Review ■

Online Practice Guidelines:
Issues, Obstacles, and Future Prospects

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A b s t r a c t   The "guidelines movement" was formed to reduce variability in practice, control costs, and improve patient care outcomes. Yet the overall impact on practice and outcomes has been disappointing. Evidence demonstrates that the most effective method of stimulating awareness of and compliance with best practices is computer-generated reminders provided at the point of care. This paper reviews five steps along the path from the development of a guideline to its integration into practice and the subsequent evaluation of its impact on practice and outcomes. Issues arising at each step and obstacles to moving from one step to the next are described. Last, developments that could help overcome the obstacles are highlighted. These include 1) more rapid knowledge acquisition using data mining, 2) better accommodation to imprecise knowledge in clinical algorithms using fuzzy logic, 3) development of a shareable model for guideline representation and execution, and 4) more widespread availability of clinically robust information systems that support decision-making at the point of care.

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The need to reduce variability in practice, control costs, and improve patient care outcomes has stimulated the development of myriad practice guidelines over the past several years.[1-6] Yet systematic reviews have shown that the mere existence of these guidelines does not necessarily lead to changes in practice.[7,8] Problems with the dissemination of guidelines are frequently cited as a major reason for failure to impact practice.[9-11] Certainly, if clinicians are unaware of best practices, they cannot implement them; and if they haven't been convinced of their utility, they will not use them. Even before the "guidelines movement" came into being, nursing literature reflected a long-standing concern with the difficulties of promoting the utilization of research findings in practice.[12-14]

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A Response to a Problem: Online Practice Guidelines

One response to the dissemination problem has been to increase accessibility by making practice guidelines available online. A review of current applications shows a wide range of what is meant by this. In some settings, text guidelines are made available within an agency's existing information system[15] or by means of an intranet using World Wide Web technology. At Partners HealthCare System in Boston, Massachusetts, for example, clinicians can access a variety of text guidelines using an intranet application known as "Handbook." Figure 1 illustrates the text that is displayed when the guideline for "Endocarditis Prophylaxis for Procedures" is selected. Some organizations like the U.S. Agency for Health Care Policy and Research (AHCPR) and the Canadian Medical Association have public Web sites where the guidelines developed by the agency can be accessed at will.[16]

This type of application solves the problem of accessibility to the guideline itself. But access to the knowledge embedded in the guideline can still be problematic when the guideline is long and complex and the answer to a specific question is needed quickly. In today's environment, clinicians have less time than ever to elicit from the patient the specific problems needing attention and then apply the appropriate knowledge for diagnosing or treating the problems.[17] Recent
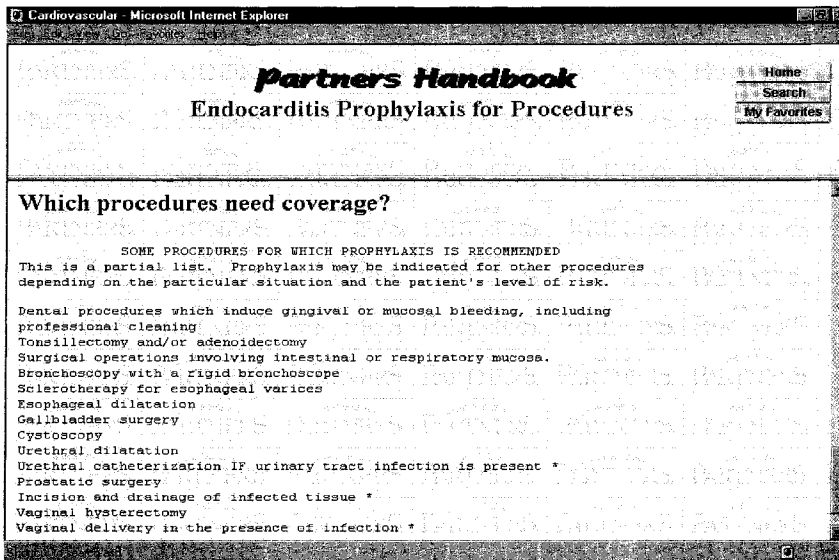
Figure 1 Example of a text guideline made available to clinicians through an agency's intranet.

publications have stressed the need to adapt an industrial paradigm, namely, supplying clinical information to clinicians "just in time" to influence the decision at hand.[18,19] One method of dealing with this need is to provide selective access to the knowledge embedded in the guideline. By entering search phrases or choosing index words, the clinician can be guided to pertinent sections of the guideline, thus enabling rapid retrieval of the needed information. For example, guidelines available at the AHCPR Web site can be accessed by entering search words[16]; Figure 2A illustrates what happens when a user, after selecting the urinary incontinence guideline, has entered the search phrase "urge incontinence." This causes the first section of the guideline where the phrase "urge incontinence" occurs to be displayed, as shown in Figure 2B. Another method of providing access to relevant portions of a guideline is to manually index a guideline with key words, then supply an interface that allows the clinician to select from the list of key words. Jenders et al.[20] describe how the AHCPR Pressure Ulcer Prevention and Treatment Guidelines were indexed and made available to clinicians in this manner.[20]

Interactive algorithms can increase decision support based on guideline knowledge. By entering parameters that are specific to a particular patient, the clinician can get recommendations tailored to that clinical situation.[21-24] In the more sophisticated applications, a rationale is provided for the recommendations given. No data are stored about any individual patient—the application is used as a reference only. Figure 3 illustrates a prototype system for Web-based access to algorithms for pressure ulcer prevention and treatment adapted from the AHCPR guidelines.[25] The

specific topic selected in the illustration is management of tissue loads. After responding yes or no to a series of questions (with the option of getting an explanation of the question if desired), a recommendation is provided. In the illustration, an explanation of the rationale for the recommendation has been requested and is displayed at the bottom of the screen.

