The *Journal of Continuing Education in the Health Professions,* Volume 23, pp. S53–S62. Printed in the U.S.A.

Issues Involving Practice-Based Learning and Improvement

Information Mastery: Integrating Continuing Medical Education with the Information Needs of Clinicians

Mark H. Ebell, MD, MS, and Allen Shaughnessy, PharmD

Abstract

Traditional continuing medical education (CME) has been disconnected from the actual practice of medicine and has not focused on providing the most useful information in the most efficient way. Physicians have different information needs at different times. When asked at the end of a day of patient care, physicians will typically report having had one question for every four or five patients. However, direct observation during patient care reveals many more questions. In the outpatient primary care setting, most studies have found, on average, that about two clinical questions are generated during every three patient encounters, with even higher numbers reported in the inpatient teaching setting. Thus, a physician seeing 25 patients in a typical day of outpatient care may have 15 clinical questions. Because clinical questions are the result of critical reflection by a clinician on his or her practice, they are central to physician learning. This connection between "need" and learning is consistent with generally accepted theories of adult learning. When applied to continuing education, this connection suggests that physicians will learn best when learning is in the context of patient care, answers their questions, does not take too much time, and is directly applicable to their work. Pursuing answers to these questions and answering them with the best available evidence, at the time the answer is needed, may well change the physician's general approach to patient care.

Key Words: Continuing, improvement, information needs of physicians, learning, medical education, practice-based learning, reflection

Traditional continuing medical education (CME) has been disconnected from the actual practice of medicine and has not focused on providing the most useful information in the most efficient way. It is usually delivered in a lecture format and may or may not meet the learning needs of a particular physician attendee. Even if CME is self-directed, it typically occurs at a time and place distinct from the delivery of care: physicians read a review article sitting comfortably in their studies in the evening and then answer a few questions to confirm their knowledge. But will that new knowledge they have gained change behavior when a patient with this problem presents to his or her practice 2 weeks later? Studies of CME suggest that it will not.[1]

In addition to being disconnected temporally and spatially from the actual delivery of care, CME has too often failed to deliver the most important and useful information to clinicians: patient-oriented evidence on common or important problems that has the potential to change practice.

The goal of CME is not merely to increase knowledge. Rather, it should be to improve patient

Dr. Ebell: Associate Professor, Department of Family Practice, Michigan State University, East Lansing, Michigan; *Dr. Shaughnessy:* Associate Director, Harrisburg Family Practice Residency, Harrisburg, Pennsylvania; Clinical Associate Professor, Drexel University College of Medicine, Philadelphia, Pennsylvania.

Reprint requests: Mark H. Ebell, MD, MS, 330 Snapfinger Drive, Athens, GA 30605.

outcomes by encouraging appropriate behavior change in physicians. The following are examples of CME activities that do not meet this goal:

1. A CME lecture that confirms the existing practice to use antibiotics for strep throat
2. A journal article that offers CME credit for learning about the mechanism behind a new class of diabetic drugs and their impact on blood sugar levels
3. A grand rounds lecture that presents a "fascinoma," a rare presentation of an even more uncommon disease that a physician is unlikely to see in his or her practice
4. A CME lecture from a local cardiologist describing his preferred approach to the management of unstable angina based on his 20 years of experience.

All of the above examples may be interesting and may even be accurate. However, they either do not present information that will change practice (example 1), do not present information linked with improved patient-oriented outcomes such as morbidity or mortality (example 2), do not address a common or important information need (example 3), or are not based on a thorough review of the best available research evidence (example 4).

In this article, we present a framework for understanding the information needs of physicians and an approach to identifying the most useful information. We then discuss how CME can be better integrated into the process of care in a way that takes advantage of our knowledge of adult learning.

Information Needs of Physicians

Physicians have different information needs at different times. Shaughnessy and colleagues have described four strategies to meet these information needs: Hunting, Foraging, Retracing, and Sporting.[2] Hunting occurs when physicians answer clinical questions that arise during the care of patients. Foraging is the regular process of keeping up to date with the medical literature. Retracing occurs when a physician reviews previously known but infrequently used information to refresh his or her memory. Sporting is learning that is driven by physicians' particular interests more than by their information needs, for example, reading an essay on handheld computers in medicine or an article on Bayesian reasoning. Because Sporting is less concerned with meeting information needs, we focus on Hunting and Foraging for the remainder of this section.

