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Applying Hospital Evidence to Paramedicine: Issues of Indirectness, Validity and Knowledge Translation

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ABSTRACT

The practice of emergency medicine (EM) has been intertwined with emergency medical services (EMS) for more than 40 years. In this commentary, we explore the practice of translating hospital based evidence into the prehospital setting. We will challenge both EMS and EM dogma—bringing hospital care to patients in the field is not always better. In providing examples of therapies championed in hospitals that have failed to translate into the field, we will discuss the unique prehospital environment, and why evidence from the hospital setting cannot necessarily be translated to the prehospital field. Paramedicine is maturing so that the capability now exists to conduct practice-specific research that can inform best practices. Before translation from the hospital environment is implemented, evidence must be evaluated by people with expertise in three domains: critical appraisal, EM, and EMS. Scientific evidence should be assessed for: quality and bias; directness, generalizability, and validity to the EMS population; effect size and anticipated benefit from prehospital application; feasibility (including economic evaluation, human resource availability in the mobile environment); and patient and provider safety.

RÉSUMÉ

La pratique de la médecine d'urgence (MU) est étroitement liée aux services médicaux d'urgence (SMU) depuis plus d'une quarantaine d'années. Aussi les auteurs traitent-ils, dans le présent article, du transfert des données probantes, du milieu hospitalier au milieu préhospitalier. Sera remis en question un dogme admis tant par la MU que par les SMU; en effet, le transfert, sur le terrain, des pratiques en milieu hospitalier n'est pas toujours la meilleure solution. Il sera question, à l'aide d'exemples de traitements préconisés dans les hôpitaux qui se sont soldés par des échecs sur le terrain, du caractère propre du milieu préhospitalier et des raisons pour lesquelles l'application directe des données probantes, recueillies en milieu hospitalier ne convient pas nécessairement au milieu préhospitalier. Les secours paramédicaux sont une discipline en évolution, si bien que la capacité de recherche sur la pratique est suffisamment importante pour jeter une lumière nouvelle sur les pratiques exemplaires. Avant d'envisager l'application des connaissances recueillies en milieu hospitalier, il faut que les données probantes à l'appui soient évaluées par des experts dans trois domaines: l'évaluation critique, la MU et les SMU. Les données probantes de scientifiques devrait faire l'objet d'examen à l'égard: de la qualité et des biais; de l'application directe des données dans la population visée par les SMU ainsi que de leur généralisabilité et de leur validité; de l'ampleur de l'effet et des avantages prévisibles de l'application préhospitalière de ces pratiques; de la faisabilité (y compris l'évaluation économique et la suffisance des ressources humaines dans un environnement mobile); et finalement de la sécurité tant des patients que des fournisseurs de soins.

Keywords: emergency medical services, paramedic, emergency medicine, evidence based medicine, knowledge translation

INTRODUCTION

If medicine is both an art and a science, then paramedicine is surely art, science, and sport. Growing from humble and basic beginnings where strength and speed defined emergency medical services (EMS), paramedicine today delivers expert resuscitators to the curbside with clinical capabilities once found only in hospitals. The practice of emergency medicine (EM) and EMS have been intertwined for more than 40 years, as hospital-based practices were adapted for prehospital application. The practice-based approach of "bringing the emergency room to the streets" was popularized in the 1970s and experienced lightning-speed advancement as well-intentioned physicians and field providers drove advances in scope of practice based on perceived needs.

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As evidence-based medicine (EBM) becomes more engrained in medical culture and health authorities seek to deliver affordable, quality health care, medical practitioners are evaluating new and old medical care strategies and questioning the status quo.

Paramedics undoubtedly make a difference every day, but the clinical benefit and cost-effectiveness of many treatments are unclear. Dogma, an authoritative belief or principle that is considered to be valid regardless of its actual accuracy, is common in both EM and EMS. The origin of EMS dogma is often lost to history, and those who question it have in the past been labeled as heretics. Some of that dogma comes from "standard of care" from EM or hospital-based care. As more clinical practice becomes grounded in evidence, there is a temptation to translate knowledge from one area to another in hopes of further improving patient outcomes. While this may be appropriate in many circumstances, we urge caution when applying medical science derived in an ED to patients in the prehospital setting. In this commentary, we discuss the incongruence between the science and art of paramedicine, highlight challenges in translating evidence from one setting to another, and urge a deliberate and disciplined approach to the care offered to patients in the prehospital setting.

