

Evidence-Based Medicine

A New Approach to Teaching the Practice of Medicine

Evidence-Based Medicine Working Group

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.

An important goal of our medical residency program is to educate physicians in the practice of evidence-based medicine. Strategies include a weekly, formal academic half-day for residents, devoted to learning the necessary skills; recruitment into teaching roles of physicians who practice evidence-based medicine; sharing among faculty of approaches to teaching evidence-based medicine; and providing faculty with feedback on their performance as role models and teachers of evidence-based medicine. The influence of evidence-based medicine on clinical practice and medical education is increasing.

CLINICAL SCENARIO

A junior medical resident working in a teaching hospital admits a 43-year-old previously well man who experienced a witnessed grand mal seizure. He had never had a seizure before and had not had any recent head trauma. He drank alcohol once or twice a week and had not had alcohol on the day of the seizure. Findings on physical examination are normal. The patient is given a loading

dose of phenytoin intravenously and the drug is continued orally. A computed tomographic head scan is completely normal, and an electroencephalogram shows only nonspecific findings. The patient is very concerned about his risk of seizure recurrence. How might the resident proceed?

The Way of the Past

Faced with this situation as a clinical clerk, the resident was told by her senior resident (who was supported in his view by the attending physician) that the risk of seizure recurrence is high (though he could not put an exact number on it) and that was the information that should be conveyed to the patient. She now follows this path, emphasizing to the patient not to drive, to continue his medication, and to see his family physician in follow-up. The patient leaves in a state of vague trepidation about his risk of subsequent seizure.

The Way of the Future

The resident asks herself whether she knows the prognosis of a first seizure and realizes she does not. She proceeds to the library and, using the Grateful Med program,¹ conducts a computerized literature search. She enters the Medical Subject Headings terms *epilepsy*, *prognosis*, and *recurrence*, and the program retrieves 25 relevant articles. Surveying the titles, one² appears directly relevant. She reviews the paper, finds that it meets criteria she has previously learned for a valid investigation of prognosis,³ and determines that the results are applicable to her patient. The search costs the resident \$2.68, and the entire process (including the trip to the library and the time to make a photocopy of the article) took half an hour.

The results of the relevant study show that the patient risk of recurrence at 1

year is between 43% and 51%, and at 3 years the risk is between 51% and 60%. After a seizure-free period of 18 months his risk of recurrence would likely be less than 20%. She conveys this information to the patient, along with a recommendation that he take his medication, see his family doctor regularly, and have a review of his need for medication if he remains seizure-free for 18 months. The patient leaves with a clear idea of his likely prognosis.

A PARADIGM SHIFT

Thomas Kuhn has described scientific paradigms as ways of looking at the world that define both the problems that can legitimately be addressed and the range of admissible evidence that may bear on their solution.⁴ When defects in an existing paradigm accumulate to the extent that the paradigm is no longer tenable, the paradigm is challenged and replaced by a new way of looking at the world. Medical practice is changing, and the change, which involves using the medical literature more effectively in guiding medical practice, is profound enough that it can appropriately be called a paradigm shift.

The foundations of the paradigm shift lie in developments in clinical research over the last 30 years. In 1960, the randomized clinical trial was an oddity. It is now accepted that virtually no drug can enter clinical practice without a demonstration of its efficacy in clinical trials. Moreover, the same randomized trial method increasingly is being applied to surgical therapies⁵ and diagnostic tests.⁶ Meta-analysis is gaining increasing acceptance as a method of summarizing the results of a number of randomized trials, and ultimately may have as profound an effect on setting treatment policy as have randomized trials themselves.⁷ While less dramatic, crucial methodological ad-

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vances have also been made in other areas, such as the assessment of diagnostic tests^{8,9} and prognosis.²

