

The Canadian Prehospital Evidence-based Protocols Project: Knowledge Translation in Emergency Medical Services Care

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Abstract

Objectives: The principles of evidence-based medicine are applicable to all areas and professionals in health care. The care provided by paramedics in the prehospital setting is no exception. The Prehospital Evidence-based Protocols Project Online (PEP) is a repository of appraised research evidence that is applicable to interventions performed in the prehospital setting and is openly available online. This article describes the history, current status, and potential future of the project.

Methods: The primary objective of the PEP is to catalog and grade emergency medical services (EMS) studies with a level of evidence (LOE). Subsequently, each prehospital intervention is assigned a class of recommendation (COR) based on all the appraised articles on that intervention, in an effort to organize the evidence so it may be put into practice efficiently. An LOE is assigned to each article by the section editor, based on the study rigor and applicability to EMS. The section editor committee consists of EMS physicians and paramedics from across Canada, and two from Ireland and a paramedic coordinator. The evidence evaluation cycle is continuous; as the section editors send back appraisals, the coordinator updates the database and sends out another article for review.

Results: The database currently has 182 individual interventions organized under 103 protocols, with 933 citations.

Conclusions: This project directly meets recent recommendations to improve EMS by using evidence to support interventions and incorporating it into protocols. Organizing and grading the evidence allows medical directors and paramedics to incorporate research findings into their daily practice. As such, this project demonstrates how knowledge translation can be conducted in EMS.

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Ensuring that medical care provided to patients is “evidence-based” is a major challenge for clinicians.¹⁻⁶ Organizing the body of existing evidence, identifying the gaps in knowledge and patient

care, and subsequently closing these gaps involves a complex set of relationships and steps. Addressing these concepts in the prehospital setting as they relate to emergency medical services (EMS) introduces a further layer of complexity. One of the purposes of evidence-based medicine is to reduce the “research-to-practice gap” by making the evidence from research easily available to practitioners.⁷⁻¹⁰ The synthesis and evaluation of research evidence are key components of the knowledge translation cycle.^{11,12}

In the past, EMS has been criticized for a lack of randomized controlled studies supporting prehospital interventions.¹³⁻¹⁷ Despite this criticism, research on prehospital care is improving, and a growing collection of evidence exists to support many interventions provided in the prehospital environment.¹⁷⁻²¹

As the quality and volume of research conducted in the prehospital setting increases, there is more demand for a way to organize this information to decrease the

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knowledge translation interval. Recommendations have been made to increase support for EMS research and knowledge translation.^{20,22-25} The Prehospital Evidence-based Protocols Project (PEP) is consistent with, and specifically addresses, these recommendations. For example, in 2007, the U.S. Institute of Medicine released a report titled “EMS at the Crossroads,” which advocated for practice guidelines for prehospital care to be solidly based in evidence.²³

Cone²⁶ described knowledge translation as a two-part process as it applies to prehospital medicine: getting the evidence straight and getting the evidence used. In the “getting the evidence straight” category, he calls for increased analysis and scrutiny on how clinical practices are incorporated into the EMS environment from other areas of medicine. A recommendation for “getting the evidence used” is to identify, develop, and validate best practices in EMS. The purpose of the PEP is to address both knowledge transition processes. The purpose of this article is to describe the genesis of the PEP, to describe its current stage of development, and to suggest its future potential.

METHODS

History

The prototype for this project grew out of a vision to evaluate the evidence for each intervention that is performed by paramedics in the EMS system in Nova Scotia, Canada (Emergency Health Services [EHS]).²⁷ The PEP project began in 1998, as a project within the Dalhousie University Division of EMS, with close collaboration with EHS, the provincial government regulator for EMS. Both the EHS medical protocols and the PEP database of ranked literature appear on the project website.²⁸

The idea was that the PEP process would lead to the EHS protocols evolving with the evidence; however, algorithms within local EMS services would still be customized to the specific scopes of practice, fiscal limitations, and availability of equipment and medications. There are essentially three components to PEP: 1) the evidence databank (which may be universal within local EMS services); 2) the protocols (which may pertain only to the local service); and 3) the linkage of these protocols within the online database.

When PEP was developed, the initial task was to determine a taxonomy of knowledge that pertains to EMS interventions; therefore, it began as an exercise in knowledge management. Pragmatically, the initial prototype of this project used the headings and subcategories of the EHS protocols and concentrated on the evidence for the specific interventions within each of these protocols. As the project grew, new categories and interventions have been added that go beyond the local (EHS) algorithms.