The most sophisticated form of online guideline is when a guideline is embedded in a computer-based patient record system. In this situation, programmed rules derived from the guideline operate in the background. The rules are triggered by patient data; when necessary, data unavailable in the record are sought from the clinician interactively; patient-specific recommendations are provided interactively or by various messaging methods. There are only a few examples of this advanced form of guideline-based decision support (see, for example, references 26–30), and only a very few are aimed at nurses.[22,31-33] At Boston's Brigham and Women's hospital, physicians get evidence-based advice about the appropriateness of certain radiology orders based on information entered with an order.[34] Figure 4 illustrates the advice given when a physician orders an abdominal radiograph to determine the cause of gastrointestinal bleeding. Figure 5 summarizes the range of decision support offered by online guidelines based on the degree of structure and integration with the patient's record.

Fully Integrating Highly Structured Guidelines into the Clinical Setting

Reviews of the effectiveness of various methods of guideline dissemination show that the most predictable impact is achieved when the guideline is made

accessible through computer-based, patient-specific reminders that are integrated into the clinician's workflow.[35–40] If this is known to be true, why don't we see more examples of it in the literature and in practice? The reason is that there are many obstacles between developing an officially accepted guideline and making it available in the form of patient-specific reminders. Figure 6 summarizes the steps along the path. Experience has shown, however, that the path is not smooth. What follows is a discussion of the issues that must be faced at each step and the obstacles that often occur. (These are summarized in Table 1.) In the final section, we highlight developments that may help in overcoming the obstacles, making it eas-ier to deliver the promise of influencing practice through evidence-based guidelines.

Step 1: Develop the Guideline

Cook et al.[41] describe a clinical practice guideline quite simply as an "attempt to distill a large body of medical expertise into a convenient, readily usable format." Despite the simplicity of the description, developing a good practice guideline is an exhausting and expensive process.[42,43] Cook and colleagues developed a model describing the steps involved, which begin with assembling a multidisciplinary team to define the problem, distill the available knowledge, and

Figure 2 *A*, Example of a text guideline that allows the clinician to retrieve sections of interest. Here, the clinician wants to search for sections related to "urge incontinence." *B*, Having entered the search, the clinician has been presented with a list of sections containing the phrase "urge incontinence," has selected a section, and gets the text shown here.
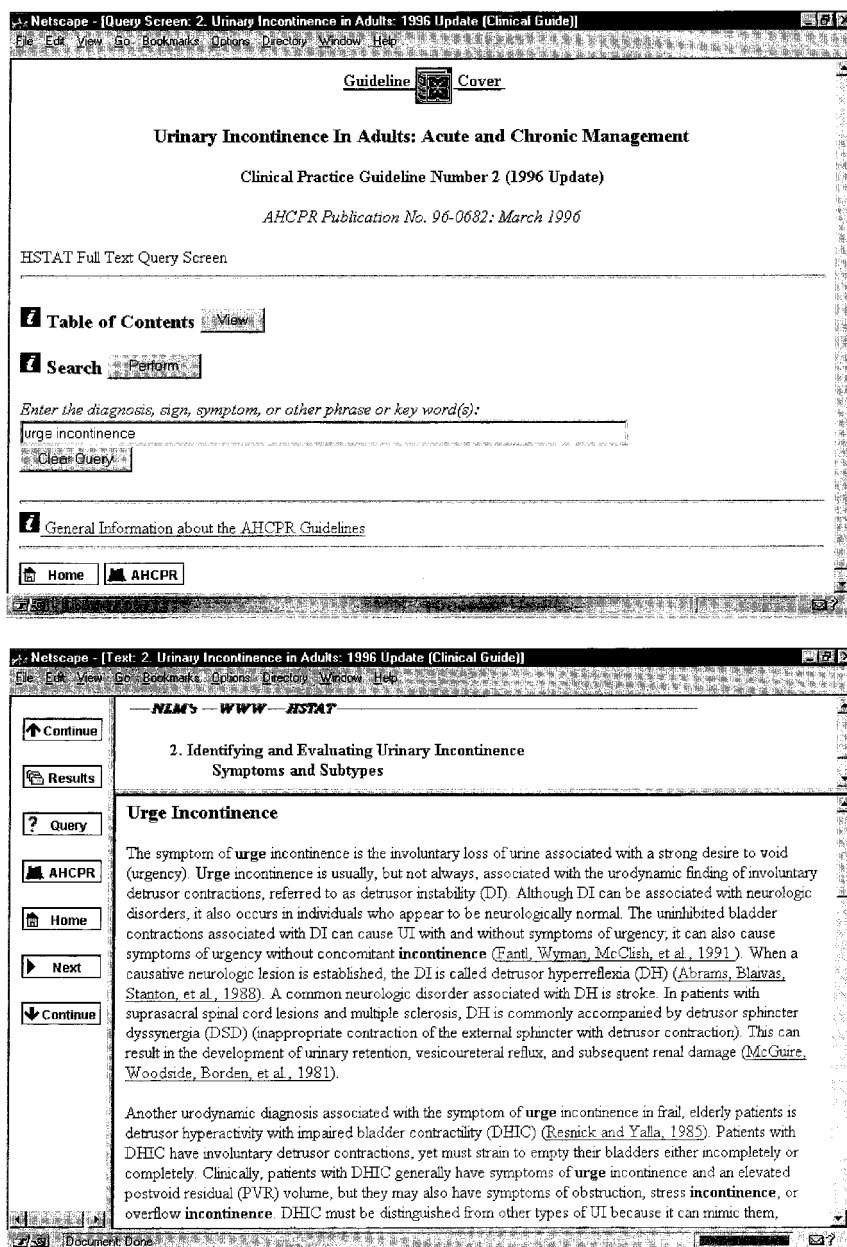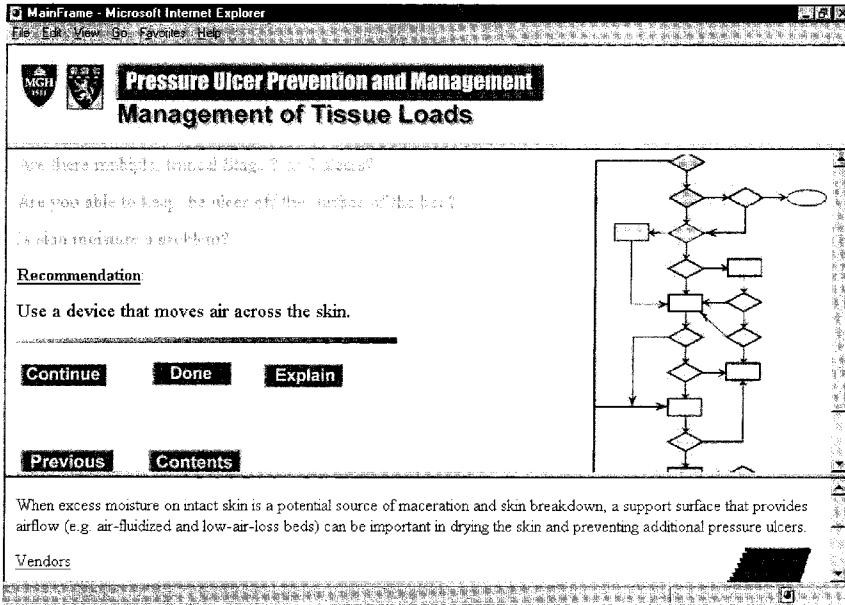
Figure 3 Example of an interactive algorithm, this one on managing tissue loads. The clinician has responded to a series of questions and has received the recommendation shown above. When the clinician then asks the system to "explain" the recommendation, the explanation appears at the bottom of the screen. There is also an optional link to vendor descriptions of the recommended product.

