (that is, search for pre-appraised evidence to apply in practice or follow the five steps of EBP) vs. conducting research (that is, conducting primary or secondary research).
New, brand-named, or more expensive treatments are not necessarily better than current alternatives.
Earlier detection of disease is not necessarily better.
Ask
How to identify and prioritise personal uncertainties or knowledge gaps in practice
The difference between background and foreground questions (e.g. "What is myocardial infarction?" versus "In adult patients with myocardial infarction, does aspirin intake improve patients' survival?").
Type of foreground clinical question (Frequency vs. Aetiology vs. Therapeutic vs. Prognosis vs. Diagnosis).
Using PICO to structure answerable clinical questions (includes: PICO elements, how to translate clinical problems into structured clinical questions, advantages of structured clinical questions).
Acquire
5S/(or)6S model/pyramid of evidence resources.
Categories of sources of information (original primary databases vs. filtered resources vs. pre-appraised clinical evidence).
The difference in topic covered between databases (e.g. PubMed: medical, CINAHL: nursing and allied health, PsycINFO: psychiatry and mental health).
How to use different databases (e.g. PubMed, EMBASE, and Cochrane).
General search strategy: How to develop one (e.g. search terms: free text vs. Key words or MeSH terms) and Boolean operations: e.g. AND, OR, NOT.
Role of search filters (e.g. limit to language, human, year or study design).
The importance of designing a search strategy that reflects the purpose of the search (e.g. a narrow "the best" search for answering a quick clinical question vs. a broad search "everything" for conducting a systematic review.
How to find full text articles.
Appraise – Epidemiological
Randomisation (the importance and methods of randomisation).
Allocation concealment.

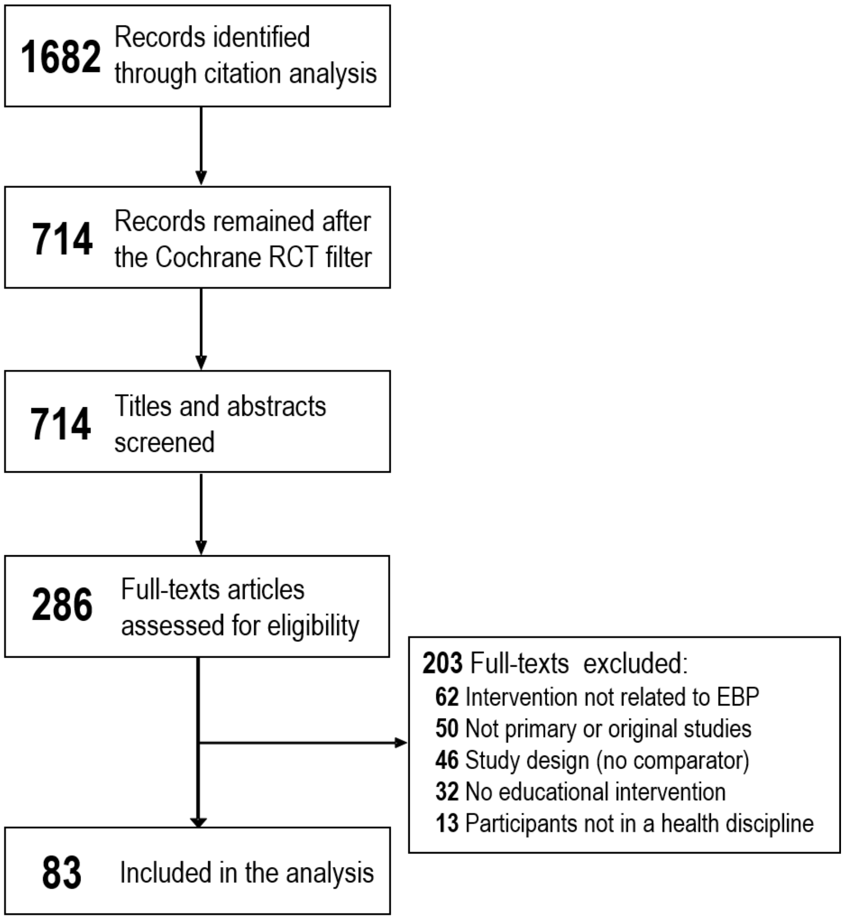
Blinding.
Loss to follow up/Attrition.
Intention-To-Treat analysis (vs. Per Protocol analysis).
The difference between Causation and Association.
Confounding (methods to detect and adjust for confounders).
The definition and calculation of incidence and prevalence.
The importance of considering conflict of interest/ funding sources in appraising articles.
Appraise – Appraisal
The anatomy of a scientific paper (IMRD: Introduction, Methods, Results, and Discussion, identifying the “must read” sections).
Classifications of study designs: e.g. Interventional vs. observational; systematic reviews, RCTs, Non-RCTs, cohort, case-control, cross-sectional, etc.
The Pros & Cons of each study design for different types of research questions.
Systematic reviews & Meta-analysis (definitions and their importance).
Level of evidence and grade of recommendations (GRADE).
How to critical appraise a systematic review.
How to critical appraise a treatment study.
How to critical appraise a diagnostic study.
How to critical appraise a prognostic study.
How to critical appraise a harm study.
How to critical appraise a qualitative study.
How to critical appraise a clinical practice guideline.
Appraise – Statistical
The importance of the reporting quality of studies: EQUATOR Network reporting guidelines (e.g. STROBE, CONSORT, and PRISMA) and how to assess the quality of reporting of an article.
Classifications of the types of data: categorical (dichotomous, nominal, ordinal) vs. continuous data
P-values: what they are and how to interpret.
Confidence Intervals: what they are and how to interpret.
The difference between clinical and statistical significance.
The difference between random error and systematic error (Bias).
Classifications of the types bias (sources, types and how to deal with): e.g. performance bias; reporting bias; detection bias; recall bias; selection bias; publication bias (funnel plot, egger's test).
Meaning and types of validity (internal vs. external validity).
Sensitivity analysis: what is it and how to interpret its results.
Subgroup analysis: what is it and how to interpret its results.
Meta-analysis: what is it and how to interpret its results.
Heterogeneity: what is it, methods to detect it and how to interpret it.

Appraise – Results Interpretation
Types of measures of association and effect for binary outcomes (how to interpret): e.g. effect size in general, odds ratio, relative risk reduction/increase, absolute risk difference, relative risk /risk ratio, hazard ratio, NNT/NNH.
Measures for continuous outcomes (how to interpret): e.g. difference of means, ratio of means.
A 2x2 or contingency table (how to interpret and construct).
Measures to evaluate diagnostic accuracy (how to interpret): e.g. sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratio.
Apply
Clinical Decision Making (its components, application of the concepts of decision anatomy in the analysis of a clinical problem, and the barriers for objective decision making).
Management of uncertainty in decision making in clinical practice.
The purpose and use of clinical prediction rules.
Shared decision making (importance of and strategies including communicating benefit and harms to patients, and sharing decision with patients) and the role of decision support tools.
Baseline risk of individual patient affects expected benefit (and calculation of individual expected benefit).
Barriers of knowledge translation: individual versus organizational level and strategies to overcome these barriers.
Assess/Evaluate
The leaky evidence pipeline (aware, accept, decide, do, recall, adhere, agree with patient, done).
Clinical Audit (its importance and how to conduct).
Reflective clinical practice (what is it and how to practice it).
Additional
Citations tracking (forward/backward).
Types of outcome measures (surrogate vs. composite end points measures).
Types of summary measures (proportion, mean, mode, median, SD, range, IQ ranges).
Graphical presentation of data (e.g. scatter plot, distribution curve, Kaplan-Meier curve, Bland-Altman plot, forest plot).
Tabular presentation of data (e.g. summary of finding tables in Cochrane reviews).
Clinical Practice Guidelines (development, sources, advantages and limitations).
Critical appraisal of cost-effectiveness paper + economic analysis.
Type I & Type II Error.
Sampling: techniques (probability vs. non-probability sampling) and sample size calculation.
Descriptive vs. Inferential statistical tests.
Parametric vs. Non-parametric tests.
Regression analysis: types (logistic, linear), independent vs. dependent variables.
Survival analysis (life table).
Random vs. Fixed effect models.

Equivalence vs. Non-inferiority vs. Superiority trials.
Reliability: reliability coefficients (e.g. intra-class correlation coefficient, kappa statistics).
Cultural competence.
Academic detailing.
Supervision and training EBP to students.

Supplementary material 5.7

PRISMA flow chart of the systematic review presented in **Chapter 5**.



eFigure 1. PRISMA flow chart of the systematic review

Supplementary material 5.8

Summary of the results of round 1 Delphi questionnaire presented in **Chapter 5**.

eTable 3. Summary of round 1 Delphi questionnaire results.

EBP Competencies	Omitted	mentioned	explained	practised
The definition of evidence-based practice (EBP): “the integration of the best research evidence with our clinical expertise and our patient’s unique values and circumstances”.	0 (0)	59 (32.1)	100 (54.3)	25 (13.6)
The distinction between the mechanistic vs. empiricism approach of dealing with what is effective (a common example is Dr. Spock's advice to put infants on fronts to sleep to avoid chocking on vomit [mechanistic] while this led to avoidable cot death (empiric evidence)	5 (2.7)	62 (33.7)	100 (54.3)	17 (9.2)
Hierarchy of levels of evidence (i.e. hierarchy for each clinical question type, primary research vs. secondary research).	2 (1.1)	7 (3.8)	81 (44)	94 (51.1)
The history and origin of EBP.	10 (5.5)	130 (71)	41 (22.4)	2 (1.1)
The rationale for EBP (e.g. there is a huge amount of literature that clinicians cannot read all: an expanding amount of publications vs. clinicians’ workload and the need to keep up-to-date).	0 (0)	61 (33.2)	101 (54.9)	22 (12)
The five steps of EBP: ask, acquire, appraise, apply and assess.	0 (0)	10 (5.4)	44 (23.9)	130 (70.7)
The distinction between using research (that is, search for pre-appraised evidence to apply in practice or follow the five steps of EBP) vs. conducting research (that is, conducting primary or secondary research).	8 (4.4)	49 (26.8)	108 (59)	18 (9.8)
New, brand-named, or more expensive treatments are not necessarily better than current alternatives.	55 (30.1)	101 (55.2)	18 (9.8)	9 (4.9)
Earlier detection of disease is not necessarily better.	48 (26.1)	109 (59.2)	15 (8.2)	12 (6.5)
How to identify and prioritise personal uncertainties or knowledge gaps in practice	3 (1.6)	45 (24.5)	113 (61.4)	23 (12.5)
The difference between background and foreground questions (e.g. “What is myocardial infarction?” versus “In adult patients with myocardial infarction, does aspirin intake improve patients’ survival?”).	3 (1.6)	51 (27.7)	106 (57.6)	24 (13)
Type of foreground clinical question (Frequency vs. Aetiology vs. Therapeutic vs. Prognosis vs. Diagnosis).	5 (2.7)	14 (7.6)	72 (39.1)	93 (50.5)
Using PICO to structure answerable clinical questions (includes: PICO elements, how to translate clinical problems into structured clinical questions, advantages of structured clinical questions).	1 (0.5)	6 (3.3)	15 (8.2)	162 (88)
5S/(or)6S model/pyramid of evidence resources[1].	2 (1.1)	45 (25.1)	109 (60.9)	23 (12.8)
Categories of sources of information (original primary databases vs. filtered resources vs. pre-appraised clinical evidence).	2 (1.1)	55 (30.7)	99 (55.3)	23 (12.8)
The difference in topic covered between databases (e.g. PubMed: medical, CINAHL: nursing and allied health, PsycINFO: psychiatry and mental health).	32 (17.9)	122 (68.2)	18 (10.1)	7 (3.9)
How to use different databases (e.g. PubMed, EMBASE, Cochrane).	2 (1.1)	17 (9.6)	26 (14.6)	133 (74.7)
General search strategy: How to develop one (e.g. search terms: free text vs. Key words or MeSH terms) and Boolean operations: e.g. AND, OR, NOT.	2 (1.1)	8 (4.5)	22 (12.3)	147 (82.1)

Role of search filters (e.g. limit to language, human, year or study design).	3 (1.7)	23 (12.8)	48 (26.8)	105 (58.7)
The importance of designing a search strategy that reflects the purpose of the search (e.g. a narrow "the best" search for answering a quick clinical question vs. a broad search "everything" for conducting a systematic review.	2 (1.1)	10 (5.6)	67 (37.4)	100 (55.9)
How to find full text articles.	3 (1.7)	21 (11.7)	48 (26.8)	107 (59.8)
Randomisation (the importance and methods of randomisation).	0 (0)	14 (7.9)	87 (48.9)	77 (43.3)
Allocation concealment.	0 (0)	12 (6.7)	58 (32.4)	109 (60.9)
Blinding.	0 (0)	13 (7.3)	56 (31.5)	109 (61.2)
Loss to follow up/Attrition.	0 (0)	16 (9)	63 (35.4)	99 (55.6)
Intention-To-Treat analysis (vs. Per Protocol analysis).	1 (0.6)	12 (6.7)	76 (42.5)	90 (50.3)
The difference between Causation and Association.	2 (1.1)	16 (9)	47 (26.4)	113 (63.5)
Confounding (methods to detect and adjust for confounders).	2 (1.1)	33 (18.5)	120 (67.4)	23 (12.9)
The definition and calculation of incidence and prevalence.	5 (2.8)	74 (41.3)	79 (44.1)	21 (11.7)
The importance of considering conflict of interest/ funding sources in appraising articles.	2 (1.1)	38 (21.3)	115 (64.6)	23 (12.9)
The anatomy of a scientific paper (IMRD: Introduction, Methods, Results, and Discussion, identifying the "must read" sections).	3 (1.7)	61 (34.3)	92 (51.7)	22 (12.4)
Classifications of study designs: e.g. Interventional vs. observational; systematic reviews, RCTs, Non-RCTs, cohort, case-control, cross-sectional, etc.	0 (0)	8 (4.5)	81 (45.5)	89 (50)
The Pros & Cons of each study design for different types of research questions.	1 (0.6)	15 (8.5)	56 (31.6)	105 (59.3)
Systematic reviews & Meta-analysis (definitions and their importance).	0 (0)	12 (6.7)	129 (72.5)	37 (20.8)
Level of evidence and grade of recommendations (GRADE).	0 (0)	63 (35.6)	89 (50.3)	25 (14.1)
How to critical appraise a systematic review.	0 (0)	7 (3.9)	28 (15.7)	143 (80.3)
How to critical appraise a treatment study.	0 (0)	3 (1.7)	18 (10.2)	155 (88.1)
How to critical appraise a diagnostic study.	2 (1.1)	12 (6.8)	38 (21.5)	125 (70.6)
How to critical appraise a prognostic study.	1 (0.6)	21 (11.9)	49 (27.7)	106 (59.9)
How to critical appraise a harm study.	7 (4)	16 (9)	59 (33.3)	95 (53.7)
How to critical appraise a qualitative study.	6 (3.4)	20 (11.2)	45 (25.3)	107 (60.1)
How to critical appraise a clinical practice guideline.	0 (0)	13 (7.3)	40 (22.6)	124 (70.1)
The importance of the reporting quality of studies: EQUATOR Network reporting guidelines (e.g. STROBE, CONSORT, and PRISMA) and how to assess the quality of reporting of an article.	3 (1.7)	60 (33.9)	91 (51.4)	23 (13)
Classifications of the types of data: categorical (dichotomous, nominal, ordinal) vs. continuous data	5 (2.8)	63 (35.6)	88 (49.7)	21 (11.9)
P-values: what they are and how to interpret.	1 (0.6)	10 (5.6)	74 (41.8)	92 (52)
Confidence Intervals: what they are and how to interpret.	0 (0)	9 (5.1)	59 (33.3)	109 (61.6)
The difference between clinical and statistical significance.	0 (0)	2 (1.1)	71 (40.1)	104 (58.8)

The difference between random error and systematic error (Bias).	3 (1.7)	58 (32.8)	101 (57.1)	15 (8.5)
Classifications of the types bias (sources, types and how to deal with): e.g. performance bias; reporting bias; detection bias; recall bias; selection bias; publication bias (funnel plot, egger's test).	6 (3.4)	60 (33.7)	92 (51.7)	20 (11.2)
Meaning and types of validity (internal vs. external validity).	3 (1.7)	48 (27.3)	102 (58)	23 (13.1)
Sensitivity analysis: what is it and how to interpret its results	5 (2.8)	56 (31.6)	95 (53.7)	21 (11.9)
Subgroup analysis: what is it and how to interpret its results	3 (1.7)	55 (31.3)	95 (54)	23 (13.1)
Meta-analysis: what is it and how to interpret its results	0 (0)	10 (5.6)	82 (46.3)	85 (48)
Heterogeneity: what is it, methods to detect it and how to interpret it.	3 (1.7)	23 (13)	53 (29.9)	98 (55.4)
Types of measures of association and effect for binary outcomes (how to interpret): e.g. effect size in general, odds ratio, relative risk reduction/increase, absolute risk difference, relative risk /risk ratio, hazard ratio, NNT/NNH.	1 (0.6)	14 (8)	36 (20.5)	125 (71)
Measures for continuous outcomes (how to interpret): e.g. difference of means, ratio of means.	7 (4)	15 (8.5)	61 (34.7)	93 (52.8)
A 2x2 or contingency table (how to interpret and construct).	2 (1.1)	18 (10.2)	51 (29)	105 (59.7)
Measures to evaluate diagnostic accuracy (how to interpret): e.g. sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratio.	2 (1.1)	20 (11.4)	45 (25.6)	109 (61.9)
Clinical Decision Making (its components, application of the concepts of decision anatomy in the analysis of a clinical problem, and the barriers for objective decision making).	1 (0.6)	76 (43.2)	82 (46.6)	17 (9.7)
Management of uncertainty in decision making in clinical practice.	2 (1.1)	68 (38.6)	90 (51.1)	16 (9.1)
The purpose and use of clinical prediction rules.	9 (5.1)	63 (36)	87 (49.7)	16 (9.1)
Shared decision making (importance of and strategies including communicating benefit and harms to patients, and sharing decision with patients) and the role of decision support tools.	0 (0)	15 (8.5)	66 (37.5)	95 (54)
Baseline risk of individual patient affects expected benefit (and calculation of individual expected benefit).	5 (2.8)	72 (40.9)	78 (44.3)	21 (11.9)
Barriers of knowledge translation: individual versus organizational level and strategies to overcome these barriers.	4 (2.3)	54 (30.5)	97 (54.8)	22 (12.4)
The leaky evidence pipeline (aware, accept, decide, do, recall, adhere, agree with patient, done)[1].	51 (29)	100 (56.8)	10 (5.7)	15 (8.5)
Clinical Audit (its importance and how to conduct).	13 (7.4)	72 (40.9)	79 (44.9)	12 (6.8)
Reflective clinical practice (what is it and how to practice it).	9 (5.1)	81 (46)	70 (39.8)	16 (9.1)

Supplementary material 5.9

Summary of the results of round 2 Delphi questionnaire presented in **Chapter 5**.

eTable 4. Summary of round 2 Delphi questionnaire results.

EBP Competencies (Group 1)		
The five steps of EBP: ask, acquire, appraise, apply and assess.		Practised
Using PICO to structure answerable clinical questions (includes: PICO elements, how to translate clinical problems into structured clinical questions, advantages of structured clinical questions).		Practised
How to use different databases (e.g. PubMed, EMBASE, Cochrane).		Practised
General search strategy: How to develop one (e.g. search terms: free text vs. Key words or MeSH terms) and Boolean operators: e.g. AND, OR, NOT.		Practised
Systematic reviews & Meta-analysis (definitions and their importance).		Explained
Critical appraisal of a systematic review.		Practised
Critical appraisal of a treatment study.		Practised
Critical appraisal of a clinical practice guideline.		Practised
Critical appraisal of a diagnostic study.		Practised
How to interpret measures of effect for binary outcomes: e.g. effect size in general, odds ratio, relative risk reduction/increase, absolute risk difference, relative risk /risk ratio, hazard ratio, NNT/NNH.		Practised
The history and origin of EBP.		Mentioned
EBP Competencies (Group 2)	**P**	**E**
Shared decision making (importance of and strategies including communicating benefit and harms to patients, and sharing decision with patients) and the role of decision support tools.	103 (71.5)	41 (28.5)
Types of clinical questions (e.g. frequency, aetiology, therapeutic)	101 (70.1)	43 (29.9)
Major types of study designs: e.g. Interventional vs. observational; systematic reviews, RCTs, cohort, case-control, cross-sectional	85 (59)	59 (41)
Hierarchy of levels of evidence (i.e. hierarchy for each clinical question type, primary research vs. secondary research).	42 (29.2)	102 (70.8)
The pros & cons of major study designs for different types of research questions.	38 (26.4)	106 (73.6)
How to find full text articles.	106 (73.6)	38 (26.4)
Role of search filters (e.g. limit to language, human, year or study design).	105 (72.9)	39 (27.1)
The importance of designing a search strategy that reflects the purpose of the search (e.g. a narrow “the best” search for answering a quick clinical question vs. a broad search “everything” for conducting a systematic review.)	101 (70.1)	43 (29.9)

Heterogeneity: what it is, methods to detect it and how to interpret it.	36 (25)	108 (75)
A 2x2 or contingency table (how to interpret and construct).	84 (58.3)	60 (41.7)
Meta-analysis: what is it and how to interpret its results.	110 (76.4)	34 (23.6)
Allocation concealment.	69 (47.9)	75 (52.1)
Blinding.	73 (50.7)	71 (49.3)
Intention-To-Treat analysis (vs. Per Protocol analysis).	86 (59.7)	58 (40.3)
Randomisation (the importance and methods of randomisation).	81 (56.3)	63 (43.8)
Loss to follow up/Attrition.	75 (52.1)	69 (47.9)
The difference between causation and association.	43 (29.9)	101 (70.1)
How to interpret measures to evaluate diagnostic accuracy: e.g. sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratio.	116 (80.6)	28 (19.4)
The difference between clinical and statistical significance.	105 (72.9)	39 (27.1)
Confidence Intervals: what they are and how to interpret.	110 (76.4)	34 (23.6)
How to interpret measures of effect for continuous outcomes: e.g. difference of means, ratio of means.	106 (73.6)	38 (26.4)
P-values: what they are and how to interpret.	101 (70.1)	43 (29.9)
Critical appraisal of a prognostic study.	57 (39.6)	87 (60.4)
Critical appraisal of a harm study.	38 (26.4)	106 (73.6)
Critical appraisal of a qualitative study.	54 (37.5)	90 (62.5)
EBP Competencies (Group 3)	**E**	**M**
The definition of evidence-based practice (EBP): "e.g. the integration of the best research evidence with our clinical expertise and our patient's unique values and circumstances [1]".	101 (72.7)	38 (27.3)
How to identify and prioritise personal uncertainties or knowledge gaps in practice	78 (56.5)	59 (42.8)
Management of uncertainty in decision making in clinical practice.	102 (73.9)	36 (26.1)
The difference between background and foreground questions (e.g. "What is myocardial infarction?" versus "In adult patients with myocardial infarction, does aspirin improve patients' survival?").	106 (76.3)	33 (23.7)
Categories of sources of information (e.g. original primary databases vs. filtered resources vs. pre-appraised evidence).	101 (73.2)	37 (26.8)

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5S (or) 6S model of evidence resources (i.e. studies, syntheses, synopses, summaries, systems): what it is and the advantages and disadvantages of resources at each level [2].	61 (44.2)	77 (55.8)
The difference between random error and systematic error (Bias).	107 (77.5)	31 (22.5)
Classifications of the type of bias (sources, types and how to deal with): e.g. performance bias; reporting bias; detection bias; recall bias; selection bias; publication bias (funnel plot, egger's test).	103 (74.6)	35 (25.4)
Types of validity (internal vs. external validity).	102 (74.5)	35 (25.5)
Sensitivity analysis: what is it and how to interpret its results.	98 (71)	40 (29)
Subgroup analysis: what is it and how to interpret its results.	96 (70.1)	41 (29.9)
The Grading of Recommendations Assessment, Development and Evaluation (GRADE) - Level of evidence.	103 (74.6)	35 (25.4)
Baseline risk of individual patient affects expected benefit (and calculation of individual expected benefit).	102 (75)	34 (25)
The Grading of Recommendations Assessment, Development and Evaluation (GRADE) - Strength of Recommendations	102 (73.9)	36 (26.1)
The purpose and use of clinical prediction rules.	66 (48.2)	71 (51.8)
Classifications of types of data: categorical (dichotomous, nominal, ordinal) vs. continuous data	99 (72.3)	38 (27.7)
The distinction between the mechanistic vs. empiricism approach of dealing with what is effective (e.g. Dr. Spock's advice to put infants on fronts to sleep to avoid choking on vomit [mechanistic] while this led to avoidable cot death [empirical]	41 (29.7)	97 (70.3)
The distinction between using research (that is, search for pre-appraised evidence to apply in practice or follow the five steps of EBP) vs. conducting research (that is, conducting primary or secondary research).	41 (29.9)	96 (70.1)
The rationale for EBP (e.g. there is a huge amount of literature that clinicians cannot read all: an expanding amount of publications vs. clinicians' workload and the need to keep up-to-date).	58 (41.7)	81 (58.3)
The importance of the reporting quality of studies: EQUATOR Network of reporting guidelines (e.g. STROBE, CONSORT, and PRISMA) and how to assess the quality of reporting of an article.	71 (52.2)	65 (47.8)
Clinical Decision Making (its components, application of the concepts of decision anatomy in the analysis of a clinical problem, and the barriers for objective decision making).	72 (52.9)	64 (47.1)
Barriers of knowledge translation: individual versus organizational level and strategies to overcome these barriers.	40 (29.4)	96 (70.6)
Clinical audit (its importance and how to conduct).	40 (29.6)	95 (70.4)
Reflective clinical practice (what is it and how to practice it).	67 (49.3)	69 (50.7)
The definition and calculation of incidence and prevalence.	78 (56.1)	61 (43.9)
The importance of considering conflict of interest/ funding sources in appraising articles.	65 (46.8)	74 (53.2)
The anatomy of a scientific paper (IMRD: Introduction, Methods, Results, and Discussion, identifying the "must read" sections).	79 (57.2)	59 (42.8)

Confounding (methods to detect and adjust for confounders).			99 (72.8)	37 (27.2)
EBP Competencies (Group 4)			**M**	**O**
The difference in topics covered between databases (e.g. PubMed: medical, CINAHL: nursing and allied health, PsycINFO: psychiatry and mental health).			116 (84.7)	21 (15.3)
Earlier detection of disease is not necessarily better.			101 (73.7)	36 (26.3)
The leaky evidence pipeline (aware, accept, decide, do, recall, adhere, agree with patient, done) [1].			64 (46.7)	73 (53.3)
New, brand-named, or more expensive treatments are not necessarily better than current alternatives.			99 (72.3)	38 (27.7)
EBP Competencies (Group 5)	**P**	**E**	**M**	**O**
Types of outcome measures (surrogate vs. composite end points measures).	16 (11.6)	68 (49.3)	43 (31.2)	11 (8)
Graphical presentation of data (e.g. scatter plot, Kaplan-Meier curve, Bland-Altman plot).	12 (8.8)	71 (51.8)	39 (28.5)	15 (10.9)
Mixed-method research: how to appraise and interpret.	15 (10.9)	43 (31.2)	67 (48.6)	13 (9.4)
Type I & Type II Error.	21 (15.2)	70 (50.7)	35 (25.4)	12 (8.7)
Cultural competence (including the workplace context).	7 (5.1)	21 (15.2)	56 (40.6)	54 (39.1)
Qualitative research: how to appraise.	69 (50)	44 (31.9)	18 (13)	7 (5.1)
Summary of Findings (SoF) tables: how to interpret.	40 (29)	75 (54.3)	17 (12.3)	6 (4.3)
Patient decision aids: what they are, role in EBP, and how to use.	20 (14.5)	69 (50)	43 (31.2)	6 (4.3)
Clinician decision support tools: role in EBP.	16 (11.6)	76 (55.1)	37 (26.8)	9 (6.5)

Supplementary material 5.10

The final set of EBP core competencies grouped into the main EBP domains and an elaboration of each competency presented in **Chapter 5**.

eTable 5. The final set of EBP core competencies grouped into the main EBP domains and an elaboration of each competency.
(M=mentioned, E=explained, P=practised with exercises).

