

Regulation of Paramedics and Emergency Medical Attendants: A Literature Review - Part 1

Health Professions Regulatory Advisory
Council (HPRAC)



A Rapid Literature Review on Patient Safety and Non-Physician EMS Providers

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Please note that this Rapid Literature Review is a summary of information from other sources, not a representation of the policy position or goals of the Ministry of Health and Long-Term Care. If material in the review is to be referenced, please cite the original, primary source, rather than the review itself.

OBJECTIVES

The requestor's stated objectives were to examine evidence related to patient safety and paramedics and emergency medical attendants.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

Individual peer-reviewed articles and review articles were identified through the Ontario Ministry of Health and Long-Term Care's computerized library database, PubMed, and Google Scholar. Grey literature was identified through Google and relevant government websites. The search was limited to English sources and therefore may not capture the full extent of initiatives in non-English speaking countries.

The Medical Subject Heading (MeSH) terms "Emergency Medical Services", "Emergency Medical Technicians", "Patient Safety", "Risk", "Safety Management", "Safety", "Harm Reduction", "Medical Errors", and "Ambulances", were used in combination with the following keywords to identify relevant articles and documents for this review: "Patient Safety Issues", "Risk Of Harm", "Adverse Events", "Complaints", "EMS", "Pre-hospital Emergency Care", and "Emergency Care Transitions".

A total of 25 references were identified and cited in this review: five review articles, 18 original research papers from peer-reviewed journals, and two documents from the grey literature. Table 1 in the Appendix consists of a summary table with details for each of the sources cited in the review. In total, the searching for relevant material and the writing of this review took approximately 11 days to complete by one person.

SUMMARY OF MAIN FINDINGS FROM THE LITERATURE REVIEW

- The research literature on patient safety in the context of emergency medical services (EMS) is limited.
- Several authors have noted that, by its nature, the pre-hospital setting presents many challenges to providing safe, high-quality medical care in emergency situations.
 - EMS providers work in environments that are physically and emotionally challenging (e.g., in unfamiliar locations under time pressure)
 - The EMS environment differs fundamentally from the environment of the emergency department or intensive care unit (where many EMS patients would otherwise receive care)
- Several risks to patient safety in the pre-hospital setting associated with paramedics are identified in this review; these have been broadly classified into risks associated with high-level contextual factors (e.g., scope of practice, training), and risks associated with point of care service delivery (e.g., medical errors, ambulance collisions).

Risks Associated with Contextual Factors Related to Providing EMS Care

- **Expanding Scope of Practice and Training:** According to the authors of a qualitative study, EMS scope of practice has expanded in recent years, and EMS providers may be expected to provide care for which they have not been trained adequately.

- **Skill Retention:** Evidence suggests that EMS providers may not have sufficient opportunities for practicing their skills and developing the expertise required for safe practice.
- **Fatigue:** The nature of EMS shift work may make it difficult for EMS workers to obtain sufficient quantity and quality of sleep. A recent study reported associations between sleep quality, fatigue, and self-reported safety outcomes among EMS workers.
- **Safety culture:** Safety culture refers to the shared perceptions or attitudes of a work group toward safety. According to a recent study, individual EMS worker perceptions of workplace safety culture are associated with safety-compromising behaviours.

Risks Associated with Point of Care Service Delivery

- **Issues with Clinical Judgment and Decision Making:** A number of studies have identified poor clinical decision making or difficulties associated with the complex process of making decisions at the point of care as key issues in pre-hospital patient safety.
- **Complexity of Care in the Pre-Hospital Setting:**
 - Medical care in a moving ambulance can be difficult, error prone, and may be poorly executed (e.g., patients may be dropped or fall from a stretcher causing injury); this can result in poor patient outcomes. Commonly identified errors in EMS care include failure to secure a patient's airway and mistakes in administration of medication.
 - One study found that roughly half of EMS providers reported committing an error during the previous year.
 - Deviation from protocols: There are reports on deviations from protocol care which commonly result in misdiagnoses, failure to initiate treatment, failure to reassess, and failure to alter treatment.
 - Medication errors: In a 2011 study, Canadian experts in EMS patient safety rated medication adverse events as the second most important patient safety issue in the pre-hospital setting; several studies presented findings related to EMS medication errors.
- **Ambulance Collisions:** Vehicle collisions were identified as an important patient safety issue in Canada.

DESCRIPTION OF THE FINDINGS

1. Definitions

Patient safety. The World Health Organization (WHO) defines patient safety as the “reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum” (Bigham et al. 2009 as cited in Bigham et al. 2011).

Emergency Medical Service (EMS) providers. EMS providers in Canada are educated through a one to two year diploma program and can upgrade to advanced, critical care, or air medical transport certification through further study and on-the-job training. Paramedic education is accredited by the Canadian Medical Association (Bigham et al. 2009). In this literature review, the

* The term “acceptable minimum” refers to the collective notions given current knowledge, the resources available, and the context in which care was delivered weighed against the risk of non treatment or other treatment (Bigham et al. 2009 as cited in Bigham et al. 2011).

terms “EMS providers,” “EMS personnel,” “EMS staff,” and “paramedics” have been used interchangeably and are considered to be non-physician care providers in the pre-hospital setting.

2. Limitations of the Literature

The research literature on the safety of patients treated by EMS providers is limited (Bigham et al. 2012; Bigham et al. 2009). Although the last decade has seen a considerable amount of work directed at the investigation of patient harm events (Price et al. 2012), little of it has focused on pre-hospital care (Bigham et al. 2012; Price et al. 2012). As a result, there is little quantitative information available regarding the specific risks to patient safety in the pre-hospital setting (Gallagher & Kupas, 2012; Price et al. 2012). As such, this literature review presents qualitative data on the risks to patient safety associated with care provided by EMS providers.