Purpose

The primary purpose of the PEP project is to catalog relevant studies and grade each article with a level of evidence (LOE) and, subsequently, use the appraised articles to assign each prehospital intervention a class of recommendation (COR). The secondary objectives

are as follows: 1) to identify gaps in the research and to stimulate debate and growth toward evidence-based prehospital emergency care; 2) to develop a process of using evidence to evaluate practice change suggestions made by paramedics and other EMS professionals; and 3) to map the evidence for any given intervention to a possible clinical care algorithm, with a movement toward “best practice” prehospital care protocols.

Current Project Flow

The paramedic project coordinator is responsible for the coordination of the literature searches. This consists of searching medical literature databases such as PubMed and the Cochrane Library, setting up automatic database searches, and hand-searching reference lists. Section editors also search for research relevant to their assigned protocol area. Paramedics and EMS physicians are encouraged to forward references of articles of interest to the coordinator. Citations found to be relevant are entered into the database under each protocol and intervention they are pertinent to. At this stage, the citations appear on the website as “under review.”

Assessment of Evidence

Our LOE scale (Table 1) was derived from a simplified version of the Canadian Task Force Guidelines.^{29,30} The intent of the LOE scale is for it to be highly useful and practical, for both EMS physicians and paramedics accessing the database, and therefore contains fewer increments than the Oxford³¹ or International Liaison Committee on Resuscitation (ILCOR)³² scales. It is similar to the LOEs used by the American College of Emergency Physicians (ACEP).³³ Section editors critically review articles and then assign each an LOE, based on the study quality. The COR for the intervention is based on the LOEs of all literature considered together (Table 2).

The PEP approach to ranking research studies conducted in the in-hospital setting is to accept that, in some circumstances, these findings may be applicable to the prehospital setting. The PEP team decided a practical way to handle evidence from a setting outside of EMS is to maintain the LOE ranking for each citation, but reduce the COR for the intervention, based on this type of evidence, by one level, to be conservative

Table 1
LOE Scale

LOE	
I	Evidence obtained from at least one properly randomized controlled trial
II	Evidence obtained from a well-designed cohort or case-control study, usually from more than one center or research group Evidence obtained from a well-designed controlled trial but without randomization Dramatic results from uncontrolled experiments
III	Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees
LOE = level of evidence.	

Table 2
COR Scale

COR	
A	There is good evidence to support intervention (procedure or treatment)
B	There is fair evidence to support intervention
C	There is poor evidence to support intervention
D	There is evidence to support that the procedure or treatment should not be used
I	Indeterminate
COR = class of recommendation.	

and to address potential concerns with external validity of articles.

Each article is sent to the section editors for assessment via e-mail, along with a standardized appraisal sheet. Section editors return the appraisals to the coordinator and senior editors, who review each appraisal before entering the LOE and COR into the database. The website is then updated with the LOE for that particular citation, under every intervention it is relevant to.

RESULTS

There are 24 certified EPs serving as section editors who practice in seven Canadian provinces, plus two international section editors, both from Ireland. Paramedics who have had training in critical appraisal of the medical literature have recently joined the project as section co-editors (n = 13).

There are 103 protocols and 182 individual interventions in the PEP, with some interventions appearing in multiple protocols. Many interventions appear under more than one protocol (e.g., bag mask ventilation appears under cardiac arrest, respiratory arrest, pediatric cardiac arrest, etc.), resulting in a total of 547 interventions in the database, distributed as follows: 4.0% COR A (n = 22), 12.6% COR B (n = 69), 60.7% COR C (n = 332), 6.6% COR D (n = 36), and 16.1% COR I (n = 88).

As of March 25, 2009, a total of 893 articles have been entered in the database and reviewed by the section editors. The LOE distribution for these articles is as follows: 14.6% LOE I (n = 130), 25.9% LOE II (n = 231), and 59.6% LOE III (n = 532). There are currently 40 articles out for review.

DISCUSSION

The PEP project illustrates that a system of knowledge translation can be developed for EMS. This project involves both medical directors and paramedics as section editors. Having these key front-line decision-makers and clinicians involved should minimize the lag between the identification of high-quality evidence and the translation to practice. As the section editor panel is a cross-section of Canadian EMS, it appears that such a project can be applied on a national and perhaps even an international basis. The section editor panel

works together to achieve the goals of the project to catalog and grade relevant studies and assign each prehospital intervention a recommendation, identify gaps in the research, to use evidence to stimulate practice change, and move toward best practice prehospital care protocols.