0. Introductory	
0.0 Understand evidence-based practice (EBP) defined as the integration of the best research evidence with clinical expertise and patient's unique values and circumstances.	**E**
In this competency, the learner needs to understand the definition of evidence-based practice and the interplay between its three main domains: (i) best research evidence (i.e. clinically relevant research, sometimes from the basic sciences of medicine, but especially from patient-centred clinical research into the accuracy and precision of diagnostic tests, the power of prognostic markers, and the efficacy and safety of therapeutic, rehabilitative, and preventive strategies); (ii) clinical expertise (i.e. the ability to use clinical skills and past experience to rapidly identify each patient's unique health state and diagnosis, their individual risks and benefits of potential interventions/exposures/diagnostic tests, and their personal values and expectations). Clinical expertise is required to integrate evidence with patient values and circumstances; (iii) patient values and circumstances (i.e. the unique preferences, concerns, expectations, hopes, strengths, limitations, and stresses each patient brings to a clinical encounter and which must be integrated into shared clinical decisions if they are to serve the patient; and their individual clinical state and the clinical setting. The clinical practice of EBP must balance and integrate these factors, deal with not only the traditional skills of diagnosis but also the applicability of relevant research evidence and the patient's preferences and circumstances before guiding choices of action.	
0.1 Recognise the rationale for EBP.	**M**
This competency includes the need to recognise: - The daily clinical need for valid information to inform decision making, and the inadequacy of traditional sources for this information. [M] - The disparity between diagnostic skills and clinical judgment, which increase with experience, and up-to-date knowledge and clinical performance, which decline with age and experience. [M] - Lack of time to find and assimilate evidence as a clinician. [M] - The gaps between evidence and practice can lead to suboptimal practice and quality of care. [M] - The potential discordance between a pathophysiological and empirical approach to thinking about whether something is effective. [M]	
In this competency, the learner needs to recognise the rationale for EBP, including the daily clinical need for valid and quantitative information about diagnosis (e.g. knowing that earlier diagnosis does not necessarily mean better), prognosis, therapy (e.g., new interventions are not necessarily better than current alternatives), and prevention. Learner needs to recognise the inadequacy of traditional information sources because they are out of date (e.g., traditional textbooks), frequently biased (e.g., experts), ineffective or too overwhelming in their volume and too variable in their validity for practical clinical use (e.g., health journals). Learner also needs to recognise the disparity between diagnostic skills and clinical judgment, which increase with experience, and up-to-date knowledge and clinical performance which decline. Learner needs to recognise clinicians' inability to afford more than a few minutes per patient to find and assimilate evidence. Learner needs to recognise the gaps between evidence and practice (including overuse and underuse of evidence) leading to suboptimal practice and quality of care. Learner needs to recognise the distinction between the pathophysiological (or mechanical) approach and empirical approach to dealing with what is effective.	
0.2 For each type of clinical question, identify the preferred order of study designs, including the pros and cons of the major study designs.	**E**

This competency includes: - Classify the major study designs for each type of clinical question. [E]	
In this competency, the learner needs to identify the preferred order (from least to most biased) of study designs for each type of clinical question (e.g., treatment question best to be answered by a systematic review of randomised controlled trials; while question about people's beliefs and experiences best to be answered by qualitative studies). Learner needs to recognise the pros and cons of the major study designs – importantly those of highest level of evidence (e.g. systematic reviews, RCTs). In addition, learner needs to recognise when randomised controlled trials are unnecessary– such as in case of large, dramatic effects of intervention "all or none".	
0.3 Practice the 5 steps of EBP: Ask, Acquire, Appraise and Interpret, Apply, and Evaluate.	**P**
In this competency, the learner needs to practice the 5 steps of EBP: (i) Step 1 – identifying uncertainty and converting the need for information (about prevention, diagnosis, prognosis, therapy, causation, etc.) into an answerable question and to know that there are various strategies to keep track of knowledge gaps in practice; (ii) Step 2 – tracking down the best evidence with which to answer that question; (iii) Step 3 – critically appraising that evidence for its validity, impact, and applicability or accessing trustworthy pre-appraised sources; (iv) Step 4 – integrating the critical appraisal, and in particular the net benefit associated with alternative courses of action, with clinical expertise and with patient's unique biology, values and circumstances; (v) Step 5 – evaluating on effectiveness and efficiency in executing steps 1–4 and seeking ways to improve them both for next time and to optimize clinical practice.	
0.4 Understand the distinction between using research to inform clinical decision making versus conducting research.	**M**
In this competency, the learner needs to describe the distinction between 'conducting research' that is, completing primary or secondary research, which requires knowing the principles of scholarly inquiry, and 'using research' that is, search for pre-appraised evidence to apply in practice or follow the five steps of EBP. The latter "using research" is what is needed for clinical practice.	
1. Ask	
1.1 Explain the difference between the types of questions that cannot typically be answered by research (background questions) and those that can (foreground questions).	**E**
In this competency, the learner needs to identify the difference between background questions (e.g., "What is myocardial infarction?" and foreground questions (e.g., "In adult patients with myocardial infarction, does aspirin improve patients' survival?".)	
1.2 Identify different types of clinical questions, such as questions about treatment, diagnosis, prognosis, and aetiology.	**P**
In this competency, the learner needs to identify different types of clinical questions, such as questions about treatment, diagnosis, prognosis, and aetiology.	
1.3 Convert clinical questions into structured, answerable clinical questions using PICO.	**P**
This competency includes: - Recognise the importance of and strategies for identifying and prioritising uncertainties or knowledge gaps in practice. [M] - Understand the rationale for using structured clinical questions. [E] - Identify the elements of PICO questions and use variations of it when appropriate (e.g., PICOT, PO, PECO - Exposure) to structure answerable clinical questions. [P]	
In this competency, the learner needs to convert clinical questions into structured, answerable clinical questions using PICO format (stands for P: population, I: intervention, C: comparator, O: outcome), and its variations (e.g., PO only for a prevalence question, PICOT to include the timing; exposure replaces intervention for observational studies, Index test replaces intervention for diagnostic studies. In addition, learner needs to recognise the strategies for identifying and prioritising uncertainties and knowledge gaps in practice, and identifying the known unknown clinical questions.	

2. Acquire	
2.1 Outline the different major categories of sources of research information, including biomedical research databases or databases of filtered or pre-appraised evidence or resources.	**E**
This competency includes: - Outline the advantages of using filtered or pre-appraised evidence sources and recognise relevant resources. [E] - Indicate the differences between the hierarchy of evidence, level of processing of evidence, and types of EBM resources. [E]	
In this competency, the learner needs to outline the different major categories of sources of research information, and the advantages of using filtered or pre-appraised evidence sources (e.g., ACCESSSS, UpToDate, ACP Journal Club, TRIP database, PEDro). In addition, learner needs to indicate the differences between the hierarchy of evidence (different hierarchy of designs for each type of question), the level of processing of this information, and types of EBM resources (e.g. summaries and guidelines, preappraised research, and non-preappraised research.)	
2.2 Construct and carry out an appropriate search strategy for clinical questions.	**P**
This competency includes: - Know where to look first to address a clinical question. [P] - When necessary, construct a search strategy that reflects the purpose of the search. [P] - Apply a general search strategy including the use of search terms, and the role of Boolean operators; truncation; and search filters for more efficient searches. [E]	
In this competency, the learner needs to design and conduct an appropriate search which reflect the purpose of the search, and to indicate the role of Boolean operators (such as AND, OR, NOT); truncation (such as the asterisk or a question mark); and search filters (such as limits on language, human, year, or study design for more efficient searches.	
2.3 State the differences in broad topics covered by the major research databases .	**M**
In this competency, the learner needs to recognise the differences in topics covered by the major traditional databases and those relevant to their profession (e.g., PubMed largely covers medical topics, CINAHL covers nursing and allied health, and PsycINFO covers psychological topics) and to know which source is the most appropriate for answering a particular clinical question.	
2.4 Outline strategies to obtain the full text of articles and other evidence resources.	**E**
In this competency, the learner needs to define strategies to obtain the full text of the articles (this may include open access, institutional access, or special access such as HINARI programme) and other evidence resources (this may include pre-appraised resources such as evidence-based guidelines and decision-support tools such as patient decision aids).	
Appraise and Interpret	
3.1 Identify key competencies relevant to the critical evaluation of the integrity, reliability, and applicability of health-related research.	**E**
This competency includes - Understand the difference between random error and systematic error (Bias). [E] - Identify the major categories of bias and the impact of these biases on the results. [E] - Interpret commonly used measures of uncertainty, in particular, confidence intervals. [P] - Recognize that association does not imply causation and explain why. [E] - Recognise the importance of considering conflict of interest/funding sources. [M] - Recognise the use and limitations of subgroup analysis and how to interpret the results of subgroup analysis. [M]	
In this competency, the learner needs to identify key competencies relevant to the critical evaluation of the integrity, reliability, and applicability of health-related research which requires an understanding of the different categories of bias (such as confounding, measurement and detection bias, and reporting and publication bias), and the impact of these biases and uncertainty (random error) on estimates from studies. Conflicts of interest may also influence research reports, particularly the conclusions drawn from results. Learner needs to recognise if it	

is necessary to read the discussion of the article, or rely on the authors' interpretation of their findings; the necessity, if this is the case and conflict of interest exists, to look to un-conflicted sources of the interpretation. Knowledge of statistical calculations is not required, but the ability to interpret statistical results, such as confidence intervals, is essential. Understanding that association does not imply causation and why (e.g., confounding) is also important. Since subgroup analyses are commonly reported, their meaning and limitations should be known.	
3.2 Interpret different types of measures of association and effect, including key graphical presentations.	**P**
This competency includes - Identify the basic types of data such as: categorical and continuous. [E] - Recognise the meaning of some basic frequency measures. [M] - Identify the difference between "statistical significance" and "importance", and between a lack of evidence of an effect and 'evidence of no effect'. [E]	
In this competency, the learner needs to interpret quantitative results of research, which implies some understanding of: (i) the basic types of data such as categorical (dichotomous, nominal, ordinal) and continuous data; (ii) the meaning of some basic frequency measures such as means, medians, and rates; and (iii) measure of association derived from these such as difference and ratio measures for both dichotomous and continuous outcomes. Note that these may best be taught within the context of studies appraisals.	
3.3 Critically appraise and interpret a systematic review.	**P**
This competency includes - Recognise the difference between systematic reviews, meta-analyses, and non-systematic reviews. [M] - Identify and critically appraise key elements of a systematic review. [P] - Interpret presentations of the pooling of studies such as a forest plot and summary of findings table. [P]	
In this competency, the learner needs to critically appraise a systematic review which requires being able to identify and assess the key elements of a systematic review such as the search strategy, the appraisal and selection of studies, and the synthesis and summary of findings (including a Summary of Findings table) and how these elements differ from a traditional review. Interpreting the results requires an understanding of the presentations of pooled studies such as a forest plot, and a basic idea of measures of statistical heterogeneity. Such appraisal skills should include understanding the concept of quality of evidence, and how one might rate the quality of evidence, particularly using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. Also, learner needs to be able to differentiate between assessing the methods used in a systematic review (trustworthy or flawed) and assessing the certainty of the evidence for estimates that a review summarises (garbage in, garbage out).	
3.4 Critically appraise and interpret a treatment study.	**P**
This competency includes - Identify and appraise key features of a controlled trial. [P] - Interpret the results including measures of effect. [P] - Identify the limitations of observational studies as treatment studies, and recognise the basics of adjustment methods and its limitations. [E]	
In this competency, the learner needs to critically appraise a treatment study (such as a randomized controlled trial) which requires being able to identify and appraise key features of a controlled trial such as Randomisation and Allocation concealment, Blinding, Loss to follow up/Attrition, Intention-To-Treat analysis (vs. Per Protocol analysis), and Performance bias. Interpreting the results requires being able to interpret the common measures of effect (such as odds ratio, relative risk reduction/increase, absolute risk difference, relative risk /risk ratio, hazard ratio, NNT/NNH) and measures of uncertainty (confidence intervals and p-values). Learner needs to Identify the limitations of observational studies to inform a treatment decision and recognise the principles of adjustment methods and why they are inadequate.	
3.5 Critically appraise and interpret a diagnostic accuracy study.	**P**

This competency includes - Identify and appraise key features of a diagnostic accuracy study. [P] - Interpret the results including interpret measures to evaluate diagnostic accuracy. [P] - Recognise the purpose and use of clinical prediction rules. [M]	
In this competency, the learner needs to critically appraise a diagnostic study, which requires being able to identify and appraise key features such as subject selection, loss to follow up/verification bias, and independent and blind comparison assessment of index and reference standard. Interpreting the results requires being able to interpret the common measures of discrimination such as sensitivity, specificity, positive and negative predictive value, positive and negative likelihood ratio. Also, learner needs to be able to interpret a 2X2 table or contingency table.	
3.6 Distinguish evidence-based from opinion-based clinical practice guideline.	**P**
In this competency, the learner needs to understand that many guidelines are not evidence-based, and be able to recognise key features of an evidence-based guideline, such as a search, selection and appraisal strategy, grading of evidence, and management of conflicts of interest. Should be able to do some appraisal of these key features, but this does not imply a full critical appraisal (e.g., Appraisal of Guidelines, Research and Evaluation – AGREE) is appropriate.	
3.7 Identify the key features of, and be able to interpret, a prognostic study.	**E**
This competency includes - Identify and appraise key features of a prognostic study. [E] - Interpret the results including measures of effect (e.g., Kaplan Meier “survival” curves) and uncertainty. [E] - Recognise the purpose and use of clinical prediction rules. [M]	
In this competency, the learner needs to be able to critically appraise a prognostic study, which requires being able to identify and appraise key features such as subject selection, loss to follow up, and blinding of (subjective) outcome measures, and methods to detect and adjust for confounders. Interpreting the results requires being able to interpret the common measures of prognosis such as cumulative incidence, hazard ratio or “survival” curves.	
3.8 Explain the use of harm/aetiologies study for (rare) adverse effects of interventions.	**E**
This competency includes - Indicate that common treatment harms can usually be observed in controlled trials, but some rare or late harms will only be seen in observational studies. [E]	
While critical appraisal of such studies is not a core skill, the learner needs to indicate when and why they are needed. Also, learner needs to recognise that treatment may be harmful and increasing the amount of an effective treatment does not necessarily increase its benefits and may cause harm.	
3.9 Explain the purpose and processes of a qualitative study.	**E**
This competency includes - Recognise how qualitative research can inform the decision making process. [M]	
In this competency, the learner needs to understand some of the basic methods of gathering qualitative data, and it's purpose. While critical appraisal of qualitative studies is not a core skill, awareness of when and why they are needed is. Also, learner needs to recognise the importance of qualitative research in informing decision making processes.	
4. Apply	
4.1 Engage patients in the decision making process, using shared decision making, including explaining the evidence and integrating their preferences.	**P**
This competency includes: - Recognise the nature of the patient’s dilemma, hopes, expectations, fears, and values and preferences. [M] - Understand and practice shared decision making. [P]	

- Recognise how decision support tools such as patient decision aids can assist in shared decision making. [M]	
In this competency, the learner needs to engage patients in the decision making process, to communicate evidence about benefit and harms to patients, to recognise the nature of the patients' dilemma, hopes, expectations, fears, and values and preferences, and to recognise the role of decision support tools such as patient decision aids in shared decision making.	
4.2 Outline different strategies to manage uncertainty in clinical decision making in practice.	**E**
This competency includes: - Recognise professional, ethical, and legal components/dimensions of clinical decision making, and the role of clinical reasoning. [M]	
In this competency, the learner needs to outline different strategies to manage uncertainty in clinical decision making in practice (which may depend on profession and level of experience, such as e.g., test of time, diagnostic pause, gut feeling for medicals). In addition, learner needs to recognise various dimensions of clinical decision (e.g., professional, legal, and ethical), and the implication of these dimensions in the analysis of a clinical problem.	
4.3 Explain the importance of baseline risk of individual patients when estimating individual expected benefit.	**E**
This competency includes: - Recognise different types of outcome measures (surrogate vs composite endpoints measures). [M]	
In this competency, the learner needs to explain the importance of baseline risk of individual patients when estimating individual expected benefit (average measures of effects can be misleading), and its role in engaging the patients in the decision making process (e.g., balance benefits and harms of a treatment). In addition, learner needs to recognise different types of outcome measures and to identify the most important to the patients (e.g., patients related outcomes are more relevant to the patients than surrogate outcomes).	
4.4 Interpret the grading of the certainty in evidence and the strength of recommendations in health care.	**E**
In this competency, the learner needs to interpret the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to evaluate the strength of recommendations and identify and consider key factors drive the direction and strength of the recommendations, and its role in shared decision making (e.g., weak recommendations are usually sensitive to the patients' values and preferences).	
5. Evaluate	
5.1 Recognise potential individual-level barriers to knowledge translation and strategies to overcome these.	**M**
This competency includes: - Recognise the process of reflective clinical practice. [M]	
In this competency, the learner needs to recognise potential individual-level barriers to knowledge translation and strategies to overcome these. More detailed information regarding the organisational level barriers and knowledge translation/ implementation science can be taught elsewhere (e.g., knowledge translation workshops).	
5.2 Recognise the role of personal clinical audit in facilitating evidence-based practice.	**M**
In this competency, the learner needs to recognise the role of personal clinical audit in facilitating evidence-based practice (e.g., various areas need to be improved can be identified by comparing clinician's clinical practice to well-defined evidence-based standards).	

Supplementary material 5.11

References of EBP educational studies included in the systematic review presented in **Chapter 5**.

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Asking the right questions takes as much skill as giving the right answers.

—Robert Heinlein

6

Chapter 6
Analysis of Clinical Questions

Clinicians' EBP learning needs: the role of social media networks

Role of professional networks on social media in addressing clinical questions at general practice: a cross-sectional study of general practitioners in Australia and New Zealand

Loai Albarqouni, Tammy Hoffmann, Katrina McLean, Karen Price, Paul Glasziou

BMC Family Practice, 2019, 20:43.

Preamble

As discussed in **Chapter 2**, the exponential growth of medical information and clinicians' workload is one of the reasons why there is a great interest in EBP. One of the 3 modes of incorporating evidence into practice, that we discussed in **Chapter 2**, is the *'replicating mode'* in which clinicians consult trusted colleagues to answer clinical questions and replicate their practice (i.e. called 'pigeon strategy' by Richard Smith, the former editor of the BMJ). In the era of social media, clinicans are increasingly using social media to network with colleagues and possibly consulting trusted professional social media groups about personal knowledge gaps. Thus, this chapter explores clinicans' needs (i.e. clinical questions asked) and use (i.e. answers to clinical questions) for research evidence. Findings from this chapter (i.e. identifying evidence/infomration and learning needs of clinicians) has been helpful in the development of the EBP educational intervention presented in the next chapter.

This chapter contains an article entitled "*Role of professional networks on social media in addressing clinical questions at general practice: a cross-sectional study of general practitioners in Australia and New Zealand*", published in BMC Family Practice on March 2019. It characterises the clinical questions asked, and evidence used in answers posted to a large Facebook network.

Work arising from this chapter was also presented in oral form at the Royal Australian College of General Practitioners (RACGP) 2018 in Gold Coast.

6.1 Abstract

Background

Clinicians frequently have questions about patient care. However, for more than half of the generated questions, answers are never pursued, and if they are, often not answered satisfactorily. We aimed to characterise the clinical questions asked and answers provided by general practitioners (GP) through posts to a popular professional social media network.

Methods

In this cross-sectional study, we analysed clinical questions and answers posted between January 20th and February 10th 2018 on a popular GP-restricted (Australia, New Zealand) Facebook group. Each clinical question was categorised according to 'background' or 'foreground' question; type (e.g. treatment, diagnosis); and the clinical topic (e.g. cardiovascular). Each answer provided in response to included questions was categorised into: (i) short answer (e.g. agree/disagree); (ii) provided an explanation to justify the answer; and (iii) referred to a published relevant evidence resource.

Results

Of 1060 new posts during the study period, 204 (19%) included a clinical question. GPs most commonly asked about treatment (n=87; 43%) and diagnosis (n=59; 29%). Five major topics (23% skin, 10% psychology, 9% cardiovascular, 8% female genital, and 7% musculoskeletal) accounted for 118 (58%) questions. Each question received on average 10 (SD=9) answers: 42% were short; 51% provided an explanation; and only 6% referred to relevant research evidence. Only 3 answers referred to systematic reviews.

Conclusions

In this sample of Australian and New Zealand GPs, who were members of a GP social media group, GPs asked clinical questions that can be organised into a limited number of question types and topics. This might help guide the development of GP learning programs.

6.2 Background

There has been a rapid expansion of information in health care over the last few decades[1]. The challenge of keeping up with this information overload in health care is becoming harder, if not impossible[2,3]. An information paradox exists, as despite being overwhelmed by this huge amount of information, clinicians frequently face personal knowledge gaps, ask clinical questions about patient care, and have many unanswered questions[2,4].

A systematic review of clinical questions raised by clinicians showed that clinicians ask about 1 question every 2 patients[5]. However, for more than half of the generated questions, answers are never pursued, and if they are, often not answered satisfactorily[5,6] – suggested missed opportunities for continuous learning. Lack of time and clinicians' doubt about the existence and usefulness of relevant answers are the most commonly reported barriers to pursuing the answers for their clinical questions[5,7]. Thus, addressing clinicians' personal knowledge gaps provides an opportunity for continuing learning, and enhanced patient care. This is especially important for general practitioners (GPs) as their information needs are much broader than that of other specialties because of the wider spectrum of clinical problems encountered[8]. Consulting colleagues to answer clinical questions is one of the most common strategies that clinicians adopt to cope with the information overload[1,2]. Clinicians are increasingly using social media to communicate and network with colleagues, share information, and disseminate research findings[9]. Thus, understanding clinicians' use of social media networks to overcome information overload and address clinical questions generated from patient care is warranted. We aimed to characterise the clinical questions asked and answers provided by general practitioners and posted to a popular professional social media network.

6.3 Methods

In this cross-sectional study, we analysed all clinical questions posted on a popular GP-restricted Facebook group 'GPs Down Under' between January 20th and February 10th 2018. 'GPs Down Under' is a GP community-led closed professional Facebook group restricted to GPs practising in Australia and New Zealand. It has over 5800 members and generates over 50 posts per day.

The criteria for GPDU group membership include being a GP or a GP registrar and working in general practice with registration to practice in Australia and/or New Zealand. A three-step verification procedure is used. Two of the co-authors (KM and KP) were co-developers and are administrators of the GPDU Facebook group.

Two of the co-authors (KM and KP) scraped all the data (including each original post and all subsequent comments and replies to that post) of the posts that were posted during the study period. One of the authors who is also a member of GPDU (PG) de-identified the data and developed a de-identified anonymised dataset for screening and analysis.

We screened all posts that were posted to the group during the study period to identify those that included a clinical question (as defined by Ely et al[10] - 'questions about medical knowledge that could potentially be answered by general sources such as textbooks and journals, not questions about patient data that would be answered by the medical record') – the focus of this analysis is on clinical questions posts. We categorised each included question as 'background' (e.g. What is myocardial infarction?) or 'foreground' question (e.g. In adult patients with myocardial infarction, does aspirin increase survival?). We also classified the type of each question (e.g. treatment, diagnosis) per the taxonomy used by Ely et al[10]. We also classified the clinical topics of each included question according to the revised version of International Classification of Primary Care (ICPC-2)[11]. ICPC is a coding system co-developed and endorsed by the World Organization of Family Doctors to allow for more appropriate classification of data frequently encountered in a primary care setting[12,13]. We screened all comments for answers provided in response to each question and classified each answer as: (i) short answer (e.g. yes/no or agree/disagree); (ii) provided an explanation (e.g. justify the answer or provide supporting clinical examples); and (iii) referred to a published relevant evidence resource (e.g. provided a website link to a research article or guideline). Three of the authors (LA, TH, and PG) independently analysed a random sample of 5% of posts and continued discussion until consensus was attained. LA coded the included questions and answers of the rest of included posts. Any uncertainties in the coding decisions were resolved by one of the co-authors with extensive experience in primary care (PG).

The study was approved by Bond University Human Research Ethics Committee. Group members were informed that all new posts during the study period would be anonymously used for research purposes without breaching members' privacy.

6.4 Results

During the study period, 504 GPs contributed a total of 1060 new posts, of which 204 (19%) included a clinical question. Of these 204 included questions, 174 (85%) were foreground and 30 (15%) background questions. The characteristics of clinical questions posted to GPDU group are presented in **Table 6.1**.

Table 6.1 Characteristics of clinical questions posted to the GPDU group (n=204).

	N (%)
Total clinical questions	204
Background Questions	30 (15%)
Foreground Questions	174 (85%)
Reaction to each question	
Comments (number of comments per question; median [IQR])	15 [7-28]
Answers (number of answers per question; median [IQR])	7 [4-14]
Short answers (% of all answers per question)	42%
With an explanation (% of all answers per question)	51%
Referred to published resources (% of all answers per question)	6%
Referred to a systematic review (number of answers of all answers)	3

Overall, most asked questions (165; 81%) concerned around 14 (30%) of the 42 identified question types: 87 (43%) about treatment followed by 59 (29%) diagnosis. The most frequently asked question types were: (i) 34 (17%) questions about the efficacy or the indication of a treatment (e.g. Does procedure/treatment x work for condition y?); (ii) 28 (14%) questions about the management (i.e. diagnostic or therapeutic) of a condition or finding (e.g. How should I manage condition/finding/situation y?); (iii) 23 (11%) questions about the cause or the interpretation of unspecified multiple findings (e.g. What does this patient have given these findings?). **Table 2** lists the 10 most frequently asked clinical question types, with examples from the included questions.

Table 6.2. The most frequently asked clinical questions' types with examples from the included questions.

Question Type	Description	No (%)	Example
2.2.1.1 Treatment Efficacy or indications of a treatment (but not limited to drug treatment)	How should I treat finding/condition y (given situation z)? What is the efficacy of treatment/procedure x (for condition y)?	34 (16.7%)	What are the treatment options for a second therapy for H. Pylori infection after a failure with Nexium Hp7?
3.1.1.1 Management Management of a condition or finding (not specifying diagnostic or therapeutic management)	How should I manage condition/finding/situation y? What management options are there in situation y?	28 (13.7%)	How should I manage ilioinguinal nerve entrapment?
1.1.4.1 Diagnosis Cause or interpretation of unspecified or multiple clinical findings	Could this patient have condition y given these findings? What is the differential diagnosis of these findings? What is the likelihood that this patient has condition y given these findings?	23 (11.3%)	Middle-age diabetic lady with osteoarthritis and chronic skin changes. She presented with a recent papules (non-itchy, rough, and translucent). No history of insect bites, new drugs. What is the differential diagnosis for her condition?
2.1.2.1 Treatment Efficacy or indications of a drug or drug of choice	Is drug x indicated in situation y or for condition y? What are the indications for drug x? What is the drug of choice for condition y?	16 (7.8%)	Is Liraglutide indicated in a female non-diabetic patient with BMI of 38?
3.2.1.1 Management Practices of other providers	How do other providers manage condition y? Why did provider x treat the patient this way?	11 (5.4%)	How many of you prescribe dietary modification as first line management of mild hypertension? If yes, do you give general or specific dietary advice?
1.3.1.1 Diagnosis Indication or efficacy of a test (e.g. lab, imaging, physical exam)	Is test x indicated in situation y? What is the best test in situation y?	10 (4.9%)	Is joint aspiration for every suspected case of recurrent gout is needed to confirm the diagnosis if considering long term urate-lowering therapy?
1.3.3.1 Diagnosis Accuracy of a test (e.g. lab, imaging, physical exam)	How good is test x in situation y? What are the performance characteristics (sensitivity, specificity, etc.) of test x in situation y?	8 (3.9%)	How good is Bone scan compared to CT scane in detecting a suspected stress fracture in the foot with a normal X-ray.

