
Graduate Medical Education and Knowledge Translation: Role Models, Information Pipelines, and Practice Change Thresholds

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Abstract

This article reflects the proceedings of a workshop session, Postgraduate Education and Knowledge Translation, at the 2007 *Academic Emergency Medicine* Consensus Conference on knowledge translation (KT) in emergency medicine (EM). The objective was to develop a research strategy that incorporates KT into EM graduate medical education (GME). To bridge the gap between the best evidence and optimal patient care, Pathman et al. suggested a multistage model for moving from evidence to action. Using this theoretical knowledge-to-action framework, the KT consensus conference group focused on four key components: acceptance, application, ability, and remembering to act on the existing evidence. The possibility that basic familiarity, along with the pipeline by Pathman et al., may improve KT uptake may be an initial starting point for research on GME and KT. Current residents are limited by faculty GME role models to demonstrate bedside KT principles. The rapid uptake of KT theory will depend on developing KT champions locally and internationally for resident physicians to emulate. The consensus participants combined published evidence with expert opinion to outline recommendations for identifying the barriers to KT by asking four specific questions: 1) What are the barriers that influence a resident's ability to act on valid health care evidence? 2) How do we break down these barriers? 3) How do we incorporate this into residency training? 4) How do we monitor the longevity of this intervention? Research in the fields of GME and KT is currently limited. GME educators assume that if we teach residents, they will learn and apply what they have been taught. This is a bold assumption with very little supporting evidence. This article is not an attempt to provide a complete overview of KT and GME, but, instead, aims to create a starting point for future work and discussions in the realm of KT and GM.

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Keywords: graduate medical education, residents, emergency medicine, knowledge translation, core competency

The task of theme IIIa of this consensus conference on knowledge translation (KT) was to develop a research framework describing how medical education strategies can promote evidence implementation by emergency medicine (EM) resident physicians.

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Received June 7, 2007; revision received July 2, 2007; accepted July 3, 2007.

This is a proceeding from a workshop session of the 2007 *Academic Emergency Medicine* Consensus Conference, "Knowledge Translation in Emergency Medicine: Establishing a Research

KT skills should be appreciated and utilized by medical students, residents, and postgraduate physicians. Yet, each of these groups has a unique baseline skill set and appreciation for the capacity of KT to enhance EM clinical practice. Accordingly, KT education will need to be

Agenda and Guide Map for Evidence Uptake," Chicago, IL, May 15, 2007.

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Dr. Diner is supported by the CDC Foundation Young Investigators in Public Health Research Training Grant, and Dr. Carpenter is supported by the Jahnigen Career Development Grant from the American Geriatric Society.

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tailored to address the specific needs and interests of each end user group.

Medical students are still learning the basics, and the bulk of evidence-based medicine (EBM) skills (critical appraisal and information mastery) would be taught during the undergraduate medical education period. During professional practice, physicians must keep up with changes in practice and regularly apply critical appraisal skills to their reading of the current medical literature in their specialty. The final stage of EBM is efficient information mastery and real-time utilization in the clinical setting (KT). Residency serves as the bridge between these two periods in a physician's professional career.

Our focus group chose to concentrate the research agenda on advancing KT within residency training. The benefits of focusing KT efforts on resident training include an overall receptiveness of residents to develop lifelong professional habits. Residents develop lifelong learning habits and application of new evidence to their clinical practice during postgraduate medical education. Medical students, on the other hand, are still learning essential background information and basic EBM skill sets necessary to efficiently and effectively perform KT. Residents were also targeted due to the recent development of the core competencies,^{1,2} and the availability of supporting professional organizations such as the Council of Emergency Medicine Residency Directors and the Emergency Medicine Residents' Association, to broadly expand KT throughout residency programs as practice-based core competencies are further defined.

Although the application of relevant medical evidence to appropriate clinical populations has been presumed throughout the history of postgraduate medical education, scant research has been conducted assessing the translation from publication of evidence to routine bedside care. Many physicians lack a solid understanding of when to cross the threshold from insufficient evidence to evidence that should change practice behavior. Not surprisingly, the early stages of KT are challenged by a lack of graduate medical education (GME) role models for residents to learn the balance between the art of medicine (experience) and the science of practice change (interpreting and applying valid new evidence).