A new philosophy of medical practice and teaching has followed these methodological advances. This paradigm shift is manifested in a number of ways. A profusion of articles has been published instructing clinicians on how to access,¹⁰ evaluate,¹¹ and interpret¹² the medical literature. Proposals to apply the principles of clinical epidemiology to day-to-day clinical practice have been put forward.³ A number of major medical journals have adopted a more informative structured abstract format, which incorporates issues of methods and design into the portion of an article the reader sees first.¹³ The American College of Physicians has launched a journal, *ACP Journal Club*, that summarizes new publications of high relevance and methodological rigor.¹⁴ Textbooks that provide a rigorous review of available evidence, including a methods section describing both the methodological criteria used to systematically evaluate the validity of the clinical evidence and the quantitative techniques used for summarizing the evidence, have begun to appear.^{15,16} Practice guidelines based on rigorous methodological review of the available evidence are increasingly common.¹⁷ A final manifestation is the growing demand for courses and seminars that instruct physicians on how to make more effective use of the medical literature in their day-to-day patient care.³

We call the new paradigm "evidence-based medicine."¹⁸ In this article, we describe how this approach differs from prior practice and briefly outline how we are building a residency program in which a key goal is to practice, act as a role model, teach, and help residents become highly adept in evidence-based medicine. We also describe some of the problems educators and medical practitioners face in implementing the new paradigm.

The Former Paradigm

The former paradigm was based on the following assumptions about the knowledge required to guide clinical practice.

1. Unsystematic observations from clinical experience are a valid way of building and maintaining one's knowledge about patient prognosis, the value of diagnostic tests, and the efficacy of treatment.

2. The study and understanding of basic mechanisms of disease and pathophysiologic principles are a sufficient practice for clinical practice.

3. A combination of thorough traditional medical training and common

sense is sufficient to allow one to evaluate new tests and treatments.

4. Content expertise and clinical experience are a sufficient base from which to generate valid guidelines for clinical practice.

According to this paradigm clinicians have a number of options for sorting out clinical problems they face. They can reflect on their own clinical experience, reflect on the underlying biology, go to a textbook, or ask a local expert. Reading the introduction and discussion sections of a paper could be considered an appropriate way of gaining the relevant information from a current journal.

This paradigm puts a high value on traditional scientific authority and adherence to standard approaches, and answers are frequently sought from direct contact with local experts or reference to the writings of international experts.¹⁹

The New Paradigm

The assumptions of the new paradigm are as follows:

1. Clinical experience and the development of clinical instincts (particularly with respect to diagnosis) are a crucial and necessary part of becoming a competent physician. Many aspects of clinical practice cannot, or will not, ever be adequately tested. Clinical experience and its lessons are particularly important in these situations. At the same time, systematic attempts to record observations in a reproducible and unbiased fashion markedly increase the confidence one can have in knowledge about patient prognosis, the value of diagnostic tests, and the efficacy of treatment. In the absence of systematic observation one must be cautious in the interpretation of information derived from clinical experience and intuition, for it may at times be misleading.

2. The study and understanding of basic mechanisms of disease are necessary but insufficient guides for clinical practice. The rationales for diagnosis and treatment, which follow from basic pathophysiologic principles, may in fact be incorrect, leading to inaccurate predictions about the performance of diagnostic tests and the efficacy of treatments.

3. Understanding certain rules of evidence is necessary to correctly interpret literature on causation, prognosis, diagnostic tests, and treatment strategy.

It follows that clinicians should regularly consult the original literature (and be able to critically appraise the methods and results sections) in solving clinical problems and providing optimal patient care. It also follows that clinicians must be ready to accept and live with

uncertainty and to acknowledge that management decisions are often made in the face of relative ignorance of their true impact.

The new paradigm puts a much lower value on authority.²⁰ The underlying belief is that physicians can gain the skills to make independent assessments of evidence and thus evaluate the credibility of opinions being offered by experts. The decreased emphasis on authority does not imply a rejection of what one can learn from colleagues and teachers, whose years of experience have provided them with insight into methods of history taking, physical examination, and diagnostic strategies. This knowledge can never be gained from formal scientific investigation. A final assumption of the new paradigm is that physicians whose practice is based on an understanding of the underlying evidence will provide superior patient care.