3. Overview of the Identified Literature

It is widely noted that providing treatment in the EMS setting poses challenges that are unique in healthcare (Brice et al. 2012; Bigham et al. 2012; Bigham et al. 2011; Price et al. 2012). According to one set of authors, “EMS providers work in perhaps the least ideal physical and emotional environment, creating a mileu ripe for patient harm” (Bigham et al. 2012). Challenges to the provision of safe, high-quality medical care in emergency situations include:

- EMS providers work in environments that are physically and emotionally challenging; providers often work in unfamiliar locations under time pressure; this may lead to crisis situations that are hectic, rushed, and stressful (Bigham et al. 2012).
- Paramedics attend medical and traumatic emergencies across the full spectrum of age, socioeconomic status and geography, and are expected to perform functions including scene management, patient assessment, treatment, and transport across that spectrum (Price et al. 2012).

According to some Canadian experts, EMS providers may be required to provide ongoing care for which they were not trained. Overcrowding in emergency departments can lead to long delays in discharging patients to emergency department staff. In the interim, EMS providers are required to provide complex care for unstable patients in a challenging environment despite never having received training for this type of care (Atack & Maher, 2010).

- The authors of the study further note that the EMS environment differs fundamentally from the environments of the emergency department or intensive care unit (where these patients would otherwise receive care); in those settings, other clinicians supervise practice, assist, and make recommendations and where quality assurance is an ongoing process because staff work in teams.

Staff stress (LeBlanc et al. 2005 as cited in Brice et al. 2012), fatigue, lack of experience (Atack & Maher, 2010), uncertainty in decision making, and the uncontrolled environment (Price et al. 2012) have all been identified as potential contributors to patient harm events in the pre-hospital setting; more research is required on the impact of each factor and how the factors combine to affect patient safety (Price et al. 2012).

Given this background, several risks to patient safety that are associated with paramedics are identified in this review; these factors have been broadly classified into risks associated with high-

level contextual factors (e.g., scope of practice, training), and risks associated with incidents that occur at the point of care (e.g., medical errors).

4. Risks Associated with Contextual Factors Related to Providing EMS Care

This review identified five factors related to the EMS providers' work conditions that have the potential to impact patients' safety; each is described below.

4.1. Expanding Scope of Practice

EMS practice has changed considerably in recent years. In a qualitative study, some Canadian experts on EMS patient safety noted that the role of EMS providers is not clear and that there is tension between the traditional stabilize-and-transport role and the increasingly complex treatment role that has come about through "scope creep." According to some of the experts included in the study, as skills, medications, and technology have been added to professional practice, training has not kept pace, (Atack & Maher, 2010). This may lead providers to make clinical decisions that could harm patients during pre-hospital care (Bigham et al. 2012).

4.2. Training

The literature further suggests that paramedics may lack proper training or experience to provide specialized care that children require (Al-Anazi, 2012; Lu et al. 2012). One UK survey found that paramedics and most emergency medical technicians had received limited pediatric training. For example, 54% of clinical directors of 16 NHS ambulance services indicated that there was a high likelihood that the first individual to respond to an emergency involving a child could be someone with no current qualification specific to paediatrics (Houston & Pearson, 2010).

Several jurisdictions have responded to the challenge of safety issues associated with paramedics' training by developing programs that aim to give paramedics enhanced capabilities. Findings regarding the effectiveness of these programs, however, have been mixed. Examples include:

- One systematic review found that there was no benefit to providing advanced life support training[†] for ambulance personnel (Jayaraman & Sethi, 2010).
- According to a recent review (Bigham et al. 2012), the only randomized controlled trial examining threats to patient safety in the EMS environment found no significant differences in the safety of clinical decisions made by extended-scope paramedics[‡] who had received additional training in the assessment and treatment of low-acuity conditions compared to the standard UK EMS care (Mason et al. 2008).
- In the US, critical care paramedics (CCPs), who have enhanced clinical capabilities in airway and cardiovascular management, are thought by some to have the potential to help reduce mortality rates in the pre-hospital environment. A 2011 UK report evaluating CCPs, however, suggested that evidence was inconclusive as to whether doctors were able to save more lives or achieve better clinical outcomes than CCPs in pre-hospital care (The National Institute for Health Research Confederation, 2011).

[†] Advanced life support (ALS)-trained ambulance crews receive extra training (e.g., endotracheal intubation, the administration of intravenous fluids, and the use of selected drugs) (Jayaraman & Sethi, 2010).

[‡] The role of extended-role paramedic practitioners in the UK was developed in order to manage minor acute illness and injury among older people in the home when appropriate, avoiding unnecessary transfer to the emergency department (Mason et al. 2008).

4.3. Skill Retention

In a qualitative study, Canadian experts with knowledge and expertise regarding policy, practice, and research in EMS patient safety[§] commented that EMS providers are often trained and certified based on a one-time evaluation; and then sent out to practice unsupervised – they noted that subsequent opportunities for practicing their skills may not be sufficient to develop the expertise required for safe practice (Atack & Maher, 2010). For instance:

- One study of paramedic students found that intubation** success rates increased with greater clinical experience, but the authors noted that many training programs may not provide enough intubation training experiences to achieve high success rates (Warner et al. 2010).