Ideally, clinician behavioral change in resident training programs would occur using bedside application of best evidence principles with model instructors that demonstrate the balanced application of evidence from clinical research and past experience to patient-specific situations.³ Lacking local KT champions upon which to model bedside care, traditional didactic and journal club models have been used with limited success to promote clinician behavior change in residency and beyond.⁴⁻⁸ Affecting real-time behavior change will require a better understanding of the cognitive pathways used in clinical decision-making⁹ and the barriers to using evidence in specific scenarios.¹⁰⁻¹² Given the lack of literature and experience with the science of KT in residency settings,¹³ our consensus group sought to first highlight the most pertinent questions surrounding GME and KT.

PATHMAN'S PIPELINE

In studying vaccine compliance, Donald Pathman, a pediatrician, and colleagues suggested a multistage model for moving from evidence to action: clinician awareness, agreement, adoption of practice change, and then adherence to the evidence (Figure 1).¹² Given the unique charge of our group, we excluded discussions pertaining to three parts of this model: awareness, agreement, and adherence to the evidence. The initial step in the pipeline by Pathman et al., "awareness," has been excluded from our discussion based on the impression that this section primarily deals with the basic principles of EBM and critical appraisal of the literature rather than KT. Additionally, we decided not to focus our efforts on the last two sections, "agree" and "adhere," because these components of the pathway are patient-focused and not as directly relevant to postgraduate medical education. The focus of our group lies on accepting, applying, availability, and the need to act on the existing evidence.

RESEARCH RECOMMENDATIONS

On average, the majority of published research findings require years to benefit patient care, and even then only about half of best evidence reaches the level of widespread use.¹⁴ At least 18% of evidence is lost from the time of research discovery to manuscript submission,¹⁵ 46% and six months from submission of findings to a journal to their acceptance,¹⁶ 50% from journal publication to erroneous or incomplete indexing,¹⁷ and an additional 35% and six to 13 years for incorporation into reviews, guidelines, and textbooks.^{14,18} Simple recognition of a "leaky" information pipeline by training physicians may slow the knowledge-to-action decay that currently exists.

Research Recommendation 1

Didactic and bedside educational models informing EM residents about theoretical barriers to knowledge transfer should be studied as isolated interventions to assess whether global awareness reduces leaks.

Research Question: Does EM Resident Physician Awareness of Pathman's Pipeline (or Similar Models of Information Decay) Reduce the Leak of Information in Moving from Evidence to Action and Improve KT during Residency? An excellent opportunity for qualitative research would be to determine what EM residents believe are the leaks and why they occur. These can then be compared with the same questions asked of EM faculty and EBM opinion leaders. If so, quantitative descriptions of where and how much leaking occurs at each point should be combined with implementable and sustainable leak solutions verified by longitudinal follow-up postintervention.

Pathman's pipeline^{10,12} (Figure 1) represents one theoretical framework to identify GME leaks in studying the failure to transfer valid clinical research to optimize patient outcomes. Moving evidence from publication to routine bedside action is a multifactorial process with temporal, behavioral, and environmental barriers inhibiting dependable utilization.

