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Introduction

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Half of what we learn in medical school is wrong.
We just don't know which half.

This statement is often heard by freshmen as they are ushered into medical school[1], but it probably rings true for students in nursing, dentistry, midwifery, physical therapy and other allied medical professions as well. A lot of truth dwells in these words. Just a few years ago, we thought that enlarged tonsils had to be removed, pregnant mothers had to be shaved before delivery and vitamin C enhanced immunity to respiratory tract infections. These were non-debatable bits of 'knowledge' then. Today, they are nothing more than sombre testimony to the fallibility of the human mind. Our problem is not healthcare education *per se*. Our problem is progress. Science evolves so fast that what we know now will quickly be outdated if we don't keep up with the literature.

If there was a problem with education in medicine and its allied professions in the last century, it was that professionals

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were not taught how to keep up with science. We were certainly told that we had to keep up-to-date, but we didn't know how to do this efficiently . . . until 1991. In that year, Dr Gordon Guyatt of McMaster University Medical College in Ontario, Canada, described what he believed were important improvements in the way medicine was taught in his university:

> Clinicians were formerly taught to look to authority (whether a textbook, an expert lecturer, or a local senior physician) to resolve issues of patient management. Evidence-based medicine uses additional strategies, including quickly tracking down publications of studies that are directly relevant to the clinical problem, critically appraising these studies, and applying the results of the best studies to the clinical problem at hand[2].

This is the first use of the term evidence-based medicine (EBM) in published literature. While the emphasis in this passage is on decision-making, the key process has to do with keeping up-to-date with the literature. The faculty of McMaster thought they were on to something exciting[2] – and they were! Within the next few years, the concept spread like fire, becoming one of the most widely-used phrases in the medical literature (see Figure 1.1). EBM was introduced into the curricula of healthcare professionals, first in medicine and later in other fields[3]. Seminars and workshops were conducted across the globe, involving thousands of practitioners from various health care disciplines.

The popularity of EBM is easy to understand. For many the proposed 'rules of evidence' were simple and easy to understand. These rules demystified scientific research, turning it into something busy practitioners could understand, challenge and keep up with. A few 'philosophers' have debated whether EBM deserves the popularity it has gained[4, 5], but the debate has been confusing rather than helpful, fuelled by misconceptions and hurt rather than meaningful differences in opinion. An example of just how confusing the debate has been is as follows:

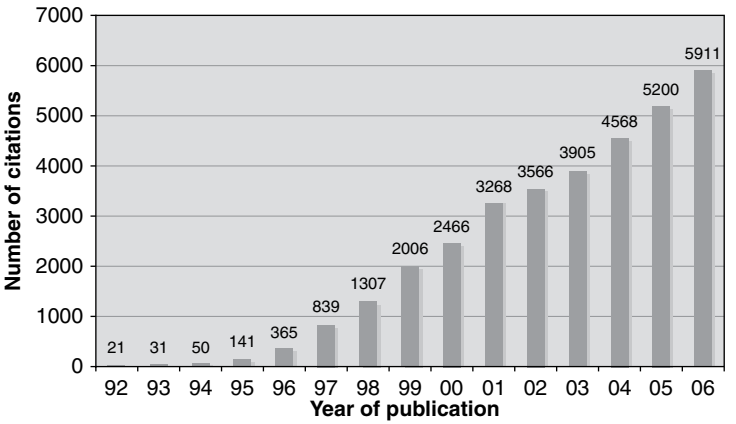

Figure 1.1 MEDLINE citations containing the phrase 'evidence-based' in the title or abstract

> The authors reframe the evidence-based medicine debate by pointing out an underappreciated epistemological deficiency: evidence-based medicine as currently conceptualized cannot accommodate concepts that resist quantitative analysis and therefore cannot logically differentiate human beings from complex machines. The authors use Michael Polanyi's philosophy of tacit knowing (which refers to the taken-for-granted knowledge at the periphery of attention that allows persons to understand the world and discern meaning in it) as a starting point for rectifying this deficiency and for working towards an improved, person-centred epistemology of medical practice[6].

We are sure the intellectual ruminations would be fascinating – if only we could understand them. The debate, however, is for philosophers and not for busy healthcare practitioners. For now, all we want to say is this: if you're overwhelmed by the literature in healthcare, then it doesn't matter if you're a physician, dentist, nurse, midwife or therapist, EBM is for you!

