Toward Improved Implementation of Evidence-based Clinical Algorithms: Clinical Practice Guidelines, Clinical Decision Rules, and Clinical Pathways

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Abstract

This is a summary of the consensus-building workshop entitled “Guideline Implementation and Clinical Pathways,” convened May 15, 2007, at the Academic Emergency Medicine Consensus Conference, “Knowledge Translation in Emergency Medicine: Establishing a Research Agenda and Guide Map for Evidence Uptake.” A new term, “evidence-based clinical algorithms” is suggested to encompass evidence-based information codified into clinical pathways, clinical practice guidelines, and clinical decision rules. Examples of poor knowledge translation (KT) relevant to the specialty of emergency medicine are identified, followed by brief descriptions of important research and concepts that inform the research recommendations. Four broad themes for research to improve the KT of evidence-based clinical algorithms are suggested: organizational factors, cognitive factors, social factors, and motivational factors. In all cases, research regarding optimizing KT for the subthemes identified by Glasziou and Haynes, “getting the evidence straight,” and “getting the evidence used,” are interwoven into the thematic research recommendations. Consensus was reached that the majority of research efforts to evaluate means to improve KT need to be centered on the factors that show promise to enhance “getting the evidence used,” focused especially on organizational factors.

Keywords: evidence-based medicine, decision trees, algorithms, clinical protocols, research design

A knowledge translation (KT) gap exists between the care patients receive and the evidence available to guide the delivery of that care. Thirty percent to 45% of patients do not receive care that is supported by current scientific evidence, and 20%–25% of the care provided may actually be unneeded or even harmful.1-3 These factors contribute to waste in the health care system.4 Some recent examples of KT gaps relevant to emergency medicine (EM) include the use of oral calcium channel blockers for rapid blood pressure reduction,5 a delay of approximately a decade between the clear and unambiguous evidence that fibrinolysis decreases mortality for acute ST-elevation myocardial infarction and its general acceptance6 (this benefit was first reported in the late 1970s and confirmed by several studies published in 19867,8), inappropriately vigorous out-of-hospital fluid resuscitation,9,10 and the induction of emesis in overdose patients.11 Graham et al. have

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noted “...patients are denied treatment of proven benefit because the time it takes for research to become incorporated into practice is unacceptably long.”12 This sentiment has been echoed by the U.S. Agency for Healthcare Research and Quality.13

Clinical pathways, clinical practice guidelines, and clinical decision rules, which hereafter will be referred to as evidence-based clinical algorithms (EBCAs), are tools that show promise to ameliorate these problems. EBCAs codify available evidence into specific rules and action plans. These “prepackaged” action plans facilitate the delivery of appropriate, efficient, evidence-based care to the bedside of patients suffering the illnesses or injuries for which these EBCAs have been developed. Human factors engineers would tell clinicians that EBCAs can augment clinicians’ ability to deliver complicated, multistep treatments consistently, without omitting important steps, while freeing their cognitive abilities and intellect to focus on the situational, contextual, intrapersonal, and intuitive nature of health care delivery. Work is under way to model medical decision-making processes using an aviation and aerospace error management model, but such efforts are still in their infancy.14

The promise of existing EBCAs of relevance to EM has yet to be realized. Some examples include the following:

- The clinical decision rule known as the Ottawa Ankle Rules (OARs) was derived in 199015 and validated in 1993.16 Subsequent research has confirmed its validity.17 Yet, implementation of the OARs has been poor.18,19
- EBCAs for care of patients with acute myocardial infarction, such implementation of the “Door to Balloon Initiative,”20 as the 2004 update of the American College of Cardiology/American Heart Association clinical guidelines,21 and of specific therapies such as Glycoprotein IIb/IIIa Inhibitors in Non-ST-Elevation Acute Myocardial Infarction,22 have not been well implemented, with negative consequences to patients,23 especially among those at higher risk for poor outcomes.24,25
- Implementation of Sepsis Care Bundles, as developed by researchers led by Emmanuel Rivers,26 which can be quite effective when well implemented,27 has been characterized by marked interinstitutional variability, with adverse consequences for patients whom compliance is poor.28

The process of identifying areas of clearly defined, evidence-based best practice, and comparing this with the care that is actually delivered, is crucial to improving KT and to improving the care patients receive. Once gaps between scientific evidence and its delivery have been mapped, barriers to implementation of best therapies can be identified and study of the best methods to overcome these barriers can begin. Research to characterize these gaps and these barriers, and how best to overcome them, is needed.