REQUIREMENTS FOR THE PRACTICE OF EVIDENCE-BASED MEDICINE

The role modeling, practice, and teaching of evidence-based medicine requires skills that are not traditionally part of medical training. These include precisely defining a patient problem, and what information is required to resolve the problem; conducting an efficient search of the literature; selecting the best of the relevant studies and applying rules of evidence to determine their validity³; being able to present to colleagues in a succinct fashion the content of the article and its strengths and weaknesses; and extracting the clinical message and applying it to the patient problem. We will refer to this process as the *critical appraisal exercise*.

Evidence-based medicine also involves applying traditional skills of medical training. A sound understanding of pathophysiology is necessary to interpret and apply the results of clinical research. For instance, most patients to whom we would like to generalize the results of randomized trials would, for one reason or another, not have been enrolled in the most relevant study. The patient may be too old, be too sick, have other underlying illnesses, or be uncooperative. Understanding the underlying pathophysiology allows the clinician to better judge whether the results are applicable to the patient at hand and also has a crucial role as a conceptual and memory aid.

Another traditional skill required of the evidence-based physician is a sensitivity to patients' emotional needs. Understanding patients' suffering²¹ and how that suffering can be ameliorated by the caring and compassionate physician are

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Role model of practice of evidence-based medicine	Seldom cites evidence to support clinical decisions	Often fails to substantiate decisions with evidence	Usually substantiates decisions with evidence	Substantiates decisions; is aware of methodological issues	Always substantiates decisions or acknowledges limitations of evidence
Leads practice of evidence-based medicine	Never assigns problems to be resolved through literature	Produces suboptimal volume or follow-through of problem resolution through literature	Assigns problems and follows through with discussion, including methodology	Discusses literature retrieval, methodology of papers, application to individual patient	Same as "Good" rating, and makes it exciting and fun

fundamental requirements for medical practice. These skills can be acquired through careful observation of patients and of physician role models. Here too, though, the need for systematic study and the limitations of the present evidence must be considered. The new paradigm would call for using the techniques of behavioral science to determine what patients are really looking for from their physicians²² and how physician and patient behavior affects the outcome of care.²³ Ultimately, randomized trials using different strategies for interacting with patients (such as the randomized trial conducted by Greenfield and colleagues²⁴ that demonstrated the positive effects of increasing patients' involvement with their care) may be appropriate.

Since evidence-based medicine involves skills of problem defining, searching, evaluating, and applying original medical literature, it is incumbent on residency programs to teach these skills. Understanding the barriers to educating physicians-in-training in evidence-based medicine can lead to more effective teaching strategies.

EVIDENCE-BASED MEDICINE IN A MEDICAL RESIDENCY

The Internal Medicine Residency Program at McMaster University has an explicit commitment to producing practitioners of evidence-based medicine. While other clinical departments at McMaster have devoted themselves to teaching evidence-based medicine, the commitment is strongest in the Department of Medicine. We will therefore focus on the Internal Medicine Residency in our discussion and briefly outline some of the strategies we are using in implementing the paradigm shift.

1. The residents spend each Wednesday afternoon at an academic half-day. At the beginning of each new academic year, the rules of evidence that relate to articles concerning therapy, diagnosis, prognosis, and overviews are reviewed. In subsequent sessions, the discussion is built around a clinical case, and two original articles that bear on the problem are presented. The residents are responsible for critically appraising the

articles and arriving at *bottom lines* regarding the strength of evidence and how it bears on the clinical problem. They learn to present the methods and results in a succinct fashion, emphasizing only the key points. A wide-ranging discussion, including issues of underlying pathophysiology and related questions of diagnosis and management, follows presentation of the articles.

The second part of the half-day is devoted to the physical examination. Clinical teachers present optimal techniques of examination with attention to what is known about their reproducibility and accuracy.

2. Facilities for computerized literature searching are available on the teaching medical ward in each of the four teaching hospitals. Costs of searching are absorbed by the residency program. Residents not familiar with computer searching, or the Grateful Med program we use, are instructed at the beginning of the rotation. Research in our institution has shown that MEDLINE searching from clinical settings is feasible with brief training.²⁵ A subsequent investigation demonstrated that internal medicine house staff who have computer access on the ward and feedback concerning their searching do an average of more than 3.6 searches per month.²⁶ House staff believe that more than 90% of their searches that are stimulated by a patient problem lead to some improvement in patient care.²⁵

3. Assessment of searching and critical appraisal skills is being incorporated into the evaluation of residents.

4. We believe that the new paradigm will remain an academic mirage with little relation to the world of day-to-day clinical practice unless physicians-in-training are exposed to role models who practice evidence-based medicine. As a result, the residency program has placed major emphasis on ensuring this exposure.