produce recommendations. The guideline must then be implemented and used; process and outcome data must be collected and analyzed; and this information must be combined with updated knowledge to reformulate the recommendations.[41] The process is so complex that organizations around the world that have had experience with the development process are beginning to publish guidelines on how to develop guidelines.[44-48]

<div align="center">Obstacles</div>

Many agencies can attest to the difficulties in achieving consensus on practice guidelines, which range from a sometimes inadequate scientific knowledge base, to conflicting evidence, to an inability to agree on recommendations.[49,50] These obstacles have led to many aborted attempts to develop practice guidelines on particular topics. In the United States, the sheer magnitude of the task is what spurred the creation by Congress of the Agency for Health Care Policy and Research. One of the charges of this agency was to develop authoritative practice guidelines based on best available evidence.

Step 2: Develop an Algorithm from the Text Guideline

In order to develop rules that can be processed by the computer, the text guideline must be converted to an

Figure 4 Example of an evidence-based guideline embedded in a patient record system. Here, the physician has ordered an abdominal radiograph, has responded to prompts for the patient's history, and gets this advisory.
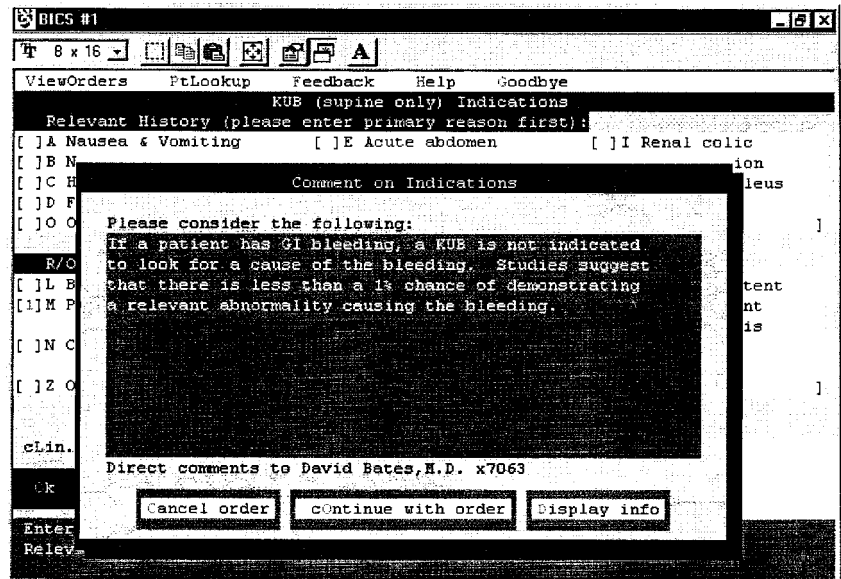
algorithm. The criteria for each decision point in the algorithm must be fully specified without ambiguity. "Waffling" statements such as "in certain circumstances," "under some conditions," and "some experts advise" cannot be computed until the circumstances and conditions are defined precisely. Because clinicians at the point of care will not accept guideline recommendations at face value, the rationale for each recommendation must be clearly stated, with supporting references. Barahona et al.[51] describe the "deep medical knowledge" that is needed to develop clinical guidelines. They assert that this knowledge, often implicit in the guideline itself, must be made explicit for two reasons: 1) to enable better transference to computer-based decision support systems and 2) to promote greater acceptability among clinicians.[51]