4.4. Fatigue

The WHO identified fatigue as a leading factor in medical error and injury in health care (WHO, 2009 as cited in Patterson et al. 2012). It has been noted that the nature of EMS shift work includes overnight duty, rotating schedules, early awakening, and interrupted nocturnal sleep, which can disrupt circadian rhythms and result in a situation where the individual is out of phase with the environment, and suffer from a decrease in the quantity and quality of sleep. As a result of these issues, it has been suggested that EMS providers suffer from poor sleep quality, often feel fatigued while at work (Brice & Patterson, 2012) and report feeling stress and burnout (Knox et al. 2006; Patterson et al. 2005 as cited in Patterson et al. 2010a). For instance, in two American studies, 44.5% (Patterson et al. 2010b) and 55.0% (Patterson et al. 2012) of EMS workers reported that they suffered from severe fatigue while at work; EMS workers also commonly reported poor sleep quality (Patterson et al. 2010b). EMS providers may work around-the-clock and work for 12- or 24-hour shifts, with limited opportunities for meals or rest which can lead to fatigue (Brice et al. 2012).

A recent study of EMS workers in the US reported associations between sleep quality, fatigue, and self-reported safety outcomes (Patterson et al. 2012). The study found that, compared to non-fatigued respondents, EMS providers who reported being fatigued were:

- More than twice as likely to report one or more medical errors or adverse events in the previous three months;
- Almost twice as likely to report having been injured in the previous three months;
- Over 3.5 times as likely to report that their safety or the safety of their patients was compromised in the prior three months.

4.5. Safety Culture

Safety culture refers to the shared perceptions or attitudes of a work group toward safety (Zohar, 1980 as cited in Weaver et al. 2012). A recent study found that individual EMS workers' perceptions of workplace safety culture were associated with patient safety outcomes; EMS

[§] Purposive sampling was used in this study to identify informants with knowledge and expertise regarding policy, practice, and research who could speak to the issue of patient safety; the committee consisted of representatives from the Canadian Patient Safety Institute, Emergency Medical Services Chiefs of Canada, and the Calgary, Alberta, EMS Foundation (Atack & Maher, 2010).

** Intubation refers to a procedure that inserts a tube into the patient's airway to protect the airway from collapsing ([The Free Dictionary](#), 2012); a Canadian study found that 62% of experts in the field of EMS patient safety identified intubation as an important patient safety issue** (Bigham et al. 2011).

workers who reported lower perceptions of the safety climate of their workplace^{††} also reported safety-compromising behaviour^{‡‡} (Weaver et al. 2012). A 2010 study found that safety culture scores varied across EMS agencies (Patterson et al. 2010a).

The authors of one article suggested that safety topics that may currently require a cultural shift include vehicle use (e.g., lights and siren use), personnel management (e.g., driver training), and behavioural response (e.g., speed at the cost of safety) (Brice et al., 2012).

5. Risks Associated with Point of Care Service Delivery

This review identified three factors that may impact patient safety at the point of care; each is described below.

5.1. Issues with Clinical Judgment and Decision Making

EMS providers are required to make critical medical decisions with incomplete information and under time pressure (Lu et al. 2012). A number of studies have identified poor clinical decision making or difficulties associated with the complex process of making decisions at the point of care as key issues in pre-hospital patient safety (Price et al. 2012; Bigham et al. 2011; Atack & Maher, 2010). A 2012 study found that regular exposure to unremarkable or low severity cases (e.g., abdominal pain) may desensitize paramedics to severe conditions that present with similar symptoms (e.g., mistaking a heart attack for abdominal pain) (Price et al. 2012). Studies have linked clinical judgment to expanding the scope of practice, training (Bigham et al. 2012), and fatigue (Atack & Maher, 2010; Patterson et al. 2010b) (these factors were described in Section 4).

5.2. Complexity of Providing Care in the Pre-Hospital Setting

It has been suggested that care in the pre-hospital setting is potentially error prone (Lu et al. 2012), and that communication failure between EMS providers and patients in the pre-hospital setting can increase the risk of medical errors (Price et al. 2012). Findings regarding problems in the care delivered by EMS workers identified in the literature are as follow:

- According to a 2012 article, several investigators have found that the quality of cardiopulmonary resuscitation (CPR) provided during transport or simulated transport was poor (Brice et al., 2012).
- Results of a retrospective review of claims against EMS agencies in the US revealed that patient handling was one of the most common adverse events and accounted for 36% of claims (e.g., instances in which patient fell or was dropped by EMS provider) (Wang et al., 2008).
- A recent article (Lu et al. 2012) noted that in one study, roughly half of EMS providers reported committing an error during the last year. The authors noted that given that approximately 16 million medical transports occur in the US annually, the actual number of pre-hospital errors is likely substantial.

^{††} EMS workers safety culture was measured by the Safety Attitudes Questionnaire (SAQ) which is a survey instrument measuring six dimensions of workplace safety culture (Safety Climate, Teamwork Climate, Perceptions of Management, Job Satisfaction, Working Conditions, and Stress Recognition) (Patterson et al. 2010a).

^{‡‡} Both EMS workplace safety culture and safety-compromising behaviours were self-reported by EMS providers and were measured at the same time (Patterson et al. 2010a).

5.2.1. Deviation from Protocols

Standard treatment protocols for certain pre-hospital complaints are designed to achieve consistent, high-quality, error-resistant care for a given complaint. In spite of this, there are reports on deviations from protocol care which commonly result in misdiagnoses, failure to initiate treatment, failure to reassess, and failure to alter treatment (Rittenberger et al. 2005). Evidence suggests that pre-hospital patients may not always receive the care recommended by protocols and that awareness of guidelines among EMS providers may be low; for example:

- A US study reported that, in the care of patients with chest pain, deviations from protocol by EMS providers occur frequently and that, as a result, the documented care of pre-hospital patients with chest pain is variable. For example despite the proven effect of aspirin in reducing mortality in patients with heart attack that is reflected in the standard medical treatment protocols, just over half of the patients in the study received aspirin prior to arrival at the hospital (Rittenberger et al. 2005).
- One US study found that awareness among EMS providers in two states regarding the use of pediatric defibrillation^{§§} guidelines was low (less than 30%) following the release of an advisory statement, but that awareness of the recommendations significantly increased (to 60% or over) following the incorporation of the recommendations into the CPR guidelines (Haskell et al. 2008).