LIMITATIONS

To date, system-level interventions have not been included in the project, to maintain focus on clinical interventions that are initiated by individual paramedics for each patient. Trip destination triage is an intervention that could be considered a system issue, but also an individual decision point by the paramedic, so it is included as an intervention in the trauma and chest pain protocols. In the future, a separate section of the PEP on system-level interventions may improve the overall usefulness of this project.

Literature searches are not conducted on a regular schedule, but are based on trends and gaps. The majority of searches are conducted by the coordinator. A more rigorous search strategy may be beneficial.

When the PEP was created in 1998, the team believed that it was best to err on the side of using a pragmatic grading scale, for ease of use by the section editors and readers, rather than a rigorously detailed and discriminating tool. However, today there are many grading schemes for appraising the medical literature, originating with various groups around the world.^{2,4,29,31,34-36} Another evidence-based source used by EMS for establishing prehospital care protocols is the resuscitation guidelines published every 5 years by the ILCOR.^{32,37-39} The ILCOR LOE scale has eight intervals. There is a movement toward uniform grading schemes,^{37,40-43} so practitioners from different areas of medicine and with various levels of training in critical appraisal of the literature can speak in "apples to apples" terms. The PEP may need to revise its grading process to meet international standards in the future.

Future Potential

Wiki Protocols and Practice Guidelines. The wiki phenomenon may be considered an important advance in knowledge management and modern epistemology. It has been praised for being a collaborative and efficient way for significant knowledge to become available for broad populations.^{44,45} One of the exciting future potentials of the PEP is to encourage a wide group of expert reviewers and users of the database to participate in creating best practices protocols. An editing or peer-review function would be necessary, but the wiki philosophy and experience has shown that over time, accountability and controversy are handled by the expert end-users who are engaged in the process.

To further the objective of getting the evidence used, this project has the potential to develop standardized national or international evidence-based prehospital guidelines, rather than influencing individual EMS system's local protocols. This evolution would be most successful if it occurred within an international collaboration of EMS experts, following a similar structure to the ILCOR process. For guideline development to be

most effective, the process should utilize a standardized methodology, such as the Appraisal of Guidelines Research and Evaluation instrument (AGREE).⁴⁶ This tool has had good uptake by various organizations that create clinical practice guidelines, including the Canadian Medical Association.⁴⁷ Other instruments are available to evaluate the implementation of guidelines into actual practice.^{48,49} Learning from other organizations that have had good success in implementing guidelines into practice, such as ILCOR, and making use of these tools is an important step in minimizing the knowledge translation interval for prehospital care.

Online Format. Information technology has been noted as a necessary component of effective knowledge translation.⁵⁰ Databases are widely used to make the literature accessible and to store appraisals.⁵¹⁻⁵³ We plan to develop a secure website, where section editors can log on to retrieve articles and enter in their appraisals. An online format of the PEP would include a discussion forum to post comments, questions, and suggestions for all members of the project to view and respond to and a better communication option than mass e-mails. It can serve as an entry portal for paramedics and others who would like to submit a citation for section editor review and can be a future wiki site and guideline database.

International Collaboration. As the PEP continues to evolve, a logical step in its growth is to continue to seek various perspectives from EMS physicians and paramedic section editors from different regions of Canada, the United States, and other countries around the world.

CONCLUSIONS

The PEP is an exercise in knowledge translation, specific to prehospital care. By organizing the PEP according to paramedic protocols and interventions, the evidence is formatted in a manner that is easily used by practicing paramedics, decision-makers, and EMS physicians. This evidence repository project is continuously growing, with many opportunities for future developments to shorten the gap between the results of research and the implementation of knowledge into practice on a wide scale.