Hunting

When asked at the end of a day of patient care, physicians will typically report having had one question for every four or five patients.[3] However, direct observation during patient care reveals many more questions. In the outpatient primary care setting, most studies have found, on average, that about two clinical questions are generated during every three patient encounters,[4] with even higher numbers reported in the inpatient teaching setting.[5] Thus, a physician seeing 25 patients in a typical day of outpatient care may have 15 clinical questions.

What is meant by a clinical question? Examples include patient-specific questions such as "Does this patient have rales?" "I wonder what this rash is?" and "Why does this patient not respond to antibiotics?" It can also include logistic questions such as "Does this patient's insurance cover colonoscopy?" For the purpose of this discussion, however, we focus on generalizable questions about patient care that can potentially be answered by the medical literature because these are most likely to affect the care of future patients. Here are some examples:

1. What is the best antiviral for treatment of herpes zoster infection?
2. Do I have to worry about postherpetic neuralgia in a younger patient?
3. Does my patient with an uncomplicated corneal abrasion need a patch?

4. Is it sufficient to treat, by telephone, an otherwise healthy woman who just called me with symptoms of urinary tract infection?

Approximately 33% of clinical questions relate to treatment, 25% to diagnosis, and 15% to pharmacotherapeutics.[3,6,7] When questions are answered, more than half of the answers come from human sources (usually other physicians) and textbooks.[6] Electronic sources of information are rarely used.[4,6]

Unfortunately, most of the clinical questions generated at the point of care go unanswered.[4] Are these questions important? One study gave the unanswered questions to medical librarians. The authors then gave the answers to the physicians who had asked them. Approximately half of the answers would have had a direct impact on patient care.

Gorman and colleagues studied the unanswered questions and found that physicians were more likely to attempt to answer a question if the question was urgent and if they were confident that they could find an answer. Two characteristics that predict whether physicians will seek and find an answer to a clinical question are the urgency of the problem and their confidence that they will find an answer.[8]

Because clinical questions are the result of critical reflection by a clinician on his or her practice, they are central to physician learning. This connection between "need" and learning is consistent with generally accepted theories of adult learning. When applied to continuing education, this connection suggests that physicians will learn best when learning is in the context of patient care, answers their questions, does not take too much time, and is directly applicable to their work.[9]

We have previously proposed a model for answering clinical questions, shown in Figure 1.[10] The process begins with a physician who has an unrecognized information need—someone who does not know that he or she does not know (i.e., unconsciously incompetent). An example would be a physician who has always patched uncomplicated corneal abrasions (a corneal abrasion is a slight scratch to the outer surface of the eye) and continues to do so. Pathophysiologic reasoning and tradition have made this the standard of care, although, until recently, no studies had examined whether they actually improved patient outcomes.

An information need is recognized when the physician reflects critically on his or her practice and asks, "I wonder if there is any reason to use a patch for these patients?" Many such questions arise in the daily care of patients, but they are often suppressed because of lack of time, lack of access to resources, inability to properly frame the question, a feeling that the answer does not exist or would be difficult to find, and a perceived lack of urgency.[3,8]

Argyris described the distinction between single- and double-loop learning.[11] Consider the example of a patient presenting with a cough initially diagnosed as bronchitis and treated with the antibiotic erythromycin. If the patient returns several days later with persistent symptoms, a "single-loop" physician would react to the situation without questioning the underlying assumptions and would simply prescribe a different, broader-spectrum antibiotic. A "double-loop" physician would be more reflective and by questioning the underlying assumptions (that this is a bacterial infection and that antibiotics help patients feel better faster) would generate a series of important clinical questions:

- Is this a viral infection that will not respond to an antibiotic?
- Perhaps bacterial bronchitis is a largely inflammatory condition that does not improve more quickly with an antibiotic?
- Does the patient have a noninfectious cause of cough, such as allergy or esophageal reflux?
- Does the patient have a different infection such as acute sinusitis that requires a different treatment strategy?
- Does the failure to respond to an antibiotic increase the likelihood of a nonbacterial infection? If so, how much?

