The value of evidence-based medicine to consultant physicians

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INTRODUCTION

Evidence-based medicine (EBM) represents a major, but still untested, attempt to optimise clinical decision-making and patient care.[1] However, EBM generates varied reactions, ranging from scepticism[2] to outright dismissal.[3] As a result, many physicians remain uncertain as to the real value of EBM to their everyday practice.[4] Rather than focus on how the paradigm of EBM relates to the health care system as a whole,[5,6] this article offers a rationale for EBM to the practising physician and an overview of its pragmatic application to everyday clinical decision-making.

WHAT IS EBM?

EBM has been defined as the 'conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients'.[7] Evidence-based practice requires integration of physicians' clinical expertise and patients' values with the best available, relevant evidence in formulating mutually agreed plans of management. The essential steps of EBM are as follows:[8] 1) formulating focused potentially answerable clinical questions from patient problems; 2) searching the literature for relevant clinical evidence; 3) appraising that evidence for validity and usefulness to patient and practice; 4) implementing useful evidence in everyday practice; and 5) evaluating practice using evidence-based standards.

WHY IS EBM NECESSARY?

Physicians are entitled to ask why the practice of EBM is better than traditional forms of care. Below we discuss some potential advantages of adopting a more explicit EMB-style of practice.

Information Management

Medical knowledge grows exponentially. Currently, Medline has approximately 11 million references from 4000 journals, with about 400,000 new entries added each year.[9] To keep abreast, physicians would need to read about 20 clinical articles every day of the year – an impossible task given limits on precious time.[10] Furthermore, observational studies of physicians performing actual clinical work reveal that while as many as one to four questions are generated per patient, up to 70% are not pursued because of lack of time.[11] For the remainder, answers are obtained from textbooks which are frequently out of date, from colleagues whose opinions may not be factually correct, or from other sources, such as pharmaceutical representatives whose advice may be biased.[12]

Practising physicians are hard pressed to conduct formal literature searches, particularly if results rarely result in new or changed clinical

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decisions.[13] This is not surprising given that fewer than one article per issue of the six most widely read medical journals rates as being both clinically important and trustworthy when subjected to critical appraisal.[14] Unless trained in methods for accessing and appraising information quickly, quality of care provided by physicians may be compromised. EBM offers methods for dealing efficiently with information overload.

Variations in Practice

Marked variations in the practice of internal medicine exist throughout different parts of Australia. A recent analysis of age/sex standardised rates of use of coronary angiography, coronary revascularisation and colonoscopy, over a two year period, in statistical local areas in Victoria showed seven to tenfold variation.[15] These large variations could not be attributed to clinical or demographic differences. Shifting to a more evidence-based style of practice, with its emphasis on appropriateness of interventions, would narrow these variations.

Cost Containment and Appropriate Utilisation

Over the seven years up to 1997, combined national expenditure on health has increased in real terms by 28%, from $29 to $37 billion in 1989-90 dollars.[16] Studies suggest that not all of this huge expenditure equates with appropriate use of resources.[17] Cost containment and resource utilisation appropriate to clinical need are now central themes of healthcare reform. In forums such as high-cost drug committees and service utilisation review groups, physicians are being asked to present evidence of efficacy, cost-effectiveness and appropriateness of use when arguing the case for more expenditure on existing or new forms of care. This task can be assisted by conducting evidence-based analyses of benefit and cost.

Faulty Heuristics

Physicians frequently use heuristics (or 'rules of thumb') to guide clinical decision-making.[18] However, heuristical decisions, which are based on personal experience and 'received wisdom', do not always concord with published evidence.[19] For example, in relation to diagnostic tests, likelihood of disease both prior to and following results of such tests can be incorrectly estimated, as can the predictive value of the tests themselves.[20]

In relation to treatment, anecdotal experience of rare, undesirable clinical events may discourage the prescribing of certain therapies in many other patients who would stand to gain substantial benefit.[21] Consider the case of two types of patient, both with recent myocardial infarction, for whom ß-blocker therapy, which is known to reduce post-infarct mortality, is being considered. The dicta that ß-blockers should be avoided in diabetic patients (because of risk of increasing hypoglycaemia unawareness) and in those with, or at risk of, depression (because of the potential to precipitate severe depression) are at odds with published studies in which such effects have not been observed.[22,23]

Prescribing habits are also known to be influenced by the ways in which the reputed benefits of therapies are communicated to physicians in 'simple message', image-linked heuristical formats as part of pharmaceutical marketing campaigns (so-called framing effects).[24] EBM challenges physicians to acquire a working knowledge of epidemiological concepts which helps expose and mitigate the bias inherent in such heuristics.