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References

- Haynes B, Haines A. Barriers and bridges to evidence based clinical practice. *BMJ*. 1998; 317:273-6.
- Guyatt G, Rennie D. Users' guides to the medical literature: essentials of evidence-based clinical practice. JAMA and archives. Chicago, IL: AMA Press, 2002.
- Waeckerle JF, Cordell WH, Wyer P, Osborn HH. Evidence-based emergency medicine: integrating research into practice. *Ann Emerg Med*. 1997; 30:626-8.
- Sackett DL, Richardson WS, Rosenberg WM, Haynes B. Evidence-based medicine: how to practice and teach EBM. Toronto, Ontario: Churchill Livingstone, 1997.
- Sackett DL, Rosenberg WM, Gray JA, et al. Evidence-based medicine: what it is and what it isn't [editorial]. *BMJ*. 1996; 312:71-2.
- Guyatt GH. Evidence-based emergency medicine [letter]. *Ann Emerg Med*. 1997; 30:675-6.
- Wyer PC. Responsiveness to change: a quality indicator for assessment of knowledge translation systems. *Acad Emerg Med*. 2007; 14:928-30.
- Lang ES, Wyer PC, Haynes RB. Knowledge translation: closing the evidence-to-practice gap. *Ann Emerg Med*. 2007; 49:355-63.
- Clancy CM. Keynote address: closing the research-to-practice gap in emergency medicine. *Acad Emerg Med*. 2007; 14:932-5.
- Graham ID, Tetroe J, and the Knowledge Translation Theories Research Group. Some theoretical underpinnings of knowledge translation. *Acad Emerg Med*. 2007; 14:936-41.
- Lang ES, Wyer PC, Eskin B. Executive summary: knowledge translation in emergency medicine. Establishing a research agenda and guide map for evidence uptake. *Acad Emerg Med*. 2007; 14:915-8.
- Canadian Institutes of Health Research. About Knowledge Translation. Available at: <http://www.cihr-irsc.gc.ca/e/29418.html>. Accessed Mar 22, 2009.
- Callahan M. Quantifying the scanty science of prehospital emergency care. *Ann Emerg Med*. 1997; 30:791-6.
- Brazier H, Murphy AW, Lynch C, Bury G. Searching for evidence in pre-hospital care: a review of randomized controlled trials. *J Accid Emerg Med*. 1999; 16:18-23.
- Spaite DW, Criss EA, Valenzuela TD, Meislin HW. Prehospital advanced life support for major trauma: critical need for clinical trials. *Ann Emerg Med*. 1998; 32:480-9.
- MacFarlane C. The advances and evidence base for prehospital care. *Emerg Med J*. 2003; 20:114-5.
- Brice JH, Garrison HG, Evans AT. Study design and outcomes in out-of-hospital emergency medicine research: a ten-year analysis. *Prehosp Emerg Care*. 2000; 4:144-50.
- Petrie DA. RCTs on trial [letter]. *Ann Emerg Med*. 1998; 32:633-4.
- Brown LH, Collins K, Gough JE, Benson NH. An evidence-based evaluation of EMS protocols. *Prehosp Emerg Care*. 1999; 3:31-6.
- Myers JB, Slovis CM, Eckstein M, et al. Evidence-based performance measures for emergency medical services systems: a model for expanded EMS