2.1.3.1 Treatment Adverse effects of a treatment	Are these findings can be caused by a drug or adverse effects of drug?	7 (3.4%)	A patient with rheumatoid arthritis on adalimumab, presented with a tendon rupture. Could this be a side effect of adalimumab?
2.1.3.3 Treatment Contraindications of a treatment	What are the safety issues or contraindications of treatment x (includes pregnancy and breast feeding)?	5 (2.5%)	Middle-age diabetic female patient on Metformin with mild microalbuminuria and normal creatinine. Is NSAIDs contraindicated in this patient due to renal complications?
1.1.1.1 Diagnosis Cause or interpretation of specified clinical findings (e.g. symptoms)	What is the cause of symptom x? Could symptom x be condition y or be a result of condition y?	5 (2.5%)	Asymptomatic middle-age lady presented with acute-onset of midline painless lump in the palate. What is the cause of this? Could be mucinous cyst?

The clinical question topics were fairly distributed across all the clinical topics reflecting the range of patients seen by GPs. However, over half of all included clinical questions (n=118; 58%) concerned five major clinical topics. The five most frequently addressed topics were skin (n=47; 23%, 11 about skin neoplasm/lesion and 9 were related to a 'rash'), mental health (n=20; 10%), cardiovascular (n=19; 9%), women's health (n=17; 8%), and musculoskeletal (n=15; 7%). **Table 6.3** shows the distribution of clinical questions across the clinical topics.

Table 6.3. The distribution of clinical questions across clinical topics per ICPC-2 classification system.

Clinical Topic	No (%)
Skin	47 (23%)
Psychological	20 (9.8%)
Cardiovascular	19 (9.3%)
Female Genital	17 (8.3%)
Musculoskeletal	15 (7.4%)
Neurological	14 (6.9%)
Digestive	13 (6.4%)
Pregnancy, Childbearing, Family Planning	12 (5.9%)
Endocrine/Metabolic and Nutritional	12 (5.9%)
General and Unspecified	10 (4.9%)
Respiratory	6 (2.9%)
Blood, Blood Forming Organs and Immune Mechanism	5 (2.5%)
Eye	4 (2%)
Urological	3 (1.5%)
Male Genital	3 (1.5%)
Social Problems	2 (1%)
Ear	1 (0.5%)

The 204 included questions elicited 4065 comments, with a mean of 20 (SD 19) comments per included question (i.e. this refers to all comments that were posted as a reply to a clinical question; whether they provide an answer or not). GPDU members commented and provided answers for all 204 included questions. On average, 10 (SD 9) of the 20 (SD 19) comments were answers to the posted question; the remaining comments did not answer the clinical question originated in the post. On average, 42% (SD 27%) of these answers were short answers; 51% (SD 27%) were answers which provided an explanation or justification to the answer; and 6% (SD 11%) referred to published relevant evidence resource. Only three answers referred to evidence derived from systematic reviews (**Table 6.1**).

Figure 6.1 shows that engagement of GPDU members in asking and answering clinical questions per day and time. The engagement is peaked in the mornings (9am) and on Thursdays, with a decline in the activity in late afternoon (4-5pm) and on weekends.

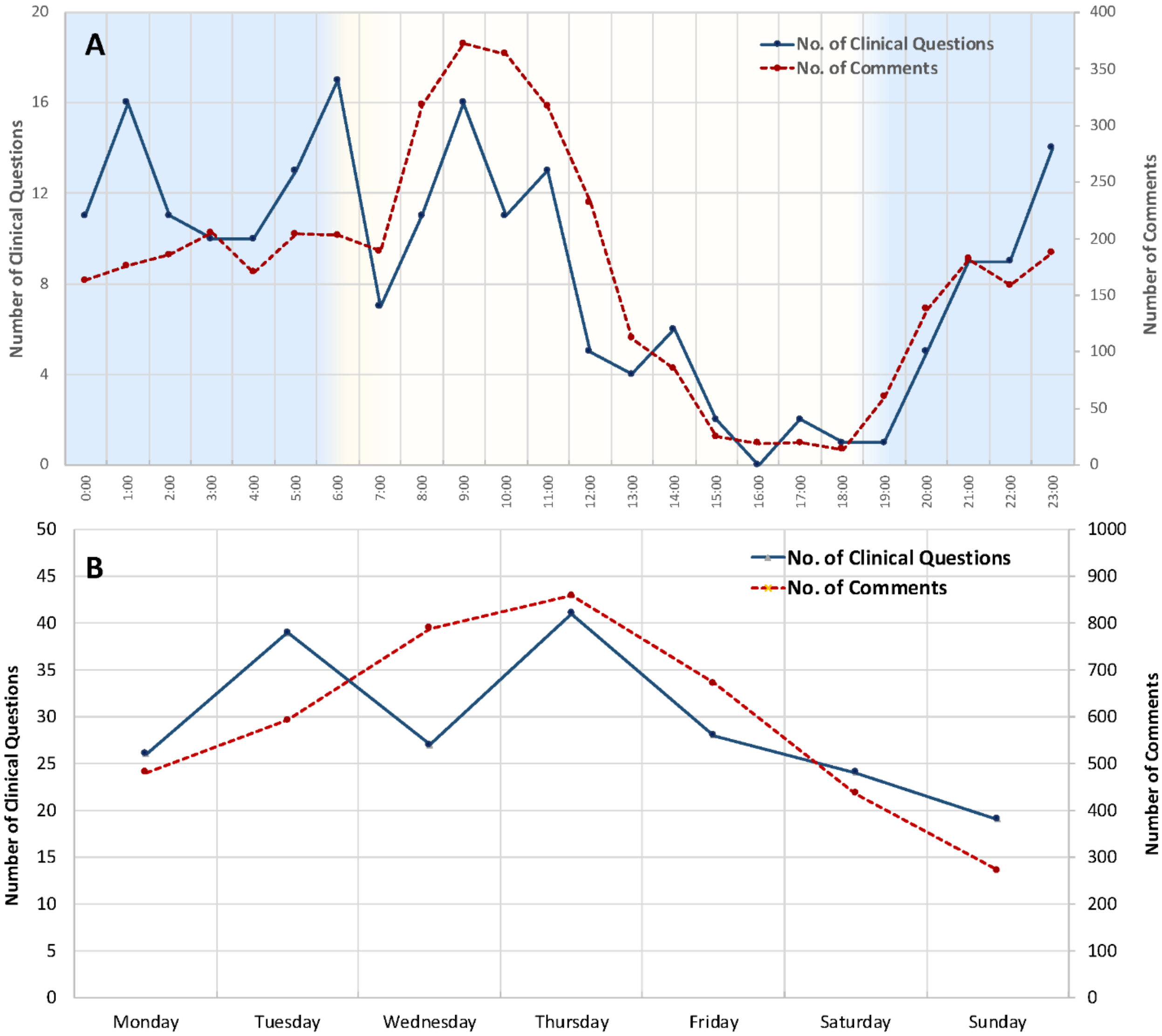

Figure 6.1. The activity of GPDU members in posting clinical questions (solid line) and comments (dashed line) per time (panel A) and day (panel B).

6.5 Discussion

In this study of GPs' use of social media networks to answer their clinical questions – GPs posted approximately 10 questions per day. The majority of questions asked were about treatment and diagnosis and more than half of all included clinical questions were about a small number of clinical topics.

Our results regarding the question types are consistent with the results of a systematic review of 11 studies which examined 7012 clinical questions raised by clinicians (mostly GPs) at the point of care and found that the majority of clinical questions concerned treatment (34%) and diagnosis (24%) - with 30% of the question types accounting for 80% of the questions asked[5]. Similar, treatment and diagnosis were the most frequently observed types of clinical questions by Allan et al (observed 38 GPs during 420 consultations)[14] and Green et al (interviewed 64 residents after 401 consultations)[15].

Despite the wide spectrum of clinical presentations seen by GPs in practice, we found that most of the clinical questions asked about a handful of clinical topics. This is consistent with frequencies in previous studies of the most frequently asked clinical questions' topics[14,16], and most commonly managed conditions in general practice settings[11]. For instance, Bjerre et al analysed 1871 questions asked by 88 Canadian GPs and found that musculoskeletal, skin, and cardiac were among the five most frequently asked question topics[17].

In this sample of GPs evidence-based resources (e.g. systematic reviews) were infrequently used to support answers to the posted clinical questions. This aligns with the findings of a systematic review of 19 studies that described information seeking behaviour of clinicians and found that evidence-based resources were rarely used by clinicians as a primary source of information to guide their decisions[18,19].

A limitation of this study is that we focused on questions that GPs pursued, articulated, and posted a clinical question to find an answer (i.e. known unknowns), but we likely missed their unpursued recognised questions as well as their unrecognised questions (i.e. unknown unknowns). Direct observation studies and post-consultation interviews may better capture the information needs of clinicians at point of care (i.e. less susceptible to memory bias), although these methods might generate superfluous questions from clinicians because they are being observed or interviewed[7,16]. Nor would they be useful in investigating the role of social media networks in addressing clinical questions asked by clinicians. Another limitation is that screening and coding of the posts were performed by one author, and three authors independently coded data from only a random sample of 5% of posts. Further, we analysed questions posted in a single restricted Facebook group by GPs who thought to be active social media users (504 GPs out of 5800 GPDU members), therefore, our findings may not be generalised to GPs who do not actively use social media or use other social media platform, or do not use social media at all. We also did not verify the validity of provided answers or the evidence used to support these answers. Thus, answers that referred to sources of evidence might not be accurate or correct and answers that did not cite a source of evidence might be evidence-based answers or correct (i.e. the lack of referral to evidence sources did not necessarily mean that these answers are not evidence-based).

Our findings that the majority of questions asked were about a limited number of questions types and topics suggest that questions raised on social media networks may be helpful in guiding the development of GP future continuous learning programs (e.g. tailored according to identified information needs) and research activities (e.g. by identifying research-practice evidence gaps)[20]. Although professional social media networks might be useful in providing evidence-based answers to clinical questions, the quality of the evidence underpinning the answers provided in social media should be questioned. Disadvantages of using the social media network in answering clinical questions might include: (i) GP members are responsible for discerning relevant answers and ascertaining the validity of the answers provided; and (ii) the possibility of delivering and perpetuation of unsound answers to a large group of GPs. Therefore, methods to enhance active dissemination of question-specific evidence-based information (such as by Facebook group administrators or evidence champions) are warranted[21].

6.6 Conclusions

In this sample of Australian and New Zealand GPs, who were members of a GP social media group, the majority of clinical questions asked were about a limited number of questions types and topics which may help inform the development of GP future continuous learning programs and research activities. The validity of the evidence underpinning the answers provided for clinical questions asked in social media needs to be considered.

6.7 Declarations

Acknowledgements

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

LA, TH, and PG conceived the research idea. All authors contributed to the design of the study. LA drafted the original manuscript. All authors contributed to the revision of the paper and approved the final manuscript for submission.

Ethics approval and consent to participate

The study was approved by Bond University Human Research Ethics Committee. Individual consent from each GPDU Facebook member was waived by the ethic committee. Instead, group members were informed that all new posts during the study period would be anonymously used for research purposes without breaching members' privacy.

Consent for publication

Not applicable

Competing interests

Karen Price and Katrina McLean are administrators on the GPDU Facebook group. Otherwise, authors declare that they have no competing interests.

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When one teaches … two learn
Asking the right questions takes as much skill as giving the right answers.

—Robert Heinlein

7

Chapter 7
EBP and SDM Teaching

Shared decision making focusing on pre-appraised evidence: an opportunity for training busy clinicians in EBP

Development of a contemporary evidence-based practice workshop for health professionals with a focus on pre-appraised evidence and shared decision making: a before-after pilot study

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Preamble

As shown in **Chapter 4**, EBP educational interventions were mainly focused on teaching detailed critical appraisal skills. The time and skills involved in the detailed critical appraisal renders it infeasible for clinicians to conduct for the evidentiary basis of their practice. In **Chapter 5**, we called for a contemporary approach to teaching EBP, in which the focus is on providing clinicians with the skills to interpret pre-appraised evidence and apply its findings to patients by using shared decision making.

This study presented in this chapter was developed based on the findings of the previous chapters in this thesis: (i) an international consensus on EBP core competencies (**Chapter 5**); (ii) an analysis of the type and topic of the most frequently asked clinical questions by general practitioners in social media (**Chapter 6**); and (iii) a systematic review of the educational interventions used in 85 EBP educational studies (**Chapter 3** and **4**)

This chapter contains an article entitled "*Development of a contemporary evidence-based practice workshop for health professionals with a focus on pre-appraised evidence and shared decision making: a before-after pilot study*", published online on BMJ Evidence-Based Medicine. It develops and pilots a new contemporary approach to teaching EBP, which commences with SDM and uses pre-appraised evidence

7.1 Abstract

Shared decision making (SDM) has emerged as a key skill to assist clinicians in applying evidence-based practice (EBP). We aimed to develop and pilot a new approach to teaching EBP, which focuses on teaching knowledge and skills about SDM and pre-appraised evidence. We designed a half-day workshop, informed by an international consensus on EBP core competencies, and invited practicing clinicians to participate. Skills in SDM and communicating evidence were assessed by audio-recording consultations between clinicians and standardised patients (immediately pre- and post-workshop). These were rated by two independent assessors using the OPTION (Observing Patient Involvement, 0-100 points) and ACEPP (Assessing Communication about Evidence and Patient Preferences, 0-5 points) tools. Participants also completed a feedback questionnaire (9 Likert scale questions, 4 open-ended questions). Fourteen clinicians participated. Skills in SDM and communicating research evidence improved from pre- to post- workshop (mean increase in OPTION score = 5.5, 95% CI 1.0 to 9.9; increase in ACEPP = 0.5, 95% CI, 0.02 to 1.06). Participant feedback was positive, with most indicating 'agree' or 'strongly agree' to the questions. A contemporary approach to teaching clinicians EBP, with a focus on SDM and pre-appraised evidence, was feasible, perceived as useful, and showed modest improvements in skills. Results should be interpreted cautiously because of the small study size and pre-post design.

7.2 Background

Shared decision making (SDM) provides a process for incorporating research evidence, along with the patient's values, preferences, and circumstances, into the patient-clinician discussions about a health decision[1,2]. Despite the growing attention of the importance of SDM to quality patient care[3], there is generally low levels of SDM use in clinical practice[4]. A Cochrane review of interventions for increasing the uptake of SDM found that training clinicians in SDM can improve the use of SDM in practice[5]. However, evidence about how best to teach SDM is scarce[6,7]. Many existing SDM training interventions are disease-specific[8-12] and few have evaluated general SDM training[13-15]. The integration of SDM training within evidence-based practice (EBP) training to capitalize on closely aligning the approaches has been advocated[2,16]. Only one study has evaluated this approach, however, it was conducted in the context of a semester-long university subject on EBP, rather than with busy clinicians[15].

EBP is the integration of the best available research evidence with clinical expertise and patient's values and preferences (i.e. personal concerns, expectations, cultural influences and individual characteristics during the clinical encounter)[17,18]. Over the last decade, EBP has been mostly taught according to the traditional approach following the 5 EBP steps addressed in order: asking clinical questions, searching for evidence, critically appraising the evidence, applying to the individual patient, and evaluating the process[19]. However, the focus of EBM teaching is commonly on detailed critical appraisal skills often to the exclusion of other steps (i.e. the application of evidence using SDM skills in particular) which has been criticised[2,20-22]. There are calls for a shift from the more traditional approach of EBP education (in which it is expected that clinicians need to be fully competent in all 5 EBP steps, including the detailed critical appraisal of research evidence) to a contemporary approach, in which the focus is on providing clinicians with the skills to critically interpret synthesised or pre-appraised evidence and apply its findings to patients by using shared decision making[2,23-25].

Pre-appraised evidence (i.e. evidence-based sources that are vetted by experts and updated regularly to accommodate the newest evidence) represents one partial solution to help busy clinicians by providing timely condensed updated summaries of research evidence[26-28]. Resources for pre-appraised evidence vary in their degree of quality and accuracy. Some resources are BMJ Best Practice and Rapid Recommendation, UpToDate, and other trustworthy evidence-based guidelines. For instance, an international multicentre study of 248 clinicians (working primarily in general internal medicine or family medicine in 10 different countries) suggested that strategies to increase clinicians' competencies in EBP, to better understand or interpret pre-appraised evidence, are still needed[29]. This study aimed to assess the feasibility and clinicians' acceptability of a new approach to teaching EBP, which focusses on SDM and uses pre-appraised evidence. We also aimed to explore the effect of this workshop on clinicians' SDM and evidence communication skills.

7.3 Methods

Design

A single-arm before and after pilot study of an educational module.

Study population, recruitment, and eligibility

We initially intended to recruit general practitioners (GPs) working within primary healthcare but recruitment difficulties led us to extended to other health professionals. To be included, participants had to be a registered and practicing clinician working in any Australian state or territory. We advertised for this workshop using social media (Twitter accounts with combined > 5000 followers; GP Down Under Facebook group with > 6000 GPs), and by sending targeted email invitations to clinicians working at the local university hospital (Gold Coast University Hospital, Queensland, Australia).

Intervention

We developed the EBP workshop based on:

(i) an international consensus on core competencies in EBP[23]: workshop content was informed by a previously developed international consensus list of the most essential core competencies in EBP that should be covered in EBP training programs. For example, we integrated the teaching of SDM skills as a core element in EBP training and focussed on pre-appraised evidence and the interpretation of GRADE framework (The Grading of Recommendations Assessment, Development and Evaluation) – which are also on the consensus list[23].

(ii) an analysis of the type and topic of the most frequently asked clinical questions by general practitioners in social media[30]: We used information from a previous analysis of the most frequently asked clinical questions on a very popular Facebook group (GP Down Under; >6000 members), in which we identified the most common presenting conditions (i.e. clinical topics such as skin, mental health) and most common type of clinical questions (e.g. treatment or diagnostic) posted. We used information regarding the type (e.g. treatment, prognosis, diagnosis) and topic (e.g. depression, acute otitis media, cardiovascular risk disease prevention) of the most frequently posted clinical questions, to hone the clinical scenarios and practical exercises of our EBP workshop. For example, the decision to focus on a treatment scenario and evidence about knee osteoarthritis/pain was based on the analysis of these clinical questions[30].

We developed this workshop with a focus on integrating SDM training and EBP training through providing video demonstration (to model the skills) followed by teaching how to interpret and communicate research evidence and decision aids. **Table 7.1** contains a the detailed description of the intervention using the Template for Intervention Description and Replication (TIDier)[31] and the guideline for reporting evidence-based practice educational interventions and teaching (GREET)[32]. Workshop materials are presented in **Supplementary materials 7.1** and **7.2**. The EBP training program evaluated in this study is envisioned as the first of a series of modules and that future modules would address different types of evidence (e.g. diagnosis, prognosis).

Procedure

At registration, participants were provided with their workshop workbook (**Supplement 7.1**). Before the workshop teaching commenced, participants completed a role-play consultation (as a GP) with a standardised patient. Participants were provided with a brief summary of the patient scenario, an extract from relevant pre-appraised evidence (as part of a decision aid) and instructions about the task (**Supplement 7.2**). Participants were given approximately 8 minutes to do the consultation. Two experienced professional standardised patients were trained to play the patient role in the scenario. They were provided with detailed information about the case scenario (e.g. presenting complaint, clinical history, and family history). The same procedure was followed after the workshop for the post-workshop consultation with a different, but comparable (in terms of number of options to be discussed) clinical scenario to minimise the impact of repetition on observed outcomes. All consultations were audio-recorded.

Table 7.1. Description of the EBP workshop intervention, using TIDieR items[31].

TIDieR Items	Description
1. Brief Name	Evidence-based practice workshop for clinicians, with a focus on shared decision making and using pre-appraised research evidence
2. Why	There is a growing interest in contemporary EBP training (i.e. aim for clinicians to be competent in the critical interpretation of pre-appraised evidence and applying its findings in practice using shared decision making) instead of the more traditional approach of EBP education (i.e. 'evidence-based clinicians need to clinicians need to be fully competent in all the 5 EBP steps including detailed critical appraisal of research evidence).
3. What (Materials)	**Materials provided to participants**: Each participant was provided with a workshop workbook which includes the workshop program, interactive activities (including a brief summary of the patient scenario that would be worked through in the workshop, extracts from the selected guideline and articles, suggested readings (e.g. types of clinical questions, and a summary of study designs and level of evidence), critical appraisal sheets, and a glossary of frequently used epidemiological terms. The workbook can be found in **Supplement 1**. **Materials used in the workshop delivery**: We delivered a 10-min presentation on 'Evidence Based Practice and Shared Decision Making' (using a PowerPoint presentation available on request). Participants watched two 7-min pre-recorded videos on 'Interpretation of research evidence' and 'Interpretation of levels of evidence and strength of recommendations' (these were also provided to participants after the workshop on request). Website links for these videos are available on request. Participants also watched a pre-recorded modelled role-play consultation demonstrating one example of what SDM might 'look like' in clinical practice (available at: https://vimeo.com/273322988). **Materials used in training standardised patients**: Standardised patients received a summary of the patient scenario (including details of the chief complaints, and relevant medical, family, and social history), and suggested opening statements and questions/treatment options to be discussed. This can be found in **Supplement 2**.
4. *What (Procedures)*	(1) Clinical Scenario considering the benefits and harms of knee arthroscopy [Small-group exercise]: We started the workshop by presenting a clinical scenario of a patient presenting to a GP with knee osteoarthritis and requesting arthroscopic surgery (2) BMJ Rapid Recommendations Clinical Practice Guideline [Small-group exercise]: Participants were presented with a relevant BMJ Rapid Recommendation Guideline (i.e. a trusted reliable source of pre-appraised evidence – this was selected as it contained all the data needed to build interactive exercises and is publicly available). (3) Evidence Based Practice and Shared Decision Making [10 min presentation]: Participants were briefly introduced to evidence based practice and shared decision making, including the principles of risk communication. (4) Applicability of Research Evidence [Small-group exercise]: Participants completed a relevant practical exercise to teach these competencies. (5) Interpretation of research evidence [Pre-recorded video]: Participants watched a 7-minute video about the interpretation of research evidence

TIDieR Items	Description
	(including the interpretation of measure of association and effect, statistical significance versus clinical importance, and measures of uncertainty). (6) Interpretation of research evidence [Small-group exercise]: Participants worked through several small group exercises to consolidate these competencies using examples from the pre-appraised evidence. (7) SDM role-play [Pre-recorded modelled role-play]: Participants watched a video of a patient-doctor consultation showing an example of what shared decision making might look like in clinical practice (8) SDM role-play [Small-group exercise role-play]: Participants completed a small group practical exercise to practice using shared decision making skills in a role-play patient-doctor consultation (one participant role-played a general practitioner, a trained standardised patient role-played a patient with knee osteoarthritis, and other -group members provided feedback). (9) Interpretation of levels of evidence and strength of recommendations [Pre-recorded video]: Participants watched a 7-minute video explaining the GRADE framework (The Grading of Recommendations Assessment, Development and Evaluation), different levels of quality of evidence (e.g. low, high) and strength of recommendations (e.g. strong, moderate), and its relevance to clinical decision-making. (10) Critical appraisal of a randomised controlled trial [Small-group exercise]: Participants applied these skills to critically appraise one of the primary randomised studies included in the pre-appraised evidence. (11) Interpretation of a forest plot [Small-group exercise]: Participants completed practical exercises about interpreting a forest plot.
5. Who provides	This workshop was developed and delivered by three professors with extensive experience in teaching EBP and shared decision making (PG; CDM; TH), and a medical doctor undertaking doctoral research in EBP teaching (LA).
6. How	It was a face-to-face workshop which involved 2 small-groups (7 participants and a facilitator in each).
7. Where	The workshop was delivered in a seminar room at Bond University on the Gold Coast, Australia. The room was equipped with required audio-visual facilities.
8. When and How much	The workshop was delivered on one occasion and lasted for an afternoon (5 hours; 12:00-17:00, which included time for lunch, afternoon tea and data collection for research purposes). See **Supplement 1** for detailed workshop schedule.
9. Tailoring	All participants received the same workbook materials, attended the same lecture and pre-recorded videos, and participated in the small-group discussion. Questions from participants were answered and additional explanation provided as needed.
10. Modifications	No modifications were made during the delivery of the workshop, although at the end of it, some participants requested that the pre-recorded video presentations be provided to them (this was then done).
11. How well *(Planned)*	Adherence to the timing schedule was maintained by one of the authors (LA).
12. How well *(Actual)*	No fidelity measures were used.

Outcome measures and data collection

Participant feedback about the workshop: At the end of the workshop, participants completed a feedback questionnaire on demographics (age, gender, health discipline, job role/position, any previous EBP training, and years of clinical experience) and workshop acceptability using 9 statements (see items in **Figure 7.1**), each rated using a 5-point Likert-scale (from strongly disagree = 1 to strongly agree = 5). In addition, there were 4 open-ended questions (the most beneficial aspect/s, least useful aspects, suggestions for improvement, and a proposed list of actions they intended to do in their practice).

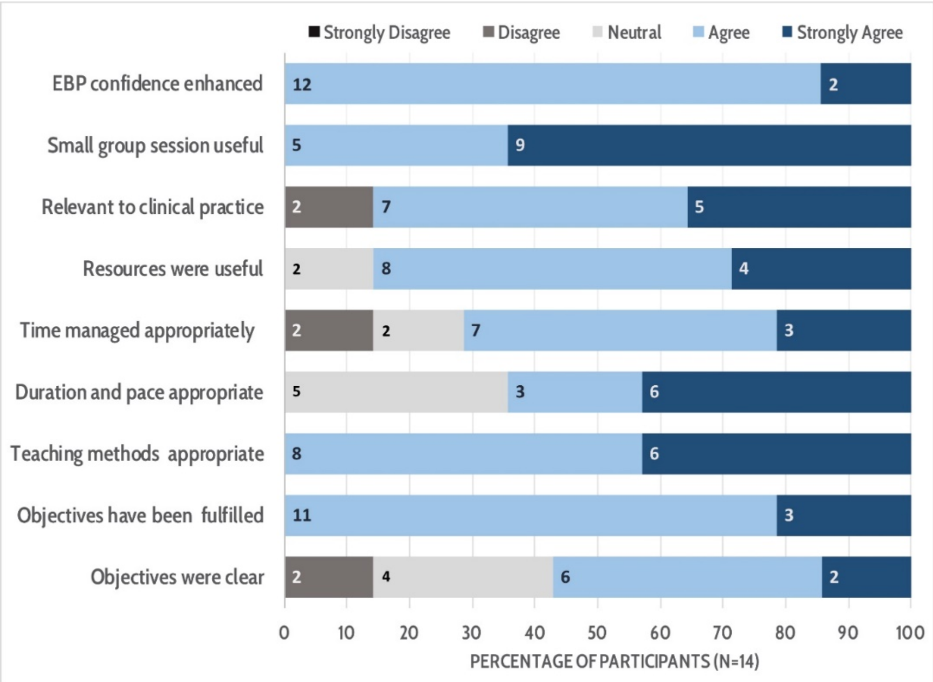

Figure 7.1. The results of the feedback evaluation questionnaire (n=14)

SDM and evidence communication skills. We measured SDM skills by rating the consultations between participants and standardised patients (as described above) using the revised Observing Patient Involvement (OPTION) scale and Assessing Communication about Evidence and Patient Preferences (ACEPP) Tool. The OPTION scale has demonstrated good validity (i.e. construct and content validity) and reliability (i.e. inter-rater reliability and internal consistency). It consists of 12 items scored with a 5-point scale (the behaviour was not observed = 0; a minimal attempt is made to exhibit the behaviour = 1; the behaviour is demonstrated = 2; the behaviour is demonstrated to a good standard

= 3; and the behaviour is executed to a high standard = 4)[33,34]. ACEPP tool has demonstrated good reliability (i.e. inter- and intra-rater reliability and internal consistency) in rating clinicians' ability to communicate the benefits and harms of a treatment. It consists of 5 items scored with a 3-point scale (i.e. the behaviour was not observed = 0; observed to a basic level = 0.5; and observed to an extended level = 1)[15,35]. All audio-recordings were rated independently by two assessors (LA, MB). Disagreements were resolved by discussion and by involving a third assessor (TH) when needed. We also measured the duration of each consultation (in minutes) to explore whether applying SDM skills increases length of consultation.