We present our research agenda recommendations for the theme “Toward Improved Clinical Practice Guideline, Clinical Decision Rule, and Clinical Pathway Implementation,” as developed at the 2007 Academic Emergency Medicine Consensus Conference, “Knowledge Transla-

tion in Emergency Medicine: Establishing a Research Agenda and Guide Map for Evidence Uptake.” The consensus conference was held May 15, 2007, in conjunction with the 2007 Society for Academic Emergency Medicine annual meeting in Chicago, Illinois.

The high attendance at this particular theme, driven in part by the attendance of many prospective end users of the research this conference hoped to inspire, demonstrates a mandate for increased dissemination of practical knowledge, and for increased research output, with respect to the science of implementation of EBCAs. The most common motivation expressed for attending this session, as expressed by one attendee, was to “...learn how to do KT for EBCAs better.” A research “push” from researchers will be met by a “pull” from those who will become consumers of the knowledge such research will demonstrate.29

The session’s consensus recommendations, which propose a research agenda for improving KT for EBCAs, focused primarily on research to improve implementation of EBCAs. Thus, the recommendations focused to a greater degree on “getting the evidence used” than on “getting the evidence straight,” as dichotomized by Glasziou and Haynes.30 Three of the session’s four thematic foci (cognitive factors, social factors, and motivational factors) appear to be interwoven, together supporting the fourth theme, organizational factors (Figure 1).

Several conceptual models have informed our efforts. The first is the sigmoidal-shaped cumulative adoption curve that characterizes adoption of virtually all new information and new products (Figure 2). Such a curve was first described for the adoption of planting hybrid seed corn by Iowa farmers during the era of the Great Depression.31 The curve can be transformed to a normal distribution curve, with time to adoption on the ordinate and adopter numbers on the abscissa.32 Five classes of adopters, as originally categorized by Rogers,33 can be recognized.32 “Innovators” are those 2.5% who adopt ≥2 standard deviations (SDs) faster than the mean. “Early adopters” are the next 13% who adopt...
between 1 and 2 SD faster than the mean. These are opinion leaders and interact with the more maverick “innovators.” The “early majority” adopt innovations 0 to 1 SD faster than the mean. They maintain a more local perspective than their faster-adopting peers. More conservative are the “late majority,” the 34% who adopt 0 to 1 SD slower than the mean, when adoption represents the status quo. Finally, the 16% who adopt more than 1 SD later than the mean, originally called “laggards,” might be better called “traditionalists.” At its core, the purpose of KT research is to shorten the time interval between KT by the innovators and the traditionalists.

Second, the ACP Journal Club article by Glasziou and Haynes in 2005 (Figure 3) described a seven-step pathway between research and improved health outcomes, beginning with clinicians being aware of the relevant information and ending with patients needing to adhere to the recommendation. Steps 1–3 are captured by the concept of “bedside evidence-based medicine”; clinicians must be able to recognize and accept the opportunity to deliver evidence-based care. Steps 3–5 encompass steps that clinical quality improvement initiatives can monitor. Steps 6 and 7 complete the implementation of EBCAs.

Third, no discussion about KT would be complete without recognizing the role of the social sciences and the study of the diffusion of innovation. Theme IIb, Cognitive, Social and Behavioral Factors, authored by Brehaut et al., develops these factors more fully. Thought leaders such as Everett Rogers and Andrew Van de Ven focus on three clusters of influence that, at least in descriptive studies, parallel the rate of spread of a change. These clusters of influence are perceptions of the innovation, characteristics of the persons who adopt the innovation (or fail to do so), and contextual factors that impact adoption of innovation (especially those that involve “…communication, incentives, leadership, and management”).

With these issues and concepts in mind, we present our set of recommendations.