Obstacles

Those who have had experience with trying to develop computable algorithms from text guidelines cite the following problems: incompletely specified decision criteria, ambiguity, and failure to account for all possibilities in the clinical situation (lack of comprehensiveness).[22,52–55] Trying to fill in the gaps in order to produce a computable algorithm is tantamount to amending the guideline, a process which may or may not be feasible, depending on the resources assigned to the project.

Step 3: Disseminate Rules and Protocols in a Local Environment

Even when a computable algorithm is achieved, the guideline must be implemented in a particular clinical setting. Ultimately, all clinical decisions are made in a local environment, which includes the practice culture, the characteristics of the particular clinician, and the characteristics of the particular patient. Efforts to educate clinicians and patients about best practices range from publications and continuing education courses to "detailing" by personnel specifically hired for the task.[56,57] In some cases, organization leaders launch major initiatives to promote a culture change that places high value on evidence-based practice.[58,59]
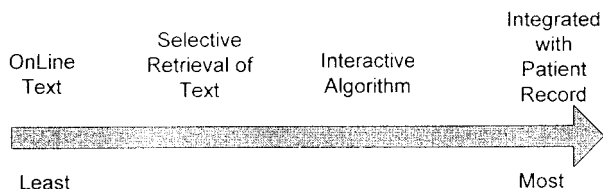

Figure 5 Continuum of decision support offered by various modes of online practice guidelines.
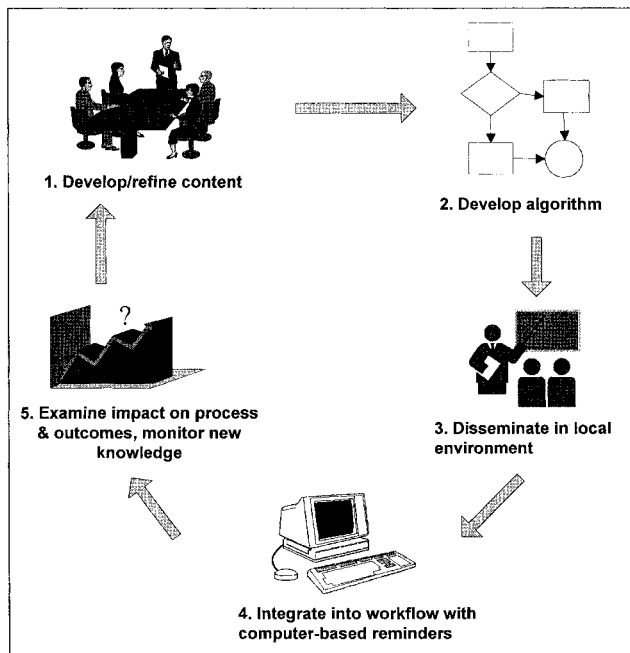

Figure 6 Steps toward fully integrating online guidelines into practice.

Obstacles

Among the many obstacles to achieving clinician acceptance of practice guidelines is conflict with personally held values and beliefs. Even when efforts to educate clinicians about practice guidelines are well carried out, there is evidence that guidelines that conflict with individual practitioners' values and beliefs are unlikely to be followed.[60] Some clinicians resent the very notion of guideline-based practice, denigrating it as "cookbook medicine." The degree of decision-making autonomy provided to practicing clinicians has been related to satisfaction and professionalism, and some view prescribed practice parameters as an infringement on their professional responsibility.

Some clinicians have ethical concerns about implementing guidelines whose primary aim is to reduce costs.[61] Others worry about the legal ramifications of using their professional judgment to override nationally promulgated guidelines of care.[62]

Lack of confidence in the validity of the guideline is frequently cited as a reason for poor acceptance.[63] This is a legitimate concern, as hard evidence for the recommendations prescribed in guidelines is often lacking and their ability to impact outcomes is even less proven.[64,65] Even when a guideline is based on good evidence, applying it in a certain specific environment may yield no benefit or even harmful results, as Wein-

Table 1 ■

Summary of Steps and Obstacles to Online Guidelines Fully Integrated into Practice

Step	Description	Obstacles
Step 1: Develop guideline.	Distill relevant knowledge, provide recommendations reflecting "best practices."	■ Inadequate knowledge base ■ Conflicting evidence ■ Difficulty achieving consensus among experts
Step 2: Develop algorithm from text guideline.	Distill decision points and criteria for decisions; convert to decision flow-chart or decision table.	■ Incompletely specified decision criteria ■ Ambiguity ■ Lack of comprehensiveness
Step 3: Disseminate rules and protocols in a local environment.	Implement guideline in local setting through education of clinicians, "detailing" by personnel, reminders, etc.	■ Conflicts with individual clinicians' values and beliefs ■ Ethical concerns ■ Legal concerns ■ Lack of confidende in validity of guideline ■ Lack of evidence for impact on outcomes ■ Difficulty applying general guideline to case at hand ■ Lack of administrative support, especially infrastructure
Step 4: Integrate guideline-based rules into clinical record system with computer-based reminders.	Install software that runs guideline algorithm within electronic patient record; use existing data or query clinician for needed data; provide patient-specific reminders integrated into workflow.	■ Lack of clinically focused patient record systems with structured, coded data amenable to processing of rules ■ Difficulty designing systems that are easy to use by clinicians ■ Variable accuracy of data stored in computer record ■ Incomplete data in computer record ■ Time and effort to write programs for each guideline to be implemented
Step 5: Examine impact on processes and outcomes, monitor new knowledge, and refine guideline as needed.	Establish mechanisms for measuring impact on processes and outcomes; carry out as appropriate. Establish mechanisms for periodic review of knowledge and revision of guideline as appropriate.	■ Lack of infrastructure for carrying out studies on processes and outcomes ■ Lack of resources for carrying out knowledge synthesis, revision of guideline ■ Expense