Data analysis and ethics approval

Descriptive statistics were calculated for the demographic characteristics and pre- and post-workshop outcome measures. A two-sided paired t-distribution was used to calculate the 95% confidence intervals of the mean differences between the pre- and post-workshop OPTION and ACEPP scores. As this is a pilot study, a formal sample size calculation was not conducted. As part of the study advertising, clinicians were informed that the workshop was free to attend, but that it was being conducted as part of a study and attendance would require completion of pre- and post-outcome measures. Clinicians provided written consent to participate on the day of the workshop. Ethics approval for the study was obtained from the Bond University Human Research Ethics Committee (LA03307).

7.4 Results

A total of 14 clinicians participated in the workshop. All 14 completed the questionnaire and 13 provided consent to record their participation in the role-play consultations.

Table 7.2 presents participants' background characteristics. Most participants (n=10) were 18 to 44 years old; 9 were female; 6 were medical doctors; and 10 worked in hospitals. All participants had current clinical roles and 4 had both clinical and teaching roles.

Table 7.2. Characteristics of workshop participants (N=14)

Characteristics	n (%)
Age	
18-29 years	4 (29)
30-44 years	6 (43)
45-59 years	4 (29)
Female	9 (64)
Discipline	
Medical	6 (43)
Pharmacy	7 (50)
Nursing	1 (7)
Workplace setting	
Primary care	4 (29)
Hospital	10 (71)
Role[1]	
Clinical	14 (100)
Teaching	4 (29)
Research	2 (14)
Previous EBP workshop	7 (50)
Clinical experience – median (IQR) years	**7 (3.6-18.3)**

Abbreviations: EBP: evidence-based practice; IQR: interquartile range
[1] Participants could choose more than 1 option

Participant feedback

The feedback of participants about the workshop was largely positive (see **Figure 7.1**). All participants agreed or strongly agreed that the workshop has addressed their intended learning objectives; the teaching and learning methods were appropriate; the small group sessions were useful and interactive; and the workshop has enhanced the participant's confidence and skills in practising EBP. The majority of participants expressed that the workshop was relevant to clinical practice (n=12); that workshop resources were appropriate (n=12); and that the time allocated for each session was adequate (n=10). Over half of the participants agreed that the workshop duration and pace were appropriate (n=9) and the workshop objectives were clear (n=8). Participants reported that 'small group teaching' and 'the use of the same clinical scenario to guide the teaching of all intended learning outcomes' were the most beneficial aspects of the workshop. However, 'the use of GP-focused clinical scenarios' was not useful. Participants reported that the workshop encouraged them to critically read journal articles relevant to their practice, carefully interpret and explain the evidence to patients, and apply SDM principles (including the search for decision aids for other commonly encountered conditions) in practice.

Audio-recorded role-play consultations

Table 7.3 shows the mean (SD) before and after the workshop scores for OPTION and ACEPP measures and the mean change score, for the total scores and each item. The mean pre-workshop OPTION score was 32 (SD=9.9; range 13 to 46) out of 100 possible points and the post-workshop mean score was 38 (SD=8.1; range 25 to 54 points), with a mean difference of 5.5 (95% CI 1 to 9.9). The pre-workshop mean ACEPP score was 2.8 (SD=1.1; range 0.5 to 4) out of 5 possible points and the post-workshop mean score was 3.4 (SD=0.7; range 2 to 4.5 points), with a mean difference of 0.54 (95% CI 0.02 to 1.1).

Table 7.3. Mean scores of OPTION and ACEPP pre- and post-workshop, and change scores (n=13).

Outcome measures	Pre	Post	Pre-Post (change score)	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (95% CI)
OPTION scale[1] – total score	32.2 (9.9)	37.7 (8.1)	5.5 (12)	5.5 (1.0 to 9.9)
Item 1: Draws attention to a problem that requires a decision making[2]	2.7 (0.9)	2.2 (1.1)	-0.46 (1.1)	-0.46 (-0.89 to -0.03)
Item 2: States that there is more than one way to deal with the problem[2]	1.7 (1.1)	1.6 (1)	-0.08 (1.4)	-0.08 (-0.63 to 0.48)
Item 3: Assesses patient's preferred approach to receiving information[2]	0.77 (0.6)	1.2 (0.6)	0.46 (0.9)	0.46 (0.12 to 0.8)
Item 4: Lists available options – can include the 'no option'[2]	1.9 (1)	2 (1)	0.15 (1.5)	0.15 (-0.41 to 0.72)
Item 5: Explains pros and cons of each option[2]	2.5 (0.9)	3.7 (0.5)	1.2 (1)	1.2 (0.77 to 1.5)
Item 6: Explores patient's expectations about managing the problem[2]	1.2 (0.4)	1.4 (0.5)	0.15 (0.7)	0.15 (-0.11 to 0.42)
Item 7: Explores patient's concerns/fears about managing the problem[2]	1 (0.4)	0.77 (0.6)	-0.23 (0.7)	-0.23 (-0.51 to 0.05)
Item 8: Checks the patient understanding of presented information[2]	0.62 (0.9)	0.38 (0.8)	-0.23 (1.1)	-0.23 (-0.65 to 0.19)
Item 9: Offers the patient explicit opportunities to ask questions[2]	1.2 (0.4)	1.1 (0.5)	-0.08 (0.5)	-0.08 (-0.27 to 0.11)
Item 10: Elicits patient's preferred level of decision making involvement[2]	0.77 (0.4)	0.77 (0.6)	0 (0.6)	0 (-0.22 to 0.22)
Item 11: Indicates the need for decision making/deferring stage[2]	1.2 (0.8)	1.6 (0.9)	-0.08 (1)	-0.08 (-0.48 to 0.32)
Item 12: Indicates the need to review the decision[2]	0.38 (0.5)	1.3 (1.5)	0.92 (1.6)	0.92 (0.33 to 1.52)
ACEPP tool[3] - total score	2.8 (1.1)	3.4 (0.7)	0.54 (1.3)	0.54 (0.02 to 1.06)
Describes the benefits of the treatment in terms of patient outcomes[4]	0.69 (0.3)	0.96 (0.1)	0.27 (0.3)	0.27 (0.14 to 0.4)
Describes the harms of the treatment in terms of patient outcomes[4]	0.85 (0.3)	0.81 (0.3)	-0.04 (0.4)	-0.04 (-0.18 to 0.11)
Discusses the probability or likelihood of benefit or harm either in words or numbers[4]	0.77 (0.4)	0.96 (0.1)	0.19 (0.5)	0.19 (0.01 to 0.38)
Tailors the individualised information the patient been provided[4]	0.15 (0.2)	0.23 (0.3)	0.08 (0.3)	0.08 (-0.06 to 0.21)
Mentions the source of research evidence[4]	0.35 (0.2)	0.38 (0.3)	0.04 (0.5)	0.04 (-0.14 to 0.22)

[1]Observing Patient Involvement Scale: score transformed to 0-100, with higher scores indicating a higher skill level
[2]score range 0 to 4, with higher scores indicating higher skill level
[3]Assessing Communication About Evidence and Patient Preferences: score range 0 to 5, with higher scores indicating higher skill level
[4]score range 0 to 1, with higher scores indicating higher skill level
OPTION scale items: (1) The clinician draws attention to a problem needing a decision-making process.; (2) The clinician states that there is more than 1 way to deal with an identified problem; (3) The clinician asks about the patient's preferred information format (words/numbers/visual display); (4) The clinician list options, including the choice of "no action/no antibiotics"

if feasible; (5) The clinician explains the pros and cons of options to the patient (taking "no action" is an option); (6) The clinician explores the patient's expectations (or ideas) about how the problem/s are to be managed; (7) The clinician explores the patient's concerns/fears about how problem/s are to be managed; (8) The clinician checks that the patient has understood the information; (9) The clinician provides opportunities for the patient to ask questions; (10) The clinician specifically asks for the patient's preferred level of involvement in decision making; (11) The clinician indicates the need for a decision making (or deferring) stage; (12) Arrangements are made to review the decision (or the deferment).
ACEPP tool items: (1) The clinician describes the benefits of the treatment in terms of patient outcomes; (2) The clinician describes the harms of the treatment in terms of patient; (3) Has the probability or likelihood of benefit or harm been discussed either in Words or Numbers; (4) Has individualised information, tailored to the patient been provided?; (5) Has the source of research evidence been mentioned?.

7.5 Discussion

In this study, we developed and piloted a half-day EBP workshop for clinicians, with a focus on teaching how to interpret pre-appraised evidence and incorporate it into discussions with patients as part of shared decision making. Feedback from participants after the workshop was very positive, with special emphasis on the usefulness of small-group sessions. There was a small increase in clinicians' skills in SDM and communicating evidence with patients from before to after the workshop.

Strengths and limitations

This pilot study has several weaknesses. A major limitation is the small sample size and that clinicians volunteered to participate in the study, which may have resulted in a non-representative sample with the possibility that less motivated clinicians with little interest in EBP might not find this workshop as useful. The improvement in SDM and communicating evidence skills might be attributed to the learning curve for the standardised patient consultation (repeated encounter with a standardised patient consultation rather than the workshop), however, we used different patient scenarios for the pre- and post-consultations to minimise this potential impact. The clinical scenarios that we used in the EBP workshop (both in workshop activities and the role-plays) were GP-focused. Although not all the participants were GPs, the chosen scenarios (e.g. ear pain, knee pain) were able to be understood by any health professionals. Limitations also include the lack of follow up period and the use of a before-after single-arm study design. This limits confidence in the findings and generalisability of the results.

Strengths of the study include measuring skill rather than just self-reported knowledge, the use of previously developed validated outcome measures to evaluate skills, and rating of consultations by two raters independently. Although the workshop was not limited to GPs as originally intended, we observed that the resultant interprofessional mixture of participants promoted interdisciplinary learning which have been shown to promote interprofessional collaboration and teamwork and enhance the development of interdisciplinary practice and improvement of quality services[36].

Comparison with other studies

Despite the repetitive calls to integrate SDM training into EBP training[2,16], a recent systematic review of the interventions used in 85 EBP training trials found that the majority of EBP training interventions focused on detailed critical appraisal of individual studies, often to the exclusion of the interpretation and implementation of research evidence (i.e. SDM)[21]. Only one randomised trial has evaluated SDM as a component of EBP training curriculum for student clinicians and found it effective in improving student clinicians' skills in SDM (adjusted difference in OPTION score = 18.9, 95% CI 12.4 to 25.4) and communicating research evidence (adjusted difference in ACEPP = 0.9, 95% CI, 0.5 to 1.3)[15]. A review of 148 SDM training programs found that despite the encouraging increase interest in the development of SDM training programs, only few training programs were rigorously evaluated[6]. A scoping review of 12 studies (only 1 randomised controlled trial[15]) evaluating SDM training in undergraduate medical training found that no evidence to indicate which training methods (e.g. duration, format, and clinical contest) were most effective[37]. Similar, a recently updated Cochrane review of 87 studies evaluated interventions for increasing the use of SDM by clinicians showed that despite the increasing number of SDM interventions being evaluated, the certainty of the evidence of the effectiveness of SDM interventions is low or very low – which precluded any firm conclusions[5]. Similar to our findings, 6 of included studies (in the same Cochrane review) that have assessed interventions targeting clinicians showed a slight improvement in the observed SDM skills among clinicians (standardised mean difference; 0.70, 95% CI, 0.21 to 1.19)[5]. In 2005, Slawson and Shaughnessy indicated that critical appraisal skills are necessary but not sufficient alone for EBP[22]. Information management skills is critical to allow clinicians incorporating the best evidence into the real world of busy clinical practice[22].

Implications on practice and research

The presented study evaluated an EBP workshop which focused on two main needs of a contemporary EBP training program - the interpretation of synthesised pre-appraised research evidence (rather than appraising primary studies) and how to incorporate it into conversations with patients as part of SDM. The international consensus on the core competencies in EBP for health professionals has stressed the importance of clinicians having skills in SDM and critical interpretation and implementation of evidence from pre-appraised resources, rather than insisting upon detailed critical appraisal of individual studies[38]. This is considered a more realistic and pragmatic way to incorporate evidence into timely decisions in busy daily clinical practice and to facilitate patient-centred care through SDM[23].

Implementing research evidence into practice involves major behaviour changes both at individual and system levels. A theory-led overview of 67 systematic reviews on the effectiveness of interventions in changing clinicians' behaviour found that educational interventions tend to be more effective when combined with other reinforcing interventions (e.g. action such as reminders, and audit and feedback)[39]. Therefore, we suggest that this type of EBP workshop may be most appropriate as part of a larger implementation strategy to enhance the use of research evidence in practice, since training is necessary but not sufficient alone for behaviour change.

Future EBP and SDM educational research should consider replicating our findings using larger sample size and various clinical scenarios (not just GP-focused). We also suggesting the use of mixed method approach to provide a thorough understanding of the results. We also propose a modular approach, with each module focussing on a clinical question type (e.g. intervention or diagnosis). Some of these modules might be more relevant to some disciplines than others.

7.6 Conclusions

We found that a half-day EBP workshop which focusses on teaching SDM skills and pre-appraised research evidence is feasible and useful for busy clinicians with a modest impact in skills. However, the interpretation and generalisability of study findings is limited because of the small size and design of this study. A larger controlled trial is warranted to evaluate the effectiveness of such an approach and to measure change in behaviour over a longer-term.

7.7 Declarations

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

LA, TH, and PG conceived the research idea. All authors contributed to the design of the study. LA drafted the original manuscript. All authors contributed to the revision of the paper and approved the final manuscript for submission.

Ethics approval and consent to participate

The study was approved by Bond University Human Research Ethics Committee (LA03307).

Competing interests

The authors declare that they have no competing interests.

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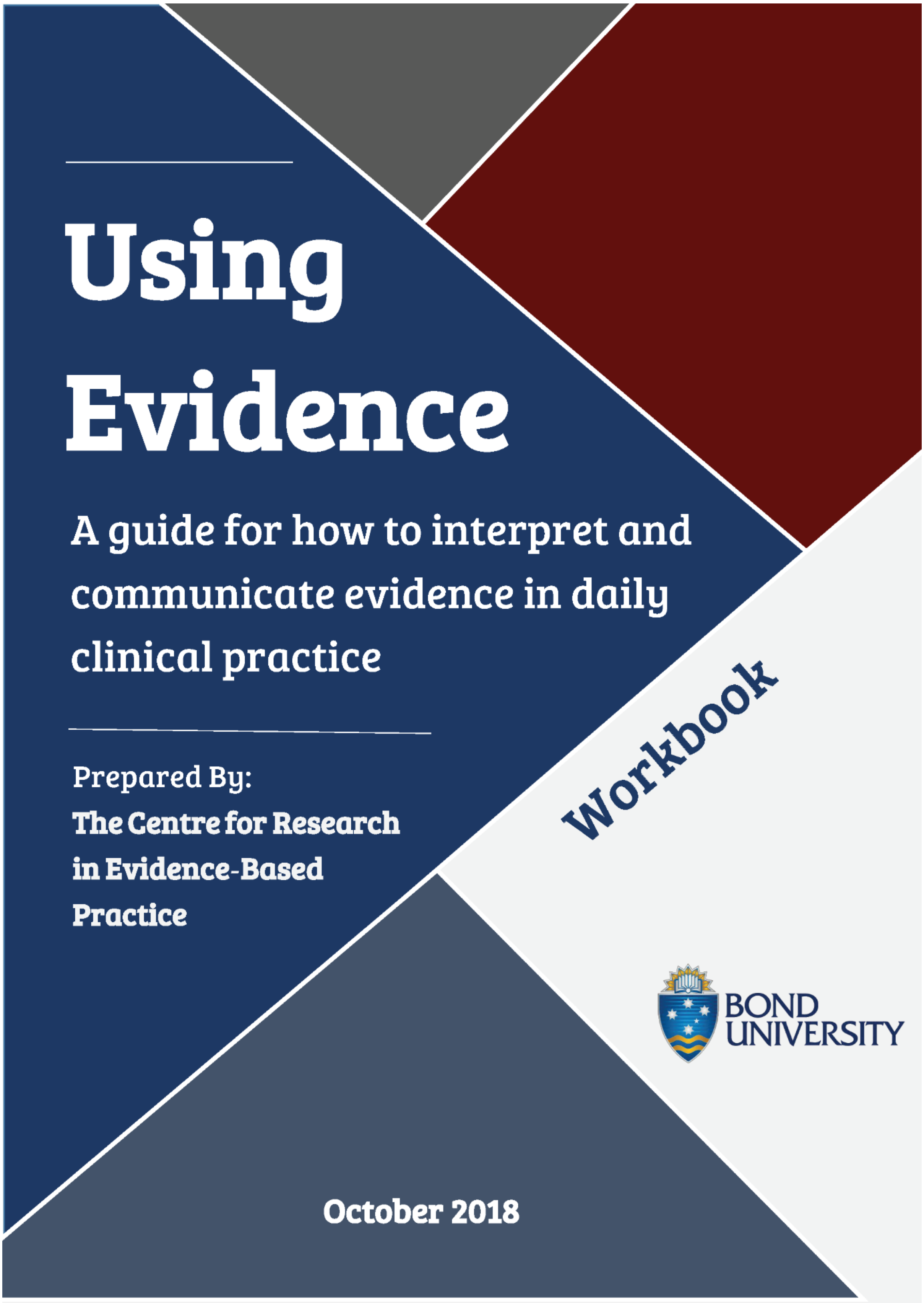
7.9 Supplementary materials 7

Published with article presented in **Chapter 7**

Supplementary material 7.1

Workbook provided for the participants in the EBP Workshop as presented in **Chapter 7**.



Using Evidence

A guide for how to interpret and communicate evidence in daily clinical practice

Workbook

Prepared By:
The Centre for Research in Evidence-Based Practice

BOND UNIVERSITY

October 2018

Contributors/acknowledgments

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Using Evidence: a guide for how to interpret and communicate in daily clinical practice

Date: Wednesday, 10 October 2018
Time: Half-day 12:00-05:00 pm
Venue: Seminar Room 6 (BLD06_4_25), Bond University

Workshop Programme

Time		Session
12:00 – 1:00	Registration & Lunch (Pre-workshop data collection will occur on a rolling basis throughout this time)	
1:00 – 1:05	Welcome	
1:05 – 1:15	Small Group	Exercise 1: Clinical Scenario + Benefits and Harms
1:15 – 1:30	Large Group	Lecture 1: Introduction – Evidence Based Practice and Shared Decision Making
1:30 – 1:40	Large group	Video: SDM
1:40 – 1:50	Small Group	Exercise 2: Applicability of Research Evidence
1:50 – 2:00	Large Group	Lecture 2: Interpretation of research evidence
2:00 – 2:25	Small group	Exercise 3: Interpretation of Research Evidence 1
2:25 – 2:45	Small group	Exercise 4: Interpretation of Research Evidence 2
2:45 – 3:00	Break	
3:00 – 3:15	Small group	Exercise 5: SDM Role Play
3:15 – 3:25	Large Group	Lecture 3: GRADE
3:25 – 3:45	Small group	Exercise 6: GRADE + Risk of Bias
3:45 – 4:00	Small group	Exercise 7: Forest Plot
4:00 – 4:45	Individual	Post-workshop role-play sessions
4:45 – 5:00	Conclusions and Closing	

Table of Contents

1. Clinical Scenario considering the benefits and harms of knee arthroscopy

Objectives include: identifying benefits and harms outcomes; recognising different types of data (e.g. dichotomous and continuous); and recognising different types of effect measures.

Clinical scenario

"You are a general practitioner in a city practice. One of your patients (Sam 56 years old) asks about 'key-hole' arthroscopic surgery to help reduce the pain she has been experiencing from osteoarthritis in her right knee for the last 2 years – but wanted your opinion. She says that this surgery improved her sister's knee pain. You are unsure of the benefits and harms of arthroscopy for knee osteoarthritis."

1.1 Exercise – Benefits and Harms of Knee Arthroscopy

Based on this clinical scenario, please list a few potential benefits and harms of knee arthroscopy that are relevant to our patient?

Benefits	Harms

You found a recently published BMJ Rapid Recommendations Clinical Practice Guideline that is relevant to this scenario[1].

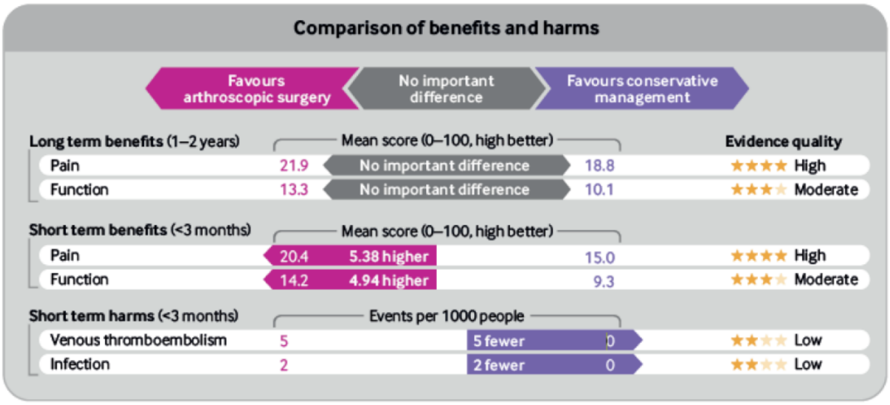
Assume that you have critically appraised the article mentioned above, and concluded that it contains the best evidence to address your patient's concern. Please answer the exercises 2.1-2.8 based on this article. *Note: Searching for best available evidence and critically appraising the validity of treatment articles are not the focus of this exercise. Resources for how to search for and critically appraise a treatment article are available later in the workbook (list of further readings).*

[1] *Siemieniuk RAC, Harris IA, Agoritsas T, et al. Arthroscopic surgery for degenerative knee arthritis and meniscal tears: a clinical practice guideline. BMJ. 2017;357:j1982.*

USING EVIDENCE: A GUIDE FOR HOW TO INTERPRET AND COMMUNICATE IN DAILY CLINICAL PRACTICE

The following figure (Figure 1) was extracted from Siemieniuk et al comparing arthroscopy with conservative treatment.

Figure 1.



1.2 Exercise – Benefits and Harms of Knee Arthroscopy

a. List the outcomes reported in figure 1 and whether each outcome is reported using dichotomous or continuous data.

b. How did they present the effect of knee arthroscopy on each of these outcomes (e.g. mean difference, event rates, risk ratio, odds ratio)?

Reported Outcomes	Continuous or Dichotomous	Presentation

c. What do you conclude from figure 1?

……

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……

……

2. Is this evidence relevant to my patient?

Objectives include: how to convert a clinical scenario into a structured answerable clinical question; identify types of clinical questions (e.g. treatment); the preferred order of study design (e.g. the pros and cons of the major study designs); and how to assess the generalisability and applicability of research findings to clinical practice.

2.1 Exercise – Clinical Question

Based on the clinical scenario, develop a clinical question to identify what you need to know to inform your discussion with Heidi.

Population ……

Intervention ………

Comparator/Control …………………………………………………………………………………………………

Outcome ………

2.2 Exercise – Applicability of Research Evidence

Based on the characteristics of patients included in the primary studies included in the guideline (Figures 1 and 2), do you think that this research evidence is applicable to your patient? Compare information in these figures to the clinical question you wrote above.

Questions to consider might include:

Is your patient so different from those in the study that its results cannot apply?

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Is the treatment feasible in your setting?

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………

USING EVIDENCE: A GUIDE FOR HOW TO INTERPRET AND COMMUNICATE IN DAILY CLINICAL PRACTICE

Did the trials/review measure/report on the outcomes that are relevant to my patient?

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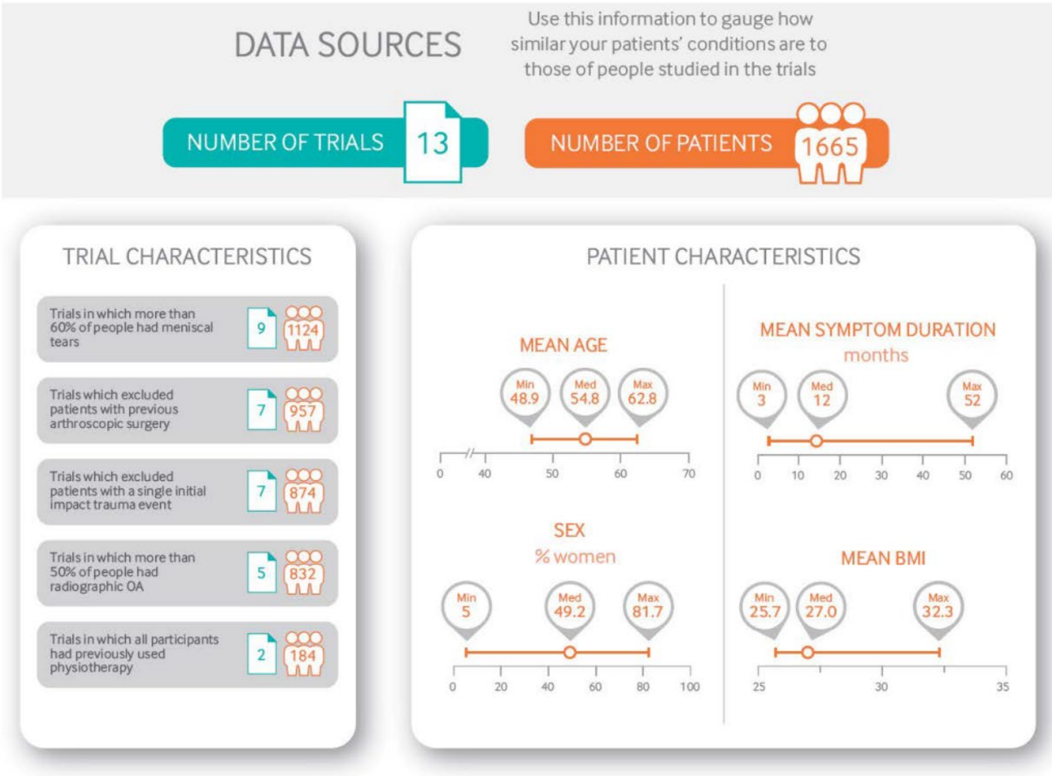
Figure 2.