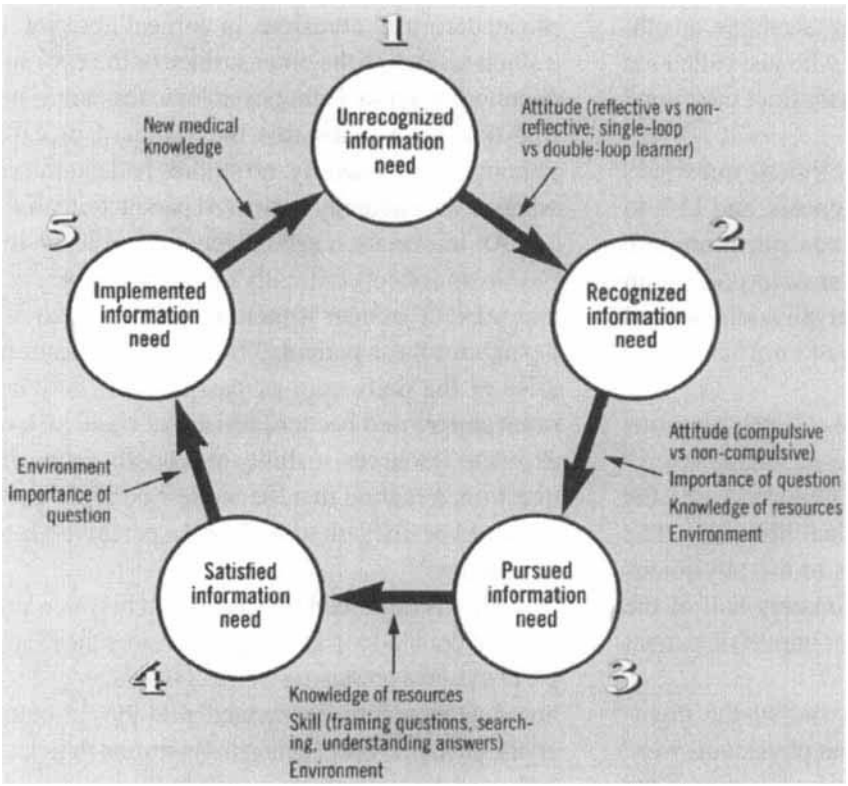

Figure 1 A model of how physicians meet their information needs when hunting for the answers to clinical questions.

Pursuing answers to these questions and answering them with the best available evidence, at the time the answer is needed, would not only change this patient's care, it might also change the physician's general approach to uncomplicated respiratory infections that rarely benefit from antibiotics.

This raises an issue that is often overlooked: is a physician getting an answer based on the best available evidence or just the most convenient answer? Clearly, it is important that we agree on what is meant by "right." The most common sources of information (other than drug handbooks to look up drug doses and adverse effects) are colleagues and textbooks.[6] Ely and colleagues have shown that textbooks are often out of date: the average age of textbooks on the shelves of a group of 102 Iowa primary care physicians was 12 years.[12] Colleagues are likely to be equally out of date because one study showed that the best predictor of knowledge of medications for hypertension was the physician's year of graduation from medical school.[13] Unfortunately, the relationship was inverse, and the more years that had passed since graduation, the worse the knowledge base.

To answer questions with the best available evidence, physicians must be skilled at framing questions; must be familiar with and have access to high-quality evidence-based references such as the Cochrane Library (<http://www.update-software.com/ccweb/cochrane/cdsr.htm>), InfoRetriever (<http://www.InfoPOEMs.com>), ACP Journal Club (<http://www.acponline.org>), and Bandolier (<http://www.jr2.ox.ac.uk/Bandolier/index.html>); and must have sufficient time to find an answer. The final steps in the cycle are to apply the answer in practice and then integrate it into that physician's standard approach to similar patients (see Figure 1). Because this is a cycle, at some point in the future there will be new, unrecognized information needs.

Once an answer is found, the physician must decide whether to apply it to the care of this patient (if the answer is found in time) and whether to apply it to future patients with similar problems. Does the local culture of the group practice or office promote a spirit of inquiry and evidence-based practice? Or is it critical of physicians who appear to stray too far from usual practice?