garten[63] points out. It is theoretically possible to build a system that allows local variation of the guideline, even at the practitioner level. Fridsma et al.[66] propose a model for doing that, as does Lobach.[67] It seems paradoxical to produce practice guidelines to reduce variations in practice and then build in mechanisms that facilitate local variations, but it seems to be necessary in order to achieve clinician acceptance.

One of the most frequently cited reasons for poor compliance with guidelines is difficulty applying recommendations that are made for populations of patients to the case of a particular patient.[50,63] Poring through pages of prose to find a recommendation that applies to the case at hand (if one can find the pages of prose to begin with) is simply not practical in today's health care environment.[17–19]

The final reason sometimes cited for the failure of guidelines to gain acceptance at a local level is lack of administrative support in 1) promoting a culture where evidence-based practice is valued and recognized, 2) providing the information technology infrastructure needed to support clinical decision-making

based on guidelines, 3) committing the resources to establishing the validity of guidelines in the local environment, and 4) carrying out ongoing quality improvement efforts to examine the impact of the guidelines on process and outcomes. Enlightened leaders are beginning to recognize this, as shown by recent reports that demonstrate strong organizational commitment to providing appropriate support.[58,59]

Step 4: Integrate Guideline-based Rules into the Clinical Record System through Computer-based Reminders

It was stated earlier that the most effective method of influencing clinical decision-making is to provide on-line, interactive, patient-specific reminders that are delivered in time to affect the decision being made.[68] But such a capability depends on having a relatively robust computer-based patient record, in order to have the data to make appropriate recommendations. Patient demographic data, laboratory findings, diagnostic test results stored in coded format, medication and treatment orders and, ideally, patient findings are all essential to the provision of patient-specific recommendations in the context of a particular guideline. In addition, there must be some mechanism for sending messages to the responsible clinician, ideally in a way that is integrated with the workflow. There are several examples in the literature,[26–32] but the sophisticated information systems needed for this type of application are the exception rather than the rule.

Obstacles

There is currently an insufficient technologic infrastructure in most settings to provide patient-specific, guidelines-based decision support. Attaining successful clinical systems is a long, arduous, and risky endeavor. It will be some years before these systems are widespread enough to provide the foundation for such support. Whether these systems will be designed with clinical decision support in mind is another matter, and if they are not, then additional work must be done to try to provide appropriate "hooks" to the data and to the clinician interface.

Even when the infrastructure is available to support online decision support, designing the system to be easy to use and no more time-consuming than traditional methods is often problematic.[69] Failure to address these concerns is often cited as a reason for poor compliance with automated reminder systems.[69]

Another concern is the accuracy of the data on which the algorithms operate. In a recent review of studies on the subject, Hogan and Warner[70] conclude that the "studies report highly variable levels of accuracy" of data in computer-stored records. Litzelman and Tier-

ney[71] cite incompleteness of data (even in their notably robust computer-based patient record) as a significant reason for inappropriate reminders to clinicians. Kuperman et al.[72] describe an application especially designed to retract alerts in cases where erroneously entered data that caused alerts are subsequently corrected.

An additional obstacle to widespread patient-specific decision support based on guidelines is the fact that even if a computable algorithm were developed from a text guideline and made generally available, each site must then program the algorithm to fit in its own technical environment. The programming resources needed to achieve this goal can be considerable, leading to extended delays in implementation and little ability to reuse either the knowledge or the programs.

Step 5: Examine Impact on Processes and Outcomes, Monitor New Knowledge, and Refine Guideline as Needed

There is universal agreement that assessing the impact of guidelines on processes and outcomes of care is essential.[63,73] When guideline recommendations are based mainly on expert opinion, it is critical that data be gathered to demonstrate their validity in clinical practice. Weingarten[63] asserts that even when a guideline shows good evidence of validity in general populations, it may not be portable to particular environments. There are some examples of attempts to evaluate the clinical validity and impact on patient outcomes of particular guidelines, and Weingarten cites several of them.[63] In addition, Petrucci et al.[33] demonstrated that when recommendations from an incontinence guideline were carried out, the number of wet incidents among patients decreased significantly in comparison with the number in units where the recommendations were not available. Willson et al.[31] reported that preliminary results of an automated reminder system pertaining to pressure ulcer prevention indicate a significant reduction in the incidence of pressure ulcers. East et al.[74] showed that standardization of care in critically ill patients with adult respiratory distress syndrome was dramatically improved after implementation of automated protocols, with consequent reduction in patient mortality.

Since knowledge is not static, it is also important to build in the ability to keep abreast of new knowledge and incorporate it into guidelines as appropriate.[75] New knowledge may require substantial revision of the recommendations, necessitating revision of the derived algorithms and a whole new cycle of implementation. Continuous quality improvement applies not only to the care delivered under practice guidelines, but to the guidelines themselves.