5.2.2. Medication Errors

In a 2011 study, Canadian experts in EMS patient safety rated medication adverse events as the second most important patient safety issue in the pre-hospital setting,^{***} with 69% of participants rating its importance highly^{†††} (Bigham et al. 2011). Several studies presented findings related to medication error; findings included:

- In a qualitative study, some Canadian experts in EMS patient safety noted that giving medications is a relatively small part of the EMS process; but that medication errors are seriously underreported (Atack & Maher, 2010).
- Other studies have found that medication errors are common in the pre-hospital setting (Hoyle et al. 2012). For example:
 - One study found that the error frequency with the dosing of one of the emergency medications, epinephrine, was 56% among EMS providers (Kaji et al. 2006 as cited in Hoyle et al. 2012).
 - A recent study reported that pre-hospital medication events contributed to 5% of safety events in the state of Pennsylvania (Gallagher & Kupas, 2012).
 - A study conducted in eight Michigan EMS agencies revealed that medications delivered in the pre-hospital care of children by paramedics were frequently administered outside of the proper dose range (Hoyle et al. 2012).^{‡‡‡}

^{§§} Defibrillation is a process in which an electronic device gives an electric shock to the heart. This helps re-establish normal contraction rhythms ([American Heart Association](#), 2012).

^{***} The most prominent patient safety issue was clinical judgment and decision making, rated as highly important by 95% of attendees (Bigham et al. 2011).

^{†††} 69% of respondents assigned intubation a score of four or five on a five-point scale of importance (Bigham et al. 2011).

^{‡‡‡} Children may be particularly vulnerable to medication errors because drug dosages are calculated according to body weight; however paramedics' often have limited experience treating children, which can contribute to errors (Hoyle et al. 2012).

5.3. Ambulance Collisions

Vehicle collisions were identified by Canadian experts in EMS patient safety as an important^{§§§} patient safety issue in pre-hospital care (Bigham et al. 2011; Atack & Maher, 2010). A growing body of research demonstrates that ambulance crashes are common (Brice et al., 2012; Brice and Patterson, 2012):

- Results of a US study showed that emergency vehicle collisions accounted for 37% of claims against EMS agencies (Wang et al., 2008).
- Another study found that from 2003 to 2010, driving issues or collisions contributed to 6% of safety events in the state of Pennsylvania (Gallagher & Kupas, 2012).

Some of the causes of collisions identified in the literature included: inexperienced drivers; effects of shift work and stress in EMS providers; lack of driver safety training (Wang et al. 2008; Kahn et al. 2001; Saunders & Heye, 1994, as cited in Bigham et al. 2011); substance abuse; fatigue (Brice et al. 2012); and the culture of speed in EMS (Atack & Maher, 2010).

^{§§§} 61% of respondents assigned intubation a score of four or five on a five-point scale of importance (Bigham et al. 2011).

APPENDIX
Table 1 – Description of the content in the articles being summarized¹³

No.	Description	Reference
Review Articles		
1.	<p>Aim: To survey the literature on Pediatric Emergency Medical Services (PEMS) with an aim to focus its drawbacks and emphasize the means of improvement. Materials and Methods: Published articles selected for inclusion were based on the significance and understanding of literature search on different aspects of PEMS. To meet this criterion, PubMed, PubMed Central, Science Direct, Uptodate, Med Line, comprehensive databases, Cochrane library and the Internet (Google, Yahoo) were thoroughly searched. Results: PEMS provide out-of-hospital medical care and/or transport the patients to definitive care. The task force represents specialties of ambulance transport, first aid, emergency medical care, life saving, trauma, emergency medicine, water rescue, and extrication. Preliminary care is undertaken to save the patients from different medical exigencies. The techniques and procedures of basic and advanced life-support are employed. A large number of weaknesses are recorded in PEMS system, such as ambulance transport irregularities, deficit equipment, lack of expertise, and ignorance of the pre-hospital care providers. These are discussed with special reference to a few examples of medical exigencies. Conclusions: The appointments in PEMS should be regularized with specific qualifications, experience, and expertise in different areas. Responsibility of PEMS should not be left to pre-hospital care providers, who are non clinicians and lack proper education and training. Pediatricians should be adequately trained to play an active role in PEMS. Meetings should be convened to discuss the lapses and means of improvement. Networks of co-operation between pre-hospital providers and experts in the emergency department should be established.</p>	<p>Al-Anazi, A. (2012). Pediatric emergency medical services and their drawbacks. <i>Journal of Emergencies, Trauma and Shock</i>, 5 (3), 220-7.</p>

¹³ Please note the studies, programs, and findings presented in this table may originate from jurisdictions with health systems that are significantly different from Ontario's. If there is intent to draw heavily from one or more sources presented in this table, we recommend that you contact the lead author of this review for assistance with evaluating the local applicability.