Physicians who want to be successful lifelong learners therefore need highly developed critical reflection skills. Applying these skills to their practice and generating clinical questions at the point of care are central to physician education and lifelong learning. To take an evidence-based approach to practice, these questions must be answered using the most valid, relevant information available. By better understanding their clinical questions generated at the point of care, physicians can define strategies for answering these questions using relevant and valid information and thereby improve the care of patients. Finally, the local practice culture will influence whether these answers are applied to patient care.

Foraging

Foraging is the regular process of reviewing the medical literature to keep up to date with new information.[2] Each month, hundreds of medical journals publish thousands of original research articles. A study of 85 prominent clinically oriented medical research journals identified over 8,085 articles in a 6-month period.[14] Even if a physician spent only 3 minutes per article, it would still take over 800 hours over the course of a year to keep up to date. Clearly, this is not an effective strategy and leaves far too little time for patient care.

Thus, for most physicians, foraging is a haphazard process, with journals piling up in the physician's home and office until they are read, filed, or (more commonly) thrown away. Articles are read because the title (or sometimes the artwork) happens to pique the physician's interest rather than as part of a systematic approach to surveying the breadth of the medical literature.

Furthermore, most physicians devote relatively little time to reading to keep up to date. A survey of Norwegian primary care physicians found that they spend less than 3 hours per week on all medical reading.[15] Because this includes sporting and reading about administrative issues, we estimate that the typical physician spends 5 to 10 hours per month reading to keep up to date with clinical medicine. What physicians badly need is a systematic framework for identifying the most useful information.

Perhaps the most important benefit of foraging is that it makes physicians aware of new drugs, tests, and treatments, as well as new information that either supports or refutes the efficacy of older interventions. For example, a physician may attend a CME course and learn that *Helicobacter pylori* is a newly recognized cause of peptic ulcer disease and is also associated with gastric cancer. However, those facts do not generally become integrated into the physician's practice until a patient with dyspepsia presents to the physician, who must then decide which tests to order (if any) and how to treat the infection.

In the next section, we describe a framework for helping physicians keep up to date with new information as well as answer their questions with the best available evidence.

Information Mastery

Slawson and colleagues have developed an approach to helping physicians manage medical information called "information mastery."[16] A central concept of information mastery is the usefulness equation:

$$\text{Usefulness of medical information} = \frac{\text{Relevance} \times \text{validity}}{\text{Work}}$$

Thus, the most important information is highly relevant and highly valid and takes little work to

obtain. We consider each of these factors in turn in the remainder of this section.

Relevance

The relevance of medical information is often overlooked by both physicians and educators and is perhaps the most important factor in making the amount of medical information more manageable. Issues to consider include the following:

- Is this information intended primarily for other researchers, or is it intended for clinicians?
- Did the study answer a question or issue that is addressed by physicians in your specialty?
- Did the study measure patient-oriented outcomes (morbidity, mortality, quality of life, symptom improvement, cost) or disease-oriented, surrogate outcomes (blood pressure, blood sugar, enzyme levels, or flow rates)?
- Would the study change practice if the information is valid?

Much medical information is communication between researchers. Although important, it is not necessarily intended or suited to change the practice of clinicians. In many cases, changing the practice based on such preliminary evidence can be harmful. For example, preliminary pathophysiologic studies suggested that the drugs encainide and flecainide suppressed ventricular arrhythmias in patients with a recent acute myocardial infarction. They were widely used, but studies that measured patient-oriented outcomes, including mortality, showed a three- to fourfold increase in the risk of death with these drugs.[17]

Studies that address a question relevant to a cardiologist, such as the selection of a catheter for coronary vascular studies, may not be relevant to a primary care physician, and vice versa. Finally, studies that merely confirm a physician's current practice are a lower priority than studies that would change practice.

Considering all of the above factors leads to the following definition of the most relevant information:

- Considers a question that is common or important in a physician's practice
- Measures patient-oriented outcomes
- Would change this physician's practice practice if the information is valid

We call this kind of information a POEM: patient-oriented evidence that matters. Studies that offer only disease-oriented evidence are "DOEs." Figure 2 is another way of illustrating the relationship among the frequency of a question, the type of outcomes, and whether it would change practice.