First, a focus of recruitment for our Department of Medicine faculty has been internists with training in clinical epidemiology. These individuals have the skills and commitment to practice evidence-based medicine. The residency program works to ensure they have clin-

ical teaching roles available to them.

Second, a program of more rigorous evaluation of attending physicians has been instituted. One of the areas evaluated is the extent to which attending physicians are effective in teaching evidence-based medicine. The relevant items from the evaluation form are reproduced in the Table.

Third, because it is new to both teachers and learners, and because most clinical teachers have observed few role models and have not received formal training, teaching evidence-based medicine is not easy. To help attending physicians improve their skills in this area, we have encouraged them to form partnerships, which involve attending the partner's clinical rounds, making observations, and providing formal feedback. One learns through observation and through criticisms of one's performance. A number of faculty members have participated in this program.

To further facilitate attending physicians' improving their skills, the Department of Medicine held a retreat devoted to sharing strategies for effective clinical teaching. Part of the workshop, attended by more than 30 faculty members, was devoted to teaching evidence-based medicine. Some of the strategies that were adduced are briefly summarized in the next section.

EFFECTIVE TEACHING OF EVIDENCE-BASED MEDICINE

Role Modeling

Attending physicians must be enthusiastic, effective role models for the practice of evidence-based medicine (even in high-pressure clinical settings, such as intensive care units). Providing a model goes a long way toward inculcating attitudes that lead learners to develop skills in critical appraisal. Acting as a role model involves specifying the strength of evidence that supports clinical decisions. In one case, the teacher can point to a number of large randomized trials, rigorously reviewed and included in a meta-analysis, which allows one to say how many patients one must treat to prevent a death. In other cases, the best evidence may come from ac-

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cepted practice or one's clinical experi-
ence and instincts. The clinical teacher
should make it clear to learners on what
basis decisions are being made. This can
be done efficiently. For instance:

Prospective studies suggest that Mr Jones'
risk of a major vascular event in the first
year after his infarct is 4%; a meta-analysis
of randomized trials of aspirin in this situa-
tion suggests a risk reduction of 25%; we
would have to treat 100 such patients to pre-
vent an event²⁷; given the minimal expense
and toxicity of low-dose, enteric-coated as-
pirin, treating Mr Jones is clearly warranted.

Or:

How long to treat a patient with antibiotics fol-
lowing pneumonia has not been systematically
studied; so, my recommendation that we give
Mrs Smith 3 days of intravenous antibiotics
and treat her for a total of 10 days is arbitrary;
somewhat shorter or longer courses of treat-
ment would be equally reasonable.

In the latter type of situation, dog-
matic or rigid insistence on following a
particular course of action would not be
appropriate.

Critical Appraisal

It is crucial that critical appraisal is-
sues arise from patient problems that
the learner is currently confronting,
demonstrating that critical appraisal is
a pragmatic and central aspect, not an
academic or tangential element of op-
timal patient care. The problem select-
ed for critical appraisal must be one that
the learners recognize as important, feel
uncertain, and do not fully trust expert
opinion; in other words, they must feel
it is worth the effort to find out what the
literature says on a topic. The likeliest
candidate topics are common problems
where learners have been exposed to
divergent opinions (and thus there is
disagreement and/or uncertainty among
the learners). The clinical teacher should
keep these requirements in mind when
considering questions to encourage the
learners to address. It can be useful to
ask all members of the group their opin-
ion about the clinical problem at hand.
One can then ensure that the problem is
appropriate for a critical appraisal ex-
ercise by asking the group the following
questions:

1. It seems the group is uncertain
about the optimal approach. Is that
right?
2. Do you feel it is important for us to
sort out this question by going to the
original literature?