Quality and Outcomes of Care

Recent reports highlight the prevalence and costs of avoidable clinical error and care-related adverse patient events within our major teaching hospitals.[25,26] Faulty decision-making is an important contributory factor and includes the failure to synthesise or correctly act upon available information, or to follow validated clinical rules or protocols.[27] The implementation of evidence-based decision support systems would help minimise this burden of error.

In addition, the increasing awareness of potential harm, particularly in older persons, has prompted more rigorous evaluation of the effects of care on functional status and quality of life.[28] Outcome evaluation, risk-benefit analysis, and active participation of informed patients in shared decision-making are now firmly on the reform agenda.[29] Applying the methods of EBM can assist physicians in advancing such initiatives.

Gaps Between Evidence and Clinical Practice

Although some important research findings are adopted into routine practice quickly,[30] others show considerable delay.[31] Even when experts review evidence on particular topics, biased recommendations can result if subjective (or 'narrative') as opposed to explicit, evidence-based methods are employed.[32]

Levels of Evidence

Not all evidence of treatment efficacy is equal in terms of validity. Results of randomised trials

TABLE 1
Levels of Evidence

I	Evidence obtained from a systematic review of all relevant randomised controlled trials
II	Evidence obtained from at least one properly designed randomised controlled trial
III-1	Evidence obtained from well-designed pseudo-randomised controlled trials (alternate allocation or some other method)
III-2	Evidence obtained from comparative studies with concurrent controls and allocation not randomised (cohort studies), case-control studies, or interrupted time series with a control group
III-3	Evidence obtained from comparative studies with historical control, two or more single-arm studies, or interrupted time series without a parallel control group
IV	Evidence obtained from case series, either post-test or pre-test and post-test

Source: Reference 33.

constitute a higher level of evidence than those based on non-randomised studies, which, in turn, rank higher than case series or expert opinion (Table 1).[33] When recommending interventions, physicians need to be aware of the strength of evidence underpinning such recommendations.

Improving Physician Performance

Clinical performance tends to deteriorate over time.[34] Systematic reviews have also shown that traditional, instructional, continuing medical education (CME) simply fails to maintain clinical performance.[35] More effective methods include interactive CME group sessions,[36] academic detailing,[37] reminder and decision supports at the point of care,[38] and targeted audits and peer-referenced feedback.[39] Clinical performance can be enhanced further by formulating and answering practice related questions, applying results to practice, and evaluating practice at regular intervals.[8] EBM provides both a stimulus and a methodology for promoting self-directed learning as part of routine work.

HOW EBM CAN ASSIST CLINICAL MEDICINE

EBM can assist the physician by placing his/her performance of the many tasks of clinical medicine on a more sound, evidence-based footing.

Clinical History-taking and Examination

Clinicians often disagree in their elicitation and/or interpretation of clinical findings, including physical signs.[40] A greater awareness of the accuracy, precision and salience of specific clinical findings in the context of hypothetico-deductive reasoning helps render the task of diagnosis more efficient. The JAMA series of 'Rational examination' articles[41] and the recent initiation of simple, pragmatic studies of the predictive value of different clinical signs[42] attempt to instill more science into the art of clinical examination.