EBM IN EM

The field of EM has embraced EBM. EM outpaces many other specialties in the publication of derived and validated clinical decision rules. There have certainly been challenges, and the knowledge-to-action gap remains wide.[1,2] Global expert collaboratives are increasingly producing evidence-informed consensus guidelines; examples can be found in cardiac resuscitation, initial sepsis management, and acute stroke care.[3] The 2010 International Liaison Committee on Resuscitation (ILCOR) Consensus on Science and Treatment Recommendations included solid EBM recommendations for both EM and EMS.[4,5]

EMS: Translation challenges

The prehospital environment is a unique and challenging setting to deliver health care. Emergency scenes are often uncontrolled, ranging from a private bedroom, to a shopping mall promenade, to a high-speed freeway. Low light, high ambient noise, and uncontrolled temperatures further complicate the environment. Patients are almost always undifferentiated. A lack of laboratory and radiology investigations forces decisions to be made based on limited information such as signs, symptoms, a cardiac rhythm strip, or a capillary glucose test. A lack of human resources further adds to the challenges of the prehospital setting: paramedics work alone or in teams of two, and have focused knowledge and training that may be limited in scope and depth. The mobile environment is complex and hazardous, involving difficult extrication techniques and a loud, moving patient compartment when en route. Flight environments are even more hostile. High noise, vibration, cramped quarters, and low partial pressures of oxygen are a few of the challenges.

EM EBM may therefore not be directly applicable to patients being treated by paramedics. We illustrate this point with the case of a 76-year-old woman who awakes in the middle of the night with shortness of breath. Paramedics arrive to her stuffy bedroom, and she volunteers a history of chronic obstructive pulmonary disease (COPD) and home oxygen use. She has diffuse expiratory wheezes and crackles. She has elevated jugular veins and mild peripheral edema. Paramedics retrieve salbutamol puffers, furosemide, and ramipril scattered throughout the house. She states that she takes other pills, but they cannot be found. The two paramedics are faced with a difficult decision of treating for COPD with bronchodilators or acute pulmonary edema (APE) with nitrates and/or diuretics. A study done with paramedics in the field found that diuretic use in presumed pulmonary edema from heart failure was associated with poor outcome.[6] Although the use of diuretics in the management of APE in the ED has declined recently, at the time of the study described, this was commonplace. In this study of paramedic management of congestive heart failure (CHF), the authors found that nearly 25% of the time, the paramedics mistakenly treated the patient for APE when the diagnosis was pneumonia or COPD.[6] A recent Canadian publication showed similar inability of paramedics to discriminate between APE and COPD: only 40% of confirmed APE patients received furosemide, while over 34% of the patients who received furosemide did not have APE.[7]

As another example: the successful use of dobutamine in post-operative cardiac surgery patients in cardiogenic shock may not translate to the management of a cardiogenic shock patient in the field. The post-operative population is not representative of cardiogenic shock patients who call 911, advanced hemodynamic monitoring (arterial lines, central venous pressure) is not available

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in the field, paramedics may lack foundational knowledge in cardiopulmonary failure, and ambulances are not usually equipped with medication pumps. This type of in-hospital evidence cannot be adapted directly into the field.

If treatments may be harmful for patients that are misidentified, and identification often requires investigations not available to the paramedic, then the principle of "first do no harm" must take precedence.

Post-arrest therapeutic hypothermia has recently been considered for prehospital implementation based on data from EDs and intensive care units. Although chilled saline infusions can be used by paramedics to induce therapeutic hypothermia (TH) for post-arrest patients similar to that shown to be effective when started in the ED, implementation studies are still needed to confirm if there is an outcome benefit to starting this in the field.[8] After numerous small studies confirming that TH initiated by EMS is feasible and affordable, a recent trial found that EMS-initiated TH did not result in any long-term benefits for the patient.[9] Since the post-arrest period is a dynamic period where paramedics must monitor and manage a complex patient with limited human and technological resources, removing any unnecessary procedures and distractions should be favored over the implementation of a therapy with no evidence of value. This is true in any patient care setting, but may be of particular relevance in the resource-limited EMS context.

Appropriate translation of EM research to the field

Other EM research has been applied to EMS with success. In the pre-percutaneous coronary intervention (PCI) era, the efficacy and safety of fibrinolysis for STEMI was first demonstrated in a coronary care unit setting, then in an ED setting, and finally by physicians in ambulances.[10] Today, paramedics with physician oversight (ECG transmission and consultation) can provide efficacious and safe early fibrinolysis when compared to transfer for PCI.[11] This type of high-risk, evidence-based treatment requires a coordinated response system with experienced paramedics, EMS physician oversight, and specialized centres. Further studies are needed to establish whether such care is cost-effective.

Relatively simple ED therapies with wide margins of safety, such as oral analgesic administration for minor to moderate pain from extremity injuries, may lend themselves to adaptation into the field.[12] Follow-up implementation studies should still confirm safety and feasibility, along with evaluation of patient-oriented outcomes. Similarly, treatments for relatively rare emergencies that have a large benefit that outweighs assumed risk, such as epinephrine for anaphylaxis, should be part of the education and scope of practice at all paramedic levels, without the need for separate randomized controlled trials to confirm the benefit.