Methodological Criteria

Criteria for methodological rigor must
be few and simple. Most published crite-
ria can be overwhelming for the novice.
Suggested criteria for studies of diagno-
sis, treatment, and review articles follow:

Diagnosis.—Has the diagnostic test
been evaluated in a patient sample that
included an appropriate spectrum of mild
and severe, treated and untreated dis-
ease, plus individuals with different but
commonly confused disorders?²⁸ Was
there an independent, blind comparison
with a "gold standard" of diagnosis?²⁸

Treatment.—Was the assignment of
patients to treatments randomized?²⁹
Were all patients who entered the study
accounted for at its conclusion?²⁹

Review Articles.—Were explicit
methods used to determine which arti-
cles to include in the review?³⁰

As learners become more sophisticat-
ed, additional criteria can be introduced.
The criteria should not be presented in
such a way that fosters nihilism (if the
study is not randomized, it is useless
and provides no valuable information),
but as a way of helping arrive at the
strength of inference associated with a
clinical decision. Teachers can point out
instances in which criteria can be vio-
lated without reducing the strength of
inference.

METHODS FOR SCALING THE BARRIERS TO THE DISSEMINATION OF EVIDENCE-BASED MEDICINE

Misapprehensions About Evidence-Based Medicine

In developing the practice and teach-
ing of evidence-based medicine at our
institution, we have found that the na-
ture of the new paradigm is sometimes
misinterpreted. Recognizing the limita-
tions of intuition, experience, and un-
derstanding of pathophysiology in per-
mitting strong inferences may be mis-
interpreted as rejecting these routes to
knowledge. Specific misinterpretations
of evidence-based medicine and their cor-
rections follow:

Misinterpretation 1.—Evidence-
based medicine ignores clinical experi-
ence and clinical intuition.

Correction.—On the contrary, it is
important to expose learners to excep-
tional clinicians who have a gift for in-
tuitive diagnosis, a talent for precise
observation, and excellent judgment in
making difficult management decisions.
Untested signs and symptoms should
not be rejected out of hand. They may
prove extremely useful and ultimately
be proved valid through rigorous test-
ing. The more the experienced clinicians
can dissect the process they use in di-
agnosis,³¹ and clearly present it to learn-
ers, the greater the benefit. Similarly,
the gain for students will be greatest
when clues to optimal diagnosis and
treatment are culled from the barrage
of clinical information in a systematic
and reproducible fashion.

Institutional experience can also pro-
vide important insights. Diagnostic tests
may differ in their accuracy depending
on the skill of the practitioner. A local
expert in, for instance, diagnostic ultra-
sound may produce far better results
than the average from the published lit-
erature. The effectiveness and compli-
cations associated with therapeutic in-
terventions, particularly surgical pro-
cedures, may also differ among institu-
tions. When optimal care is taken to
both record observations reproducibly
and avoid bias, clinical and institutional
experience evolves into the systematic
search for knowledge that forms the core
of evidence-based medicine.³²

Misinterpretation 2.—Understand-
ing of basic investigation and pathophys-
iology plays no part in evidence-based
medicine.

Correction.—The dearth of adequate
evidence demands that clinical problem
solving must rely on an understanding
of underlying pathophysiology. More-
over, a good understanding of patho-
physiology is necessary for interpreting
clinical observations and for appropri-
ate interpretation of evidence (especial-
ly in deciding on its generalizability).

Misinterpretation 3.—Evidence-
based medicine ignores standard aspects
of clinical training, such as the physical
examination.

Correction.—Careful history taking
and physical examination provide much,
and often the best, evidence for diag-
nosis and direct treatment decisions. The
clinical teacher of evidence-based med-
icine must give considerable attention
to teaching the methods of history tak-
ing and clinical examination, with par-
ticular attention to which items have
demonstrated validity and to strategies
that enhance observer agreement.

Barriers to Teaching Evidence-Based Medicine

Difficulties we have encountered in
teaching evidence-based medicine in-
clude the following:

1. Many house staff start with rudi-
mentary critical appraisal skills and the
topic may be threatening for them.

2. People like quick and easy answers.
Cookbook medicine has its appeal. Crit-
ical appraisal involves additional time
and effort and may be perceived as in-
efficient and distracting from the real
goal (to provide optimal care for pa-
tients).