No.	Description	Reference
2.	<p>Background. Preventable harm from medical care has been extensively documented in the inpatient setting. Emergency medical services (EMS) providers care for patients in dynamic and challenging environments; pre-hospital emergency care is a field that represents an area of high risk for errors and harm, but has received relatively little attention in the patient safety literature.</p> <p>Objective. To identify the threats to patient safety unique to the EMS environment and interventions that mitigate those threats, The authors completed a systematic review of the literature. Methods. The authors searched MEDLINE, EMBASE, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) for combinations of key EMS and patient safety terms composed by a pan-Canadian expert panel using a year limit of 1999 to 2011. The authors excluded commentaries, opinions, letters, abstracts, and non-english publications. Two investigators performed an independent hierarchical screening of titles, abstracts, and full-text articles blinded to source. The authors used the kappa statistic to examine interrater agreement. Any differences were resolved by consensus. Results. The authors retrieved 5,959 titles, and 88 publications met the inclusion criteria and were categorized into seven themes: adverse events and medication errors (22 articles), clinical judgment (13), communication (6), ground vehicle safety (9), aircraft safety (6), interfacility transport (16), and intubation (16). Two articles were randomized controlled trials; the remainder were systematic reviews, prospective observational studies, retrospective database/chart reviews, qualitative interviews, or surveys. The kappa statistics for titles, abstracts, and full-text articles were 0.65, 0.79, and 0.87, respectively, for the first search and 0.60, 0.74, and 0.85 for the second. Conclusions. The authors found a paucity of scientific literature exploring patient safety in EMS. Research is needed to improve our understanding of problem magnitude and threats to patient safety and to guide interventions.</p>	<p>Bigham, B.L., Buick, J.E., Brooks, S.C., Morrison, M., Shojania, K.G., & Morrison, L.J. (2012). Patient safety in emergency medical services: a systematic review of the literature. <i>Prehospital Emergency Care, 16</i>(1), 20-35.</p>
3.	<p>Introduction: Pre-hospital airway management is a controversial subject, but there is general agreement that a small number of seriously ill or injured patients require urgent emergency tracheal intubation (ETI) and ventilation. Many European emergency medical services (EMS) systems provide physicians to care for these patients while other systems rely on paramedics (or, rarely, nurses). The ETI success rate is an important measure of provider and EMS system success and a marker of patient safety.</p> <p>Methods: The authors conducted a systematic search of Medline and EMBASE to identify all of the published original English-language articles reporting pre-hospital ETI in adult patients. The authors selected all of the studies that reported ETI success rates and extracted information on the number of attempted and successful ETIs, type of provider, level of ETI training and the availability of drugs on scene. The authors calculated the overall success rate using meta-analysis and assessed the relationships between the ETI success rate and type of provider and between the ETI success rate and the types of drugs available on the scene. Results: From 1,070 studies initially retrieved, the authors identified 58 original studies meeting the selection criteria. Sixty-four per cent of the non-physician-manned services and 54% of the physician-manned services reported ETI success rates but the success rate reporting was incomplete in three studies from non-physician-manned services. Median success rate was 0.905 (0.491, 1.000). In a weighted linear regression analysis, physicians as providers were significantly associated with increased success rates, 0.092 (P = 0.0345). In the non-physician group, the use of drug-assisted intubation significantly increased the success rates. All physicians had access to traditional rapid sequence induction (RSI) and, comparing these to non-physicians using muscle paralytics or a traditional RSI, there still was a significant difference in success rate in favour of physicians, 0.991 and 0.955, respectively (P = 0.047).</p> <p>Conclusions: This comprehensive meta-analysis suggests that physicians have significantly fewer pre-hospital ETI failures overall than non-physicians. This finding, which remains true when the non-physicians administer muscle paralytics or RSI, raises significant patient safety issues. In the absence of pre-hospital physicians, conducting basic or advanced airway techniques other than ETI should be strongly considered.</p>	<p>Lossius, H.M., Røislien, J., & Lockey, D.J. (2012). Patient safety in pre-hospital emergency tracheal intubation: a comprehensive meta-analysis of the intubation success rates of EMS providers. <i>Critical Care, 16</i>(1).</p>

No.	Description	Reference
4.	<p>Emergency medical services (EMS) personnel care for patients in challenging and dynamic environments that may contribute to an increased risk for adverse events. However, little is known about the risks to patient safety in the EMS setting. To address this knowledge gap, the authors conducted a systematic review of the literature, including nonrandomized, noncontrolled studies, conducted qualitative interviews of key informants, and, with the assistance of a pan-Canadian advisory board, hosted a 1-day summit of 52 experts in the field of EMS patient safety. The intent of the summit was to review available research, discuss the issues affecting pre-hospital patient safety, and discuss interventions that might improve the safety of the EMS industry. The primary objective was to define the strategic goals for improving patient safety in EMS. Participants represented all geographic regions of Canada and included administrators, educators, physicians, researchers, and patient safety experts. Data were collected through electronic voting and qualitative analysis of the discussions. The most prominent patient safety issue discussed was clinical judgment and decision making, rated as highly important by 95% of attendees. There was a consensus that paramedics in Canada are providing increasingly complex and time-sensitive patient care; examples include new cardiopulmonary resuscitation (CPR) process measures for cardiac arrest, early stroke identification and transport bypass protocols, and therapeutic interventions in trauma. The informants stated that training may be inadequate to ensure that paramedics are competent in performing complex protocols and making clinical decisions regarding diagnosis and treatment, and this may contribute to patient safety issues. The group reached consensus on nine recommendations to increase awareness, reduce adverse events, and suggest research and educational directions in EMS patient safety: increasing awareness of patient safety principles, improving adverse event reporting through creating nonpunitive reporting systems, supporting paramedic clinical decision making through improved research and education, policy changes, using flexible algorithms, adopting patient safety strategies from other disciplines, increasing funding for research in patient safety, salary support for paramedic researchers, and access to graduate training in pre-hospital research.</p>	<p>Bigham, B.L., Bull, E., Morrison, M., Burgess, R., Maher, J., Brooks, S.C., & Morrison, L.J. (2011). Patient safety in emergency medical services: executive summary and recommendations from the Niagara Summit. <i>Canadian Journal of Emergency Medicine</i>, 13(1), 13–18.</p>