**RESEARCH QUESTIONS**

**Cognitive Factors**

1. Researchers should study whether or not educational efforts targeted not only at emergency physicians (EPs) but also non-EPs (including emergency nurses, office-based physicians who see emergency department patients in follow-up, and patients) can improve acceptance of and compliance with EBCAs.
2. Researchers should study in more detail the question of how EPs think, so that EBCAs can be more effectively utilized.
3. Researchers should also study, “How well must clinicians understand an EBCA, in order for those clinicians to implement that algorithm?”

**Discussion.** Implementation of EBCAs relevant to EM may be enhanced by education, developed not only for EPs but also for physicians outside of our specialty, nurses and allied health workers, and patients. It is obvious that EPs must be aware of EBCAs to implement them. It is not clear how much effect intensive educational efforts have on the speed of EBCA uptake. However, implementation of EBCAs involves a team effort, and that team is not composed strictly of EPs. When EBCAs involve follow-up care of a physician from another specialty, implementation may be derailed if that follow-up physician is unaware of the EBCA. For example, an orthopedist ignorant of the OARs may react with disdain (which can cause patients to question the quality of their emergency department care) when no ankle film has been obtained for patients for whom the OARs determine no need for radiography. Nurses, who generally perceive themselves as patient advocates and educators, probably need to be both aware of and supportive of EBCAs if clinical implementation of EBCAs is to succeed. If nurses or allied health personnel, in conversations with patients, cast doubt on the validity or appropriateness of EBCAs, patient compliance and acceptance of these EBCAs is likely to suffer. Patients, who for whatever reason might not accept the validity of EBCAs, might engage clinicians in time-consuming clinical debate or might express dissatisfaction or noncompliance with algorithm-guided care when they do not believe or trust the algorithm. Inpatient efforts that involve physicians of multiple specialties risk failure if all team members are not educated in regard to the evidence and the rationale for the EBCA. For instance, some general surgeons remain ignorant of the fact that the administration of narcotic pain medication to patients with abdominal pain will not lead to management errors in diagnosing these patients. Implementation of EBCAs for patients with sepsis requires extensive teamwork across numerous medical specialties and hospital departments. The ability of various educational methods to help important stakeholders “get the evidence straight,” to improve non-EP awareness and acceptance of EBCAs, and to improve patients’ understanding and acceptance of EBCAs requires further study.

Most of EPs’ time is spent in cognitive behavior, more than is spent in procedural or affective behavior. The issue of how EPs’ thinking is unique deserves further study. EM presents its practitioners with a clinical milieu having greater inconstancy, variety, uncertainty, and complexity than do most other specialties. Kassirer has stated,
No matter how advanced our technology becomes, and no matter how far our computer systems evolve, the cognitive tactics and strategies for the clinician-problem-solver are not likely to be replaced in the foreseeable future. (Medical educators) should recognize that these critical cognitive skills constitute a specific body of knowledge and should find imaginative ways of teaching them.

The question of how to make educational interventions more efficacious, to facilitate “getting the evidence used,” deserves further study. There should not only be an assessment of whether or not understanding is present, but also an assessment of the influence of understanding on the motivation of the practitioner to adopt the new EBCA. Interaction may exist between understanding the rationale for an EBCA and clinician motivation to implement it and between this motivation and actual implementation.

In regard to other cognitive factors that impact KT, see recommendations from Brehaut et al. For more on motivational factors, see recommendation 3 in the following text.

**Nature of Consensus.** Evidence-based, plus expert opinion.

**Social Factors**

1. Social factors may influence patient trust of EBCAs applied to them and may influence both “getting the evidence straight” and “getting the evidence used.” Research investigating optimal social contexts and structures to transmit patient appropriate education, in a manner that engages trust and enhances compliance, should be evaluated. Social factors that influence physicians’ knowledge of medical evidence are a primary focus of the group led by Brehaut and are not further discussed here.

2. Researchers should also attempt to determine the optimal mechanisms of social interaction for clinicians to best enable an environment to foster knowledge uptake and change.