3. Interpretation of Research Evidence – part 1

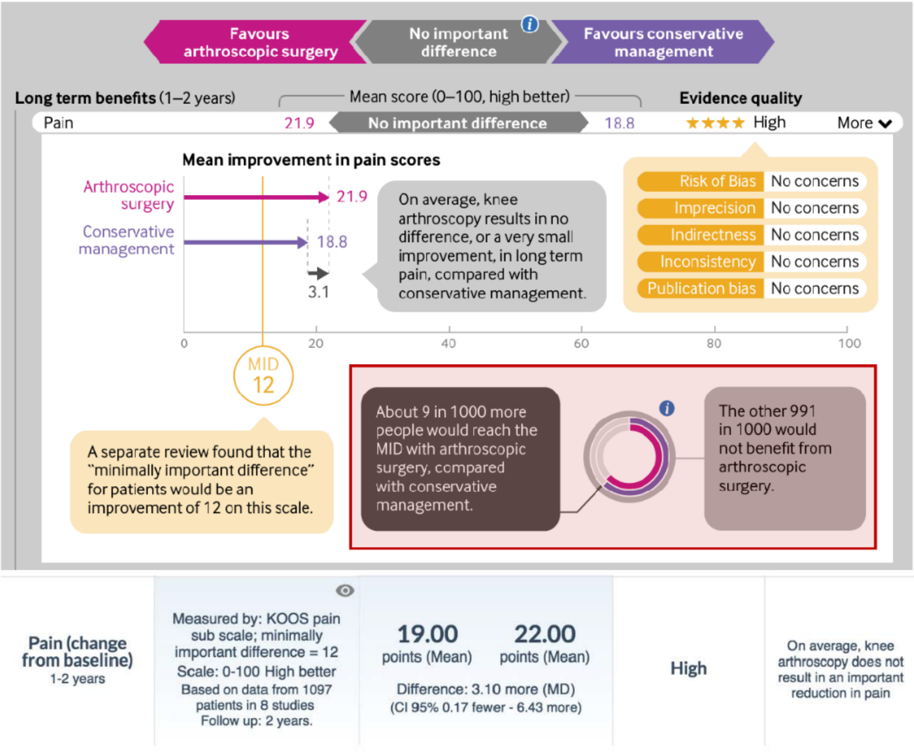
Objectives include: how to understand and interpret the findings of treatment effect on continuous outcomes; identify difference between 'statistical significance and importance'; and identify different measures of uncertainty.

Please watch this pre-recorded video on the measures of effect and uncertainty.

3.1 Exercise – Long-term pain (1-2 years) – does arthroscopy help?

The following results are from Siemieniuk et al reporting the effect of arthroscopic surgery (compared to conservative management) on long-term pain for patients with knee osteoarthritis.

Figure 3.



What is the difference in mean change in pain score (from baseline to 1-2 years) between the two groups?

………

………

How would you explain the effect of arthroscopic surgery on long-term pain to the patient?

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………

How else could you discuss the effect of arthroscopic surgery on long-term pain? (Hint: highlighted in red in Figure 3)

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What does the 95% CI tell you about the statistical significance of arthroscopic surgery on long-term pain (Hint: consider 95%CI)

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....

....

....

....

Is this difference clinically important? How can you tell that?

....

....

....

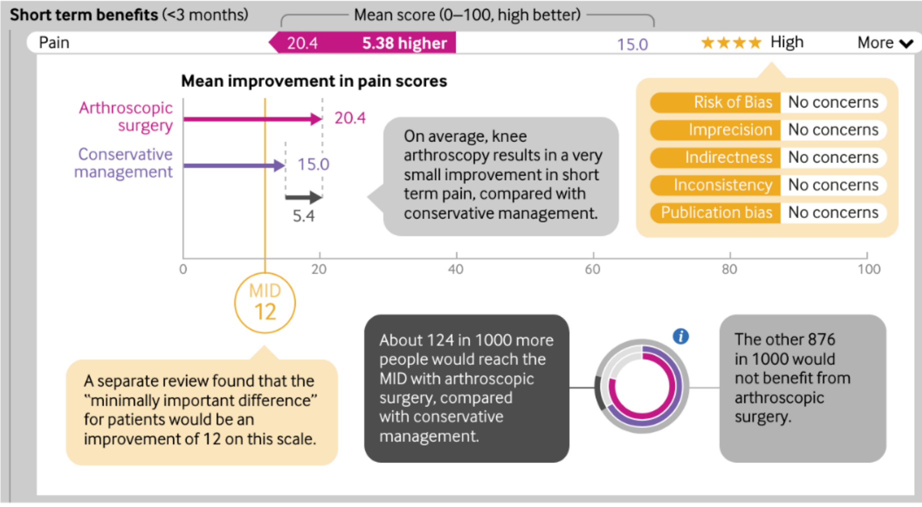
....

....

3.2 Exercise – Short-term pain (<3 months) – does arthroscopy help?

Consider the short-term effect of arthroscopic surgery on pain in patients with osteoarthritis of knee (see results below)

Figure 4.



What is the magnitude of the treatment effect?

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....

How precise is the estimate of the treatment effect?

....

....

....

....

What does the 95% CI tell you about the statistical significance of arthroscopic surgery on long-term pain (Hint: consider 95%CI)

……

……

……

……

Is this difference clinically important? How can you tell that?

……

……

……

……

4. Interpretation of Research Evidence – part 2

Objectives include: how to understand and interpret the findings of treatment effect on categorical outcomes; identify different effect measures such as risk ratio; recognise the difference between absolute and relative effect measures; and recognise the different types of outcome measures such as surrogate outcomes and patient related outcomes, and when to accept considering surrogate outcomes.

4.1 Exercise – The need for knee replacement – effect of arthroscopy

The following results are from Siemieniuk et al and report the effect of arthroscopic surgery (compared to conservative management) on the occurrence of knee replacement for patients with osteoarthritis of knee.

Figure 5.

Outcome Timeframe	Study results and measurements	Absolute effect estimates Conservative management	Arthroscopy	Certainty in effect estimates (Quality of evidence)	Plain text summary
Knee replacement 1-2 years	Relative risk 1.89 (CI 95% 0.51 - 7.00) Based on data from 497 patients in 2 studies Follow up: 1 year.	**12** per 1000	**23** per 1000	**Moderate** Due to serious imprecision	Knee arthroscopy may increase the chance of having a knee replacement
		Difference: 11 more per 1000 (CI 95% 6 fewer - 72 more)			

Calculate the risk ratio and absolute risk difference for this outcome

How would you explain the results to the patient? (considering which do you think is easiest for patients to understand)

4.2 Exercise – Other outcomes

If the guideline authors found that arthroscopic surgery has tremendous improvement in radiographic features of the affected knee, what do you think about the importance of this type of outcome?

……

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……

5. Shared Decision Making

Objectives include: how to engage patients in the decision making process, communicate evidence, and use decision support tools.

Please watch this pre-recorded video of a patient-doctor consultation showing one example of what shared decision making might 'look like' in clinical practice.

5.1 Exercise – SDM role play

Using the clinical scenario on page 16 and the guideline previously discussed (with extra figures and data on pages 17-19), role-play a general practitioner leading a consultation with a patient. Using SDM principles, see what it feels like to share the discussion on management. See over for a framework to guide you.

In a small group, one of you will play the role of the general practitioner. At the end, the other members of the group will provide feedback on this consultation.

Case scenario #1: Knee Osteoarthritis

Workshop participant INSTRUCTIONS

You are a GP in a city practice. One of your patients (Sam 56 years old) started the consultation asking about 'key-hole' arthroscopic surgery to help with the pain she experiences from osteoarthritis in her right knee for the last 2 years – but wanted to check with you first. She says that this surgery improved her sister's knee pain.

Patient[2]: Sam Smith is aged 56 years

Patient's clinical picture:

- She has been experiencing pain in her right knee for the last 2 years. She has been diagnosed with right knee osteoarthritis.
- She takes paracetamol and ibuprofen as needed, but reports that they do not help much.
- She does not smoke and occasionally drinks alcohol.
- She is in good general health. She has no allergies, or history of chronic medical conditions.

Sam will ask for your advice regarding knee arthroscopy for her knee pain. You will need to discuss some options available to her:

- **Option #1:** Sam has knee arthroscopic surgery.
- **Option #2:** Sam does not have knee arthroscopic surgery.

Relevant Evidence

Here is an extract from a recently published BMJ Rapid Recommendations Clinical Practice Guideline that evaluated the effect of knee arthroscopic surgery for degenerative knee arthritis.

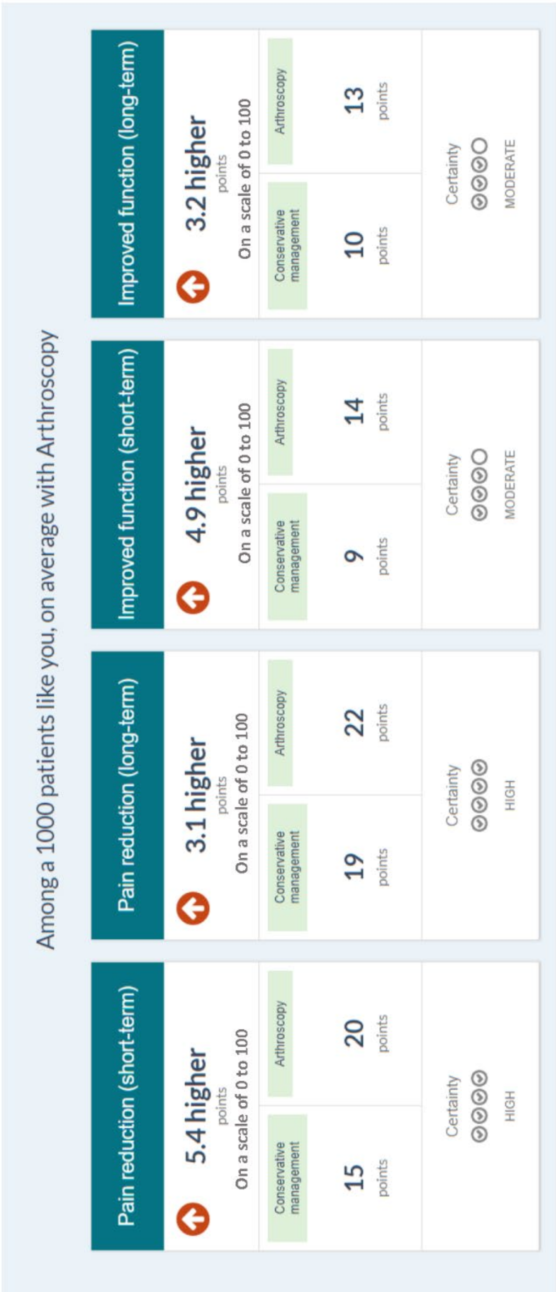
Siemieniuk RAC, Harris IA, Agoritsas T, et al. Arthroscopic surgery for degenerative knee arthritis and meniscal tears: a clinical practice guideline. BMJ. 2017;357:j1982.

Your Task: You will have up to about **8 minutes** to:

- Discuss the evidence with Sam, using Shared Decision Making principles. Assist her to move towards a decision about the best option for her care. This may include: discussing the options; describing the benefits and harms of each option using the evidence extract and decision aid on the following page/s (include information on the likelihood or size of the benefits and harms of each option where possible); discussing the patient's preferences, and ensuring she has enough information to make a choice.

[2] Sam is a standarised patient that may be either a man or a woman

Figure 3. Benefits of knee arthroscopy



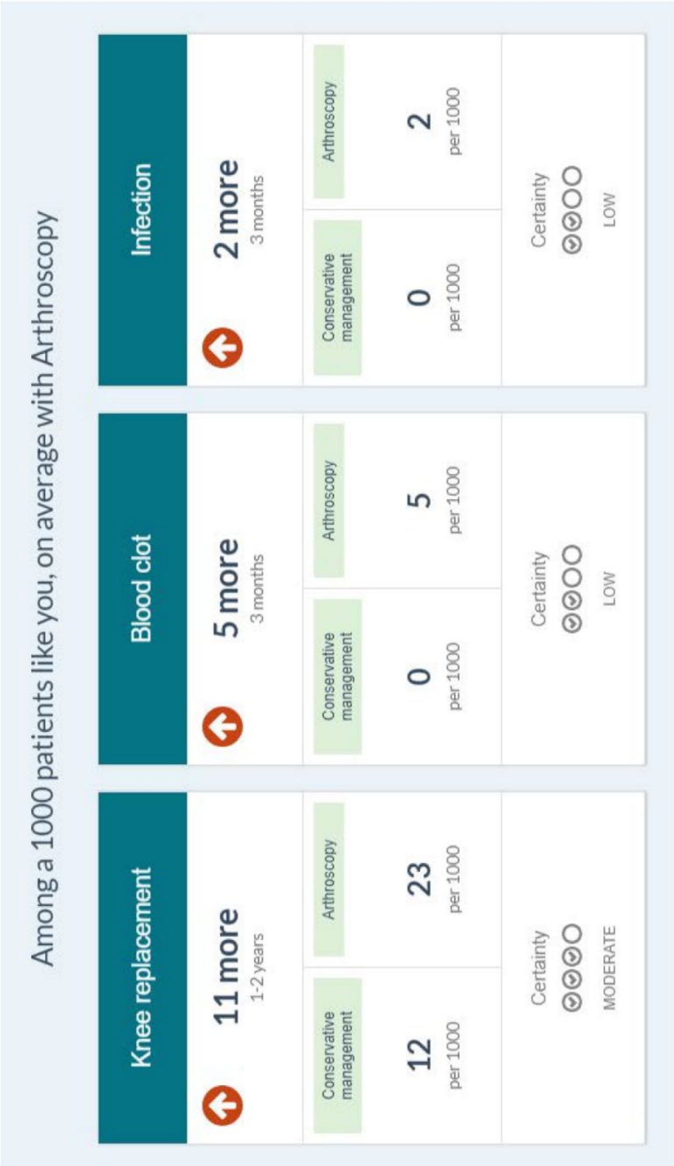
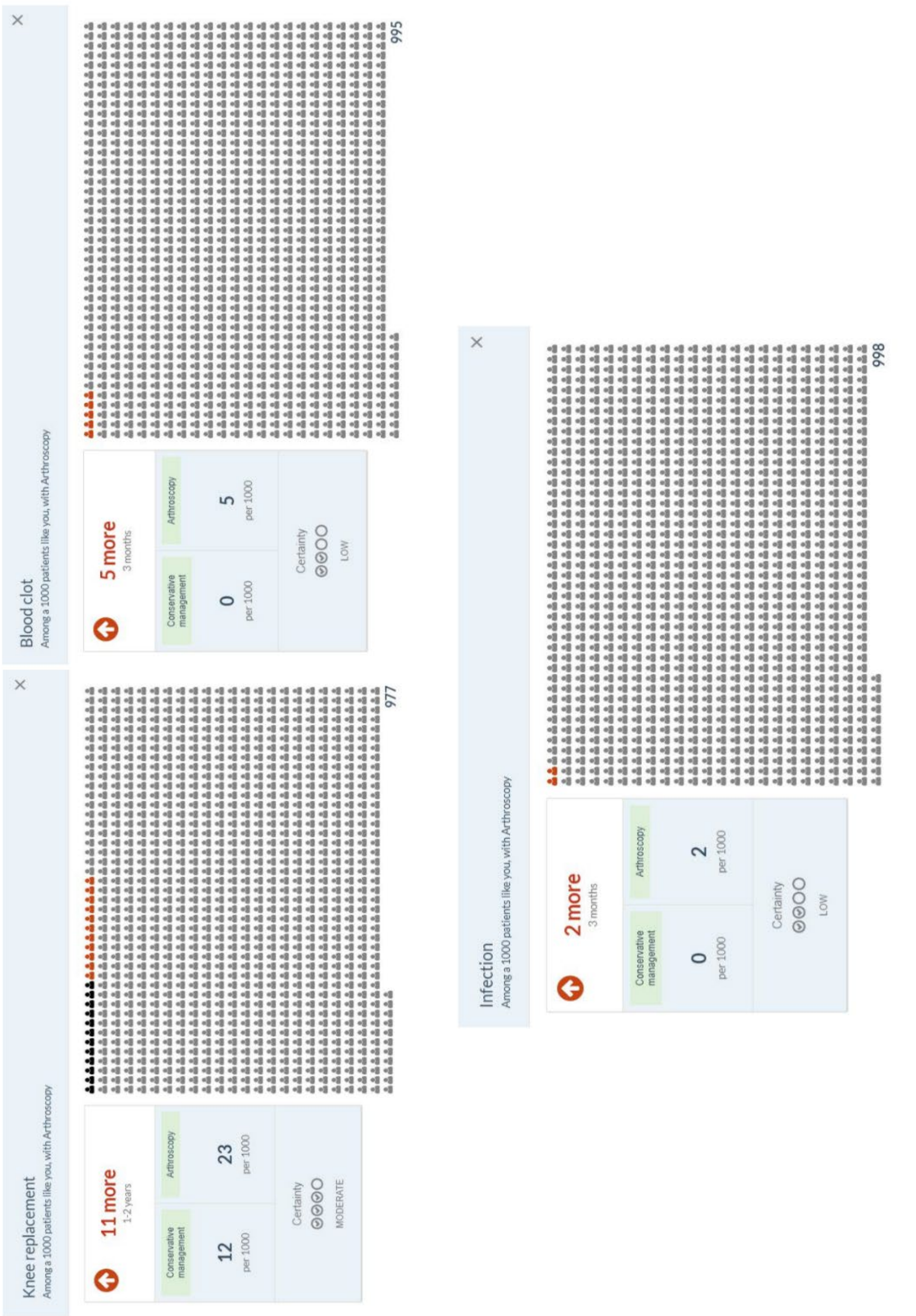


Figure 4. Harms of knee arthroscopy



Knee replacement
Among a 1000 patients like you, with Arthroscopy
11 more
1-2 years
Conservative management
Arthroscopy
12
per 1000
23
per 1000
Certainty
MODERATE
977
Blood clot
Among a 1000 patients like you, with Arthroscopy
5 more
3 months
Conservative management
Arthroscopy
0
per 1000
5
per 1000
Certainty
LOW
995
Infection
Among a 1000 patients like you, with Arthroscopy
2 more
3 months
Conservative management
Arthroscopy
0
per 1000
2
per 1000
Certainty
LOW
998

6. GRADE

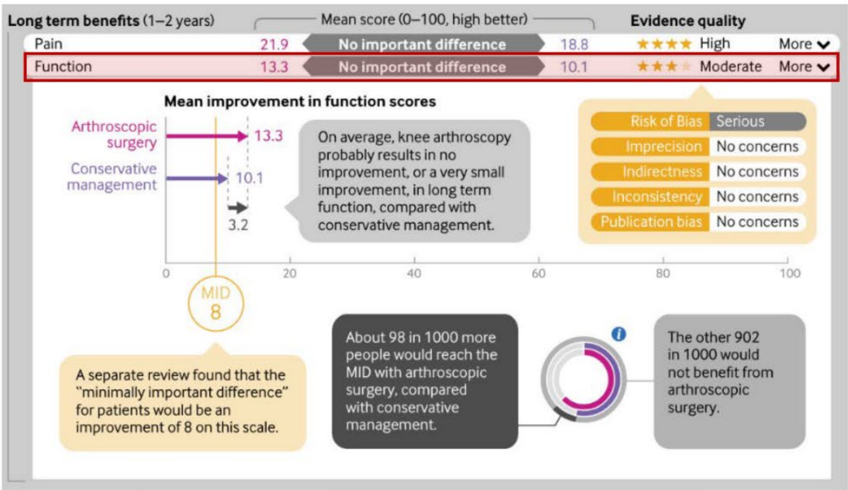
Objectives include: interpret the findings of the different levels of evidence quality and it is impact on clinical decisions.

Please watch the pre-recorded video on GRADE.

6.1 Exercise – GRADE

Considering the effect of knee arthroscopy on function scores (Figure 8 below), you noticed that the evidence quality is reported as moderate.

Figure 8.



Function (change from baseline) 1-2 years	Measured by: KOOS ADL sub scale; minimally important difference = 8 Scale: 0-100 High better Based on data from 843 patients in 6 studies Follow up: 2 years.	**10.00** points (Mean)	**13.00** points (Mean)	**Moderate** Due to serious risk of bias and borderline imprecision	On average, knee arthroscopy probably does not result in an important improvement in function
		Difference: 3.20 more (MD) (CI 95% 0.48 fewer - 6.80 more)			

RISK OF BIAS Serious	COMMENT Inadequate/lack of blinding of participants and personnel, resulting in potential for performance bias
INCONSISTENCY No serious	COMMENT
INDIRECTNESS No serious	COMMENT
IMPRECISION Serious	COMMENT Wide confidence intervals
PUBLICATION BIAS No serious	COMMENT

Explain what this means and how this might affect decision-making (*Hint: refer to the resources at the end for more information about GRADE*).

………

………

One of the factors determining the evidence quality is the risk of bias, which was assessed to be 'serious' for this outcome. What does this mean?

………

………

Below is a structured summary adopted from one of the randomised controlled trials included in this evidence summary (*Sihvonen R et al. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. NEJM. 2013;369(26):2515-24.*)

Study Design: A multicentre, randomised, double, blind, shame-controlled trial.
Setting: Five orthopaedic clinics in Finland.
Participants: 146 Patients 35 to 65 years of age who had knee pain (for >3 months) that was unresponsive to conventional conservative treatment and had clinical findings consistent with a tear of the medial meniscus.
Intervention: Arthroscopic partial meniscectomy or sham surgery.
Outcomes: Primary outcomes were changes in the Lysholm and Western Ontario Meniscal Evaluation Tool (WOMET) scores (each ranging from 0 to 100, with lower scores indicating more severe symptoms) and in knee pain after exercise (rated on a scale from 0 to 10, with 0 denoting no pain) at 12 months after the surgery. Secondary outcomes included changes in the score for Lysholm, WOMET, and knee pain after exercise at 2 and 6 months after surgery; knee pain at rest at 12 months; and health-related quality of life (measured using 15D instrument with scores on a scale of 0 to 1, with 0 indicating full health and 1 indicating death) at 12 months.
Results:
In the intention-to-treat analysis, there were no significant between-group differences in the change from baseline to 12 months in any primary outcome. The mean changes (improvements) in the primary outcome measures were as follows: Lysholm score, 21.7 points in the partial-meniscectomy group as compared with 23.3 points in the sham-surgery group (between-group difference, −1.6 points; 95% confidence interval [CI], −7.2 to 4.0); WOMET score, 24.6 and 27.1 points, respectively (between-group difference, −2.5 points; 95% CI, −9.2 to 4.1); and score for knee pain after exercise, 3.1 and 3.3 points, respectively (between-group difference, −0.1;
95% CI, −0.9 to 0.7). There were no significant differences between groups in the number of patients who required subsequent knee surgery (two in the partial meniscectomy group and five in the sham-surgery group) or serious adverse events (one and zero, respectively).
Authors' conclusion:
In this trial involving patients without knee osteoarthritis but with symptoms of a degenerative medial meniscus tear, the outcomes after arthroscopic partial meniscectomy were no better than those after a sham surgical procedure

Based on the following extracts of the main article, could you please determine whether its results are valid and reliable? (Hint: **RAMbo**)

R*andomised: Was there random allocation, concealed allocation, and baseline similarity of groups?*

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A*ttrition: Was there adequate follow-up, intention-to-treat analysis, and, aside from the experimental intervention, were the groups treated equally?*

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M*easurement: Was the outcomes measurement done by* ***b****linded assessors, or were* ***o****bjective measures used?*

………

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Extracts from the main article *Sihvonen et al*

During Arthroscopic examination of the knee (first performed in all patients to confirm trial eligibility), the surgeon asked a research nurse to open an envelope containing the study-group assignment (arthroscopic partial meniscectomy or sham surgery) and reveal it to the surgeon; the assignment was not revealed to the patient. The sequentially numbered, opaque, sealed envelopes were prepared by a statistician with no involvement in the clinical care of patients in the trial. Randomization was performed in a 1:1 ratio with a block size of 4 (known only to the statistician) using a computer-generated random numbers. The randomization sequence involved stratification according to study site, age (35 to 50 or 51 to 65 years of age), sex, and the absence or presence of minor degenerative changes on a radiograph (Kellgren–Lawrence grade 0 or 1, respectively). Only the orthopaedic surgeon and other staff in the operating room were made aware of the group assignment, and they did not participate in further treatment or follow-up of the patient. The patients, the people who collected and analysed the data, and the authors were unaware of the study-group assignments.

For the sham surgery, a standard arthroscopic partial meniscectomy was simulated. To mimic the sensations and sounds of a true arthroscopic partial meniscectomy, the surgeon asked for all instruments, manipulated the knee as if an arthroscopic partial meniscectomy was being performed. The patient was also kept in the operating room for the amount of time required to perform an actual arthroscopic partial meniscectomy. All procedures were standardized and recorded on video.
In both groups, postoperative care was delivered according to a standardized protocol specifying that all patients receive the same walking aids and instructions for the same graduated exercise program. Patients were instructed to take over-the-counter analgesic agents as required.
All statistical analyses were performed on an intention-to-treat basis; no per-protocol analysis was performed, because the frequency of crossover was low.

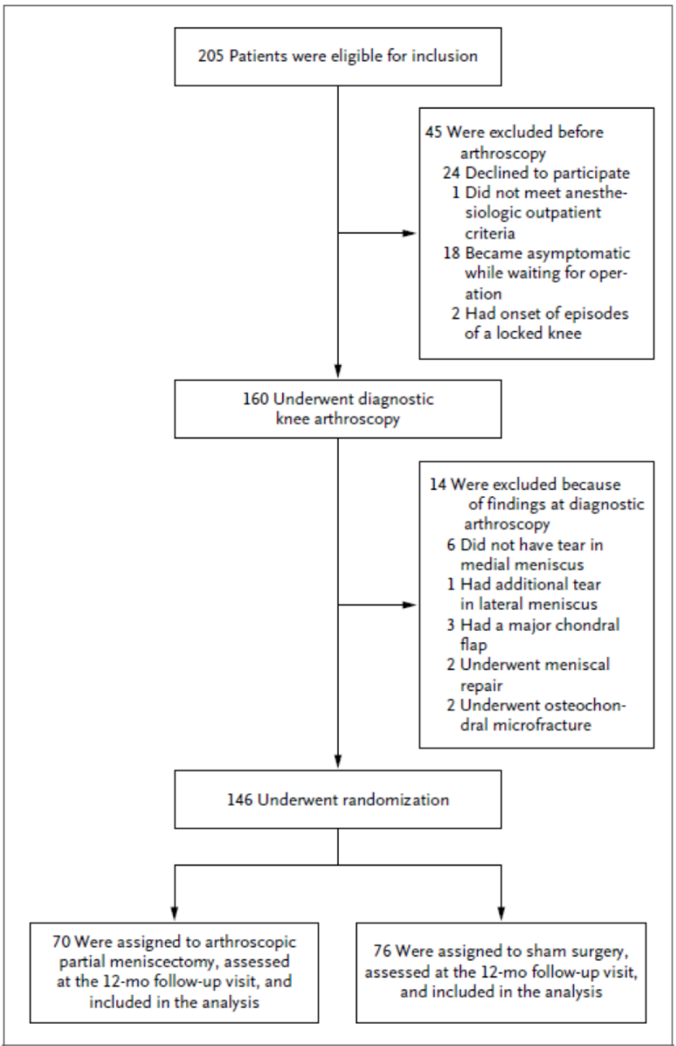


Figure 1. **Enrollment of Patients and Randomization.**

Table 1. Baseline Characteristics of the Patients According to Study Group.*

Characteristic	Partial Meniscectomy (N=70)	Sham Surgery (N=76)
Age — yr	52±7	52±7
Male sex — no. (%)	42 (60)	47 (62)
Weight — kg	81±14	83±15
Height — cm	173±8	173±9
Body-mass index†	26.9±4.0	27.9±4.0
Duration of medial knee pain — mo		
Median	10	10
Range	3–50	3–47
Onset of symptoms — no. (%)		
Gradual	48 (69)	48 (63)
After exercise or hard work	12 (17)	14 (18)
Suddenly or after twisting	10 (14)	14 (18)
Kellgren–Lawrence grade — no. (%)‡		
0	35 (50)	36 (47)
1	35 (50)	40 (53)
Symptoms of catching or locking — no. (%)	32 (46)	37 (49)
Positive result of McMurray test — no. (%)§	16 (23)	15 (20)
Pain provoked by forced flexion, causing compression, at the medial tibiofemoral joint line — no. (%)	50 (71)	59 (78)
Pain provoked by palpation at the medial tibiofemoral joint line — no. (%)	63 (90)	74 (97)
Lysholm knee score¶	60.2±14.7	60.1±14.6
WOMET score‖	56.4±17.3	52.8±18.1
Score for knee pain**		
After exercise	5.8±2.0	6.1±2.0
At rest	4.1±2.3	4.4±2.4
15D score††	0.90±0.06	0.89±0.06

* Plus–minus values are means ±SD. There were no significant differences in the baseline characteristics between the two treatment groups.
† The body-mass index is the weight in kilograms divided by the square of the height in meters.
‡ The Kellgren–Lawrence scale is a radiographic classification of the severity of knee osteoarthritis. Grade 0 denotes no abnormalities, and grade 1 minor degenerative changes (doubtful narrowing of the joint space or possible osteophytic lipping).
§ Results of a McMurray test are positive if a "click" over the medial tibiofemoral joint line is felt by the examiner during flexion and extension of the knee under varus stress.
¶ The Lysholm knee score is based on an eight-item questionnaire designed to evaluate knee function and symptoms in activities of daily living. Scores range from 0 to 100; higher scores indicate less severe symptoms.
‖ The Western Ontario Meniscal Evaluation Tool (WOMET) contains 16 items addressing three domains: 9 items addressing physical symptoms; 4 items addressing disabilities with regard to sports, recreation, work, and lifestyle; and 3 items addressing emotions. The score indicates the percentage of a normal score; therefore, 100 is the best possible score, and 0 is the worst possible score.
** Knee pain after exercise and at rest (during the preceding week) was assessed on a rating scale of 0 to 10, with 0 denoting no pain and 10 denoting extreme pain.
†† The 15D instrument is a generic health-related quality-of-life instrument comprising 15 dimensions. The maximum 15D score is 1 (full health), and the minimum score is 0 (death).