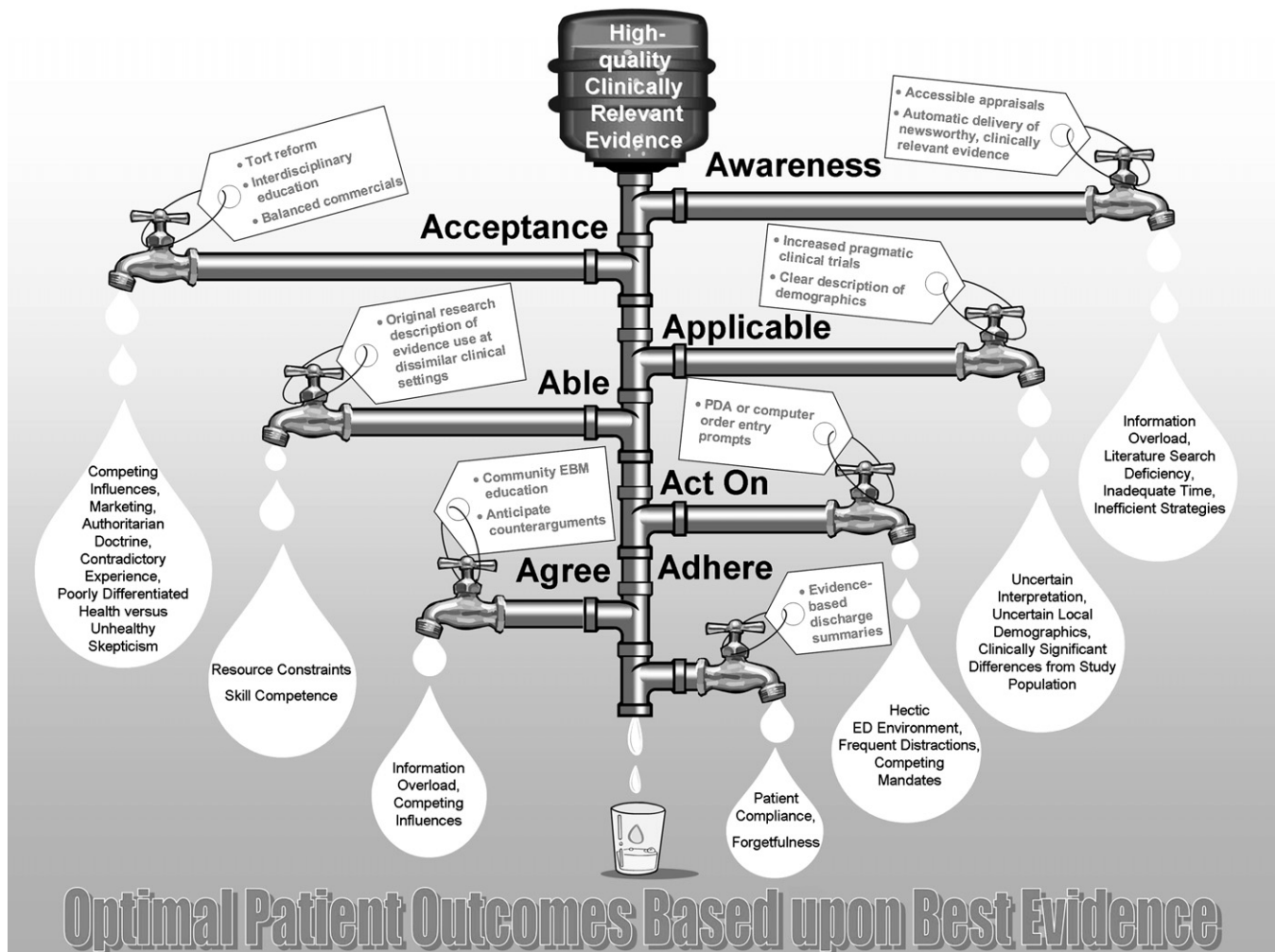


Figure 1. Pathman's pipeline. This illustration depicts the flow of high-quality evidence to optimal patient outcomes. Each waterspout represents the preventable leak of information based on unique barriers with ideas to slow the leaks depicted by the tags around the water handles. The droplets of water provide illustrative examples of information loss, misuse, or inapplicability at each level. The first five leaks deal with the physician and health care team, while the last two leaks are specific to the patient's environment. In developing the theme IIIa research agenda, our group chose to focus on acceptance, applicability, availability/ability, and remembering to act on the existing evidence. "Awareness" was excluded from our discussion based on the impression that this section primarily deals with the basic principles of evidence-based medicine and critical appraisal of the literature rather than knowledge translation. Additionally, we decided not to focus our efforts on the last two sections, "agree" and "adhere," because these patient-focused components are not as directly relevant to post-graduate medical education. Reprinted with permission with modifications from Glasziou P, Haynes B. The paths from research to improved health outcomes. *ACP J Club*. 2005;142:A8-A10. PDA = personal digital assistant; EBM = evidence-based medicine.

Research Recommendation 2

Qualitative research in EM resident education should further describe when and why strong research findings fail to reach the patients' bedsides in the emergency department.

The various "leaks" within Pathman's pipeline will now be addressed separately.