Differential Diagnosis and Initial Management

In formulating the differential diagnosis and initial management plan, the likelihood of serious, treatable but rare illness can be overestimated,[43] invoking a cascade of multiple tests and treatments which may be unnecessary and potentially harmful.[44] The use of validated clinical decision rules, derived from multivariate analysis of clinical findings and results of simple investigations, may avoid such occurrences by providing more accurate estimates of disease likelihood, prognosis, and response to initial management.[45] Diagnostic scenarios for which such rules have been developed include suspected pulmonary thromboembolism,[46] pneumonia,[47] renal artery stenosis,[48] and malignancy associated with solitary pulmonary nodules.[49] Similarly, management rules have been reported that can predict which recently hospitalised elderly persons are likely to suffer delirium,[50] which cases of 'positive' blood cultures represent true bacteraemia,[51] and which patients presenting with acute myocardial infarction (AMI) are likely to benefit most from receiving thrombolytic therapy.[52] The judicious application of such rules can render evaluation and management more efficient and effective.

Diagnostic Tests

Physicians are expected to be adept in selecting the most appropriate diagnostic tests and interpreting their results according to clinical context. This requires an understanding of test performance (sensitivity and specificity), precision, cost, safety, and patient acceptability. Not infrequently, test results are misinterpreted because of insufficient appreciation of pre-test probability or likelihood ratios of diagnostic tests.[53] Evidence-based tools, such as tables of pre-test disease probabilities for common clinical scenarios, likelihood ratios for commonly used tests, and Bayesian nomograms for rapid calculation of post-test probabilities, all assist in optimising test selection and interpretation.[54,55]

Therapy

Once a diagnosis is established, treatments need to be selected that do more good than harm, and

are worth the effort and cost of using them. Prioritising treatments for individual patients, and avoiding the pitfalls of polypharmacy (especially in older patients), require an appreciation of treatment-related reduction in absolute risk of clinical events.[56] In contrast, the benefits of many therapies are reported in trials and by pharmaceutical representatives as relative risk reductions (relating to all patients in the trials), which often sound more impressive, and which may invite indiscriminate over-use.[57] The concept of number needed to treat (NNT) – the reciprocal of absolute risk reduction – provides a more meaningful measure of treatment efficacy which helps to ensure patients receive those treatments which confer highest net benefit.[58] The reporting of NNT is now common in the literature and NNT tables are available for an increasing number of interventions.[59]

Prognosis and Risk

Predicting the risk of adverse clinical events in both patients with known disease, as well as in asymptomatic, at-risk individuals, is fundamental in estimating the extent to which that risk could be reduced by administering certain preventive or therapeutic interventions. Subjects with high baseline risk are likely to gain more from treatment than those with low baseline risk, particularly if the intervention itself carries some risk of harm.[60] Estimates of risk may be incorrect if based on limited personal experience, or averaged figures obtained from studies of heterogenous populations.[61]

Multivariate analysis of prospective 'inception' cohort studies yields useful predictors of future events which more accurately identify higher-risk individuals. Examples include predictors of cardiac thromboembolism in patients with non-valvular atrial fibrillation,[62] of atherothrombotic stroke in carotid artery stenosis,[63] and of cardiac deaths in patients following AMI.[64] The use of such risk prediction tools, in the form of nomograms and tables,[65] enables physicians to customise patient management according to baseline risk.

Patient Participation, Education and Adherence

Another important task is to optimise patients' understanding of their disease and commitment to its proper long-term management. Many patients defer or do not adhere to treatment simply because the issues they consider important are not adequately discussed, or the risks and benefits are not expressed in language they comprehend or perceive as relevant to their concerns.[66] A number of evidence-based, patient-centred decision aids have been developed which facilitate lay understanding of numeric estimates of risk.[67] These appear to enhance patients' level of confidence with, and acceptance of, treatment decisions which one hopes will translate into long-term adherence.[67,68]

Quality Improvement

Increasingly, clinical research is looking at methods for improving quality of routine practice. Strategies for enhancing transfer of research findings into practice,[69] of optimising efficiency of care delivery,[70] and of reducing levels of inappropriate care[71] are being subject to scientific analysis. The results of such studies warrant consideration and adoption, as appropriate, by physicians acting in the role of opinion leaders and agents of change.

APPLYING EBM TO ROUTINE CLINICAL PRACTICE

Having offered a detailed and hopefully convincing rationale for EBM, we now turn to the issue of how the methods of EBM can be applied more consistently in routine practice.