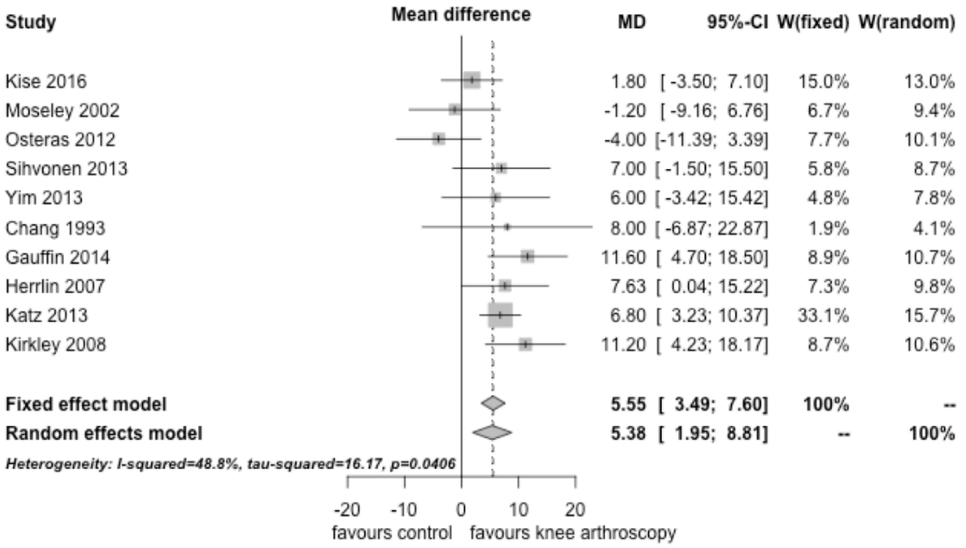
7. Interpretation of Forest Plot

Objectives include: how to read and interpret the findings of a forest plot; understand the heterogeneity between studies and how to assess it.

7.1 Exercise – Interpretation of Forest Plot

Authors presented a summary of their results on the effect of knee arthroscopy on short-term changes on pain scores in the following forest plot (Figure 9).

Figure 9. Forest Plot[3]



How many studies are there?

………

………

Which do you think is (i) the largest study; (ii) the smallest study?

………

………

[3] *Siemieniuk RAC, Harris IA, Agoritsas T, et al. Arthroscopic surgery for degenerative knee arthritis and meniscal tears: a clinical practice guideline. BMJ. 2017;357:j1982.*

For how many studies are the central estimates in favour of treatment? In favour of control?
………

………

………

How many studies are (i) statistically significant; (ii) not statistically significant?
………
………
………

For how many studies are the central estimates (i) more beneficial (ii) less beneficial than the overall results.
………

………

………

What do you think about the scatter between the studies (Hint: this means heterogeneity)? What does it mean for the truth about the summary estimates?
………

………

………

8. Suggested Readings

Clinical Questions

The following classification covers the main types of questions that come up in health care practice.

Question	Question type	Description
What should I do about this condition or problem?	Intervention	By far the most common type of clinical question is about how to treat a disease or condition, or how to alleviate other health care problems. We refer to such actions as 'interventions'.
What causes the problem?	Aetiology and risk factors	We often would like to know the cause of health care problems, such as whether cigarette smoking causes lung cancer, or being overweight increases the risk of heart disease.
Does this person have the condition or problem?	Diagnosis	In order to treat a person, it is first important to correctly determine what the health care condition or problem is. Because most detection methods are not 100% accurate, questions of diagnosis often arise, related to the accuracy of available tests.
Who will get the condition or problem?	Prognosis and Prediction	A necessary precursor to treatment is to know the likelihood that a person will develop a particular condition or problem so as to target preventative actions. For example, a patient's risk of stroke or deep vein thrombosis, or young children's risk of learning difficulties.
How common is the problem?	Frequency and rate	It is often important to know the prevalence (frequency) or incidence (rate) of a health care problem in the population. For example, the frequency of a particular birth defect in mothers Of a particular age or genetic background, or the incidence of an infectious disease during summer or winter.
What are the types of problems?	Phenomena or Thoughts	Finally, some questions relate to more general issues, such as the concerns of parents about vaccination of their children, or the barriers to lifestyle change such as healthy eating.

What study designs should you be looking for?

Most clinical questions can be classified as being about interventions, aetiology and risk factors, diagnosis, prognosis, frequency and rate, or phenomena. The types of studies that give the best evidence are different for the different types of questions. In every case, however, the best evidence comes from studies where the methods used maximise the chance of eliminating bias.

The study designs that best suit the different question types are as follows:

QUESTION	BEST STUDY DESIGNS*	DESCRIPTION
INTERVENTION	Randomised controlled trial (RCT)	Subjects are randomly allocated to treatment or control groups and outcomes assessed.
AETIOLOGY AND RISK FACTORS	Randomised controlled trial	As aetiology questions are similar to intervention questions, the ideal study type is an RCT. However, it is usually not ethical or practical to conduct such a trial to assess harmful outcomes.
	Cohort study	Outcomes are compared for matched groups with and without exposure or risk factor (prospective study).
	Case-control study	Subjects with and without outcome of interest are compared for previous exposure or risk factor (retrospective study).
FREQUENCY AND RATE	Cohort study	As above
	Cross-sectional study	Measurement of condition in a representative (preferably random) sample of people.
DIAGNOSIS	Cross-sectional study with random or consecutive sample	Preferably an independent, blind, comparison with 'gold standard' test.
PROGNOSIS AND PREDICTION	Cohort/survival study	Long-term follow-up of a representative cohort.

* Descriptions of these study types are given in the 'Glossary' of this workbook. In each case, a systematic review of all the available studies is better than an individual study.

Designation of levels of evidence according to type of research question4

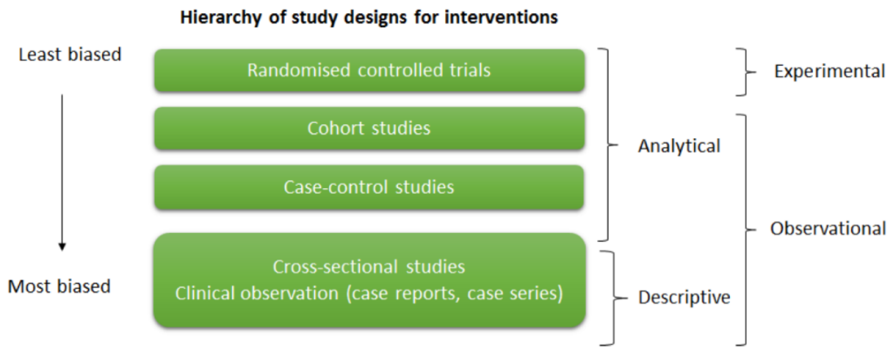
	Level	Intervention[1]	Diagnosis[2]	Prognosis[1]	Aetiology[1,3]	Frequency (Point prevalence)
Least biased	I	Systematic review of level II studies	Systematic review of level II studies	Systematic review of level II studies	Systematic review of level II studies	Systematic review of level II studies
	II	Randomised controlled trial	Cross-sectional study among consecutive presenting patients	Inception cohort study	Prospective cohort study	Cross-sectional study of a representative sample
	III	One of the following: • non-randomised experimental study (eg controlled pre- and post-test intervention study) • comparative (observational) study with a concurrent control group (eg cohort study, case-control study)	One of the following: • cross-sectional study among non-consecutive patients • diagnostic case control study	One of the following: • untreated control patients in a randomised controlled trial • retrospectively assembled cohort study	One of the following: • retrospective cohort study • case-control study (Note: these are the most common study types for aetiology, but see level III for intervention studies for other options)	
Most biased	IV	Case series	Case series	Case series, or a cohort study of patients at different stages of disease	A cross-sectional study	

[1] In rare instances, 'all-or-none' evidence may be available for these types of questions (see Glossary) and, depending on the circumstances, may provide confirmation of effectiveness or causation.
[2] These levels of evidence apply only to studies of diagnostic accuracy. To assess the *effectiveness* of a diagnostic test, there also needs to be a consideration of the impact of the test on patient management and health outcomes.
[3] If it is possible and/or ethical to determine a causal relationship using *experimental* evidence, then the 'intervention' hierarchy of evidence can be used. If it is only possible and/or ethical to determine a causal relationship using observational evidence (eg because it is not possible to allocate groups to a potential harmful exposure, such as nuclear radiation), then this 'aetiology' hierarchy of evidence can be used.

[4] Source: Modified from the Centre for Evidence-Based Medicine (Oxford) website and the National Health and Medicine

USING EVIDENCE: A GUIDE FOR HOW TO INTERPRET AND COMMUNICATE IN DAILY CLINICAL PRACTICE

The figure below shows the different types of studies arranged in a descending hierarchy from the least (top) to the most (bottom) biased.



Rapid critical appraisal sheet for a treatment study

TREATMENT STUDY: Are the results of the trial valid? (Internal Validity)

What question did the study ask?
Patients –
Intervention -
Comparison -
Outcome(s) –

1a. R- Was the assignment of patients to treatments randomised?	
What is best?	Where do I find the information?
Centralised computer randomisation is ideal and often used in multi-centred trials. Smaller trials may use an *independent* person (e.g, the hospital pharmacy) to "police" the randomization.	The ***Methods*** should tell you how patients were allocated to groups and whether or not randomisation was concealed.
This paper: Yes ☐ No ☐ Unclear ☐ Comment:	
1b. R- Were the groups similar at the start of the trial?	
What is best?	Where do I find the information?
If the randomisation process worked (that is, achieved comparable groups) the groups should be similar. The more similar the groups the better it is. There should be some indication of whether differences between groups are statistically significant (ie. p values).	The ***Results*** should have a table of "Baseline Characteristics" comparing the randomized groups on a number of variables that could affect the outcome (ie. age, risk factors etc). If not, there may be a description of group similarity in the first paragraphs of the ***Results*** section.
This paper: Yes ☐ No ☐ Unclear ☐ Comment:	
2a. A – Aside from the allocated treatment, were groups treated equally?	
What is best?	Where do I find the information?
Apart from the intervention the patients in the different groups should be treated the same, eg., additional treatments or tests.	Look in the ***Methods*** section for the follow-up schedule, and permitted additional treatments, etc and in ***Results*** for actual use.
This paper: Yes ☐ No ☐ Unclear ☐ Comment:	
2b. A – Were all patients who entered the trial accounted for? – and were they analysed in the groups to which they were randomised?	
What is best?	Where do I find the information?
Losses to follow-up should be minimal – preferably less than 20%. However, if few patients have the outcome of interest, then even small losses to follow-up can bias the results. Patients should also be analysed in the groups to which they were randomised – *'intention-to-treat analysis'*.	The ***Results*** section should say how many patients were andomised (eg., Baseline Characteristics table) and how many patients were actually included in the analysis. You will need to read the results section to clarify the number and reason for losses to follow-up.
This paper: Yes ☐ No ☐ Unclear ☐ Comment:	

3. M - Were measures objective or were the patients and clinicians kept "blind" to which treatment was being received?	
What is best?	Where do I find the information?
It is ideal if the study is 'double-blinded' – that is, both patients and investigators are unaware of treatment allocation. If the outcome is *objective* (eg., death) then blinding is less critical. If the outcome is *subjective* (eg., symptoms or function) then blinding of the outcome assessor is critical.	First, look in the ***Methods*** section to see if there is some mention of masking of treatments, eg., placebos with the same appearance or sham therapy. Second, the ***Methods*** section should describe how the outcome was assessed and whether the assessor/s were aware of the patients' treatment.
This paper: Yes ☐ No ☐ Unclear ☐ Comment:	

What were the results?

1. How large was the treatment effect?	
Most often results are presented as dichotomous outcomes (yes or not outcomes that happen or don't happen) and can include such outcomes as cancer recurrence, myocardial infarction and death. Consider a study in which 15% (0.15) of the control group died and 10% (0.10) of the treatment group died after 2 years of treatment. The results can be expressed in many ways as shown below.	
What is the measure?	**What does it mean?**
Relative Risk (RR) = risk of the outcome in the treatment group / risk of the outcome in the control group. In our example, the RR = 0.10/0.15 = 0.67	The relative risk tells us **how many times more likely** it is that an event will occur in the treatment group relative to the control group. An **RR** of **1** means that there is no difference between the two groups thus, the treatment had **no effect**. An RR < 1 means that the treatment decreases the risk of the outcome. An RR > 1 means that the treatment increased the risk of the outcome. Since the RR < 1, the treatment decreases the risk of death.
Absolute Risk Reduction (ARR) = risk of the outcome in the control group - risk of the outcome in the treatment group. This is also known as the **absolute risk difference.** In our example, the ARR = 0.15 - 0.10 = 0.05 or 5%	The absolute risk reduction tells us the absolute difference in the rates of events between the two groups and gives an indication of the baseline risk and treatment effect. An **ARR** of **0** means that there is no difference between the two groups thus, the treatment had **no effect**. The absolute benefit of treatment is a 5% reduction in the death rate.
Relative Risk Reduction (RRR) = absolute risk reduction / risk of the outcome in the control group. An alternative way to calculate the RRR is to subtract the RR from 1 (eg. RRR = 1 - RR) In our example, the RRR = 0.05/0.15 = 0.33 or 33% Or RRR = 1 - 0.67 = 0.33 or 33%	The relative risk reduction is the complement of the RR and is probably the most commonly reported measure of treatment effects. It tells us the reduction in the rate of the outcome in the treatment group relative to that in the control group. The treatment reduced the risk of death by 33% relative to that occurring in the control group.

Number Needed to Treat (NNT) = inverse of the ARR and is calculated as 1 / ARR. In our example, the NNT = 1/ 0.05 = 20	The number needed to treat represents the number of patients we need to treat with the experimental therapy in order to prevent 1 bad outcome and incorporates the duration of treatment. Clinical significance can be determined to some extent by looking at the NNTs, but also by weighing the NNTs against any harms or adverse effects (NNHs) of therapy. We would need to treat 20 people for 2 years in order to prevent 1 death.
2. How precise was the estimate of the treatment effect?	
The true risk of the outcome in the population is not known and the best we can do is estimate the true risk based on the sample of patients in the trial. This estimate is called the **point estimate**. We can gauge how close this estimate is to the true value by looking at the confidence intervals (CI) for each estimate. If the confidence interval is fairly narrow then we can be confident that our point estimate is a precise reflection of the population value. The confidence interval also provides us with information about the statistical significance of the result. If the value corresponding to **no effect** falls outside the 95% confidence interval then the result is statistically significant at the 0.05 level. If the confidence interval includes the value corresponding to **no effect** then the results are not statistically significant.	

Will the results help me in caring for my patient? (External Validity/Applicability)

The questions that you should ask before you decide to apply the results of the study to your patient are:

- Is my patient so different to those in the study that the results cannot apply?
- Is the treatment feasible in my setting?
- Will the potential benefits of treatment outweigh the potential harms of treatment for my patient?

GLOSSARY

Absolute risk reduction
The difference between the rate of relevant outcomes in the treatment and control groups.

Accuracy (*see also* Diagnostic accuracy)
The degree to which a measurement represents the true value of the variable measured.

Adjustment (*see also* Confounding)
A procedure for minimising differences in the composition of populations being compared using statistical methods.

Allocation
The way that subjects are assigned to the different groups in a study (eg drug treatment vs placebo; usual treatment vs no treatment).

All-or-none evidence
Is when all patients died before the treatment became available, but some now survive on it; or when some patients died before the treatment became available, but none now die on it. For a refinement of this see: Glasziou P, et al (2007). When are randomised trials unnecessary? Picking signal from noise. *British Medical Journal* 334:349-51.

Applicability (*see also* External validity)
Addresses whether a particular treatment or exposure that showed an overall effect in a study can be expected to convey the same effect for an individual or group in a specific clinical or population setting.

Bias
Deviation of a measurement from the 'true' value leading to either an over or underestimation of the treatment effect. Bias can originate from many different sources, such as allocation of patients, measurement, interpretation, publication and review of data.

Blinding
A study protocol that prevents those involved in a clinical study from knowing to which treatment groups subjects have been assigned. Blinding of the subjects themselves minimises bias in patient responses; blinding of outcome assessors minimises biasing in measurements.

Case-control study
A study in which a group of patients with a specific outcome are matched with a group of matched controls without the outcome and information is obtained about their past exposure to a factor under investigation.

Case series
Outcome information collected for a series (consecutive or non-consecutive) of patients after a treatment or exposure (ie with no control group). For a pre-test/post-test case series, measures are taken before and after the intervention is introduced to a series of people and are then compared (also known as a 'before-and-after study').

Cohort study
A study in which data are obtained from matched groups who have been either exposed or not exposed (controls) to a new technology, prognostic factor or risk factor. There are two study designs:

- prospective — the cohorts are identified at a point in time (such as time of birth, residence at a specific location, exposure to a particular risk factor) and followed forward in time to record health outcomes

- retrospective — the cohorts are defined at a point of time in the past and information is collected on subsequent outcomes.

An 'inception cohort' is a group of patients assembled near the onset of the target disorder (such as at the time of first exposure to a supposed cause) and followed forward in time.

Comparator
Treatment, prognostic indicator or test that is compared with the treatment, indicator or test of interest in a clinical trial.

Confidence interval (CI)
An interval within which the population parameter (the 'true' value) is expected to lie with a given degree of certainty (eg 95%).

Confounding (*see also* Adjustment)
The distortion of the true effect of treatment (or a risk factor) by other factors that vary between the study and control groups (eg baseline differences in age, sex or lifestyle).

Critical appraisal
Process of assessing how well the methods of a clinical study eliminate bias (and therefore how reliable the results are). Process of (a) assessing how well the methods of a clinical study eliminate bias and therefore how reliable the results are (which is also called 'internal validity'); and (b) interpreting what the results mean.

Cross-sectional study
A study that examines the relationship between specific outcomes and variables of interest in a defined population at a particular time (ie exposure and outcomes are both measured at the same time). For a diagnostic cross-sectional study, a consecutive group of subjects receive both the test under study (index test) and the reference standard test.

Diagnostic case-control study (*see also* Case–control study)
A study in which the index test results for a group of patients already known to have the disease (through the reference standard) are compared to the index test results for a separate group of normal/healthy people known to be free of the disease (through the reference standard).

Diagnostic accuracy
A measure of how often a diagnostic test gives the right answer (that is, positive result for people with the condition and negative result for people without it).

Evidence-based practice (also called evidence-based medicine)
Patient care in which clinical expertise and patient values are integrated with the best research evidence from the medical literature.

Experimental studies
Studies in which subjects are allocated to two or more groups to receive an intervention, exposure or test and then followed up under carefully controlled conditions.

External validity (*see also* Applicability, Validity)
The degree to which the results of a clinical study can be applied to clinical practice in a specific setting.

Hazard ratio (HR)
The ratio of the hazards in the treatment and control groups where the hazard is the probability of having the outcome at time t, given that the outcome has not occurred up to time t.

Heterogeneity
Differences in treatment effect between studies contributing to a meta-analysis. Significant heterogeneity suggests that the trials are not estimating a single common treatment effect.

Index test (*see also* Reference test)
In a diagnostic study, the index test is the test for which the diagnostic accuracy is being measured.

Intention to treat
Analysis of clinical trial participants according to the group to which they were initially allocated, regardless of whether or not they dropped out, fully complied with the treatment, or crossed over to the other treatment.

Interrupted time series (*see* Time series)

Intervention
A therapeutic procedure, such as treatment with a pharmaceutical agent, surgery, a dietary supplement, a dietary change, psychotherapy, early detection (screening) or use of patient educational materials.
Level of evidence
A hierarchy of study designs according to their internal validity, or degree to which they are not susceptible to bias.

Meta-analysis
Results from several studies, identified in a systematic review, are combined and summarised quantitatively.

Null hypothesis
Presumption that the results observed in a study (eg the apparent beneficial effects of an intervention) were due to chance.

Number needed to treat (NNT)
The number of patients with a particular condition who must receive a treatment in order to prevent the occurrence of one adverse outcome. NNT is the inverse of the absolute risk reduction. Similarly, 'number needed to harm' (NNH) refers to harmful outcomes.

Odds ratio (OR)
Ratio of the odds (those with the outcome divided by those without it) in the treatment group to the corresponding odds in the control group. An odds ratio of 1 implies that the outcome is equally likely in both groups.

Primary research
Individual studies such as a randomised controlled trial, cohort study etc.

Prognostic indicator
A factor (such as age, gender, risk factor) that is related to a person's probability of developing the disease or outcome.

Pseudorandomised controlled study
An experimental comparison study in which subjects are allocated to treatment/intervention or control/placebo groups in a non-random way (such as alternate allocation, allocation by day of week, odd–even study numbers, etc).

Random error
The portion of variation in a measurement that is due to chance.

Randomised controlled trial
An experimental comparison study in which participants are allocated to treatment/intervention or control/placebo groups using a random mechanism (such as coin toss, random number table or computer-generated random numbers). Participants have an equal chance of being allocated to an intervention or control group and therefore allocation bias is eliminated.

Reference test (*see also* Index test)
A method, procedure or measurement that is widely regarded or accepted as being the best available (also known as a 'gold standard'). Often used to compare with a new method (index test).

Relative risk or risk ratio (RR)
Ratio of the rates of outcome in the treatment and control groups. This expresses the risk of the outcome in the treatment group relative to that in the control group.

Relative risk reduction (RRR)
The relative reduction in risk associated with an intervention or exposure. It is calculated as one minus the relative risk.

Secondary research
An academic review of primary research studies to gain new insights on a specific topic (such as a systematic review).

Selection bias
Error due to systematic differences in characteristics between those who are selected for study and those who are not. It invalidates conclusions and generalisations that might otherwise be drawn from such studies.

Systematic review (*see also* Secondary research)
The process of systematically locating, appraising and synthesising evidence from scientific studies in order to obtain a reliable overview.

Time series
A set of measurements taken over time. An interrupted time series is generated when a set of measurements is taken before the introduction of an intervention (or some other change in the system), followed by another set of measurements taken over time after the change.

Validity
Of a study: the degree to which the inferences drawn from the study are warranted when account is taken of the study methods, the representativeness of the study sample, and the nature of the population from which it is drawn (internal and external validity, applicability, generalisability).

Glossary adapted from *How to Review the Evidence: Systematic Identification and Review of the Scientific Literature*, National Health and Medical Research Council, Canberra, Australia, 2000.

Notes

Notes

Supplementary material 7.2

Materials used in training standardised patients in the EBP Workshop as presented in **Chapter 7**.

Using Evidence: a guide for how to interpret and communicate in daily clinical practice

Evidence Based Practice Workshop for General Practitioners

Using Evidence: a guide for how to interpret and communicate in daily clinical practice

Evidence Based Practice Workshop for Clinicians

Name (optional): ....

Email address (optional): ....

1. What is your age?

A. 18-29 years *B.* 30-44 years *C.* 45-59 years *D.* 60+ years

2. What is your gender?

A. Female *B.* Male *C.* Not Listed .... *D.* Prefer not to answer

3. Please indicate your health discipline

1- Medicine 2- Pharmacy 3- Allied Health 4- Others ....

4. Please indicate which of the following describes your place of employment

1- Primary care 2- Secondary care 3- Others ....

5. Please indicate which of the following describes your role or position (more than one apply)

1- Teaching 2- Clinical 3- Research 4- Others ....

6. Have you ever attended a training in evidence based practice?

1- No 2- Yes If yes, where and when ....

7. Please indicate the number of years of clinical experience .... years

Workshop Evaluation Form

Instructions: We appreciate your help in evaluating this workshop. Please note that the consultations with standardised patients at the beginning and end of the workshop form part of the study evaluating the workshop, rather than part of the workshop itself.

Please give your answers or comments for the questions below.

What was the most beneficial aspect of the workshop for you?

Do you have any suggestions that will enable us to improve these workshops for the future?

Are there any aspects of this workshop that you did not think were useful? If so, please describe

----

Please list up to three actions you intend to do as a result of your participation in the workshop?

1. --
   ----
2. --
   ----
3. --

Please indicate your position to each of the following statement about your experience of the workshop on a scale 1 to 5 (1 = strongly disagree, 2=agree, 3=neutral, 4=agree, and 5 = strongly agree).

1. The objectives of the workshop were clear to the learners

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

2. The workshop addressed the intended learning objectives (learning outcomes were fulfilled)

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

3. The teaching and learning methods used during the workshop to teach EBP were appropriate to the learners?

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

4. The workshop duration and pace (half day) were appropriate to cover the content

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

5. The time allotted for each of the topics was adequate

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

6. The workshop resources provided to the learners were appropriate

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

7. The workshop is relevant to your clinical practice

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

8. The small group sessions were useful and interactive, and provided you with an opportunity to ask questions and discuss matters

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

9. My confidence and skills in practising evidence-based practice have enhanced as a result of my participation in the workshop.

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree

Case scenario #1: Knee Osteoarthritis (BEFORE)

Workshop participant INSTRUCTIONS

You are a general practitioner in a city practice. One of your patients (Sam 56 years old) started the consultation asking about 'key-hole' arthroscopic surgery to help with the pain she experiences from osteoarthritis in her right knee for the last 2 years – but wanted to check with you first. She says that this surgery improved her sister's knee pain.

Patient[1]: Sam Smith is aged 56 years

Patient's clinical picture:

- She has been experiencing pain in her right knee for the last 2 years. She has been diagnosed with right knee osteoarthritis.
- She takes paracetamol and ibuprofen as needed, but reports that they do not help much.
- She does not smoke and occasionally drinks alcohol.
- She is in good general health. She has no allergies, or history of chronic medical conditions.

Sam will ask for your advice regarding knee arthroscopy for her knee pain. You will need to discuss some options available to her:

- **Option #1:** Sam has knee arthroscopic surgery.
- **Option #2:** Sam does not have knee arthroscopic surgery.