Obstacles

The obvious obstacles to this process are the expense and effort required. Some organizations have taken on the task of maintaining the validity of the content for particular topics.[76,77] For some, a commitment to examining the effects of guidelines on costs, processes, and outcomes of care is not so much an academic pursuit as a strategic imperative, since outdated or invalid guidelines embedded in the organization's clinical practice have such potential for harm.

Promising Developments

A vision of the future with respect to online guidelines is one where the obstacles to each step in Figure 6 are overcome. Advances in clinical research, partly assisted by technology, can improve the clinical knowledge base, possibly shortening the time to consensus for achieving evidence-based guidelines. When randomized controlled trials do not provide answers, new technologies such as data mining may help. By this technique, large accumulated clinical data bases are searched to ascertain correlations among findings, diagnoses, treatments, and outcomes, thus enabling the discovery of knowledge based on experience.[78,79] Better experimental and empirical evidence could decrease the need to rely on expert opinion, which is often the source of difficulty in achieving consensus about best practices. Clearer guidelines well supported by evidence may more easily gain clinician acceptance.

Clearer guidelines based on better evidence would also make it easier to construct algorithms and decision tables, leading more readily to computer-based decision support applications. When knowledge remains imprecise, advances in computing methods such as fuzzy logic may assist us in developing decision-support algorithms that take into account the imprecision of the knowledge base.[80]

In an ideal world, these algorithms and tables will be developed in standard interchange formats that permit installation in a wide variety of technical infrastructures, with only moderate programming needed for local requirements. The InterMed Collaboratory[81] has as one of its goals the generation of a shareable model for clinical guideline representation. According to its investigators, "The purpose of this representation is to facilitate the sharing of clinical guidelines, as well as the documentation amplifying on the guideline or particular steps thereof. It enables the construction of translation facilities for conversion of guideline information to and from site-specific formats, and provides a substrate upon which to build

software components that wish to interchange guideline data at runtime."[82] Such a capability would greatly shorten the amount of time currently needed to implement patient-specific decision support based on particular guidelines.

The strategic value of clinical information has increased dramatically since the advent of managed care in the United States. This has stimulated concentrated efforts to develop more advanced clinical information systems. This impetus could lead to an environment where robust systems with structured, coded clinical data provide integrated decision support as a commonplace resource. Evaluation of the effects of guideline-based decisions on patient outcomes can be facilitated by the clinical information system, providing the means to refine the guideline and improve practice still further.

Evidence-based practice made possible through practice guidelines makes great sense to clinicians, payers, and policymakers alike. Efforts to achieve that goal have been labor-intensive and uneven in their impact. Technology holds great promise to make evidence-based practice a reality, leading to the ultimate goal of high-quality, cost-efficient patient care.

References ■

1. Jacox A. Addressing variations in nursing practice/technology through clinical practice guidelines methods. Nurs Econ. 1993;11(3):170–2.
2. Pryor DB, Fortin DF. Managing the delivery of health care: care-plans/managed care/practice guidelines. Int J Biomed Comput. 1995;39:105–9.
3. Magyary D, Brandt P, Fleming J, et al. Nursing specialty practice guidelines: the implications for clinical scholarship and early intervention practice. J Pediatr Nurs. 1993;8(4):253–60.
4. Chassin MR. Practice guidelines: best hope for quality improvement in the 1990s. J Occup Med. 1990;32:1199–1206.
5. Leape LL. Practice guidelines and standards: an overview. Q Rev Biol. 1990;42–9.
6. Sylvestri MF, Marro EP. Disease management: partnering for better patient care. Med Interface. 1996;9(7):100–4.
7. Lomas J, Anderson GM, Domnick-Pierre K, et al. Do practice guidelines guide practice? The effect of a consensus statement on the practice of physicians. N Engl J Med. 1989;321:1306–11.
8. Greco PJ, Eisenberg JM. Changing physicians' practices. N Engl J Med. 1993;329:1271–3.
9. Davis DA, Thomson MA, Oxman AD, Haynes RB. Changing physician performance: a systematic review of the effect of continuing medical educational strategies. JAMA. 1995;274:700–5.
10. Wallace KG, Graham KM, Ventura MR, Burke R. Lessons learned in implementing a staff education program in pain management in the acute care setting. J Nurs Staff Dev. 1997;13(1):24–31.
11. Mosser G, Sakowski J. Establishing a central structure for supporting guideline implementation. Med Interface. 1996;9(7):136–9.

12. McKenna HP. Dissemination and application of mental health nursing research. Br J Nurs. 1995;4(21):1257–63.

13. Stetler CB, Marram G. Evaluating research findings for applicability in practice. Nurs Outlook. 1976;24:559–63.

14. Grilli R. Developing recommendations to promote the uptake of research information in clinical practice. Therapie. 1996;51(3):265–8.

15. Willson D, Neiswanger M. Information system support of changes in health care and nursing practice. Holist Nurs Pract. 1996;11(1):84–96.

16. For example, see the AHCPR home page, available at: http://www.ahcpr.gov (Nov 3, 1997), and the Canadian Medical Association home page, available at: http://www.cma.ca (Nov 3, 1997).

17. Elson RB, Connelly DP. Computerized patient records in primary care: their role in mediating guideline-driven physician behavior change. Arch Fam Med. 1995;4(8):698–705.