By focusing on POEMs, physicians can greatly reduce the amount of original research that requires their review. The previously mentioned study of 8,085 articles in 85 clinical research journals showed that less than 2% met the above criteria for POEMs.[14] Because not all of these will be relevant or "practice changing" for every physician, the true percentage of POEMs in these journals is probably closer to 1%. Thus, only about 160 articles per year form the critical literature base for keeping up to date in primary care practice. This is the number of articles that physicians can realistically absorb, particularly if the articles are summarized for them by content and validity experts. Assessment of validity, and its communication to physicians, is described in the next section.

Validity

Physicians have traditionally looked to the authoritativeness of information as a substitute for validity. Research published in a prestigious journal was more authoritative and was seen as more credible. Evidence-based medicine is an important paradigm that encourages physicians to base their decisions on the best available evidence rather than tradition, authority, habit, pathophysiologic reasoning, or local custom.[18] The quality of evidence is, in turn,

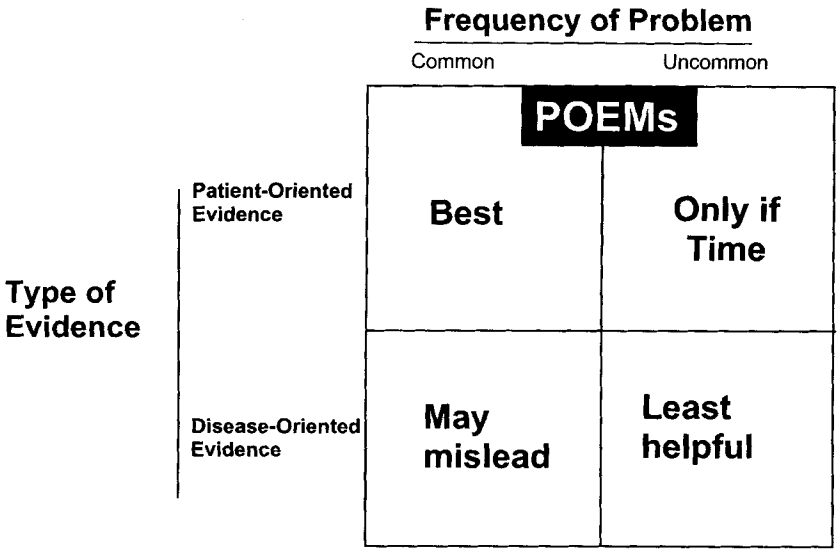

Figure 2 Patient-oriented evidence that matters (POEMs) in the context of other types of medical information.

determined by the quality of the original research that supports that recommendation. For therapy, randomized controlled trials (RCTs) and meta-analyses of RCTs provide a higher level of evidence than observational studies, which, in turn, are more valid than case series, case reports, and pathophysiologic reasoning. Many examples of recommendations not based on the best available evidence have since been shown to be incorrect:

- Hormone replacement therapy to reduce the risk of heart disease
- Laparoscopic knee surgery for osteoarthritis
- Patches for corneal abrasion
- Having infants sleep on their stomach to reduce the risk of sudden infant death syndrome
- Calcium channel blockers for diabetic hypertensives

An evidence-based approach to synthesis and guideline development encourages physicians to look at all of the evidence, rate the quality of the studies, and then base the management recommendation on the best evidence. This is in contrast to consensus guidelines and traditional review articles that typically begin with a series of conclusions, codify them, and selectively identify references from the research literature to support them.

The evaluation of the quality of an article, including identification of threats to validity, is a skill that most physicians do not have. It is also quite time consuming. In the next section, we discuss strategies to reduce the work of finding information and evaluating its validity.

Work

Whereas evaluation of relevance requires input from the physician (to determine whether it is a question addressed in their scope of practice and to determine whether the recommendation would change their current practice), evaluation of validity can be done by a third party. A number of review services survey the original research literature, synopsize articles, and disseminate them to physicians.

Although these review services are helpful in the foraging process, it is important that they use a rational framework for the assessment of relevance and standard criteria for the assessment of validity. As shown in Table 1, the available services differ considerably in their approach to these key factors.