Formulating (Potentially) Answerable Clinical Questions

In order to maximise efficiency of literature searches, questions need to be focused and comprised of three parts:

(1) Population – what is the group of patients to which this question applies?

(2) Intervention – what is the treatment, test, risk factor, etc., of interest?

(3) Comparator – what is usual practice? and

(4) Outcome – what are the results or outcomes of interest (treatment effects, diagnostic test accuracy, risk estimate, etc.)?

Example: Your patient is a 36-year-old woman with multiple sclerosis for whom you are considering administering ß-interferon therapy. The question becomes: in middle aged women with long standing multiple sclerosis in remission (1), is ß-interferon (2), compared to usual care (3), efficacious and safe in preventing further relapses (4)?

Searching and Appraising the Literature for Relevant Clinical Information

The most useful information is relevant to the question at hand, highly valid and takes very little

TABLE 2
Bare-bones Appraisal Guides for Determining Validity of Clinical Studies

Subject	Guides		
Key study outputs			
• Therapy Relative risk reduction Absolute risk reduction Number need to treat/harm	Randomised controlled trial with concealed random allocation of subjects to comparison groups	Key outcome measures measured blindly	Few lost to follow-up compared with number of bad outcomes
• Diagnosis Sensitivity, specificity Likelihood ratios ROC curves	Cross-sectional study of patients to whom you would want to apply test in practice	Objective diagnostic standard applied to all subjects	Blinded assessment of test and diagnostic standards
• Prognosis Survival curves Time to event Life expectancy	Inception cohort of patients early in course of disease and initially free of outcome of interest	Objective or reproducible assessment of clinically important outcomes	Few lost to follow-up compared with number of bad outcomes
• Aetiology Attributable risk	Clearly defined comparison group or those at tisk for, or having, outcome of interest	Blinding of observers of outcome to exposure; blinding of observers of exposure to outcome	
• Reviews Pooled effect sizes (expressed as odds ratios)	Systematic reviews or meta-analyses which use explicit criteria for selecting studies and rating validity	Comprehensive search for all relevant articles	

Adapted from reference 73.

work to acquire.[72] Two broad approaches can be employed.

The initial EBM approach advocated formal Medline searches of primary studies and critical appraisal of the retrieved evidence, with emphasis on assessing *validity* before deciding on *applicability* to patients.[1] While this constitutes a 'gold standard' approach for those undertaking original research or seeking answers to esoteric or rare clinical problems, it is too time-consuming and impractical for busy physicians wanting answers to common clinical problems.

A more practical adaptation of EBM is to search secondary (or 'predigested') sources of information which include integrative studies, such as meta-analyses, systematic reviews, practice guidelines, and decision analyses. These reports synthesise and analyse data from multiple primary studies which in turn have been selected on the basis of explicit quality criteria.[10] With this approach, the physician first decides if such evidence is relevant to his/her clinical problem and, if so, then double checks its validity by means of succinct, 'bare-bones' appraisal guides that can be memorised or kept as pocket references[73] (see Table 2).

Several readily searchable, secondary databases are now available (see Appendix) which present results in standardised formats and which physicians can use with minimal training and effort. A literature search and appraisal process which, using traditional methods may have taken hours to days, now takes only minutes[74] and may be supplemented with searches of primary studies when necessary.

Most physicians have computers at or near the point of care. Where information is often most needed (such as the clinic or ward), desk top, lap top and hand-held computers are being used increasingly to access rapidly evidence databases and decision support.[75]

Integrating Useful Data with Clinical Expertise and Applying Results to Routine Care

Clinical expertise ensures research findings are matched appropriately to the particular needs of the patient at hand. Reconciling evidence of efficacy with patients' views and preferences is critical if patients are to accept and commit to recommended therapy.[76,77] EBM can help by highlighting valid methods for improving adherence, such as patient-oriented decision guides, reminders, self-monitoring, and reinforcement techniques.[78,79]

In addition, as previously discussed, using an EBM approach to profile forms of care which are both clinically and cost-effective enables physicians and managers to reach agreement on how to allocate limited resources.[80]