No.	Description	Reference
5.	<p>Background: There is an increasing global burden of injury especially in low- and middle-income countries (LMICs). To address this, models of trauma care initially developed in high income countries are being adopted in LMIC settings. In particular, ambulance crews with advanced life support (ALS) training are being promoted in LMICs as a strategy for improving outcomes for victims of trauma. However, there is controversy as to the effectiveness of this health service intervention and the evidence has yet to be rigorously appraised. Objectives: To quantify the impact of ALS-trained ambulance crews versus crews without ALS training on reducing mortality and morbidity in trauma patients. Search methods: Searches were not restricted by date, language or publication status. The authors searched the Cochrane Injuries Group Specialised Register, CENTRAL (<i>The Cochrane Library</i> 2009, Issue 3), MEDLINE (Ovid SP), EMBASE (Ovid SP), CINAHL (EBSCO) and PubMed in all years up to July 2009. The authors also searched the reference lists of relevant studies and reviews in order to identify unpublished material. Selection criteria: Randomised controlled trials, quasi-randomised controlled trials and non-randomised studies, including before-and-after studies and interrupted time series studies, comparing the impact of ALS-trained ambulance crews versus crews without ALS training on the reduction of mortality and morbidity in trauma patients. Data collection and analysis: One review author applied eligibility criteria to trial reports for inclusion and extracted data. Main results: The authors found one controlled before-and-after trial, one uncontrolled before-and-after study, and one randomised controlled trial that met the inclusion criteria. None demonstrated evidence to support ALS training for pre-hospital personnel. In the uncontrolled before- and- after study, 'a priori' sub-group analysis showed an increase in mortality among patients who had a Glasgow Coma Scale score of less than nine and received care from ALS trained ambulance crews. Additionally, when the pre-hospital trauma score was taken into account in logistic regression analysis, mortality in the patients receiving care from ALS trained crews increased significantly. Authors' conclusions: At this time, the evidence indicates that there is no benefit of advanced life support training for ambulance crews.</p>	<p>Jayaraman, S. & Sethi, D. (2009). Advanced trauma life support training for ambulance crews. <i>The Cochrane database of systematic reviews</i>, 20(1).</p>
Articles in Peer-Reviewed Journals		
6.	<p>The pre-hospital setting is an unpredictable and often hazardous environment for providers and patients. Recent research shows that emergency medical services (EMS) personnel often work multiple jobs, are physically unfit or unhealthy, suffer from poor sleep quality, and often feel fatigued while at work. These factors increase the risks of negative safety outcomes for the EMS provider, such as musculoskeletal injury or exposure to blood-borne pathogens. Several known threats to patient safety include medication errors, missed intubations, inadequate chest compression fraction, and drops from a stretcher. The authors note that understanding is limited regarding threats to provider and patient safety, the magnitude of these problems, the cause, and what interventions are effective in reducing risk. A growing body of research demonstrates that ambulance crashes are common and deadly events that may be preventable. The ambulance is ergonomically disadvantageous for safe care delivery. Crashworthiness testing of ambulances may provide additional information about external design and internal configuration that can be applied to save the lives of providers and patients. The nature of pre-hospital care requires that medical decisions be made quickly and often with limited information from the patient or bystanders. This lack of sufficient information may lead to a medication error or an adverse event.</p>	<p>Brice, J.H. & Patterson, P.D. (2012) Special Section: Safety in EMS. <i>Prehospital Emergency Care</i>, 16(1), 1.</p>

No.	Description	Reference
7.	<p>The out-of-hospital setting is unique to health care and presents many challenges to providing safe, high-quality medical care in emergency situations. The challenges of the pre-hospital environment require thoughtful design of systems and processes of care. The unique challenges of ambulance safety may be met by analyzing systems and incorporating process improvements. The purposes of this paper are to 1) outline the nature of this problem, 2) introduce a framework for this discussion, 3) provide expert opinion from a two-day ambulance safety conference, and 4) propose a plan of action to address the safety issues identified in the literature and expert opinion at the conference. Utilizing the Haddon Matrix as a framework, the authors present the safety issues and proposed solutions for factors contributing to an injury event in the emergency medical services (EMS) transport environment: host, agent, physical environment, and social environment. <i>Host</i> refers to the person or persons at risk, in this case, the EMS personnel or the patient. Conceptualizing the EMS professional as the host in Haddon's injury matrix allows us to examine many facets of injury that occur in and around an ambulance during the care and transport of a patient. Host factors that may play an important role in ambulance safety include fitness, sleepiness, education, knowledge, skills, and capability. The <i>agent of injury</i> refers to the energy exerted during the course of an injury, and may be modified to include unrestrained equipment that contributes to the injury. In the context of safety in a moving vehicle, the ambulance itself is the most obvious equipment to be considered. The equipment within an ambulance is also important in the discussion of safety in the moving ambulance, particularly if it is not carefully secured. The <i>physical environment</i> refers to the characteristics of the setting in which the injury takes place, such as the roadway or the physical design of the ambulance. The physical environment within the patient compartment of an ambulance can compromise a provider's ability to safely deliver care. Several investigators have found that the quality of cardiopulmonary resuscitation (CPR) provided during transport or simulated transport was poor. Finally, the <i>social environment</i> refers to the social, legal, and cultural norms and practices in the society, such as peer pressure and a culture that discourages the use of safety equipment. Quality patient care can be provided in a safe and timely manner. Current safety topics that may require a cultural shift can be broken into three broad areas: vehicle use, personnel management, and behavioral response. Vehicle use incorporates ambulance response times, lights and siren use, and call prioritization. Personnel management includes seat-belt usage and driver training. Behavioral response includes the notion of speed at all costs, personal accountability, error recognition, and self-reporting.</p>	<p>Brice, J.H., Studnek, J.R., Bigam, B.L., Martin-Gill, C., Custalow, C.B., Hawkins, E., & Morrison, L.J. (2012). EMS provider and patient safety during response and transport: proceedings of an ambulance safety conference. <i>Prehospital Emergency Care</i>, 16(1), 3-19.</p>

