Evidence-Based and Personalized Medicine. It's [AND] not [OR]

Sahar Mokhles, PhD, Johanna JM Takkenberg, MD, PhD, and Tom Treasure, MD, MS

Department of Cardio-Thoracic Surgery, Erasmus University Medical Center, Rotterdam, The Netherlands; and Clinical Operational Research Unit, University College London, London, United Kingdom

Good clinical practice is an amalgamation of personalized medicine with evidence-based medicine in the best interests of patient. Hence, our title uses Boolean operators to indicate that it is [AND] not [OR]. This is the syntax of formal searching for systematic reviews, ensuring that all the evidence is found. Comprehensive evidence-based guidance can thus be formulated. Many residents and fellows around the world, and their chiefs, are now exposed to consensus documents, white papers, levels of appropriateness, and guidelines and are in many jurisdictions expected to comply with them. However, they are the summation of many forms of evidence, each of which has its place, and we consider them in turn in this article.

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An aptitude for surgery has two components: manual ability and mind-set. Surgery demands technical skill; that is, an innate ability honed by practice and attention to detail. The surgical mind-set has admirable components: decisiveness, self-reliance, the ability to keep going in adversity, clarity of purpose, optimism. However, it is that very same mind-set that makes, for some, the trappings of evidence-based medicine (EBM) hard to bear. We hope to make it better understood in this article. The pyramid of evidence was introduced in the early 1990s as a new paradigm for improving patient care. Running through this article is the distinction in EBM between efficacy (does it work under ideal circumstances?) and effectiveness (does it benefit the patient in daily clinical practice?). The words are interchangeable in most English usage, but in EBM a simple example might be that in an anemic patient a blood transfusion can be relied on to raise the hemoglobin (it works, it has efficacy) but in moderate chronic anemia it would not generally be the most clinically effective line of treatment. Finally, we touch on efficiency (does it contribute to more efficient use of resources?), a growing determinant in health care expenditure.

There are three components to any clinical encounter.

1. The patient's values and expectations. These vary between cultures and throughout history. Faced with illness or injury, all sentient beings would prefer to remain alive and to avoid suffering. The treatment may heighten as well as reduce fears.
2. The doctor's skills and experience. These also vary with place and time, but modern civilizations have come to rely on the attention of physicians, but only relatively recently has medicine made a large impact on disease [1].
3. Best available evidence. Even more recently medical practice has comes under close scrutiny, and evidence is expected to inform decisions.

These three components are illustrated by the three-legged milking stool analogy (Fig 1). A three-legged stool will sit on even the roughest floor. You need to have all three legs for it to work, but they can vary in length and breadth and still give support. The analogy is attributed to the late David Sackett (1934–2015) who wrote:

> Evidence based medicine is not "cookbook" medicine. Because it requires a bottom up approach that integrates the best external evidence with individual clinical expertise and patients' choice, it cannot result in slavish, cookbook approaches to individual patient care. External clinical evidence can inform, but can never replace, individual clinical expertise, and it is this expertise that decides whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision [2].

The Pyramid of Evidence Versus the Best Available Evidence

The EBM movement introduced doctors to the pyramid of evidence which ranked the value of evidence from highest to lowest (Fig 2). In present day surgical practice this ranking may be used in the levels of evidence for clinical practice guidelines [3], but it is a subject of debate and change. Although helpful in categorizing types of studies, it has become clear that it is too simplistic to rank evidence by methodologic sophistication. There are times when accurate observation is most or all that we need [4]. Furthermore, it is not what happens in practice, as seen in Figure 3 derived from an analysis of the forms of evidence used in more than 250 articles in the 50th Anniversary Volume 100 of *The Annals of Thoracic Surgery*.

Address correspondence to Dr Treasure, CORU (UCL), 4 Taviton St, London WC1H 0BT, United Kingdom; email: tom.treasure@gmail.com.

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Abbreviations and Acronyms

CONSORT = Consolidated Standards of Reporting Trials
EBM = evidence-based medicine
GRADE = Grading of Recommendations Assessment, Development and Evaluation
IRLM = International Registry of Lung Metastases
MOOSE = Meta-analysis of Observational Studies in Epidemiology
RCT = randomized controlled trial
PICO = P = patients, population, or participants, I = intervention, C = control or comparator, O = outcome
PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses

We ground this article in the reality of cardiothoracic surgery teaching and training, starting with the simpler methods and progressing to those of increasing complexity. We want to convey the message that more complex methods are not always better. Less sophisticated methods have often served as evidence enough, but they should be tested for their appropriateness as evidence for clinical practice.

The practice of EBM involves five essentials steps (five A's) [5]: (1) ask: formulate the question; (2) acquire: search for answers by acquiring the evidence; (3) appraise: evaluate the evidence for quality, relevance, and clinical significance; (4) apply: apply the results; and (5) assess: assess the outcome.

These steps are developed to overcome automatic decision making and to deliver optimal patient care. However, there are a number of possible features of a research method that would contribute unbiased and more trustworthy evidence.

- Was the question prespecified?
- Was the outcome clearly defined from the outset?
- Was there was a protocol?
- Was there independent allocation?
- Was a formal comparison made?
- Was there was a power calculation?

Not all of the features are achievable and not all are essential, but absence of one of these criteria may lead to a weakness in the conclusion and hence in the evidence. In surgery it is difficult to satisfy all of the features of research method, but the fewer that are satisfied, the less reliable is the conclusion. Many studies that are trusted as guiding practice will pass only some of them.

In this article, for each form of evidence, first, we define the method and set out its essential features and virtues. Second, we illustrate the method in practice with one or more examples. We accentuate the positive by choosing examples that have provided evidence for practice.

Fig 1. The three-legged stool of which best available evidence is just one leg.

Finally, for each example, we comment on whether we think the method worked well (and that involves our judgments and opinions) and its limitations.

Case Reports

Humans have evolved as a successful species by observation and experimentation with the world around us. Having discovered which berries are nourishing and which are poisonous, how to hunt and kill an animal, how to catch a fish, how to make a controlled fire and to cook with it, man's instinct is to stick with what he knows works. In medicine we love case reports as can readily be gathered from the tally of published items in *The Annals of Thoracic Surgery* volume 100 (Fig 3).

A case report is an original and personal experience of the authors. Writing of a single clinical case has been the way for young surgeons to start their publishing career; often that is also where it stops. However, the clinical case report, if we are to judge by publications in *The Annals of Thoracic Surgery*, is as popular as ever. Cases are often used to start of teaching rounds or for student presentations. For teaching cases they are not chosen to be unusual; they should be representative of what is to be taught. Then the case is an exemplar or a parable. In contrast, cases for publication are rarities or even cautionary tales: "We'll never do this again!" It was interesting that as extrapleural pneumonectomy for