Evaluating Clinical Practice

Physicians are obliged to review regularly and systematically their individual practice to

TABLE 3
Logistical Impediments (and responses) to the Practice of EBM

- *No time:* Advances in medical informatics and the availability of 'pre-digested' evidence sources actually saves time in finding information compared to searching outdated textbooks or disorganised journals.
- *No access to computer:* Most physicians have computers, and many have Internet access.
- *No (or limited) skills in finding and interpreting evidence:* These skills are easily self taught using readily available resources (see Appendix). Secondary evidence sources make the task even easier.
- *No evidence (or no relevant evidence):* This should not be seen as a shortcoming of EBM but rather a strength and a challenge. It highlights areas of practice for which more research is needed to provide useful evidence.

determine if interventions supported by high-level evidence are being consistently provided when indicated.[81] Currently, within the RACP MOPS programme, clinical audit and practice review are under-represented in Fellows' applications for points,[82] despite previously cited evidence indicating their effectiveness in improving clinical performance.

BARRIERS TO PRACTISING EBM IN ROUTINE CARE

A recent survey of Australasian physicians identified limitations of time, access to evidence at the point of care, relevance and quality of the evidence itself, and personal skills in EBM as major barriers to using EBM in routine practice.[83] Such logistical impediments have been reported elsewhere,[84] but are capable of being overcome (see Table 3).

More fundamental are various philosophical objections to EBM,[85] which are not easily ascertained in questionnaire surveys, but which find expression in statements such as: 'My practice is already evidence-based'; 'I don't believe in cook book medicine'; 'Clinical practice is more complex than what goes into randomised trials'; and 'EBM is always about cutting costs'. Space does not allow detailed rebuttal of all these objections although Sackett and colleagues have responded elsewhere.[7]

Moves to reform litigation procedures, such as clearly defining the authority of expert witnesses,[86] and weighting scientific evidence in legal proceedings,[87] suggest an accelerating convergence of the legal and EBM perspectives. Finally, in the age of the Internet, patients seek expert guidance in interpreting the mass of publicly available information which is often of questionable veracity.[88]

PROFILING THE EVIDENCE-BASED PHYSICIAN

The reader can take several steps immediately to improve his/her clinical practice using evidence-based methods.

- Take time to reflect regularly on daily clinical practice, and ask questions which may identify previously unrecognised information needs.
- Pursue these identified information needs by formulating focused clinical questions and searching for answers first in the 'predigested' secondary literature sources.
- When asking colleagues for advice, ask: 'What's your evidence for saying that?'
- Develop a working knowledge of clinical epidemiology by reading selected texts[89] and accessing the many user-friendly EBM resources now freely available (see Appendix).
- Construct files of clinical guidelines and critically appraised topics (CATs) centred on personally encountered clinical problems. Software for creating and storing CATs in a standardised format has been developed,[90] which can then be shared with others by e-mail, or through websites such as the home page of the Internal Medicine Society of Australia and New Zealand.
- Encourage physician trainees to undertake systematic reviews of an appropriately scoped clinical question as research projects which serve to satisfy fellowship training requirements.
- Join (or create if necessary) an EBM journal club or working group within your practice or department with the purpose of bringing evidence to bear on problematic cases or clinical policy issues.
- Conduct case presentations and educational meetings in an evidence-based way, elaborating on the performance of tests and treatments in quantitative terms.
- Interrogate pharmaceutical representatives about the science behind the glossy advertisements promoting 'advances' in drug therapy.
- Undertake a practice audit at least once a year, and plan it as a research study with a testable hypothesis.
- Implement the above strategies in daily practice, and demonstrate them in your role as teacher of registrars, residents and students.