1.1 The definition of EBM

Choosing an acceptable definition of EBM is difficult since there are so many definitions available[7]. This is partly because EBM has evolved so much since 1992, and partly because various healthcare professions have modified its definition to suit particular fields. Thus, there are definitions for evidence-based surgery[8], evidence-based nursing[9], evidence-based pediatrics[10], evidence-based psychiatry[11], evidence-based healthcare[12] and even evidence-based alternative medicine[13], to state a few. Our search for the best definition led to the conclusion that there are too many definitions, so what the heck, here's our own:

> *EBM is a systematic approach to the acquisition, appraisal and application of research evidence to guide healthcare decisions.*

Below is our first *tackle box* on understanding the definition of EBM (Tackle Box 1.1). As with other tackle boxes in this book, please spend as much (or as little) time on it as you need to, before proceeding with the text. In the following sections of this chapter, we discuss the three essential skills necessary for the practice of EBM.

1.2 The three skills of EBM

Our proposed definition of EBM requires that healthcare providers demonstrate three major skills to efficiently process the literature. Each skill has several components which are illustrated in Figure 1.2 and discussed in the following sections.

Skill number 1: Acquiring the evidence

The literature on healthcare can be acquired in two modes: by active searching or by browsing[14]. In the active mode, acquisition

Tackle Box 1.1 Components of the definition of evidence-based medicine

Instructions: This tackle box summarizes our definition of EBM and explains various components of the definition. Read column 1 in its entirety before reading the details row by row.

Components of the definition	Explanation of the component
EBM is a systematic approach to the . . .	EBM allows practitioners to assess new (as well as old) technology in an efficient and logical manner, without being intimidated or overwhelmed. This approach requires three sets of skills:
. . . acquisition,	the skill to conduct an efficient literature search and secure a publication in response to information needs;
. . . appraisal	the skill to criticize medical literature and decide if results are credible or not; and
. . . and application of research evidence	the skill to utilize the information in the care of specific persons or populations.
. . . to guide decisions	The evidence itself is only one component of the decisions that need to be made. Other components are tacit knowledge, professional expertise and patients' preferences.
. . . in healthcare.	The skills in EBM have found application in medicine, surgery, physical therapy, nursing, dentistry, primary care, emergency medicine and many other fields including public health.

Note: What have we omitted from other definitions and descriptions?

1. The role of clinical expertise[14]: while this is an important aspect of healthcare decisions, it is a set of skills distinct from EBM, developed and taught in other areas of training of a healthcare professional.
2. The role of patient preferences[14]: again, we feel this is an important element of medical decisions but, like clinical expertise, skills for eliciting patient preferences are distinct from EBM, and are developed and taught in other areas of training.
3. EBM is a philosophy, a movement, or even a scientific revolution[15]. Let's leave the debate to philosophers. This is a book for healthcare practitioners. We say it again - if you are drowning in the medical literature, then EBM is for you!

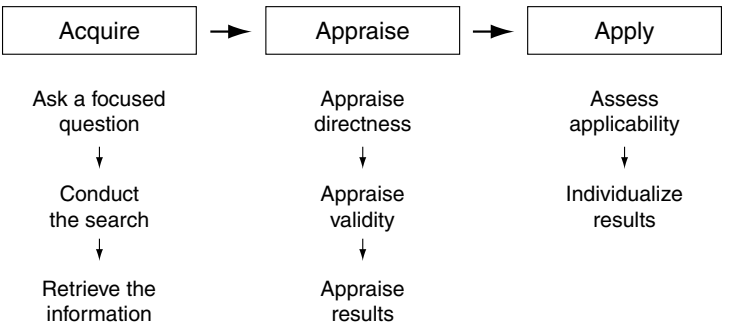

Figure 1.2 The three skills of EBM: how to acquire, appraise and apply the evidence

of evidence is driven by a problem we encounter during the actual care of a specific patient. This triggers a process of search and retrieval for a specific article. In contrast, data acquisition happens by accident in the browse mode, e.g. while leafing through articles in a journal, listening to a lecture series or surfing the net. Most EBM advocates prefer the active mode because the evidence is used almost immediately on a patient. Any lessons learned in this process are more likely to be retained.