Relevant Evidence

Here is an extract from a recently published BMJ Rapid Recommendations Clinical Practice Guideline that evaluated the effect of knee arthroscopic surgery for degenerative knee arthritis.

Siemieniuk RAC, Harris IA, Agoritsas T, et al. Arthroscopic surgery for degenerative knee arthritis and meniscal tears: a clinical practice guideline. BMJ. 2017;357:j1982.

Your Task: You will have up to about **8 minutes** to:

- Discuss the evidence with Sam, using Shared Decision Making principles. Assist her to move towards a decision about the best option for her care. This may include: discussing the options; describing the benefits and harms of each option using the evidence extract and decision aid on the following page/s (include information on the likelihood or size of the benefits and harms of each option where possible); discussing the patient's preferences, and ensuring she has enough information to make a choice.

[1] Sam is a standardised patient that may be either a man or a woman

Case scenario #1: Knee Osteoarthritis (BEFORE)

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You are a general practitioner in a city practice. One of your patients (Sam 56 years old) started the consultation asking about 'key-hole' arthroscopic surgery to help with the pain she experiences from osteoarthritis in her right knee for the last 2 years – but wanted to check with you first. She says that this surgery improved her sister's knee pain.

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[1] Sam is a standardised patient that may be either a man or a woman

Case scenario #1: Knee Osteoarthritis (BEFORE)

SIMULATED PATIENT CASE

<table>
<tr><td>Patient</td><td>Sam Smith, aged 56 years old</td></tr>
<tr><td>Summary of the clinical scenario</td><td>• You experience pain in your right knee for the past 2 years, which is worse at the end of the day and after prolonged use.
• You have no night pain, knee swelling, or prolonged morning stiffness (> 30 minutes).
• You have been diagnosed with right knee osteoarthritis; but the pain has increased over the last month and has been so bad that you have to stop going to work for two days.
• You have been given paracetamol and ibuprofen. They have been of some help but not much, and you have not used anything else.

Background information about your general health
• You are a non-smoker and drink alcohol occasionally.
• Otherwise in good general health.
• No allergies, history of chronic medical conditions (e.g. high blood pressure), or family history of similar complaints.
• You are overweight – Body Mass Index is 26.
• You are a primary school teacher</td></tr>
<tr><td>Opening statement</td><td>• My sister had knee arthroscopy for her osteoarthritis, and her knee pain has improved. Can I have this done to my knee as well?</td></tr>
<tr><td>Ask about your options</td><td>• You are about to discuss the available options to improve your knee pain, particularly your suggestion of knee arthroscopy.
• A decision needs to be made about whether you should have a knee arthroscopic surgery or not.
• Ask: Would it be possible to have a knee arthroscopy to fix my knee pain?
• Be prepared to discuss these options in more details.</td></tr>
<tr><td>When asked if you have enough information to make a choice</td><td>• Ask an appropriate further question, if it hasn’t already been covered:
  ○ e.g., would this surgery work for the type of patient that I belong?
• Be prepared to give your decision and clarify what comes next</td></tr>
</table>

Figure 3. Benefits of knee arthroscopy

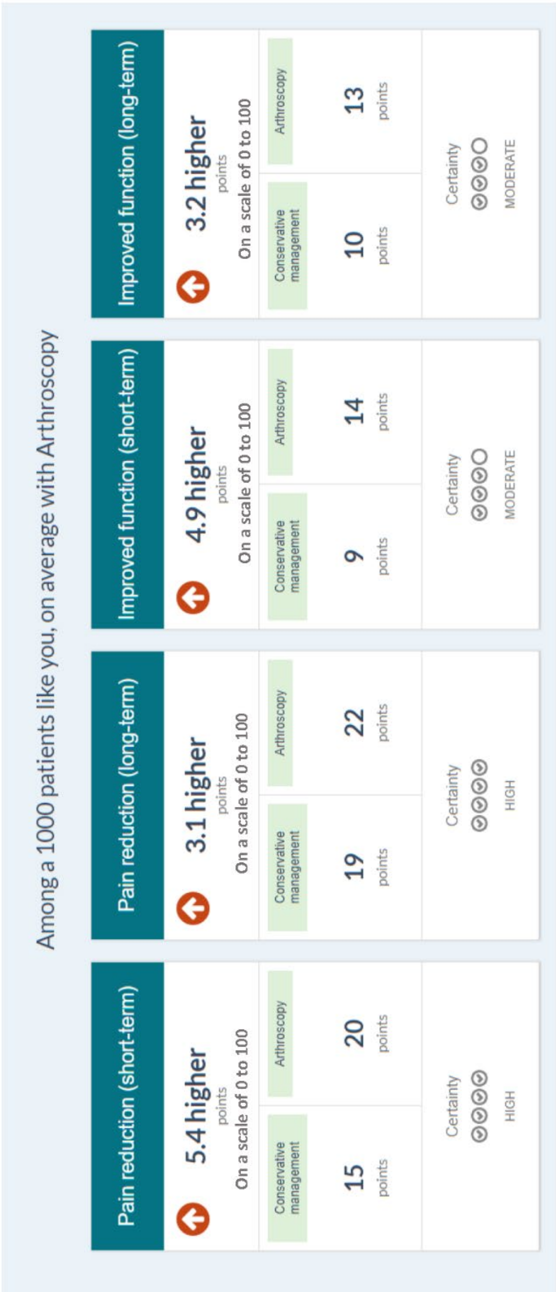
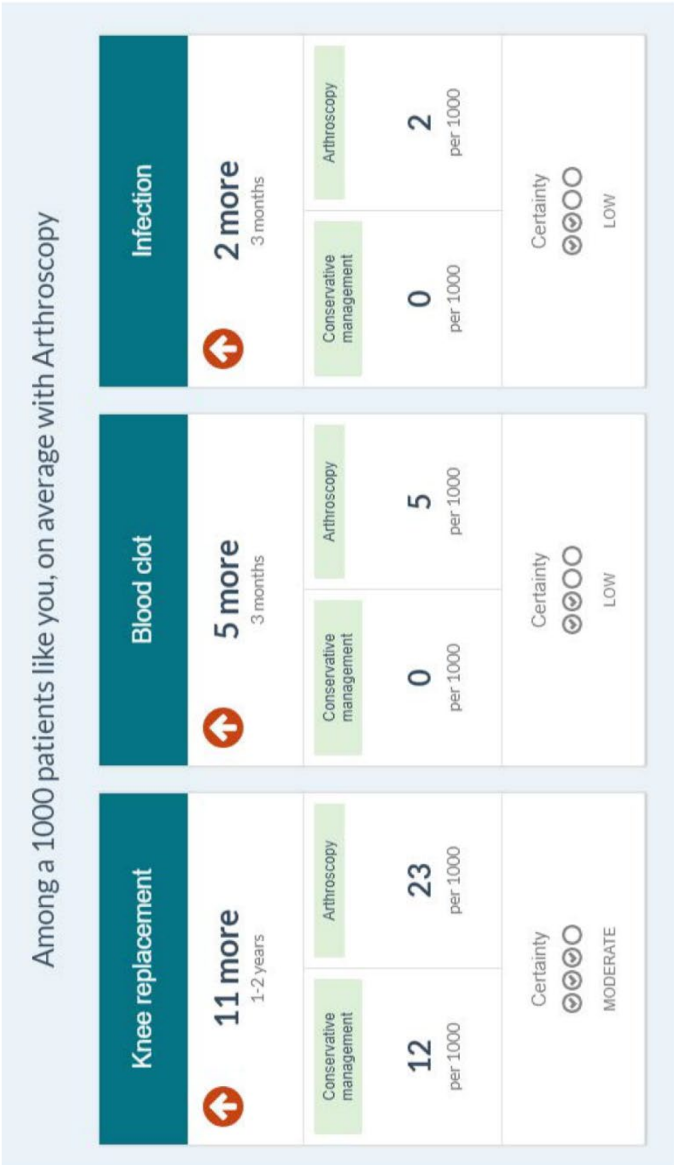
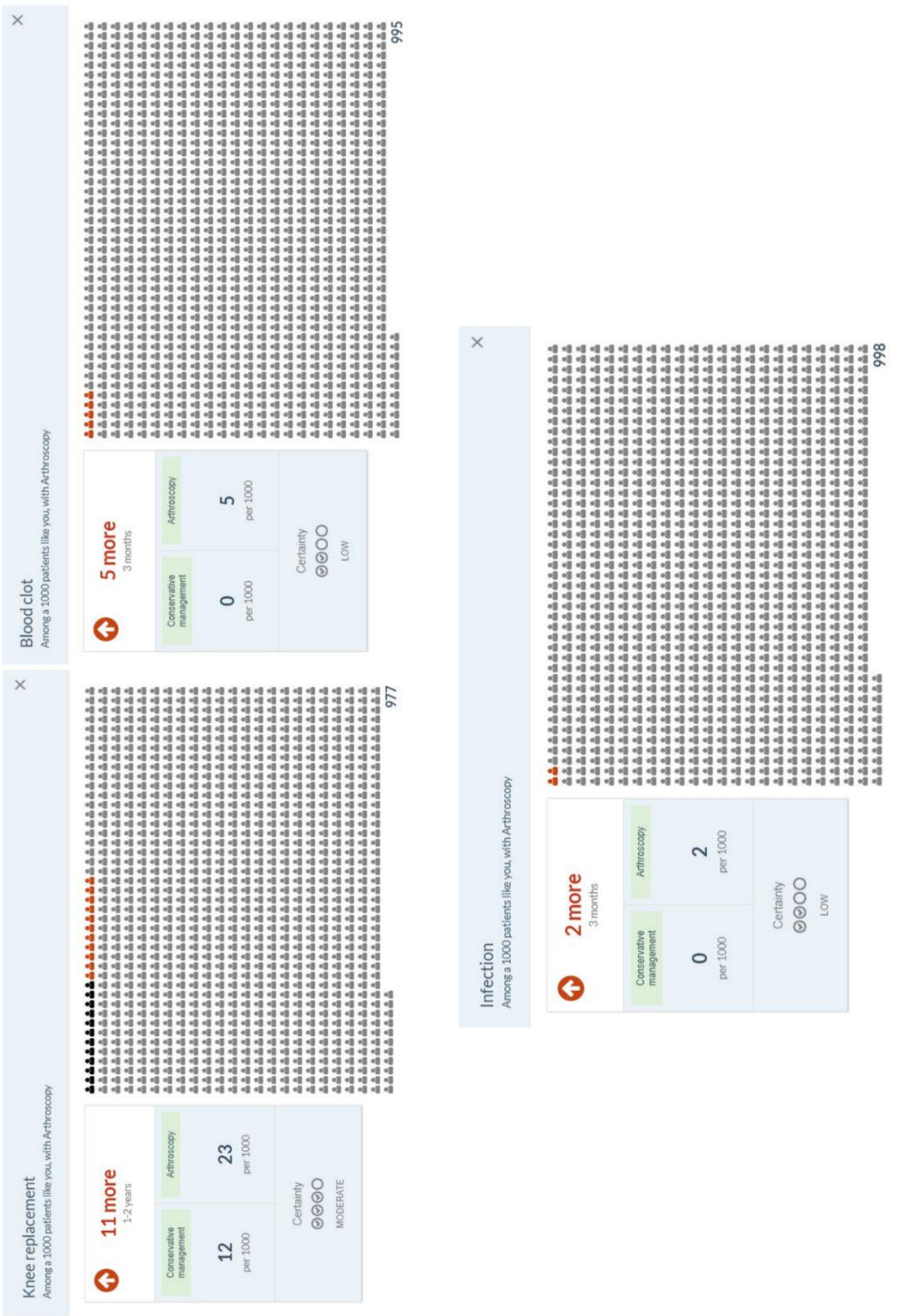


Figure 4. Harms of knee arthroscopy




Knee replacement
Among a 1000 patients like you, with Arthroscopy
11 more
1-2 years
Conservative management
Arthroscopy
12
per 1000
23
per 1000
Certainty
MODERATE
977
Blood clot
Among a 1000 patients like you, with Arthroscopy
5 more
3 months
Conservative management
Arthroscopy
0
per 1000
5
per 1000
Certainty
LOW
995
Infection
Among a 1000 patients like you, with Arthroscopy
2 more
3 months
Conservative management
Arthroscopy
0
per 1000
2
per 1000
Certainty
LOW
998

Case scenario #2: Acute otitis Media (AFTER)

Workshop participant INSTRUCTIONS

You are a general practitioner in a city practice. You are about to see Lily, brought by her grandparent Morgan, regarding her ear pain. You will help her decide on a treatment option **(i.e. to be prescribed antibiotics or sent home with no antibiotics)**

Patient[2]: Morgan Armani is accompanying her grandchild Lily, aged 3

Patient's clinical picture:
- Lily's mother works full-time and has asked Morgan (Lily's grandparent) to bring Lily to the doctor.
- Lily was screaming and unusually irritable at dinnertime yesterday. She woke up in the night needing comforting three or four times.
- She was unwell with a cold for 3-4 days, and then yesterday became worse with fevers and screaming.
- On examination you confirmed symptoms of an acute respiratory infection, plus a red bulging tympanic membrane on the right.

You have confirmed a diagnosis of acute otitis media. The options to discuss with the patient:
- Option #1: Lily to commence antibiotics
- Option #2: Lily not to take antibiotics.

  (Paracetamol or ibuprofen can be used with either option to reduce pain and fever)

<u>Relevant Evidence</u>

Here is an extract from a Cochrane systematic review that evaluated the effect of antibiotics for acute otitis media in children and a decision aid.

Your Task: You will have up to about **8 minutes** to:

- Discuss the evidence with Morgan, using Shared Decision Making principles. Assist her to move towards a decision about the best option for Lily's care. This may include: discussing the options; describing the benefits and harms of each option using the evidence in the decision aid on the following page/s (include information on the likelihood or size of the benefits and harms of each option where possible); discussing the patient/carer's preferences, and ensuring she has enough information to make a choice.

[2]Morgan is a standarised patient that may be either a man or a woman

Case scenario #2: Acute otitis Media (<u>AFTER</u>)

Workshop participant INSTRUCTIONS

You are a general practitioner in a city practice. You are about to see Lily, brought by her grandparent Morgan, regarding her ear pain. You will help her decide on a treatment option **(i.e. to be prescribed antibiotics or sent home with no antibiotics)**

Patient[2]: Morgan Armani is accompanying her grandchild Lily, aged 3

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- She was unwell with a cold for 3-4 days, and then yesterday became worse with fevers and screaming.
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  (Paracetamol or ibuprofen can be used with either option to reduce pain and fever)

<u>Relevant Evidence</u>

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[2]Morgan is a standarised patient that may be either a man or a woman

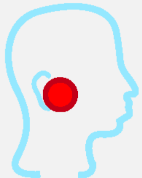
Case scenario #2: Acute otitis Media (AFTER)

SIMULATED PATIENT CASE

Patient	Morgan Armani accompanying her granddaughter Lily, aged 3.
Summary of the clinical scenario	• Lily was screaming and unusually irritable at dinnertime yesterday. Her mother works full-time and has asked you to take Lily to the doctor. • Lily woke up in the night needing comforting three or four times. • Lily was unwell with a cold for 3-4 days, and then yesterday became worse with fevers and screaming.
Opening statement	• ***Lily is my grandchild. Her mother asked me to bring her because she is very unsettled.***
Ask about your options	• You are about to be told that Lily has Acute Otitis Media (AOM; occurs when a child's eustachian tube, the tube that runs from the middle of the ear to the back of the throat, becomes swollen or blocked and traps fluid in the middle ear. The trapped fluid can become infected). • A decision needs to be made about whether you should start Lily on antibiotics • You want Lily to get better quickly, but you want to know the options • Be prepared to discuss these options in more detail
When asked if you have enough information to make a choice	• Ask an appropriate further question, if it hasn't already been covered: ○ e.g., ***Lily seems to pick colds up from childcare all the time, does that mean she might get these infections often?*** • Be prepared to give your decision and clarify what comes next

Middle ear infection: should my child take antibiotics?

- This decision aid is to help you and your doctor decide whether to use antibiotics when **your child** has a middle ear infection.
- This can help you to talk and make a **shared decision** with your doctor about what is best for your child.



What causes middle ear infection?

- It can be caused by a viral or bacterial infection. It is hard for your doctor to tell which it is.
- It is also called 'acute otitis media'. Acute means it is a short-term infection.

How long does the earache last?

- Symptoms (such as earache) usually get better in 2 to 7 days, without antibiotics.

What are the treatment **options?**

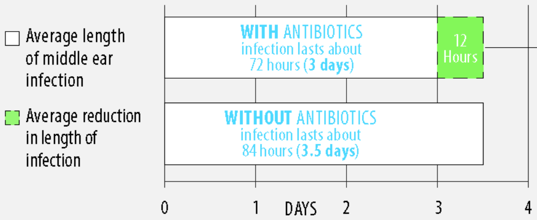
There are 2 options that you can discuss with your doctor:

1. Not taking antibiotics
This means letting the infection get better by itself.

2. Taking antibiotics

Symptoms, such as pain and fever, can be treated with over-the-counter medicines. They can be used with either option.

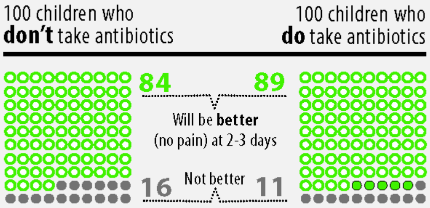
What are the likely **benefits and harms** of each option?



Children who take antibiotics have the earache for only about **12 hours less** than children who do not.

These figures show what happens to children with middle ear infection who **do not** take antibiotics and those who **do**. Each circle is one child. We can't predict whether your child will be one of the children who is helped or harmed.

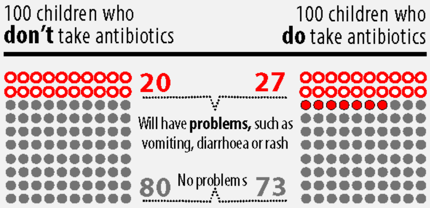
- gets better by 2-3 days
- gets better by 2-3 days due to antibiotics
- not better by 2-3 days



With antibiotics, **5 more children** will be better after 2-3 days.

After about **4 days** most children will be better anyway - without antibiotics.

- has problems
- has problems due to antibiotics
- no problems



With antibiotics, **7 more children** will have problems like vomiting and diarrhoea. Other antibiotic harms are:

- the **cost** of buying them
- **remembering** to take them
- the risk of **antibiotic resistance** (see next page)

Where do these estimates of benefits and harms come from?

- They come from the most up-to-date medical evidence of benefits and harms about what works best. This is a review of 13 studies, and over 3,400 children, that looked at antibiotic use in children with middle ear infection.
- The quality of this research evidence is ranked as high. This means that further research is very unlikely to change these estimates.

Why might antibiotics be used?

There might be a special reason why your doctor may suggest antibiotics, such as in people who are more likely to get complications. This can be Indigenous children and children who are under 2 years of age.

What is antibiotic resistance?

- Using antibiotics means the bacteria can develop resistance to the antibiotic.
- This means that **antibiotics may not work if your child needs them in the future** to treat a bacterial infection.
- A person who has recently used antibiotics is more likely to have resistant bacteria in their body.

Are there other things I can do?

- Pain and fever are best treated with over-the-counter **paracetamol and/or ibuprofen**. Do not give more than the maximum recommended dose. Read the dose information on the packet.
- Aspirin should NOT be used with children who are younger than 16 years.

When should you see a doctor and get further help?

If the child with the middle ear infection has any of these signs:

- Very drowsy
- Fast or difficulty breathing, wheezing, or shortness of breath
- Cold or discoloured hands and/or feet with a warm body
- A high fever (over 38.5°C)
- Pain in the arms and/or legs
- Unusual skin colour (pale or blue) around the lips
- A rash that does not fade when the skin is pressed
- Pain and tenderness of the bone behind the ear
- Blood or discharge from the ear

Questions to consider when talking with your doctor

- [ ] Does my child need antibiotics?
- [ ] What happens if my child doesn't take antibiotics?
- [ ] Do I know enough about the benefits and harms of:
  - taking antibiotics?
  - not taking antibiotics?
- [ ] Am I clear about which benefits and harms matter most to me?
- [ ] Do I have enough information and support to decide?

References

Venekamp RP, Sanders S, Glasziou PP, Del Mar CB, Rovers MM. Antibiotics for acute otitis media in children. Cochrane Database Syst Rev 2015;1:CD000219. www.cochranelibrary.com

The information in this decision aid is provided for general information only. It is not intended as medical advice and should not be relied upon as a substitute for consultations with a qualified health professional who can determine you or your child's individual medical needs.

Last reviewed: November 2015. Update due: November 2017. Developed by Peter Coxeter, Professor Chris Del Mar and Professor Tammy Hoffmann - Centre for Research in Evidence-Based Practice, Bond University. Decision Aid development funded by the National Health and Medical Research Council (APP1044904)

When one teaches … two learn
Asking the right questions takes as much skill as giving the right answers.

—Robert Heinlein

8

Chapter 8
Overall Discussion

The overall aim of this thesis was to facilitate improved translation of EBP educational interventions into clinical practice. This thesis explored two main research issues: (i) the quality of the current published EBP educational interventions; and (ii) efforts to improve the quality and the uptake of EBP education in practice.

The five studies presented in the preceding chapters of this thesis (**Chapters 3 - 7**) examined these two main research issues via the focused research questions presented in **Chapter 1** and each makes important and unique contributions to improve the quality of EBP education. By presenting and integrating these key research studies, the whole thesis collectively provides a novel contribution which advances the field of EBP education, supports the harmonisation of quality EBP educational interventions for clinicians, and identifies area for improvement and future research directions in the field of EBP education.

This thesis focussed on EBP education, which is just one of numerous barriers to evidence translation (previously described in **Chapter 2** such as clinician-related, system-related, patient-related, and research-related barriers), on the assumption that more effective EBP education may assist in improving the translation of evidence into practice.

8.1 Discussion of the main findings

Challenges in the research evidence evaluating EBP education

The earlier studies (studies 1 and 2 reported in **Chapters 3** and **4**) in this thesis investigated challenges in the existing research on EBP educational interventions which might impede the translation of that evidence into the practice of EBP education for clinicians. Studies 1 and 2 were based on a systematic review of controlled trials that evaluated EBP educational interventions to examine the completeness of reporting of EBP educational intervention details (**Chapter 3**), the EBP topics covered, and outcomes measures used (**Chapter 4**). These studies found that the incomplete reporting of EBP educational interventions along with the inconsistent and infrequent use of high-quality instruments to measure the effect of EBP educational interventions are major challenges for translating research evidence about EBP education into practice.

The first study (**Chapter 3**) found numerous deficiencies in the reporting of EBP educational interventions, with none of the included studies completely reporting all of the essential intervention details that are required for their replication and/or implementation. Unfortunately, the reporting of EBP educational interventions remained incomplete for the majority of studies, even after study authors were contacted and asked to provide missing information.

'Intervention materials' was the most poorly reported item. Details were provided in the original publication in only 4% of the studies, which increased to 25% after contacting the study authors. Although missing information could be obtained by contacting study authors, this is time-consuming and usually impractical for those want to use the intervention. Without adequate reporting of essential details, EBP educational interventions are hard to understand, cannot be replicated and implemented, and reliable conclusions cannot be drawn regarding the effectiveness of these interventions (as shown in **Chapter 2**). This issue is not unique to EBP educational interventions, an analysis of the reporting of non-pharmacological interventions in a sample of randomised trials found inadequate reporting of intervention details in more than half of included trials – with 'intervention materials' was the most frequently missing item[1].

The second study (**Chapter 4**) examined the differences in the EBP content covered and outcome measures used in evaluating EBP educational interventions. It found that the majority of EBP educational interventions focus on critically appraising evidence (EBP step 3), often to the exclusion of other steps (i.e. EBP step 4: apply). There are increasing calls to shift the focus of EBP education from the detailed critical appraisal of primary studies to teaching student clinicians and clinicians how to apply findings from trusted pre-appraised evidence, and practice collaboration with individual patients through shared decision making[2] (which have also shaped the last study in this thesis – reported in **Chapter 8**). Furthermore, the systematic review reported in **Chapter 4** found that over half of EBP educational studies did not use a high-quality instrument (i.e. supported by established inter-rater reliability, objective outcome measures, and three or more types of established validity) to measure their outcomes of interest – which might impede accurately measuring the impact of EBP education. To harmonise the content of EBP educational interventions, and with possibly future flow-on effect to the measured outcomes, an international consensus statement of EBP core competencies for clinicians was developed as part of this thesis[3] (reported in **Chapter 5**).

Variations in evidence-based practice training programs and the need for core competencies

The third study (reported in **Chapter 5**) followed a rigorous process (which involved integrating evidence from a systematic review, conducting a modified Delphi survey, holding a consensus meeting, and receiving external feedback from EBP experts) to develop an international consensus statement of 68 core competencies that should be taught in EBP educational programs for clinicians. This consensus set of core competencies will contribute to harmonising the variations in EBP educational programs. These challenges were highlighted in **Chapter 3** and **4** and include the variation in the content, outcomes measures, and instruments used in EBP educational interventions. A major strength of this study is the contemporary and dynamic nature of this set of EBP core competencies. For example, competencies relevant to SDM and the interpretation of recommendations developed using the GRADE approach are not typically taught in EBP curricula, but are increasingly considered essential, and hence included in the set of core competencies.

Clinicians' evidence-based practice learning needs: the role of social media networks

The analysis reported in **Chapter 6** attempted to understand clinicians' use of social media networks to address clinical questions generated from patient care by characterising clinicans' needs (i.e. clinical questions asked) and use (i.e. answers to clinical questions) of research evidince. A key finding is that the majority of clinical questions asked were about the treatment and diagnosis of a handful number of clinical topics. Identifying the clinician's information/evidence needs (i.e. types and topics of most frequently asked clinical questions) was very useful in informing the development of the EBP educational intervention that was presented in **Chapter 7**. Evidence-based resources, such as systematic reviews and evidence-based guidelines, were found to be infrequently used to support answers to the asked clinical questions. This represents an opportunity for EBP champions to disseminate relevant and practical evidence-based information for clinicians at point of care.

Shared decision making focused on pre-appraised evidence: an opportunity for training busy clinicians in evidence-based practice

The findings from the before-after pilot study (reported in **Chapter 7**) indicate that a half-day EBP workshop with a focus on teaching SDM skills and the interpretation of pre-appraised research evidence is feasible and acceptable for busy clinicians. A small increase in clinicians' skills in SDM and communicating evidence with patients from before to after the workshop was observed.

The time, efforts, and skills involved in searching for research evidence and critically appraising it renders the traditional EBP process infeasible for many clinical decisions. This, along with the increased availability of trustworthy pre-appraised evidence resources that can be available at the point of care, led to calls to refocus EBP education approaches to the critical interpretation and application of the results that are presented in pre-appraised sources[4,5]. For instance, key skills that clinicians need are to be able to assess the trustworthiness of pre-appraised evidence, interpret the wording used in guidelines recommendations (e.g. strength of recommendations and quality of evidence), and communicate the options of trade-off of the benefits and harms to patients in a shared decision making process.

8.2 Strengths and limitations of this thesis

Each individual study in this thesis has key strengths and limitations which have been previously discussed in each corresponding chapter. A summary of the key strengths and limitations is presented in **Table 8.1**.

The broad and inclusive nature of data collection processes (e.g. systematic searching of published studies, purposive and snowballing participant sampling and recruitment) were repeatedly highlighted as strengths across individual studies. Consequently, a key strength of this thesis is providing a broad and comprehensive picture of the current state of evidence for the challenges and future directions in EBP education. Furthermore, the use of rigorous multiple study methodologies to address the thesis's main research questions (including a systematic review of literature, modified Delphi study, cross-sectional analysis, and interventional before-after study) and the use of standardised reporting guidelines to adequately report the findings of each study (e.g. PRISMA checklist, TIDieR checklist) help this thesis to make a valuable contribution to the current body of evidence in the field of EBP education.