3. For many clinical questions, high-
quality evidence is lacking. If such ques-
tions predominate in attempts to intro-
duce critical appraisal, a sense of futility
can result.

4. The concepts of evidence-based
medicine are met with skepticism by

many faculty members who are therefore unenthusiastic about modifying their teaching and practice in accordance with its dictates.

These problems can be ameliorated by use of the strategies described in the previous section on effective teaching of evidence-based medicine. Threat can be reduced by making a contract with the residents, which sets out modest and achievable goals, and further reduced by the attending physician role modeling the practice of evidence-based medicine. Inefficiency can be reduced by teaching effective searching skills and simple guidelines for assessing the validity of the papers. In addition, one can emphasize that critical appraisal as a strategy for solving clinical problems is most appropriate when the problems are common in one's own practice. Futility can be reduced by, particularly initially, targeting critical appraisal exercises to areas in which there is likely to be high-quality evidence that will affect clinical decisions. Skepticism of faculty members can be reduced by the availability of "quick and dirty" (as well as more sophisticated) courses on critical appraisal of evidence and by the teaching partnerships and teaching workshops described earlier.

Many problems in the practice and teaching of evidence-based medicine remain. Many physicians, including both residents and faculty members, are still skeptical about the tenets of the new paradigm. A medical residency is full of competing demands, and the appropriate balance between goals is not always evident. At the same time, we are buoyed by the number of residents and faculty who have enthusiastically adopted the new approach and found ways to integrate it into their learning and practice.

Barriers to Practicing Evidence-Based Medicine

Even if our residency program is successful in producing graduates who enter the world of clinical practice enthusiastic to apply what they have learned about evidence-based medicine, they will face difficult challenges. Economic constraints and counterproductive incentives may compete with the dictates of evidence as determinants of clinical decisions; the relevant literature may not be readily accessible; and the time available may be insufficient to carefully review the evidence (which may be voluminous) relevant to a pressing clinical problem.

Some solutions to these problems are already available. Optimal integration of computer technology into clinical practice facilitates finding and accessing evidence. Reference to literature over-

views meeting scientific principles^{30,33} and collections of methodologically sound and highly relevant articles¹⁴ can markedly increase efficiency. Other solutions will emerge over time. Health educators will continue to find better ways of role modeling and teaching evidence-based medicine. Standards in writing reviews and texts are likely to change, with a greater focus on methodological rigor.^{15,16} Evidence-based summaries will therefore become increasingly available. Practical approaches to making evidence-based summaries easier to apply in clinical practice, many based on computer technology, will be developed and expanded. As described earlier, we are already using computer searching on the ward. In the future, the results of diagnostic tests may be provided with the associated sensitivity, specificity, and likelihood ratios. Health policymakers may find that the structure of medical practice must be shifted in basic ways to facilitate the practice of evidence-based medicine. Increasingly, scientific overviews will be systematically integrated with information regarding toxicity and side effects, cost, and the consequences of alternative courses of action to develop clinical policy guidelines.³⁴ The prospects for these developments are both bright and exciting.

DOES TEACHING AND LEARNING EVIDENCE-BASED MEDICINE IMPROVE PATIENT OUTCOMES?

The proof of the pudding of evidence-based medicine lies in whether patients cared for in this fashion enjoy better health. This proof is no more achievable for the new paradigm than it is for the old, for no long-term randomized trials of traditional and evidence-based medical education are likely to be carried out. What we do have are a number of short-term studies which confirm that the skills of evidence-based medicine can be taught to medical students³⁵ and medical residents.³⁶ In addition, a study compared the graduates of a medical school that operates under the new paradigm (McMaster) with the graduates of a traditional school. A random sample of McMaster graduates who had chosen careers in family medicine were more knowledgeable with respect to current therapeutic guidelines in the treatment of hypertension than were the graduates of the traditional school.³⁷ These results suggest that the teaching of evidence-based medicine may help graduates stay up-to-date. Further evaluation of the evidence-based medicine approach is necessary.