EMS-centred research

Perhaps the sentinel example of the need for evidence-based paramedic practice dates back to the pneumatic anti-shock garment studies, which had initially been enthusiastically embraced in North American EMS systems in the 1970-1980s. One study led to the elimination of this popular war-era therapy from the prehospital setting after evidence of harm was realized.[13] As a result of this study, other dogma around prehospital care has been questioned, and evidence has been used to clarify traditional treatments. EMS research has grown from small, anecdotal studies to large multi-centred studies that are asking and answering important questions and replacing dogma with scientific evidence. EMS research in Canada was launched into the spotlight with the Ontario Prehospital Advanced Life Support (OPALS) studies, a series of analyses based on multi-site implementation of advanced life support (ALS) trained paramedics in Ontario.[14] Although the benefit of these ALS paramedics was considered dogma for decades and they had become standard in most urban regions in North America, the OPALS studies showed that while some patients benefited from advanced paramedic care, many did not.[15,16]

EMS research has greatly expanded in the decade since the OPALS trials were published. Paramedic-trained scientists are now working with physician-scientists, EMS operators, governments, and medical directors to conduct research specific to the EMS setting. Examples of EMS-specific research include therapeutic interventions for cardiac arrest, the use of continuous positive airway pressure for respiratory distress, fibrinolysis for STEMI in rural settings, therapeutic hypothermia for post-arrest, and reducing ED visits for nursing home patients through collaborative models of care.[2,8,9,11,17-22] Similarly, EMS researchers have addressed policy matters, such as termination of resuscitation, hospital bypass, and ED offload delay.[23,24] Workforce issues, such as clinical judgment, workplace

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violence, and occupational hazards, have also been scientifically investigated.[25,26,27]

"Reverse translation"

Just as evidence has been translated from the hospital to the field, so too have EMS research findings been adopted in hospital settings. Cardiopulmonary resuscitation (CPR) and cardiac arrest resuscitation improvements based on large prehospital prospective cohort studies and randomized controlled trials have occurred.[28] Studies on compression rate and depth, peri-shock compression pause, and resuscitation choreography have all stemmed from prehospital research efforts.[17,29,30] CPR quality is a focus for many EMS services, which have championed real-time biometric feedback and post-event quality improvement strategies.[31] These efforts have led to a more than doubled increase in survival from out-of-hospital cardiac arrest, but have not yet been implemented in many hospital settings.[32]

EMS RESEARCH: A UNIQUE FUND OF KNOWLEDGE

The maturity of Canadian EMS has recently been demonstrated by the writing of a Canadian EMS Research Agenda.[33] This national collaborative project between paramedics, EMS operators, regulators, and physicians identifies barriers, opportunities, strengths, and priorities related to EMS. Paramedic competency assessment in initial and continuing education has been rigorously studied,[34] and national competency profiles are utilized in accreditation processes.[35] Recently, significant attention has been paid to adverse events and patient safety in the prehospital setting. The mindset of "just culture" is being fostered—an environment where individuals are encouraged to report mistakes or concerns in order to benefit from system-level interventions that make human error less likely.[36,37] Basic research literacy is being introduced as a foundational skill during initial education, with the goal of promoting a culture of evidence-based practice. The profession of paramedicine must continue to reflect on ways to improve reliability and consistency in the care provided by paramedics.

As the focus on quality and the introduction of bundled care continues, it will become increasingly difficult to tease out the effect of a single, prehospital intervention on survival at hospital discharge or on length of stay. If a therapy has no effect on patient-oriented outcomes, such as relief of pain or survival, then there is no value in using resources to continue that therapy. We caution that data not originating from the EMS setting must be scrutinized by experts with multi-disciplinary credentials. We encourage the evaluation of evidence by people with expertise in these three domains: critical appraisal, EM, and EMS. Science should be assessed for: 1) quality and bias; 2) directness, generalizability and validity to the EMS population; 3) effect size and anticipated benefit from prehospital application; 4) feasibility, including health economics and human resource availability; and 5) patient and provider safety.

If hospital-based research is introduced to the prehospital field based on compelling evidence, then implementation studies must further evaluate feasibility, safety, unintended consequences, and patient-oriented outcomes.

LOOKING FORWARD

Paramedicine has advanced tremendously in the last 40 years thanks to the pioneering spirit and innovative minds of EM and EMS leaders. As EBM continues to make clinical practice evolve, paramedic practice must stay focused and be guided by the evidence. That evidence should be specific to the prehospital field, wherever possible, because certain practices may be generalizable to the field while others may not. Paramedic scope of practice should be viewed as fluid. New ways of delivering better, safer care should be embraced by funders, regulators, employers, physicians, and paramedics alike.

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