Active searches entail three important skills:

(a) how to ask focused clinical questions;

(b) how to search the literature for answers; and

(c) how to retrieve the necessary references.

How to ask focused clinical questions

The most common types of questions asked in clinical practice pertain to the effectiveness of treatment, accuracy of diagnostic tests, prognosis of certain conditions or harmful effects of certain exposures. Whether they are on therapy (Chapter 2), diagnosis

(Chapter 3), harm (Chapter 4) or prognosis (Chapter 5), focused clinical questions have three components: the population of interest (P), the exposure in question (E) and the outcome expected (O). These are explained in detail in their respective chapters. Tackle Box 1.2 includes examples of how to phrase these questions.

Generating focused clinical questions during day-to-day practice is very important because it is during encounters with patients that we come face to face with much of our information needs. Because health technology evolves so rapidly, it is safe to assume that healthcare professionals should be asking these questions all their lives. In an actual healthcare service, this will entail constant vigilance. It will also entail a measure of humility. Instead of posing as professors who know everything, practitioners should role-model curiosity and information-seeking behaviour in their daily practice.

How to search the medical literature

One advantage of phrasing clinical questions as populations (P), exposures (E) and outcomes (O) is that these variables are our gateways to the medical literature. Medical literature databases (such as MEDLINE) usually classify articles according to P, E and O. Looking for articles in these databases becomes a simple matter of using these keywords as filters.

In recent years, managers of these medical literature databases have begun to classify articles according to study design. This is an exciting development because now we can specify not just the topic, but the study design as well.

More details on systematic search strategies are described in the final chapter of this book. It is sufficient to say at this point that the ability to conduct efficient searches is a new skill expected of all healthcare providers. This skill is now a specific expectation in undergraduate and postgraduate curricula for healthcare professionals.

Tackle Box 1.2 Asking a focused clinical question

Instructions: A well-stated question makes it clear whether one is dealing with a query on therapy, diagnosis, harm or prognosis. If the type of question is not clear, then something is wrong. Go through this tackle box to learn the syntax then rehearse the skill while drawing from your own clinical experience.

Type of question	Syntax	Sample question
Therapy	Among P (patients with a certain disease), how effective is E (a certain treatment) in preventing O (an adverse outcome)?	Among children with HIV (P), how effective is isoniazid prophylaxis (E) in preventing tuberculosis (O)?
Diagnosis	Among P (patients with a certain condition), how accurate is E (a certain test), in diagnosing O (a disease)?	Among patients with acute chest pain (P), how accurate is an electrocardiogram (E) in diagnosing acute myocardial infarction (O)?
Harm	Among P (a certain group of patients), how much does E (a potentially harmful exposure), contribute to the causation of O (a certain disease)?	Among healthy males (P), how much does smoking (E) contribute to the causation of lung cancer (O)?
Prognosis	Among P (patients with a certain disease), by how much does E (a prognostic factor), increase the risk of O (a certain complication)? or Among patients with P, how big is the risk of O?	Among patients with prostatic cancer (P), by how much does lumbar metastasis (E) increase 5-year mortality (O)? or Among patients with stage IV breast cancer (P), what is the risk of mortality in the next 5 years (O)?

Note: P = the population of interest (usually characterized by a disease or condition); E = the exposure being evaluated (a treatment, test, harmful exposure or a prognostic factor); O = the outcome expected (a disease, complication or some measure of health). **In a single study, several Ps, Es and Os may be compared at the same time.**

Exercise: Look back to a patient you took care of in the previous week. Think of four focused questions that you could have asked while caring for that patient, and state them in terms of P, E and O.

How to retrieve articles

In most developed countries, once an article has been identified through a systematic search it can almost always be retrieved electronically at the touch of a key. Unfortunately, there are

great inequities in access to health information. Libraries in low to middle income countries (LMICs) are generally small and under-resourced. For this reason, journal retrieval can become long-drawn, tedious and frustrating. Methods of tackling this problem include the following:

1. Access free articles online. Many journals such as the Journal of the American Medical Association (JAMA) and Lancet provide free access six to twelve months after publication. Others such as BioMed Central (BMC) are entirely free for the developing world. Freemedicaljournals.com lists journals that currently provide open access. PubMed also highlights such journals. The World Health Organization through the Health InterNetwork Access to Research Initiative (HINARI) provides free online access to major journals to many developing countries.
2. Seek help from multinational companies which have access to extensive library collections (this will be better for your health than seeking free meals).
3. Write to the authors of the publication and request a copy of their article. E-mail addresses are usually listed in the article itself, and authors are often happy to learn of interest in their papers.
4. Keep a list of friends in developed countries, especially those with access to university libraries. Make sure to rotate requests for journals so that they all remain your friends.