**Discussion.** Certain social and/or social structure variables may influence patient acceptance of EBCAs. For inpatient therapy, patient consent is required (except for emergencies). For outpatient therapy, patient compliance is crucial. If trust is not engendered, patient compliance may suffer, hampering effectiveness of care (consider the impact of the Tuskegee Syphilis Study on the African American community). Methods to overcome patient and/or patient group distrust of physicians and of the health care delivery system in general deserve further study. Trust building is a necessary step toward patient knowledge of, compliance with, and acceptance of EBCAs.

In addition, social interactions modify behavior, but little knowledge exists regarding the mechanisms by which this occurs for KT. Also, little knowledge exists regarding the factors that promote these favorable mechanisms. Research is needed to define factors that enable creation
of an environment supportive of practice change and thus able to accommodate and quickly support adoption of validated, new EBCAs. This is true for patient-centered and for clinician-centered factors.

Researchers should study the relative contribution of a sense of community, a nonpunitive group culture, an environment that favors group learning, and internalization of comparable feedback in one’s individual practice self-assessment, as can be enabled by a Communities of Practice (CoP) model. Research is also needed regarding other socially related factors that may stand between the existence of good evidence and its delivery to the patient.

Nature of Consensus. Evidence-based, plus expert opinion.

Motivational Factors
1. Researchers should study how to best motivate clinicians to stay “up to date,” in regard to keeping current medical evidence “straight.”
2. Study is needed to determine how clinician and patient motivations influence implementation of knowledge embedded in EBCAs (patient-related motivational issues are inherent in the social factors related to recommendation 2, above).

Discussion. The effectiveness of knowledge uptake may vary, depending on whether the suggestion to learn new knowledge comes from the clinicians themselves, other clinicians, academic detailing,40 requirements related to the maintenance of specialty board certification,41 or administrators. These potential influences on clinician motivation require further comparison and evaluation.

Certain models of interaction are known to favorably motivate clinicians. A CoP model, as has been applied in Australia to support the uptake of evidence across the emergency care setting, is an effective tool to create a willingness to change. The experience from the Cancer Care Ontario CoP, which focuses on multifaceted KT with emphasis on social influence elements, is illustrated by the following feedback from these CoP participants. According to postevent feedback forms, 60% of participants (on average) plan to change their practice based on information they received at CoP events.42 Factors that may foster willingness and deserve further study include self-motivation, altruism, drive for self-excellence, pressure from peers, and fear of negative consequences. However, not only is knowledge needed regarding whether and why physicians are willing to make changes and implement evidence-based care; knowledge is needed regarding what factors motivate clinicians beyond willingness to actual implementation and to the sustaining of that implementation.43,44 The interaction of motivation for change (as the independent variable) versus success of implementing and/or sustaining change (as the dependent variable), across a variety of reward schemes, deserves investigation to study the influence of motivation and reward on KT. Also, study is needed regarding what negative motivational stimuli or influences work against change.35,45

More specifically, study is needed regarding how incentives to patients and to clinicians can be adjusted to deliver the care patients need, which may not be the care they want. For example, if a patient’s out-of-pocket charge for an emergency department visit for an ankle injury is not increased by obtaining a radiograph, the clinician may perceive that the effort needed to educate the patient regarding the OARs is not worth the time, and these rules may be ignored due to motivational factors. In addition, the patient may complain about perceived poor treatment, provide low patient satisfaction scores if surveyed, or engage a hurried clinician in time-consuming clinical debate. Such motivational influences may derail efforts to implement KT to the care of the patient.

Nature of Consensus. Evidence-based, plus expert opinion.

Organizational Factors
1. Study is required regarding the influence that the nature of educational organizations, the mode of material presentation, and the characteristics of the person(s) doing the educating have on the effectiveness of clinician education.
2. The influence of local presentation of algorithms versus electronic “distance learning” presentation should be studied.
3. Whether educational efforts should be directed differently, in terms of timing or in terms of educational mode or content, for the five adopter groups (innovators, early adopters, early majority, late majority, and traditionalists) as conceived by Rogers should be studied.
4. Researchers should also study what enhances and detracts from system effectiveness in the implementation of EBCAs. These studies should take place both on the large-scale, multi-institutional level and at the local level, within institutions.
5. Circumstances enabling KT may differ within different health care systems. Another organizational factor that should be studied is whether regular international systematic review and appraisal of relevant literature can enhance adoption of EM-specific EBCAs by enhancing their adoption to different local health care systems.
6. All studies of organizational influences on KT for EBCAs would be facilitated by the adoption of standardized nomenclature.