Acceptance. There are multiple influences that affect emergency physicians' adoption of new evidence into practice or prevents changing outdated behaviors when new treatments or diagnostic strategies are more effective. Studies conducted in the United States and The Netherlands demonstrate that 30%–40% of care given to patients is not based on current evidence and that

20% of care is either unnecessary or potentially harmful.¹⁹ There are numerous theories explaining these findings and why medical professionals are reluctant to accept the most current medical evidence. In a study investigating the failed implementation of hand hygiene in the health care setting, several barriers to change were noted, including a lack of awareness, knowledge, reinforcement, control, leadership, and facilities.²⁰ The concept that there is "no free lunch" is a marketing technique that has been well studied and shows the influence exerted by nonmedical and not evidence-based external factors (the pharmaceutical industry in this case) over medical professionals on persuading certain prescribing behavior.^{21,22} Additionally, in the realm of therapy, residents are bombarded with industry-sponsored meals

and other promotional activities in an attempt to “help” them interpret the evidence. These commercial influences may impede KT through errors of omission or commission by discouraging cost-effective, well-established alternatives in favor of novel, more expensive diagnostic tests or treatment modalities.

The Canadian cervical spine rules were appropriately derived, were externally validated, and are highly sensitive for cervical injuries requiring diagnostic imaging. Many U.S. EM residents, however, are taught that the medical-legal environment in the United States negates the benefit of best evidence and that practicing defensive medicine is better for their career than practicing EBM.²³ The legal environment of the United States is but one impediment in resident acceptance of this evidence. Other factors include consultants who either may have no knowledge of these clinical decision rules or only deal with a select patient population where the rules do not apply.

Applicable. Within GME training environments, the hurdles to overcome underutilization of evidence from the applicability leak can be conceptualized at two levels. At the macro level, global considerations may impede uptake of otherwise sound practice patterns. For example, emergency physicians within the United States may feel that clinical decision rules such as the Ottawa Ankle Rules or the Canadian C-Spine Rule lack external validity in their medical-legal environment, where litigation is more common and more expensive.^{24,25} Thus, evidence they would otherwise use goes neglected for nonmedical reasons. Alternatively, at the micro level, residents may believe that their individual patient may be dissimilar from those reported in the literature, prohibiting confident application at the bedside. An example of this phenomenon would be the inability to extrapolate data on optimal treatment for aging adults with acute coronary syndrome, who were grossly underrepresented in these clinical trials.²⁶

Able. EM training environments often mimic the academic environments where the clinical research that generates new knowledge occurs. Most EM residents ultimately will practice in nonacademic community settings once their postgraduate training is complete. Application of the research results from adequately staffed, high-tech academic institutions to rural or community settings lacking similar resources may be a perceived or realistic leak from knowledge to application. For example, the original trials of early goal-directed therapy for sepsis occurred in an urban teaching hospital staffed with numerous EM and specialty physicians with ample nursing staff reserve.²⁷ A solitary emergency physician in an isolated rural community emergency department with limited ancillary staff support might be aware of these findings, accept them as best evidence practice, and find his or her patients to be similar enough to the study patients to justify evidence-based application but lack the local resources to safely apply the evidence in his or her environment without compromising other patients' care.

Act On. Even when the evidence is conclusive and the standard of care has been changed, the impact of certain guidelines and legitimate evidence has a limited shelf life. Health services research has an uneven uptake across

different health care settings, countries, and specialties,²⁸ which has been demonstrated with the Ottawa Ankle Rules.²⁹⁻³¹

An example of a guideline that has wide uptake across multiple specialties is the Pneumonia Patient Outcomes Research Team (PORT) pneumonia score. In a recent study by Yealy et al., a cluster randomized control trial demonstrated that the level of intensity of the guideline implementation approach had a direct effect on the outcomes of patients with pneumonia.³²

In a review by Grimshaw et al. that included 41 systematic reviews of different approaches to influence professional behavior, they concluded that passive approaches are generally ineffective and unlikely to result in behavioral changes, in contrast to educational outreach and reminders, which were both promising approaches.³³ Cabana et al. reviewed 76 articles describing at least one barrier to clinical guideline adherence; 293 potential barriers were identified, but the generalizability of these barriers is uncertain.³⁴

The research questions that follow are general questions that can be applied to all four of these leaks in Pathman's pipeline.