Our advocating evidence-based medicine in the absence of definitive evidence of its superiority in improving pa-

tient outcomes may appear to be an internal contradiction. As has been pointed out, however, evidence-based medicine does not advocate a rejection of all innovations in the absence of definitive evidence. When definitive evidence is not available, one must fall back on weaker evidence (such as the comparison of graduates of two medical schools that use different approaches cited above) and on biologic rationale. The rationale in this case is that physicians who are up-to-date as a function of their ability to read the current literature critically, and are able to distinguish strong from weaker evidence, are likely to be more judicious in the therapy they recommend. Physicians who understand the properties of diagnostic tests and are able to use a quantitative approach to those tests are likely to make more accurate diagnoses. While this rationale appears compelling to us, compelling rationale has often proved misleading. Until more definitive evidence is adduced, adoption of evidence-based medicine should appropriately be restricted to two groups. One group comprises those who find the rationale compelling, and thus believe that use of the evidence-based medicine approach is likely to improve clinical care. A second group comprises those who, while skeptical of improvements in patient outcome, believe it is very unlikely that deterioration in care results from the evidence-based approach and who find that the practice of medicine in the new paradigm is more exciting and fun.

CONCLUSION

Based on an awareness of the limitations of traditional determinants of clinical decisions, a new paradigm for medical practice has arisen. Evidence-based medicine deals directly with the uncertainties of clinical medicine and has the potential for transforming the education and practice of the next generation of physicians. These physicians will continue to face an exploding volume of literature, rapid introduction of new technologies, deepening concern about burgeoning medical costs, and increasing attention to the quality and outcomes of medical care. The likelihood that evidence-based medicine can help ameliorate these problems should encourage its dissemination.

Evidence-based medicine will require new skills for the physician, skills that residency programs should be equipped to teach. While strategies for inculcating the principles of evidence-based medicine remain to be refined, initial experience has revealed a number of effective approaches. Incorporating these practices into postgraduate medical ed-

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References

1. Lindberg DA. Information systems to support medical practice and scientific discovery. *Methods Inform Med.* 1989;28:202-206.
2. Hart YM, Sander JW, Johnson AL, Shorvon SD. National general practice study of epilepsy: recurrence after a first seizure. *Lancet.* 1990;336:1271-1274.
3. Sackett DL, Haynes RB, Guyatt GH, Tugwell P. *Clinical Epidemiology: A Basic Science for Clinical Medicine.* 2nd ed. Boston, Mass: Little Brown & Co Inc; 1991:173-186.
4. Kuhn TS. *The Structure of Scientific Revolutions.* Chicago, Ill: University of Chicago Press; 1970.
5. European Carotid Surgery Trialists' Collaborative Group. MRC European Carotid Surgery Trial: interim results for symptomatic patients with severe (70-99%) or with mild (0-29%) carotid stenosis. *Lancet.* 1991;337:1235-1243.
6. Larsen ML, Horder M, Mogensen EF. Effect of long-term monitoring of glycosylated hemoglobin levels in insulin-dependent diabetes mellitus. *N Engl J Med.* 1990;323:1021-1025.
7. L'Abbe KA, Detsky AS, O'Rourke K. Meta-analysis in clinical research. *Ann Intern Med.* 1987;107:224-233.
8. Ransohoff DF, Feinstein AR. Problems of spectrum and bias in evaluating the efficacy of diagnostic tests. *N Engl J Med.* 1978;299:926-930.
9. Nierenberg AA, Feinstein AR. How to evaluate a diagnostic market test: lessons from the rise and fall of dexamethasone suppression test. *JAMA.* 1988;259:1699-1702.
10. Haynes RB, McKibbon KA, Fitzgerald D, Guyatt GH, Walker CJ, Sackett DL. How to keep up with the medical literature, V: access by personal computer to the medical literature. *Ann Intern Med.* 1986;105:810-816.
11. Bulpitt CJ. Confidence intervals. *Lancet.* 1987;1:494-497.
12. Godfrey K. Simple linear regression in medical research. *N Engl J Med.* 1985;313:1629-1636.