Discussion. “Getting the evidence straight” factors that are organizational in nature, and that may influence clinicians’ learning of clinical care algorithms, include whether the approach is one of traditional education versus “marketing” new information, whether or not “opinion leaders” or “champions” are utilized to convey educational messages, the frequency of reminders about the clinical care algorithm, the rapidity of “rollout” of the new information, and the organization of the clinical care environment (whether accessing EBCAs can be done in a “user-friendly” manner). All merit further study. In addition, study is needed regarding whether educational efforts should be organized or directed differently, in terms of timing or in terms of educational mode or content, for the five adopter
groups (innovators, early adopters, early majority, late majority, and traditionalists) as conceived by Rogers.  

Regarding “getting the evidence used,” little data exist regarding efficacy of structures that foster implementation of evidence-based practice within EM. Both within-hospital and at multihospital/multisystem levels of organization, study is needed regarding how clinicians and administrators can work together to trigger change favoring delivery of EBCAs. At the multi-institutional level, evaluation of how public policy can be constructed to support these changes is needed. Potential leadership from organizations in the United States, such as the Agency for Healthcare Research and Quality, requires further cultivation. Goubanova reported that a supportive multi-institutional CoP process for surgical oncology care has shown success when configured as follows:

| Problem identified by practitioners | Gap and barrier analysis | Communication → iterative feedback back of data |
| Professional development | Multidisciplinary projects | Evidence adoption |

However, CoP models need more study regarding how to most effectively enhance learning among their member-practitioners, how to more effectively engage practitioners in system-level enhancements to KT, how to improve the environment supportive of KT, and how to sustain change once it has occurred. Also, at the multi-institutional level, standardization of nomenclature, terminology, and defined end-points may be needed to enhance KT by enhancing the clarity of research communications, much as the Ustein guidelines and the Bone et al. consensus helped standardize resuscitation trial reporting and sepsis research, respectively. Work has been performed comparing different single organizational efforts to implement different feedback techniques and study their effects on practice patterns. Surveys designed to identify common factors at locations where practice change has successfully occurred have been initiated, as regards the implementation of sepsis bundle therapy. Studies of multiple institutions are needed to evaluate what factors characterize organizations that fail, versus what factors characterize those that succeed, in various types of KT efforts. Items for study could include the following: what medical information systems are best at fostering KT; whether preformatted algorithm templates improve implementation of EBCAs; how often and intense continuous quality improvement and peer feedback must be; who receives the feedback (physicians, nurses, both, or other); who provides the feedback (a fellow clinician, an administrator, or other); the role of “champions” of change; the role of different strategies for change when implementing changes of various complexity; the role of different strategies for change when few, or many, departments of a hospital are involved (as exemplified by implementing OARs vs. sepsis bundles); the best means to foster acceptance of new EBCAs among colleagues from multiple specialties and from patients; what differences exist for organizational factors that favor efficient KT when relatively frequently used vs. relatively infrequently used EBCAs are compared (as exemplified by implementation of sepsis bundles vs. the application of hypothermia for cardiac arrest survivors); what differences exist for organizational factors that favor efficient KT when single-step vs. multistep EBCAs are implemented; possible influences of the size, type (teaching vs. community), and location (urban vs. suburban vs. rural) of the hospital; what organizational factors increase the local degree of motivation of nonphysicians to cooperate willingly in KT efforts; the possible influence of nursing staffing ratios; and “audit and feedback” on efficient KT for any EBCA.

**Nature of Consensus.** Expert opinion.

**CONCLUSIONS**

It is hoped that by investigation of these issues, KT practices can become better informed by data and KT can be enhanced to help close the gap between the knowledge that underpins EBCAs and the implementation of those EBCAs. It appears that the majority of efforts need to be centered on the factors that will enhance “getting the evidence used,” focused especially on organizational factors.

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**References**