No.	Description	Reference
8.	<p>Background: Patient and provider safety is paramount in all aspects of emergency medical services (EMS) systems. The leaders, administrators, and policymakers of these systems must have an understanding of situations that present potential for harm to patients or providers. Objective: This study analyzed reports to a statewide EMS safety event reporting system with the purpose of categorizing the types of incidents reported and identifying opportunities to prevent future safety events. Methods: This statewide EMS safety incident reporting system is a Web-based system to which any individual can anonymously report any event or situation perceived to impact safety. The authors reviewed all reports between the system's inception in 2003 through August 2010. A stipulation of the system is that any entry containing information that identifies an EMS provider, agency, or patient will be deleted and thus not included in the analysis. Each event report included the description of the event, the relationship of the reporter, and the year in which the event occurred. Each entry was placed into a category that best represents the situation described. Results: A total of 415 reports were received during the study period, and 186 reports were excluded—163 (39%) excluded by the state because of identifiable information and 23 (6%) excluded by the authors because of nonsensical description. Within the remaining 229 reports, there were 237 distinct safety events. These events were classified as actions/behavior (32% [e.g., training/clinical judgment, 23%]), vehicle/transportation (16% [e.g., driving issue or collision, 6%]), staffing or ambulance availability (13%), communications (8%), medical equipment (9%), multiple patients/agencies/units and level-of-care issues (7%), medical procedure (6%), medication (5%), accident scene management/scene safety (3%), and protocol issues (1%). EMS providers directly involved in the event represented the largest reporting group (33%). The authors also provide examples of statewide system and policy changes that were made in direct response to these reports. Conclusion: This EMS safety incident reporting system identified situations that occurred in many categories of EMS care. These potential dangers represent opportunity to assess, and ultimately change, policy and procedures to reduce potential safety events and medical errors and improve overall safety. A substantial number of cases were excluded to maintain the promise of anonymity within the system. Limitations: The data set used in the study is limited by the willingness of the reporters to submit the events that they witness and all reports are treated as factual and do not correct for misunderstandings, varying points of view, or fraudulent reports.</p>	<p>Gallagher, J.M. & Kupas, D.F. (2012). Experience with an anonymous web-based state EMS safety incident reporting system. <i>Prehospital Emergency Care, 16</i>(1), 36-42.</p>

No.	Description	Reference
9.	<p>Background: Medication dosing errors occur in up to 17.8% of hospitalized children. There are limited data to describe pediatric medication errors by emergency medical services (EMS) paramedics. It has been shown that paramedics have infrequent encounters with pediatric patients. Objective: To characterize medication dosing errors in children treated by EMS. Methods: The authors studied patients aged ≤ 11 years who were treated by paramedics from eight Michigan EMS agencies from January 2004 through March 2006. They defined a medication dosing error as $\geq 20\%$ deviation from the weight-appropriate dose, as determined by the patient's reported weight in the pre-hospital medical record or by use of the Broselow-Luten tape (BLT). The authors studied errors in administering six EMS medications commonly given to children: albuterol, atropine, dextrose, diphenhydramine, epinephrine, and naloxone. Results: There were 5,547 children aged ≤ 11 years who were treated during the study period, of whom 230 (4.1%) received drugs and had a documented weight. These patients received a total of 360 medication administrations. Multiple drug administrations occurred in 73 cases. Medication dosing errors occurred in 125 of the 360 drug administrations (34.7%). Relative drug dosage errors were as follows: albuterol 23.3%, atropine 48.8%, diphenhydramine 53.8%, and epinephrine 60.9%. The mean error (\pm standard deviation) for intravenous/intraosseous 1:1000 epinephrine overdoses was $808\% \pm 428\%$. The mean error (\pm standard deviation) for intravenous/intraosseous 1:1000 epinephrine underdoses was $35.5\% \pm 27.4\%$. Conclusions: Medications delivered in the pre-hospital care of children were frequently administered outside of the proper dose range when compared with patient weights recorded in the pre-hospital medical record. EMS systems should develop strategies to reduce pediatric medication dosing errors.</p>	<p>Hoyle, J.D., Davis, A.T., Putman, K.K., Trytko, J.A., & Fales, W.D. (2012). Medication dosing errors in pediatric patients treated by emergency medical services. <i>Prehospital Emergency Care</i>, 16(1), 59-66.</p>
10.	<p>Out-of-hospital medical errors are likely common. There are important unanswered questions about the type, level of harm, and root cause of out-of-hospital errors. Safety experts and national guidelines recommend disclosing harmful medical errors to patients. Communicating with patients and families about errors respects their autonomy, supports informed decision making, may decrease malpractice costs, and can enhance patient safety. Yet existing disclosure guidelines may not account for the difficulty in discussing out-of-hospital errors with patients. Emergency medical services (EMS) providers operate in unpredictable environments that require rapid interventions for patients with whom they have only brief relationships. EMS providers also have limited access to patient medical data and risk management resources, which can make conducting disclosure conversations even more difficult. In addition, out-of-hospital errors may be discovered only after the transition of care to the inpatient setting, further complicating the question of who should disclose the error. EMS organizations should support the disclosure of out-of-hospital errors by fostering a nonpunitive culture of error reporting and disclosure, as well as developing guidelines for use by EMS systems.</p>	<p>Lu, D.W., Guenther, E., Wesley, A.K., & Gallagher, T.H. (2012). Disclosure of harmful medical errors in out-of-hospital Care. <i>Annals of Emergency Medicine</i>, Aug 7. [Epub ahead of print]</p>