If all else fails, you can always pay for online access to an article. The more often you try to retrieve articles, the easier it becomes. Hopefully, one day, someone will address this problem of inequitable access to healthcare information.

Skill number 2: Appraising the evidence

Once an article has been obtained, three aspects of a study need detailed appraisal: directness, validity and results. These are described briefly below, and are discussed in greater detail in Chapters 2–6.

Appraising directness

Directness refers to how well the PEO in the article corresponds to the PEO that you ask. Because medical knowledge is limited, the answers provided in the literature are often similar but not identical. Sometimes the difference is trivial and can be neglected. Other times, however, the differences are important and worrisome.

Appraising validity

Validity refers to how close we think study results are to the truth. As can be seen in later chapters, there are numerous ways in which studies may be flawed. These flaws can lead to biases, meaning they can lead to over- or under-estimates of the things we want to measure such as effectiveness of a treatment, accuracy of a test or causation or prognosis of disease. The higher the number of flaws, the greater is the expectation of bias.

Unfortunately, it is impossible to simply classify evidence as valid or invalid based on study design. The difference between a perfectly valid and a totally invalid study is a huge grey area of intermediate validity. This has led to the concept of a 'hierarchy of evidence', where study designs are ranked according to validity rather than categorized as valid or invalid. The goal of EBM is to identify the best evidence in this hierarchy for each focused clinical question. More will be learnt about evaluating the validity of specific studies in Chapters 2–6.

Appraising the results

We use the term 'results' to refer to numeric expressions of effectiveness, accuracy, causal relationships and prognosis. Examples include the relative risk reduction, number needed to treat, likelihood ratios, odds ratios and hazards ratios. Understanding these numeric expressions can be problematic, especially for the numero-phobic. However, as will be seen, time spent understanding these concepts will eventually be gratified by improvements in the quality of care rendered. We have exerted a lot of effort trying to simplify these concepts in this book.

Skill number 3: Applying the evidence

After acquiring the evidence and appraising directness, validity and results, the last step in processing the evidence is applying it to a particular clinical situation. Two tasks are required: assessment of applicability and individualization of results.

Assessing applicability

Applicability refers to the extent to which conclusions of a study can be expected to hold true for a particular patient. It is similar to directness, but not exactly the same. Directness compares the clinical PEO to the research PEO (in a very general sense). Clinicians can then decide if an article is worth reading or not. Applicability, on the other hand, takes a closer look at specific issues such as biologic and socioeconomic differences between the study population and the patients we see. Clinicians reading articles in scientific journals intuitively ask: will this technology work for my patients? While the hesitation is sometimes well founded, it may actually be unnecessary in some cases. In Chapters 2–6, we share ways of thinking about applicability that have helped us

strike a balance between hasty application and excessive caution in the interpretation of results.

Individualizing the results

Studies are concerned with average effects of health technology on large groups of people. As healthcare providers, however, we deal with individual patients whose responses may differ from the average. The estimation of the effect in an individual is therefore an important process. We refer to this process as 'individualization of results'. Individualization is both a science and an art. The science deals with estimation of the magnitude of the effect on a particular individual. This involves some grappling with numbers. The art refers to sharing decisions with patients, laying the cards on the table and using their own values and preferences to assess the trade-offs between benefit, harm and cost.

1.3 Summary

Evidence-based medicine is a systematic approach to the acquisition, appraisal and application of research evidence to guide healthcare decisions. The key skills in EBM help us keep up-to-date with the literature. Acquisition of evidence involves skills in asking focused clinical questions, searching for the evidence and retrieving articles. Appraisal of evidence involves skills in the critical assessment of directness, validity and results. Finally, application of evidence involves skills in the assessment of applicability and individualization of results. Acquisition skills are detailed in Chapter 7 (Literature searches), while appraisal and application skills are discussed more extensively in Chapters 2–6.

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Good! You acquired the article! Now you need to appraise and apply.