Research Question: What Are the Barriers That Influence a Resident's Ability to Act on Valid Health Care Evidence? The initial step in changing medical practice is to select “new evidence” with the following criteria:

1. The results should be definitely helpful, plausible, and clinically-significant as compared with the traditional scheme. It would be best if it relates to mortality and morbidity.
2. If the intervention has a harmful effect, it must be minimal and reversible in the sense that if we stop the new intervention, the harm will terminate.
3. It must be easily accessible and end-user friendly.
4. It should be easy for residents to understand fully the content of the intervention (benefits and harm).
5. “New evidence” must be process tested, designed, and packaged to fit end-users.

Once this has been established, the health care professional must accept, then understand, believe, and finally, “change practice.”

The barriers associated with this final step—change—are as follows:

1. self-motivation and incentives that reinforce the old behavior
2. an environment condition, such as budget, liability, or interpersonal relations (peer group influence)
3. recommendations that contradict previously accepted standards of care
4. a competing physician's voice of expertise (when grandfatherly clinicians/researchers contest the results based on their experience and discount the findings)
5. competing nonphysician influences (i.e., drug company marketing, hospital administrators concerned about overall costs, and Joint Commission mandates).

How Do We Break Down These Barriers? If the new interventions are too complex, it might be better to initiate new interventions in a sequential matter by breaking

them into smaller units and presenting each unit over time. Studying the benefit to improving KT of “bundling” interventions for specific problems such as sepsis³⁵ would be a useful research strategy. Graduate learners might also need to delearn prior habits. “How to deal with and get rid of old stuff?” This might be a serious concern because residents might struggle to unfreeze “old thinking” and then they must “refreeze” the new material. This process might be especially difficult if the old stuff is still there for them to choose. One strategy is to assist them by getting rid of old interventions; for example, residents are forced to order new drug “X” because there is no stock of traditional drug “Y” in the hospital. To dismantle these barriers, a strategy involving all stakeholders, including researchers, policy makers, front-line physicians, allied health professionals, and patients is essential.

How Do We Incorporate This into Residency Training? To help residents in the early implementation phase of the KT process, the following may be used to assist in incorporating the evidence into residency training: 1) a teaching scheme, road show, or tutorials to make sure the learners understand clearly the implications and feel confident with the new evidence; 2) a learning period for residents and related stakeholders to adapt to the change; 3) empowering the residents with the right and authority to order the new interventions; 4) health care professionals and related stakeholders (pharmaceutical companies, hospital administrators, policy makers) must share the same visions, which will lead to less resistance in carrying the KT message through all four steps of the process; and 5) classifying outcomes into immediate, intermediate, and long-term goals, which are measurable, will assist residents with positive feedback, and will translate into satisfaction and the continuation of the “acted-on” part of the pathway.

Journal club is a recognized and standard component of residency programs in EM. Frameworks vary from one program to another and may or may not include EBM elements other than critical appraisal, such as use of online resources and databases to search for evidence. Although current evidence is limited in quality, research suggests that journal club improves trainee knowledge but not skills³⁶; there is no research that follows trainees to measure practice outcomes during residency or when starting out in practice. Journal club exercises usually include attention to applicability of information included in primary research reports to clinical practice. This creates the possibility of using journal club as a more formal bridge between research and clinical practice.

How Do We Monitor the Longevity of the Intervention? What parameters can be put in place to quantitatively assess teaching done in residency?

Research Recommendation 3

A major impediment to teaching residents KT is a lack of role models for them to emulate. Because clinical decision-making remains poorly understood, it is difficult to effectively delineate healthy and unhealthy skepticism regarding clinical research in resident education. KT education in the classroom is incomplete at best. Instead, KT must occur at the bedside or through an expanded

journal club (that explicitly includes KT in the discussion of new evidence) or academic detailing in real time as research evidence is translated into optimal diagnostic and therapeutic decision-making to facilitate optimal patient outcomes. While medical practice is replete with alternating claims of efficacy and best evidence practice, research uncertainty alone should not account for gaps measuring in decades between publication and widespread clinical practice changes.¹⁸ EM clinical educators must recognize their own thresholds to changing practice based on evolving evidence to teach residents when evidence-based practice evolutions are both medically and legally safe and in patients’ best interests. Resident educators’ evidence-based practice changing thresholds must be individually recognized and qualitatively described for residents to develop their own thresholds to facilitate lifelong confidence with an ever-evolving landscape of medical evidence.³⁷