18. Elson RB, Faughnan JG, Connelly DP. An industrial process view of information delivery to support clinical decision making: implications for systems design and process measures. J Am Med Inform Assoc. 1997;4(4):266–78.

19. Chueh H, Barnett GO. ''Just-in-time'' clinical information. Acad Med. 1997;72(6):512–7.

20. Jenders RA, Estey G, Martin M, et al. Indexing guidelines: applications in use of pulmonary artery catheters and pressure ulcer prevention. Proc 18th Annu Symp Comput Appl Med Care. 1994:802–6.

21. Margolis A. Computerized practice guidelines for heart failure management: the HeartMan system. Proc 19th Annu Symp Comput Appl Med Care. 1995:228–32.

22. Zielstorff RD, Barnett GO, Fitzmaurice JB, et al. A decision support system for prevention and treatment of pressure ulcers based on AHCPR guidelines. Proc AMIA Annu Fall Symp. 1996:562–6.

23. Cimino JJ, Socratous SA, Clayton PD. Automated guidelines implemented via the World Wide Web. Proc 19th Annu Symp Comput Appl Med Care. 1995:941.

24. Liem EB, Obeid JS, Shareck EP, Sato L. Representation of clinical practice guidelines through an interactive World-Wide-Web interface. Proc 19th Annu Symp Comput Appl Med Care. 1995:223–7.

25. Hulse M, Zielstorff RD, Estey G. User-interface design of a web-based clinical decision support system. Proc AMIA Annu Fall Symp. 1997:951.

26. Schriger DL, Baraff LJ, Hassanvand M, Cretin S. Presentation of clinical guidelines via a rule-based expert chart system. Medinfo. 1995;Part 2:1018–21.

27. Lam SH. Implementation and evaluation of practice guidelines. Proc 17th Annu Symp Comput Appl Med Care. 1993:253–7.

28. Safran C, Rind DM, Davis RB, et al. A clinical trial of a knowledge-based medical record. Medinfo. 1995;Part 2:1076–80.

29. Overhage JM, Tierney WM, McDonald CJ. Computer reminders to implement preventive care guidelines for hospitalized patients. Arch Intern Med. 1996;156:1551–6.

30. Sittig DF, Pace NL, Gardner RM, et al. Implementation of a computerized patient advice system using the HELP clinical information system. Comput Biomed Res. 1989;22:474–87.

31. Willson D, Ashton C, Wingate N, et al. Computerized support of pressure ulcer prevention and treatment protocols. Proc 19th Annu Symp Comput Appl Med Care. 1995:646–50.

32. Tape TG, Stoupa RA, Campbell JR. Implementing guidelines in ambulatory practice. Proc Annu Symp Comput Appl Med Care. 1992:806–7.

33. Petrucci K, Petrucci P, Canfield K, et al. Evaluation of UNIS: urological nursing information system. Proc 15th Annu Symp Comput Appl Med Care. 1991:43–7.

34. Harpole LH, Khorasani R, Fiskio J, et al. Automated evidence-based critiquing of orders for abdominal radiographs: impact on utilization and appropriateness. J Am Med Inform Assoc. 1997:511–21.

35. Nilasena DS. A computer-generated reminder system improves physician compliance with diabetes preventive care guidelines. Proc 19th Annu Symp Comput Appl Med Care. 1995:640–5.

36. Lobach DF, Hammond WE. Development and evaluation of a computer-assisted management protocol (CAMP): improved compliance with care guidelines for diabetes mellitus. Proc 18th Annu Symp Comput Appl Med Care. 1994:787–91.

37. Elson RB, Connelly DP. Computerized patient records in primary care. Arch Fam Med. 1995;4:698–705.

38. Robbins JA, Dickinson A, Bartel AG, Hartman CW. Lipid management program: results of applying national guidelines in a private practice. South Med J. 1993;86(3):289–92.

39. Yamamoto LG, Wiebe RA. Pediatric and adult emergency management assistance using computerized guidelines. Am J Emerg Med. 1989;7(1):91–6.

40. Barnas GP, Green SS, Schmitt SM. The impact of incorporating NCEP cholesterol guidelines into a computerized prevention feedback reminder system. Proc AMIA Annu Fall Symp. 1996:827.

41. Cook DJ, Greengold NL, Ellrodt AG, Weingarten SR. The relation between systematic reviews and practice guidelines. Ann Intern Med. 1997;127:210–6.

42. Lumsdon K. Disease management: the heat and headaches over retooling patient care create hard labor. Hosp Health Netw. 1995;69(7):34–36, 38, 40–2.

43. Bosl GJ. Development and implementation of clinical management guidelines. Oncology (Huntingt). 1996;10(11 suppl):247–53.

44. Marek KD. Manual to Develop Guidelines. Washington, DC: American Nurses Publishing, 1995.

45. Dean-Baar SL. Application of the new ANA framework for nursing practice standards and guidelines. J Nurs Care Qual. 1993;8(1):33–42.

46. Canadian Medical Association. Guidelines for Canadian Clinical Practice Guidelines. Ottawa, Ontario: CMA, 1994.

47. Agency for Health Care Policy and Research. Clinical practice guidelines development [AHCPR program note]. Silver Spring, Md: AHCPR, 1993. Publication 93-0023.

48. Field MJ, Lohr KN (eds). Guidelines for Clinical Practice: From Development to Use. Washington, DC: National Academy Press, 1992.