As well as ensuring clinical decisions are based more on evidence, practising EBM also assists in: 1) increasing one's understanding of research methods; 2) generating interest in conducting one's own research; 3) improving confidence in decision-making and communication of decision

Appendix: List of EBM resources

Resource	Comments	URL address
Secondary (predigested) evidence sources		
ACP Journal Club Evidence-based Medicine	Bi-monthly secondary publication journals which provide structured abstracts and expert commentaries on key articles chosen according to quality criteria and potential practice impact.	http:///www.acponline.org
Best Evidence	CD-ROM commencing 1997 with all first years of ACP Journal Club and all issues of Evidence-based Medicine; latest version (version 4) includes *Diagnostic Strategies for Common Medical Problems.*	http://www.evidence-based medicine.com
Cochrane Library	CD-ROMs of 4 separate databases containing more than 270 systematic reviews (from both Cochrane Review Groups and non-Cochrane groups) and more than 250,000 RCTs.	http:///www.update-software.com or on-line at http://www.cochranelibrary.com/clibhome/clib.htm
Up-to-Date in Medicine	CD-ROM containing regularly updated expert reviews of all topics in internal medicine, fully referenced and complemented by graphs, figures, and videoclips.	http://www.uptodate.com
Clinical Evidence	Quarterly evidence-based compendium of updated key topics in medicine and surgery.	http://www.evidence.org/index-welcome.htm
Effective Health Care	Quarterly publication from NHS Centre for Reviews and Dissemination which contains systematic reviews of topical subjects in health care and health service research.	http://www.york.ac.uk/inst/crd/ehcb.htm
Bandolier	Useful monthly newsletter commenting on recent seminal research papers.	http://www.jr2.ox.ac.uk/Bandolier
Primary evidence sources		
Pubmed; Internet Grateful Med	NLM's free Web interfaces to MedLine.	http://www.ncbi.nlm.hih.gov
Clinical practice guidelines (CPGs)		
National Guideline Clearinghouse	Repository of evidence-based guidelines sponsored by AHRQ in US.	http://www.ahrq.gov/ or http://www.guideline.org
Health Services/Technology Assessment Test (HSTAT)	NLM resource providing CPGs, quick-reference guides, AHRQ evidence reports, consumer brochures.	http://www.text.nlm.nih.gov
NHMRC Guidelines	Australian produced evidence-based guidelines.	http://www.nhmrc.health/gov.au
Scottish Intercollegiate Guidelines Network (SIGN)	Scottish guidelines produced by interdisciplinary groups.	http://www.show.scot.nhs.uk/sign/clinical.htm
Critical appraisal		
JAMA *Users' Guides to the Literature*	McMaster guides to critical appraisal.	http://www.hiru.mcmaster.ca/ebm/
'Bare-bones' appraisal guides	Succinct guides emphasising key appraisal criteria.	http://www.cebm.jr2.ox.ac.uk/
How to Read a Paper	BMJ series which complements the above guides.	http://www.bmj.com/bmj/
Other useful EBM resources		
ScHARR 'Netting the evidence'	Links to more than 40 EBM sites.	http://www.shef.ac.uk/~scharr/ir/netting.html
Evidence Based Medicine Resources List	Inventory of useful EBM resources and aids.	http://www.herts.ac.uk/lis/subjects/health/ebm.htm
Academy of Sciences, New York	Useful teaching resources; links to other sites	http://www.ebmny.org
Oxford Centre for EBM	Useful teaching resources, case tutorials, toolkits. Educational resources, national and international links	http://www.cebm.jr2.ox.ac.uk/
Australasian Cochrane Centre		http://www.som.flinders.edu/fusa/cochrane/acc/accbroch/htm

rationales; 4) enhancing computer literacy and data searching techniques; and 5) saving time and money in cancelled journal subscriptions and book purchases.

CONCLUSIONS

Being able to offer patients advice, which is consistently based on current best evidence, is satisfying professionally and assists patients in making management decisions with which they feel comfortable. Being able to bring evidence to bear on debates about cost control, quality improvement and transfer of research into practice also helps to counter ill-informed managerial policies and to reinforce physicians' role as trusted patient advocates. While there are clearly limits to the extent to which every clinical decision needs, or is able, to be based on scientific evidence,[91] we would offer the methods described here as tools for ensuring that such evidence, when it exists and is capable of generating a better decision, is consistently incorporated into decision-making to the benefit of all concerned. ■

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