Developing KT role models and instructors may include professional society interest groups, local or international workshops, or a KT fellowship to fully develop a curriculum for resident physicians. In addition to developing a cadre of expertise and GME instructional modules, these KT role models will require training in collaborative communication beyond the ED to effect behavioral change. Perhaps the first objective of KT experts will involve the development of instruments for evaluating KT initiatives.³⁸⁻⁴³

Research Question: Can Resident Educators’ Practice Change Thresholds Be Qualitatively Delineated on Any Given Clinical Question? If so, will clinical educators be better able to define practice-changing evidence to resident physicians? Will recognition of thresholds to change enhance long-term confidence in postresidency physicians while enhancing KT? Can local KT role models arise from recognition of regional experts, or will formal training programs be required to develop curricula, effective interventions, and evaluation instruments?

SUMMARY OF THE WORKSHOP SESSION’S FINDINGS AND SUGGESTIONS

During the consensus conference group IIIa workshop session, participants engaged in a lively and expansive discussion about KT and GME. Following is a brief summary of recurrent themes and focused suggestions from the breakout session.

The Pathman pipeline model was proposed as a tool to better focus KT research and resident education. The model outlines various “leaks” that inhibit EBM from being incorporated into clinical practice. Each leak provides a potential focal research topic to investigate the abilities of an EM resident to translate EBM into clinical practice. For example, the “applicability leak” focuses on the ability of a physician to determine if an evidence-based intervention is applicable to a given patient. The “applicability leak” could be studied to determine if residents are capable of applying evidence-based interventions to the appropriate patient population, or if further education is needed to improve a resident’s ability to plug the “applicability leak.”

We recognized that relying solely on the Pathman pipeline model to generate a research agenda was a reasonable starting point, but it had limitations. Accordingly, additional research themes were generated that do not entirely fit into the Pathman model. One such theme centers on the various barriers that likely inhibit residents from acquiring KT skills. Teaching KT in the classroom instead of at the bedside may be a barrier that inhibits acquisition of KT, and novel educational models should be studied to determine their effect on acquisition of KT skills, looking at realistic clinical outcomes of application of KT to patients. Additionally, a fear of litigation may hinder residents from incorporating KT into daily practice. The variability of clinical practice habits between staff physicians is a potential barrier that may significantly deter young physicians from attaining KT skills during residency. Research identifying barriers that prevent residents from attaining KT skills will prove essential in developing superior KT curriculums.

The idea of customizing a KT curriculum to match the needs of residents at each distinct level of training was an additional hot topic during the breakout session. Important research questions were generated, such as defining at what point in a career physicians are most susceptible to change practice habits. As an example, EM interns may be more concerned with developing their knowledge base and pattern recognition rather than applications of KT. On the other hand, graduating residents may feel a heightened urgency to understand KT as they approach the daunting demands of their first year out of residency.

CONCLUSIONS

One of the educational goals of EM residency is to provide the resident with the skills to bridge the gap between learning the basic skills of medicine (including critical appraisal and principles of EBM) and putting them into the best clinical practice (using EBM to develop good habits of KT). Residency must teach medical students to become mindful and reflective medical practitioners. Models of KT, such as Pathman's pipeline, reflect stages during which KT fails in bringing readily accepted results of scientific clinical research to clinical practice. Another KT barrier is clinical practice variability among faculty members. Research projects can be designed around these two models to determine the most effective ways to teach residents optimal skills for KT and ensure that they become efficient practitioners of evidence-based EM.

The authors thank the organizers of the "Consensus Conference on Knowledge Translation" for their leadership and direction; *Academic Emergency Medicine* for their participation; theme IIIa members Tara O'Connell and Rawle Seupaul (scribes) and Kai Choumanivong of Holland, MI; and Alex Lee in Hong Kong for providing the pipeline illustration.

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