49. Scott L. Disease management faces obstacles. Mod Healthcare. 1995;25(24):30–3.

50. Fletcher RH, Fletcher SW. Clinical practice guidelines [editorial]. Ann Intern Med. 1990;113:645–6.

51. Barahona P, Walton R, Ilic Z, daSilva JF. Deep medical knowledge to design clinical guidelines. Comput Methods Programs Biomed. 1995;48(1–2):27–34.

52. Shiffman RN. Towards effective implementation of a pediatric asthma guideline: integration of decision support and clinical workflow support. Proc 18th Annu Symp Comput Appl Med Care. 1994:797–801.

53. Shiffman RN, Greenes RA. Improving guidelines with logic and decision-table techniques. Med Decis Making. 1994;14(3):245–54.

54. Tierney WM, Overhage JM, Takesue BY, et al. Computerizing guidelines to improve care and patient outcomes: the

example of heart failure. J Am Med Inform Assoc. 1995;2: 316–22.

55. McDonald CJ, Overhage JM, Tierney WM, et al. The promise of computerized feedback systems for diabetes care. Ann Intern Med. 1996;124(1, pt 2):170–4.

56. Rischer JB, Childress SB. Cancer pain management: pilot implementation of the AHCPR guideline in Utah. Jt Comm J Qual Improv. 1996;22(10):683–700.

57. Schmidt KL, Alpen MA, Rakel BA. Implementation of the Agency for Health Care Policy and Research pain guidelines. AACN Clin Issues. 1996;7(3):425–35.

58. Bisognano MA, Caldwell C. Best practices in quality leadership. Qual Lett Healthc Lead. 1995;7(6):16–21.

59. Rafuse J. Evidence-based medicine means MDs must develop new skills, attitudes, CMA conference told. Can Med Assoc J. 1994;150:1479–81.

60. Wallace CJ, Metcalf S, Zhang X, et al. Cost effective computerized decision support: tracking caregiver acceptance at the point of care. Proc 19th Annu Symp Comput Appl Med Care. 1995;810–3.

61. Berger JT, Rosner F. The ethics of practice guidelines. Arch Intern Med. 1996;156:2051–6.

62. Murphy RN. Legal and practical impact of clinical practice guidelines on nursing and medical practice. Adv Wound Care. 1996;9(5):31–4.

63. Weingarten S. Practice guidelines and prediction rules should be subject to careful clinical testing. JAMA. 1997;277: 1977–8.

64. Nash DB. Practice guidelines and outcomes. Where are we headed? Arch Pathol Lab Med. 1990;114:1122–5.

65. Appleton JV. Establishing the validity and reliability of clinical practice guidelines used to identify families requiring increased health visitor support. Public Health. 1997;111(2): 107–13.

66. Fridsma DB, Gennari JH, Musen MA. Making generic guidelines specific. Proc AMIA Annu Fall Symp. 1996:597–61.

67. Lobach DF. A model for adapting clinical guidelines for electronic implementation in primary care. Proc 19th Annu Symp Comput Appl Med Care. 1995:581–5.

68. Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. Ann Intern Med. 1994;120:135–42.

69. Nilasena DS, Lincoln MJ, Turner CW, et al. Development and implementation of a computer-generated reminder system for diabetes preventive care. Proc 18th Annu Symp Comput Appl Med Care. 1994:831–5.

70. Hogan WR, Wagner MM. Accuracy of data in computer-based patient records. J Am Med Inform Assoc. 1997;4: 342–55.

71. Litzelman DK, Tierney WM. Physicians' reasons for failing to comply with computerized preventive care guidelines. J Gen Intern Med. 1996;11:497–9.

72. Kuperman GJ, Hiltz FL, Teich JM. Advanced alerting features: displaying new relevant data and retracting alerts. Proc AMIA Annu Fall Symp. 1997:243–7.

73. Naditch MP. Practice guidelines and the emperor's new clothes. J Healthcare Resource Manag. 1995;13(12):24–7.

74. East TD, Morris AH, Wallace CJ, et al. A strategy for development of computerized critical care decision support systems. Int J Clin Monit Comput. 1992;8:263–9.

75. Gotzsche PC. Clinical practice should reflect clinical science. Stud Health Technol Inform. 1995;16:17–25.

76. Bonichon F, Renaud-Salis JL, Philip T. Development, dissemination and implementation of best cancer practices: the ECOLE/GRIP project [meeting abstract]. Anti-Cancer Treatment, Sixth International Congress, 1996:131.

77. Parboosingh EJ, Anderson G, Clarke EA, et al. Cervical cancer screening: are the 1989 recommendations still valid? Can Med Assoc J. 1996;154:1847–53.

78. Prather JC, Lobach DF, Goodwin LK, et al. Medical data mining: knowledge discovery in a clinical data warehouse. Proc AMIA Annu Fall Symp. 1997:101–5.

79. Eriksen LR, Turley JP, Denton D, Manning S. Data mining: a strategy for knowledge development and structure in nursing practice. Proc 6th Int Cong Nurs Inform (NI '97). Amsterdam, The Netherlands: IOS Press, 1997:383–8.

80. Liu JCS, Shiffman RN. Operationalization of clinical practice guidelines using fuzzy logic. Proc AMIA Annu Fall Symp. 1997:283–7.

81. Shortliffe E, Barnett G, Cimino J, et al. Collaborative medical informatics research using the Internet and the World Wide Web. Proc AMIA Annu Fall Symp. 1996:125–9.

82. Deibel SRA. Introduction to the InterMed Common Guideline Model and Guideline Interchange Format (GLIF). Available at: http://dsg.harvard.edu/public/intermed/glif_overview.html. Accessed November 3, 1997.