- benchmarking. *Prehosp Emerg Care*. 2008; 12:141–51.
21. Smith E, Jennings P, McDonald S, MacPherson C, O'Brien T, Archer F. The Cochrane Library as a resource for evidence on out-of-hospital health care interventions. *Ann Emerg Med*. 2007; 49:344–50.
 22. Sayre MR, White LJ, Brown LH, McHenry SD. National EMS Research Agenda. *Prehosp Emerg Care*. 2002; 6:s1–43.
 23. Institute of Medicine. *Emergency Medical Services at the Crossroads. Chapter 7: Optimizing Prehospital Care Through Research*. Washington DC: National Academies Press, 2007, pp 207–30.
 24. Delbridge TR, Bailey B, Chew JL Jr, et al. EMS agenda for the future: where we are...where we want to be. *Prehosp Emerg Care*. 1998; 2:1–12.
 25. Floccare DJ, Cushman JT. Endotracheal intubation in the field: pro position. *Hosp Med*. 2005; 66:89–91.
 26. Cone DC. Knowledge translation in the emergency medical services: a research agenda for advancing prehospital care. *Acad Emerg Med*. 2007; 14:1052–7.
 27. Cain E, Ackroyd-Stolarz S, Alexiadis P, Murray D. Prehospital hypoglycemia: the safety of not transporting treated patients. *Prehosp Emerg Care*. 2003; 7:458–65.
 28. Dalhousie University. Canadian Prehospital Evidence Based Protocols. Available at: <http://emergency.medicine.dal.ca/ehsprotocols/protocols/toc.cfm>. Accessed Feb 22, 2009.
 29. Canadian Task Force on the Periodic Health Examination. The periodic health examination 2: 1987 update. *CMAJ*. 1988; 138:618–26.
 30. Canadian Task Force on the Periodic Health Examination. The Periodic Health Examination. *Can Med Assoc J*. 1979; 121:1193–254.
 31. Centre for Evidence Based Medicine. Oxford Centre for Evidence-based Medicine Levels of Evidence. Available at: http://www.mcw.edu/FileLibrary/User/fvastalo/Oxford_Levels.pdf. Accessed Feb 22, 2009.
 32. Zaritsky A, Morley P. The evidence evaluation process for the 2005 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care science with treatment recommendations [editorial]. *Circulation*. 2005; 112:III-128–III-130.
 33. ACEP Clinical Policies Subcommittee on Penetrating Extremity Trauma and Clinical Policies Committee. Clinical policy for the initial approach to patients presenting with penetrating extremity trauma. *Ann Emerg Med*. 1999; 33:612–36.
 34. GRADE Working Group. Grading quality of evidence and strength of recommendations. *BMJ*. 2004; 328:1–8.
 35. Higgins JP, Green S (eds.). *Cochrane Handbook for Systematic Reviews of Interventions, Version 5.0.0*. Available at: <http://www.cochrane-handbook.org/>. Accessed Feb 22, 2009.
 36. Goldbloom R, Battista RN. The periodic health examination 1: Introduction. *Can Med Assoc J*. 1986; 134:723.
 37. Morley PT. Monitoring the quality of cardiopulmonary resuscitation. *Curr Opin Crit Care*. 2007; 13:261–7.
 38. Timmerman S, Gonzalez MM, Mesquita ET, et al. The International Liaison Committee on Resuscitation (ILCOR). Roll in guidelines 2005–2010 for cardiopulmonary resuscitation and emergency cardiovascular care. *Arq Bras Cardiol*. 2006; 87:e201–8.
 39. Gazmuri RJ, Nolan JP, Nadkarni VM, et al. Scientific knowledge gaps and clinical research priorities for cardiopulmonary resuscitation and emergency cardiovascular care identified during the 2005 international consensus conference on ECC and CPR science with treatment recommendations. A consensus statement from the International Liaison Committee on Resuscitation; the American Heart Association Emergency Cardiovascular Care Committee; The Stroke Council; and The Cardiovascular Nursing Council. *Resuscitation*. 2007; 75:400–11.
 40. Harbour RT, Miller J. A new system for grading recommendations in evidence based guidelines. *BMJ*. 2001; 323:334.
 41. Atkins D, Briss PA, Eccles M, et al. Systems for grading the quality of evidence and the strength of recommendations II: pilot study of a new system. *BMC Health Serv Res*. 2005; 5:25.
 42. Rowe RH, Alderson P. The Cochrane Library: a resource for clinical problem solving in emergency medicine. *Ann Emerg Med*. 1999; 34:86–90.
 43. Upshur REG. Are all evidence-based practices alike? Problems in the ranking of evidence. *CMAJ*. 2003; 169:672–3.
 44. Wikipedia. Available at: <http://www.wikipedia.org/>. Accessed Mar 22, 2009.
 45. Tapscott D, Williams AD. *Wikinomics: how mass collaboration changes everything*. New York, NY: Penguin Group, 2006.
 46. AGREE collaboration. Appraisal of Guidelines Research and Evaluation. Available at: <http://www.agreecollaboration.org/>. Accessed Mar 22, 2009.
 47. Palda VA, Davis D, Goldman J. A guide to the Canadian Medical Association handbook on clinical practice guidelines. *CMAJ*. 2007; 177:1221–6.
 48. Shiffman RN, Dixon J, Brandt C, et al. The Guide-Line Implementability Appraisal (GLIA): development of an instrument to identify obstacles to guideline implementation [abstract]. *BMC Med Inform Decis Mak*. 2005; 5:23.
 49. Adapte: The ADAPTE Collaboration. Homepage. Available at: <http://www.adapte.org/rubrique/the-adapte-collaboration.php>. Accessed Feb 22, 2009.
 50. Holroyd BR, Bullard MJ, Graham TA, Rowe BH. Decision support technology in knowledge translation. *Acad Emerg Med*. 2007; 14:942–8.
 51. MacKaway-Jones K, Carley S. Bestbets.org: odds on favourite for evidence in emergency medicine reaches the World Wide Web. *J Accid Emerg Med*. 2000; 17:235–6.
 52. MacKaway-Jones K. Towards evidence based emergency medicine: best BETs from the manchester royal infirmary. *J Accid Emerg Med*. 1999; 16:215–8.

53. Wyer PC, Rowe BH. Evidence-based reviews and databases: are they worth the effort? Developing evidence summaries for emergency medicine. *Acad Emerg Med.* 2007; 14:960-4.

Appendix A

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