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13. Haynes RB, Mulrow CD, Huth EJ, Altman DG, Gardner MJ. More informative abstracts revisited. *Ann Intern Med.* 1990;113:69-76.
14. Haynes RB. The origins and aspirations of ACP Journal Club. *Ann Intern Med.* 1991;114(ACP J Club, suppl 1):A18.
15. Chalmers I, Enkin M, Keirse MJNC, eds. *Effective Care in Pregnancy and Childbirth.* New York, NY: Oxford University Press Inc; 1989.
16. Sinclair JC, Braken MB, eds. *Effective Care of the Newborn Infant.* New York, NY: Oxford University Press Inc; 1992.
17. Audet AM, Greenfield S, Field M. Medical practice guidelines: current activities and future directions. *Ann Intern Med.* 1990;113:709-714.
18. Guyatt GH. Evidence-based medicine. *Ann Intern Med.* 1991;114(ACP J Club, suppl 2):A-16.
19. Light DW. Uncertainty and control in professional training. *J Health Soc Behav.* 1979;20:310-322.
20. Chalmers I. Scientific inquiry and authoritarianism in perinatal care and education. *Birth.* 1983;10:151-164.
21. Cassell EJ. The nature of suffering and the goals of medicine. *N Engl J Med.* 1982;306:639-645.
22. Ende J, Kazis L, Ash A, Moskowitz MA. Measuring patients' desire for autonomy: decision-making and information-seeking preferences among medical patients. *J Gen Intern Med.* 1989;4:23-30.
23. Carter WB, Inui TS, Kukull WA, Haigh VH. Outcome-based doctor-patient interaction analysis. *Med Care.* 1982;20:550-556.
24. Greenfield S, Kaplan S, Ware JE Jr. Expanding patient involvement in care: effects on patient outcomes. *Ann Intern Med.* 1985;102:520-528.
25. Haynes RB, McKibbon A, Walker CJ, Ryan N, Fitzgerald D, Ramsden ME. Online access to MEDLINE in clinical settings: a study of use and usefulness. *Ann Intern Med.* 1990;112:78-84.
26. McKibbon KA, Haynes RB, Johnston ME, Walker CJ. A study to enhance clinical end-user MEDLINE search skills: design and baseline find-

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- ings. In: Clayton PD, ed. *Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care, November 1991; Washington, DC.* New York, NY: McGraw-Hill International Book Co; 1992:73-77.
27. Laupacis A, Sackett DL, Roberts RS. An assessment of clinically useful measures of the consequences of treatment. *N Engl J Med.* 1988;318:1728-1733.
28. Department of Clinical Epidemiology and Biostatistics, McMaster University. How to read clinical journals, II: to learn about a diagnostic test. *Can Med Assoc J.* 1981;124:703-710.
29. Department of Clinical Epidemiology and Biostatistics, McMaster University. How to read clinical journals, V: to distinguish useful from useless or even harmful therapy. *Can Med Assoc J.* 1981;124:1156-1162.
30. Oxman AD, Guyatt GH. Guidelines for reading literature reviews. *Can Med Assoc J.* 1988;138:697-703.
31. Campbell EJM. The diagnosing mind. *Lancet.* 1987;1:849-851.
32. Feinstein AR. What kind of basic science for clinical medicine? *N Engl J Med.* 1970;283:847-853.
33. Mulrow CD. The medical review article: state of the science. *Ann Intern Med.* 1987;106:485-488.
34. Eddy DM. Guidelines for policy statements: the explicit approach. *JAMA.* 1990;263:2239-2243.
35. Bennett KJ, Sackett DL, Haynes RB, et al. A controlled trial of teaching critical appraisal of the clinical literature to medical students. *JAMA.* 1987;257:2451-2454.
36. Kitchens JM, Pfeifer MP. Teaching residents to read the medical literature: a controlled trial of a curriculum in critical appraisal/clinical epidemiology. *J Gen Intern Med.* 1989;4:384-387.
37. Shin J, Haynes RB. Does a problem-based, self-directed undergraduate medical curriculum promote continuing clinical competence? *Clin Res.* 1991;39:143A.