Table 1 Review Services for Physicians

Service	Determination of Relevance	Validity Assessment	Dissemination
ACP Journal Club	Based on judgment of reviewers	***	WWW, print
POEMs	Based on POEMs criteria (common/important problem, patient-oriented outcomes, would change practice)	***	WWW, print, electronic mail, handheld desktop computer
Journal Watch	Based on judgment of reviewers	*	Print
Primary Care Medical Abstracts	Based on judgment of reviewers	**	WWW, print, cassette, CD-ROM

Key to validity assessment: ***consistent assessment of validity using evidence-based medicine (EBM) principles; **usually assess validity using EBM principles; *inconsistent assessment of validity using EBM principles.
POEMs = patient-oriented evidence that matters; WWW = World Wide Web.

Physicians also need innovative tools to reduce the work of hunting for answers to their clinical questions. Although a number of software tools are available, relatively few take an evidence-based approach to evaluating the validity of information or use a framework for assessing relevance.

Sorting Out Information

The unprecedented availability of information in medicine produces its own issues. Clinicians can quickly go from too little information to too much, often bouncing ping-pong-like among different answers to the same question, no more sure than when they started of what constitutes the "truth." It is easy to develop "information anxiety," characterized by frustration that occurs when there is a great deal of information that does not tell learners what they need to know.

The problem is that not all of what is loosely labeled "information" really "informs" the user. There is a progression from data to wisdom, and each has its own usefulness at different times (Figure 3). For example, a recent study may tell us that a drug for asthma increases lung function by 0.14 L compared with another drug that increases it by 0.09 L. These *data* need to be interpreted, usually through statistics, for us to have any understanding of them (i.e., *information*). Further thinking about the information will allow the clinician to determine whether the change is one that is clinically meaningful (*knowledge*) and, ultimately, whether a particular patient will benefit from one medication versus the other (*wisdom*).

As one progresses up this hierarchy of evidence, the information it provides becomes more relevant, whereas validity becomes more difficult to confirm. The best balance seems to be found by sources that provide *knowledge* coupled with supporting information that can be verified by the user.

Integrating CME with Practice

Traditional CME has occurred far from the actual practice of medicine, both literally and figuratively. For the most part, physicians need to leave their place of practice to obtain CME. As a result, CME is often seen as a way to improve one's knowledge but is not necessary to changing one's own practice behavior or improving one's practice.[19]

Learning occurs best in adults when they have a high need for the information being presented to them and when they have control over

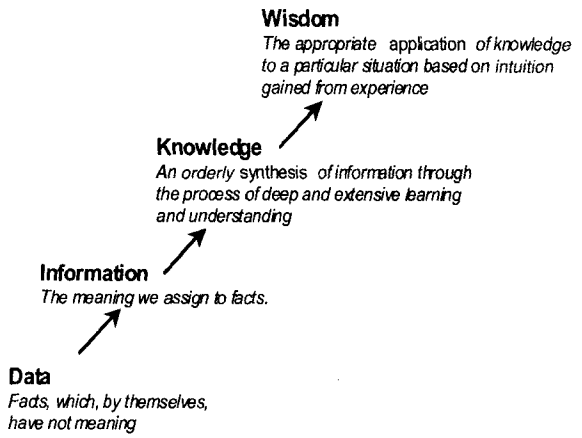

Figure 3 Progression from data to wisdom. Adapted from Slawson et al.[16]

the type of information they are receiving. It makes the most sense, then, to provide new information in a manner that can be rapidly assimilated and at a time when it can be used immediately. In other words, CME has to be integrated into the practice of medicine, presented at the "point of care." With the advent of the handheld computer and broadband access to the World Wide Web, the time is ripe for the development of new methods of providing opportunities for learning of a type that can be used by the reflective practitioner during his or her day-to-day activities. Future efforts toward innovative CME should focus on providing the most useful information—POEMs—at the point of care. Examples include the following:

- Providing physicians with a menu of validated "practice change interventions" to improve the quality of care for a particular condition. Physicians would implement one of these interventions as part of the continuing education process, perhaps reporting back on changes in process measures.

- Each time a physician looks up the answer to a question on a handheld computer, the computer logs the date, time, and topic of the search. The physician also indicates the likelihood that the answer to this question will change his or her practice.