A major limitation to the systematic review presented in **Chapter 3** and **4** is the risk that relevant articles might not be detected by using citation analysis as a search strategy. However, the accuracy rate of citation analysis has been found to be acceptable[6,7]. Another shortcoming to the analysis of GPs' clinical questions presented in **Chapter 6** is that the analysis was limited to questions posted in a single restricted Facebook group by GPs who thought to be active social media users, therefore, our findings may not be generalised to GPs who do not actively use social media or use other social media platform, or do not use social media at all. Finally, the findings observed in the before-after EBP study (presented in **Chapter 7**) are likely to be confounded by other factors (discussed in **Table 8.1**), which in turn might limit the generalisability of the findings.

Table 8.1. A summary of key strengths and limitations of the individual studies that are presented in this thesis.

	Strengths	Limitations
Study 1 (Reporting of Intervention)	▪ Inclusive eligibility criteria. ▪ The use of internationally recognised checklist (TIDieR checklist) to assess the quality of reporting of intervention details. ▪ Contacting study authors requesting missing information.	▪ The use of citation analysis as a search strategy, instead of the traditional search methods. ▪ Screening and data extraction were performed by one author.
Study 2 (EBP content and outcome measures)	▪ Inclusive eligibility criteria. ▪ Contacting study authors requesting missing information.	▪ The use of citation analysis as a search strategy, instead of the traditional search methods. ▪ Screening and data extraction were performed by one author. ▪ The assessment of the psychometrics properties of EBP instruments was limited by inadequate reporting of the results of psychometric testing.
Study 3 (EBP core competencies)	▪ The systematic review and Delphi survey approach to achieving international consensus. ▪ Delphi participants were selected to represent a diverse range of health professions and expertise.	▪ Delphi participants may not adequately represent the full spectrum of views held by individuals within a single profession.

Study 4 (Analysis of clinical questions)	▪ The use of a very active social media network – "GPs Down Under" with >5800 GP members who generate >50 posts per day. ▪ Three authors independently coded data from a random sample of 5% of posts.	▪ GPs' unpursued recognised clinical questions as well as their unrecognised questions (i.e. unknown unknowns) were not captured. ▪ Screening and coding of the posts were performed by one author. ▪ Analysis of questions posted to a single restricted Facebook group. No analysis of other social media platforms or groups. ▪ The validity of provided answers or the evidence used to support these answers was not verified. ▪ The motivations behind asking the questions (e.g. are these the most important questions or the most convenient for group thinking?) could not be identified. A qualitative analysis is needed to explore these issues.
Study 5 (Integrated SDM and EBP teaching approach)	▪ Measurement of observed skills rather than just self-reported knowledge. ▪ The use of previously developed validated outcome measures. ▪ Two raters independently rated the audio-recorded consultations. ▪ The resultant interprofessional mixture of participants.	▪ The use of a before-after single-arm study design. ▪ The small sample size. ▪ The lack of a follow-up period. ▪ Non-representative sample, as clinicians volunteered to participate in the study. ▪ The clinical scenarios used in the EBP workshop were GP-focussed and not all participants were GPs. ▪ The possible effect of learning due to the repeated encounter with a standardised patient consultation.

8.3 Implications, Recommendations, and Future Research

The key implications and recommendations arising from this thesis have been derived from issues raised in one or more of the studies in this thesis. These are discussed in detail below.

Recommendations based on the findings of this thesis to improve EBP education and close the potential evidence-practice gap

R1. The reporting of EBP educational interventions needs to be improved at the level of individual studies, systematic reviews, and curricular documents. The observed inadequate reporting of EBP educational interventions contributes to the waste in research and is a potential barrier to evidence synthesis and implementation.

In **Chapter 3**, it was shown that the majority of EBP educational studies do not adequately report the required essential information to allow for their implementation, replication, or even interpretation of this body of research evidence. Though neither unique to the EBP education field or to a specific study methodology, these findings were worse than other studies (e.g. Hoffmann et al found that complete descriptions of interventions can be obtained in 59% of included studies compared to 20% shown in **Chapter 3**)[1,8]. Incomplete reporting of research is a major problem that contributes to the overall waste in health research[9]. The *EQUATOR* network (Enhancing the QUAlity and Transparency Of health research, http://www.equator-network.org/) was established to improve the quality of reporting of health research. Several reporting guidelines have been developed and endorsed to help improve the reporting standards across fields and study designs, such as the CONSORT (Consolidated Standards of Reporting Trials) and TIDieR (Template for Intervention Description and Replication) statements. Although these efforts have resulted in a modest improvement in the quality of reporting of health research[10], the overall quality of reporting remains below an acceptable level. Further, most of these reporting guidelines might not be useful to guide the reporting of other elements that might affect the observed outcomes of these interventions (e.g. the dynamic between the teacher and the students during the teaching sessions).

The level of inadequate reporting of EBP educational intervention that was observed, even in the most recent studies, suggests that efforts to improve the reporting quality of EBP educational interventions are needed. Efforts involving study authors, journal editors, and reviewers are required. Authors of studies that report on the evaluation of EBP educational interventions should be encouraged by funders and journals to adhere to reporting checklists relevant to intervention details in general (i.e. TIDieR[11] checklist) and EBP education in particular (i.e. the recently developed GREET - the Guideline for Reporting Evidence-based practice Educational interventions and Teaching - checklist[12]). Journals should endorse the use of reporting guidelines, and more importantly, they should implement measures to ensure high adherence. For instance, journals should incorporate these reporting guidelines into their instruction to authors and reviewers, and explicitly indicate the requirement to adhere to these guidelines as a prerequisite for handling a manuscript. Adherence to these reporting guidelines will allow for standardised and detailed descriptions of all necessary details about the intervention and the study[13]. Efforts of improving the reporting of research interventions should be aligned with endorsing good standards in designing, conducting, and analysing research studies.

R2. Establish a repository of freely-available learning resources intended to help clinicians to teach and learn EBP.

This thesis has found that 'Intervention materials' was the most poorly reported item in EBP educational interventions, which was partially remediable by contacting study authors requesting for intervention materials. The availability and accessibility of intervention materials is an important prerequisite for widespread use by EBP educators and researchers. Therefore, the development of a repository or a library of freely-available learning resources is recommended to enhance the availability of materials relevant to EBP. In 2018, the teaching EBHC website (www.teachingebhc.org) was established to provide global sharing platform of materials for teaching EBP, with an emphasis on those that have reliable evidence of effectiveness. Findings from this thesis (**Chapter 6**), related to the development of EBP core competencies, were used to guide the inclusion and classification of EBP resources in the webiste[14]. The International Society of Evidence-Based Healthcare (ISEHC) has endorsed and hosted the EBHC teaching website. Such an initiative to collaborate globally on enhancing the accessibility of free-available high-quality EBP resources should be supported by the EBP community. EBP educators are encouraged to contribute their teaching materials (e.g. presentations and workbooks); tips; or resources relevant to EBP education to the EBHC teaching website. Barriers to sharing learning resources - including concerns regarding the quality of the resources; institutional copyrights; and patient's confidentiality - need to be addressed[15,16]. The development and the sustainability of an avenue for sharing freely-available learning resources may help to harmonise and ameliorate the quality of EBP education resources available for clinicians. In addition, this repository of freely-available EBP learning resources should be helpful to overcome the problem of access restrictions (e.g. paywall) and word count limits in journal articles.

R3. Develop a set of core outcome measures for EBP educational interventions that represents the minimum outcomes that should be consistently measured in all EBP educational studies.

This thesis (in **Chapter 4**) has provided evidence showing the inconsistency in the choice of outcome measures and the type of instruments (and the proportion for which there is some evidence of their validity) that have been used to evaluate EBP educational interventions in published articles. An understanding of the current state of the outcome measures and the validity and reliability of EBP instruments is one crucial step toward developing a set of core outcome measures (supported by valid and reliable instruments) for EBP education. Development of a core set of valid and reliable instruments to measure outcome domains is essential to reduce the heterogeneity and facilitate comparing and pooling the effect of EBP educational interventions across studies. This is a multistep process which would include: (i) identification of instruments that provide accurate, reliable, and timely evaluation of the EBP education; (i) mapping these instruments using CREATE framework (as described in **Chapter 2**), which proposed guidance for classifying EBP instruments by the assessment domains (e.g.

self-efficacy, knowledge, skills) and types (e.g. self-report, performance assessment) within the five EBP steps (**Figure 2.3**)[17]; (ii) evaluation of previously developed validated and reliable EBP instruments (e.g. the Fresno test, Berlin Questionnaire) across health disciplines, and translation of these tools into other languages using standardised methods; and (ii) developing and validating new instruments designed specifically to evaluate the identified gaps in EBP assessment.

R4. Integrate the set of EBP core competencies into EBP curricula for clinicians of any level of education and any discipline.

The core competencies (reported in **Chapter 5**) should provide EBP educators with building blocks that are suitable to inform the curricula of an introductory course in EBP for clinicians of any level of education and from any discipline. The development of a set of core competencies in EBP for clinicians is one of several needed steps for the implementation of competency-based EBP education. EBP educators and curriculum developers are encouraged to (i) evaluate the content of their current curriculum and map it to core competencies to allow for the identification of any gaps in the coverage of essential content; (ii) integrate these competencies into curriculum according to local learning needs, time availability, discipline, and the previous EBP experience of the learners; and (iii) develop clearly defined assessment framework that are mapped to the core competencies (see **Recommendation 3**). Other additional advanced competencies (e.g. in implementation science) can be also addressed, depending on the needs and desires of their learners. Educators are encouraged to teach these competencies in more than one setting using a number of different scenarios and/or articles. This thesis (in **Chapter 7**) has also provided an example of a teaching workshop, developed based on some of these competencies, which commenced with teaching shared decision making using an equivocal risk-benefit balance case scenario, followed by teaching how to interpret and communicate research evidence presented in pre-appraised resources to patients. However, the focus of this EBP workshop was on competencies relevant to specific type of evidence (i.e. intervention/treatment). Future teaching sessions addressing other competencies relevant to different types of evidence (e.g. diagnosis, prognosis) are needed.

Unanswered questions for future research

While the five recommendations presented have emerged from the research in this thesis, several unanswered questions were raised in the course of this work but were beyond the scope of this thesis.

Q1. What are the impacts of an evidence-based practice training which focuses on shared decision making and the use of pre-appraised evidence?

This thesis (in **Chapter 7**) has shown the feasibility of a contemporary approach to teaching EBP, which commences with providing clinicians with the skills to interpret pre-appraised evidence and apply its findings to patients using SDM. However, before implementation of this approach could be considered, a large well-conducted controlled trial is needed to examine its effectiveness on clinicians' skills in SDM and communicating research evidence and on their EBP behaviour in clinical practice. Future trials should consider the following suggestions: (i) **Interdisciplinary learning**: an interdisciplinary learning approach should be adopted to foster fruitful interdisciplinary discussions and collaborations, with possible impact on teamwork in clinical practice; (ii) **Clinical content**: various clinical scenarios and modules (i.e. with each module focusing on a clinical question type such as diagnosis or intervention) should be used; (iii) **Follow-up duration**: a longer follow-up period is recommended to measure change in clinicians' behaviour over a longer-term, and whether changes are sustained; and (iv) **Mode of delivery**: the effectiveness of different modes of delivery (e.g. online/blended vs. face-to-face) could be examined once initial effectiveness is established.

Once the effectiveness of this approach to EBP education has been established, implementation strategies using one of the knowledge translation conceptual frameworks (such as the most commonly used *Knowledge-to-Action* framework[18] – **Figure 8.1**) should be developed to effectively translate this research evidence into practice. The research in this thesis contributed to the *'knowledge creation'* phase through the extensive systematic review of EBP educational interventions (reported in **Chapter 3** and **4**) as well as the pilot study (**Chapter 7**). This could be followed by a series of iterative actions which include a detailed assessment of the likely barriers and facilitators, executing the implementation of the tailored intervention; monitoring knowledge use; outcomes evaluation; and aiming to sustain the knowledge use (**Figure 8.1**).

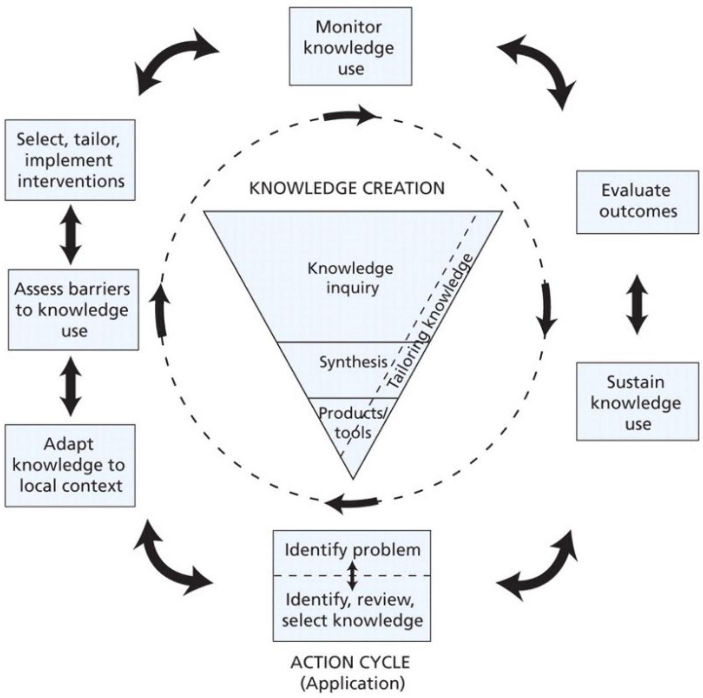


Figure 8.1. The knowledge to action framework.
This framework contains two main components: knowledge creation and action cycle. Knowledge creation is represented by the central funnel where knowledge is refined from knowledge inquiry (e.g. primary research), to knowledge synthesis (e.g. systematic review) and finally to knowledge tools (guidelines and evidence summaries). The action cycle describes the seven steps for knowledge translation starting from problem or knowledge gap identification; local adaptation of knowledge; barriers and facilitators evaluation; executing the knowledge translation; monitoring the knowledge use; outcomes evaluation; and ended with the sustainability of knowledge translation[19].

Q2. How can the impact of EBP education on clinicians' behaviour and patients' outcomes be better evaluated and measured?

As previously discussed in **Chapter 4** and **Recommendation 3**, there is a need to develop valid and reliable instruments to specifically evaluate the identified gaps in EBP assessment such as measuring the clinicians' use of EBP in practice and patients' outcomes. New instruments that balance the robustness with feasibility should be investigated and validated – these might include instruments such as objective structured clinical examinations[20], the use of standardised patients within the context of a performance-based examination[21], and the use of audio-recording in clinics[22]. Audio-recording of clinical consultations could not only allow retrospective assessment of clinical encounters, but can also increase the trust and openness of patient-clinician consultations and potentially improve the patient care[23]. Evaluating the impact of EBP education on patients' outcomes is challenging because (i) the observed effect may be confounded by many different unmeasurable factors that are related to the clinical context and (ii) the effect on patient outcomes may not be apparent for many months or years[24].

Q3. What is the quality of evidence underpinning health information that is distributed in professional social media networks? How this can be improved?

This research gap largely arose from the analysis of clinical questions that were posted in a large professional social media network (discussed in **Chapter 6),** in which it was found that evidence-based resources, such as systematic reviews, were infrequently used to support the validity of health information posted by GPs. However, the quality of the evidence underpinning the answers/health information provided was not verified. Future research could examine methods to enhance the dissemination of quality evidence-based health information/answers provided in professional social media networks. This might include investigating the effect of using infographics on evidence translation (e.g. the promotion of articles with infographics found to improve the dissemination of research findings among clinicians[25]), and the impact of evidence champions on the successful dissemination of evidence-based health information in social media networks (e.g. an organised social media strategy, involving evidence champions such as journal's editorial board, increased the level of engagement with content published in a peer-reviewed journal[26]).

8.4 Conclusions

This thesis has evaluated the quality of the current research evidence on EBP education, the clinicians' use and need for evidence, a consensus for an EBP curriculum, and explored potential solutions to improve the uptake of quality EBP education in practice. The findings of this thesis identified key gaps in the literature as well as contributed to shaping the growing evidence on EBP education. Through a systematic review, this thesis discovered that most studies which evaluated EBP educational interventions had inadequately reported intervention details, did not comprehensively teach all EBP steps, and did not use high-quality instruments to measure the outcomes. Using a rigorous multistage modified Delphi survey, research in this thesis led to the development of a consensus-based contemporary set of EBP core competencies for clinicians. Three research studies were collectively used to develop and test a contemporary EBP teaching workshop which had a focus on SDM and the use of pre-appraised evidence, and was found to be feasible and potentially effective in improving clinicians' skills in SDM and communicating research evidence.

Although many challenges and gaps still remain, collective efforts in the research conducted as part of this thesis offer important recommendations that may facilitate the delivery of quality EBP education for clinicians.

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About the candidate

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Education

Nov 2015 - Today **Doctor of Philosophy (PhD),** Centre for Research in Evidence Based Practice (CREBP), Faculty of Health Science and Medicine, Bond University, *Gold Coast, Australia.*

Project Thesis **Evidence-Based Practice Education: Bridging the gap between knowledge and practice**

Supervisors **Prof Paul Glasziou and Prof Tammy Hoffmann**

Sep 2013 - Oct 2015 **Master of Science (MSc) in Epidemiology,** Faculty of Medicine, Ludwig Maximilian University of Munich, *Munich, Germany.*
A two-year (120 ECTS) programme including two specialisations (clinical and genetic epidemiology), two internships (3 months each) and a master thesis (6 months).

Project Thesis **What gain is worth a daily pill? A systematic review of patient values and preferences for cardiovascular preventive medication**

Supervisors **Prof Paul Glasziou and Prof Jenny Doust**

Sep 2005 - July 2011 **Doctor in Medicine (MD),** Faculty of Medicine, AlQuds University, *Jerusalem, Palestine.*
one of the top three performing students, First class Honours, 85.9%

Sep 2004 - July 2005 **General Certificate of Secondary Education,** AlKarmel Secondary School, *Gaza, Palestine.*
One of the top five performing students all over the country, 98.9%

Experience

2015 - Now **Research Assistant,** *Centre for Research in Evidence Based Practice Services, Bond University, Gold Coast, Australia.*
(Casual appointment) assist in multiple systematic reviews and research projects

2015 - Now **Teaching Fellow,** *Faculty of Health Science and Medicine, Bond University, Gold Coast, Australia.*
(Casual appointment) Participate in teaching evidence-based practice and systematic reviews training workshops/courses for medical and allied health professionals; teaching different courses such as statistics for medical students, the Influence of Biology on Human Behaviour course; Australia's Health Issues and Priorities; and Global Health Issues

2016 - Now **Epidemiologist,** Epidemiology II Department, German Research Center for Health, Helmholtz Zentrum, Munich, Germany.
(DAAD Fellow) Work on a systematic review and meta-analysis investigating the effectiveness of educational interventions in reducing prehospital delay in patients with acute coronary syndrome.

2016-Now **Researcher,** *British Columbia Centre for Excellence in HIV/AIDS, Vancouver, Canada.*
(consultancy) Work from a distance on a research projects related to alcohol withdrawal and opioid abuse.

2015-Now Researcher, *Evidence Based Medicine Unit, Faculty of Medicine, Gaza, Palestine*.
(Volunteer) Work from a distance on various research projects to promote the evidence based practice among Palestinian clinicians including three systematic/scoping reviews about obesity, reproductive health, and diabetes mellitus in Palestine

2014-2015 Research Assistant, *School of Social and Community Medicine, University of Bristol, UK*.
(Volunteer) I led a project investigating reporting bias in medical research under the supervision of Prof Julian Higgins.

2013 - 2015 Research Assistant, Epidemiology II Department, German Research Center for Health, Helmholtz Zentrum, Munich, Germany.
(Part-time appointment) Work on multiple projects within the MEDEA (Munich Examination of Delay in Patients Experiencing Acute Myocardial Infarction), KORA (Cooperative Health Research in the Augsburg Region) studies.

2014 Teaching Assistant, *Epidemiology Department, Faculty of Medicine, Ludwig Maximilian University of Munich, Germany*.
(Casual appointment) Tutor a one-week intensive course of Clinical Epidemiology for postgraduate students under the supervision of Prof Albert Hofman.

2012-2013 Graduate Teaching Fellow, *Faculty of Medicine, Gaza, Palestine*.
(Full-time appointment) Tutoring clinical and research skills for final year medical students.

2012-2013 Junior Doctor, *Al-Shifa Hospital, Gaza, Palestine*.
(Part-time) Working in the surgical and emergency department at the largest hospital in Palestine - 300 beds. Responsibilities included undertaking patient consultations and physical examinations, performing surgical procedures.

2011-2012 Intern Doctor, *Al-Shifa Hospital, Gaza, Palestine*.
(Full-time appointment) Clinical rotations in Paediatrics, Obstetrics & Gynaecology, Emergency, Primary Care, Internal Medicine, and Surgery.

2010 Research Intern, *Cochrane Wounds Group, University of York, York, UK*.
(Volunteer) Work on a systematic review investigating the interventions for treating phosphorus burns.

2010 Elective Medical Student, *Paediatrics Department, NHS York Hospitals, York, UK*.
(Volunteer) A two-month elective rotation in the Paediatrics department at NHS York Hospital.

Awards and Prizes

2018 2018 The Australian and New Zealand Association for Health Professional Educators Post-Graduate Student Award in Health Professional Education for the best higher degree research project submitted to the Conference.

2018 DAAD Short Term Research Grant to conduct short term research visit to Helmholtz Zentrum Munich (values more than 10.000 AUD).

2018 Emerging Voices for Global Health Scholarship to participate in an intensive training program in Liverpool (values more than 6.000 AUD).

2016 2016 Australian Epidemiological Association (AEA) Student Conference Award for the best abstracts submitted to the AEA Annual Conference.

2015 Australian Government Research Training Program Scholarship to undertake a doctoral research qualification in Australia (values more than 100,000 AUD).

2013 DAAD Postgraduate Scholarship to undertake a postgraduate master qualification in Germany (values more than 60,000 AUD.

2013 **Best Oral Presentation** among postgraduate epidemiology students at EpiSlam, Ludwig Maximilian University.

2010 **Top Achiever and Excellence Award** in the Faculty of Medicine, Palestine.

2009 **International Student Prize** Trauma Conference 2009, Imperial College London, UK.

2005 **Presidential undergraduate scholarship and Distinction Award** to undertake an undergraduate degree in Medicine.

Workshops and Conferences

2018 **Evidence Live 2018** Oxford University, Oxford, UK.

2016 **Grants, Tenders, and Proposal Writing workshop** The GrantEd Group, Bond University, Australia.

2016 **EQUATOR Publication School** Centre for Research in Evidence Based Practice (CREBP), Bond University, Australia.

2016 **Foundations of University Learning and Teaching** Learning and Teaching Office, Bond University, Australia.

2017 **GRADE-CERQual: An introduction for qualitative evidence synthesis** Cochrane, Learning and Support, Webinar

2016 **RoB 2.0: A revised tool to assess risk of bias in randomized trials** Cochrane, Learning and Support, Webinar

2016 **Extracting data from figures using software** Cochrane, Learning and Support, Webinar

2016 **Evidence Based Practice Workshop** Centre for Research in Evidence Based Practice (CREBP), Bond University, Australia.

2016 **Systematic Review Workshop** Centre for Research in Evidence Based Practice (CREBP), Bond University, Australia.

2014 **Elsevier Publishing Campus hosted by The Cell and The Lancet** Ludwig Maximilian University of Munich, Munich, Germany.

2014 **Project Management Fundamentals for Graduate Students** German Research Center for Health, Helmholtz Zentrum, Munich, Germany.

2014 **How to publish in a peer-reviewed journals** by Dr. Gunther Tress in the German Research Center for Health, Helmholtz Zentrum, Munich, Germany.

2014 **Global Mental Health Symposium - Mental Health in developing countries** LMU Center for International Health, Munich, Germany.

2014 **Non-Communicable Diseases in Developing Countries** LMU Center for International Health, Munich, Germany.

2012 **Training the Trainers: Developing Teaching Skills** 2-day workshop by Dr Ezzedin Gouta, Royal College of Paediatrics and Child Health (RCPCH).

2010 **Statistics for Clinical Trials** York Trial Unit, University of York, UK.

2010 **Design and Conduct of Clinical Trials** York Trial Unit, University of York, UK.

2010 **Developing a Protocol for a Review** Cochrane Wounds Group, University of York, UK.

2010 **Analysis of Systematic Review** Cochrane Wounds Group, University of York, UK.

Presentations

2018 **Core Competencies in Evidence Based Practice For Health Professionals** Oral Presentation at the Australian and New Zealand Association for Health Professional Educators Conference, Hobart, Tasmania, Australia.

2017 **Smoking and respiratory conditions** Guest lecturer in Australia Health Issues and Priorities Interdisciplinary course, Faculty of Health Science and Medicine, Bond University, Gold Coast, Australia.

2016 **Indirect evidence of reporting bias in medical research: a cross-sectional survey** Oral Presentation at the 23rd Australian Epidemiological Association Annual Conference, Australian National University, Canberra, Australia.

2016 **The quality of reports of medical and public health research from Palestinian institutions: a survey** Oral Presentation at 7th Lancet Palestinian Health Alliance, Amman, Jordan.

2016 **Indirect evidence of reporting bias in medical research: a cross-sectional survey** Oral Presentation at Evidence Live 2016, University of Oxford, Oxford, UK.

2016 **Patient values and preferences for cardiovascular preventive medication: a systematic review** Oral Presentation at the Gold Coast Health and Medical Research Conference, Gold Coast, Australia.

2015 **What gain is worth a daily pill: a systematic review** Oral Presentation at Preventing Overdiagnosis Conference 2015, National Institute of Health (NIH), Bethesda, US.

2015 **White Phosphorus Burns: a Systematic Review** Oral Presentation at Oxford-Palestinian Medical Week, Green Templeton College, Oxford University, Oxford, UK.

2015 **Awareness, attitude and knowledge of Palestinian doctors about Evidence-based Medicine** Oral Presentation at the fifth Lancet Palestinian Health Alliance, American University Beirut (AUB), Beirut, Lebanon.

2015 **Preparing and updating a systematic reviews: Methodology and Process** Oral Presentation at the fourth Lancet Palestinian Health Alliance, Amman, Jordan.

2009 **White phosphorus burn, case report** Poster Presentation at Imperial College London, UK.

Publications

Vernooij RWM, Lytvyn L, Pardo-Hernandez H, **Albarqouni L**, Canelo-Aybar C, Campbell K et al. **Values and preferences of men for undergoing prostate-specific antigen screening for prostate cancer: a systematic review**; BMJ Open. 2018; 8(9):e025470

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Castle JC, Chalmers I, Atkinson P, Badenoch D, Oxman AD, Austvoll-Dahlgren A et al. **Establishing a library of resources to help people understand key concepts in assessing treatment claims-The "Critical thinking and Appraisal Resource Library"(CARL).** ; PLoS ONE. 2017;12(7).

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Albarqouni L, Skaik SI, Nafiz R Abu Shaban RAS, Barqouni N. **White phosphorus burn.** ; Lancet. 2010; 376(9734):68.

Technical skills

Basic	Microsoft Word, Excel, PowerPoint, Outlook, Access
Statistical	STATA, R, SAS, SPSS, RevMan, Comprehensive Meta-Analysis
Miscellaneous	LaTeX, Prezi, Endnote, Covidence, GRADEpro

Languages

- **Arabic** (First language)
- **English** (Fluent: overall IELTS score 8)
- **German** (Intermediate: CEFR B2 level certificate, Goethe Institute)