- Foraging and hunting are linked: physicians receive one or two brief evidence-based summaries of recent research per day, and these summaries are added to a searchable database containing a wide variety of evidence-based information that is selected for its relevance and validity. This is the principle behind InfoRetriever software, which we have codeveloped.[20,21]

Lessons for Practice

- Although answering clinical questions is central to physician learning, most questions generated at the point of care are not answered with the best available evidence.
- The "information mastery" framework identifies the most useful information for clinicians: information that measures patient-orientated outcomes (i.e. morbidity, mortality, symptom improvement, cost, quality of life), addresses a common or important question, uses a valid study design, and would change practice. This information is "patient-orientated evidence that matters" (POEMs).
- POEMs must be delivered to physicians in a two-pronged approach: as part of a system for keeping up to date (a "foraging" tool) and an information means (a "hunting" tool) that allows them to quickly find the POEM again when they need it to answer clinical questions at the point-of-care.

We believe that these approaches to CME have great potential to increase not only knowledge but also the quality of care delivered.

References

1. Davis DA, Thomson MA, Oxman AD, Haynes RB. Changing physician performance. A systematic review of the effect of continuing medical education strategies. JAMA 1995; 274:700–705.
2. Shaughnessy AF, Slawson DC, Bennett JH. Becoming an information master: a guidebook to the medical information jungle. J Fam Pract 1994; 39:489–499.
3. Barrie AR, Ward AM. Questioning behaviour in general practice: a pragmatic study. BMJ 1997; 315:1512–1515.
4. Covell DG, Uman GC, Manning PR. Information needs in office practice: are they being met? Ann Intern Med 1985; 103:596–599.
5. Osheroff JA, Forsythe DE, Buchanan BG, Bankowitz RA, Blumenfeld BH, Miller RA. Physicians' information needs: analysis of questions posed during clinical teaching. Ann Intern Med 1991; 114:576–581.
6. Smith R. What clinical information do doctors need? BMJ 1996; 313:1062–1068.
7. Woolf S, Benson DA. The medical information needs of internists and pediatricians at an academic medical center. Bull Med Libr Assoc 1989; 77:372–380.
8. Gorman PN, Ash J, Wykoff L. Can primary care physicians' questions be answered using the medical journal literature? Bull Med Libr Assoc 1994; 82:140–146.
9. Knowles MS. Self-directed learning: a guide for learners and teachers. Chicago: Association Press, 1975.
10. Ebell MH. Information at the point of care: answering clinical questions. J Am Board Fam Pract 1999; 12:225–235.
11. Argyris C. Reasoning, learning, and action: individual and organizational. San Francisco: Jossey-Bass, 1982.
12. Ely JW, Levy BT, Hartz A. What clinical information resources are available in family physicians' offices? J Fam Pract 1999; 48(2):135–139.
13. Evans CE, Haynes RB, Birkett NJ, et al. Does a mailed continuing education program improve physician performance? Results of a randomized trial in antihypertensive care. JAMA 1986; 255:501–504.
14. Ebell MH, Barry HC, Slawson DC, Shaughnessy AF. Finding POEMs in the medical literature. J Fam Pract 1999; 48(5):350–355.
15. Nylenna M, Aasland OG. Primary care physicians and their information-seeking behaviour. Scand J Prim Health Care 2000; 18(1):9–13.
16. Slawson DC, Shaughnessy AF, Bennett JH. Becoming a medical information master: feeling good about not knowing everything. J Fam Pract 1994; 38:505–513.
17. CAST Investigators. Preliminary report: effect of encainide and flecainide on mortality in a randomized trial of arrhythmia suppression after myocardial infarction. N Engl J Med 1989; 321:406–412.
18. Sackett DL, Richardson WS, Rosenberg W, Haynes RB. Evidence-based medicine: how to practice and teach EBM. New York: Churchill Livingstone, 1997.
19. Slawson DC, Shaughnessy AF. Becoming an information master: using POEMs to change practice with confidence. J Fam Pract 2000; 49:63–67.
20. Ebell MH, Barry HC. InfoRetriever: rapid access to evidence-based information via a handheld computer. MD Computing 1998; 15(5):289–297.
21. Ebell M, Messimer SR, Barry HC. "Putting computer-based evidence in the hands of clinicians." JAMA 1999; 281(13):1171–1172