No.	Description	Reference
11.	<p>Objective: To determine the association between poor sleep quality, fatigue, and self-reported safety outcomes among emergency medical services (EMS) workers. Methods: These authors used convenience sampling of EMS agencies and a cross-sectional survey design. They administered the 19-item Pittsburgh Sleep Quality Index (PSQI), 11-item Chalder Fatigue Questionnaire (CFQ), and 44-item EMS Safety Inventory (EMS-SI) to measure sleep quality, fatigue, and safety outcomes, respectively. The authors used a consensus process to develop the EMS-SI, which was designed to capture three composite measurements of EMS worker injury, medical errors and adverse events (AEs), and safety-compromising behaviors. They used hierarchical logistic regression to test the association between poor sleep quality, fatigue, and three composite measures of EMS worker safety outcomes. Results: The authors received 547 surveys from 30 EMS agencies (a 35.6% mean agency response rate). The mean PSQI score exceeded the benchmark for poor sleep (6.9, 95% confidence interval [CI] 6.6, 7.2). More than half of the respondents were classified as fatigued (55%, 95% CI 50.7, 59.3). Eighteen percent of the respondents reported an injury (17.8%, 95% CI 13.5, 22.1), 41% reported a medical error or AE (41.1%, 95% CI 36.8, 45.4), and 90% reported a safety-compromising behavior (89.6%, 95% CI 87, 92). After controlling for confounding, They identified 1.9 greater odds of injury (95% CI 1.1, 3.3), 2.2 greater odds of medical error or AE (95% CI 1.4, 3.3), and 3.6 greater odds of safety-compromising behavior (95% CI 1.5, 8.3) among fatigued respondents versus nonfatigued respondents. Conclusions: In this sample of EMS workers, poor sleep quality and fatigue are common. The authors provide preliminary evidence of an association between sleep quality, fatigue, and safety outcomes.</p>	<p>Patterson, P.D., Weaver, M.D., Frank, R.C., Warner, C.W., Martin-Gill, C., Guyette, F.X., et al. (2012). Association between poor sleep, fatigue, and safety outcomes in emergency medical services providers. <i>Prehospital Emergency Care</i>, 16(1), 86-97.</p>
12.	<p>Background: The last decade has seen a vast amount of work directed at the investigation of patient harm events. Unfortunately, little of it has pertained to pre-hospital care and as such, risk remains unquantified and poorly understood in this setting. The authors hypothesised that adverse patient events occurring during the pre-hospital phase may fall into discernible patterns, and that an understanding of these patterns would be valuable in the development of mitigation strategies. Methods: A survey tool was developed with reference to the human factors literature. Paramedics in a large Australian ambulance service were asked to recall an adverse event and to nominate factors that may have contributed to its occurrence. Responses were analysed using principal components analysis in order to identify contributory factors that could be statistically grouped together in meaningful patterns. Results: The survey yielded 370 responses. Eight key single contributors and 14 groups of contributory factors were identified. Of the groups, only two were strongly associated with serious patient outcomes, such as reported significant deterioration or death. Conclusions: The deteriorating patient was identified as the leading single contributor to pre-hospital adverse events, and two perfect storm patient harm scenarios were found to contribute materially to adverse outcomes. This approach to identifying both single factors contributing to an incident and factors which could be grouped together in a pattern, appears useful in delineating risk in the acute pre-hospital setting, and warrants further exploration in this and other areas of patient safety.</p>	<p>Price, R., Bendall, J.C., Patterson, J.A., & Middleton, P.M. (2012). What causes adverse events in prehospital care? A human-factors approach. <i>Emergency Medicine Journal</i>, Jul 16. [Epub ahead of print]</p>

No.	Description	Reference
13.	<p>Introduction. In 2005, the American Heart Association (AHA) released guidelines to improve survival rates from out-of-hospital cardiac arrest (OHCA). Objective. To determine if, and when, emergency medical services (EMS) agencies participating in the Resuscitation Outcomes Consortium (ROC) implemented these guidelines. Methods. The authors contacted 178 EMS agencies and completed structured telephone interviews with 176 agencies. The survey collected data on specific treatment protocols before and after implementation of the 2005 guidelines as well as the date of implementation crossover (the “crossover date”). The crossover date was then linked to a database describing the size, type, and structure of each agency. Descriptive statistics and regression were used to examine patterns in time to crossover. Results. The 2005 guidelines were implemented by 174 agencies (99%). The number of days from guideline release to implementation was as follows: mean 416 (standard deviation 172), median 415 (range 49–750). There was no difference in time to implementation in fire-based agencies (mean 432), nonfire municipal agencies (mean 365), and private agencies (mean 389, $p = 0.31$). Agencies not providing transport took longer to implement than agencies that transported patients (463 vs. 384 days, $p = 0.004$). Agencies providing only basic life support (BLS) care took longer to implement than agencies who provided advanced life support (ALS) care (mean 462 vs. 397 days, $p = 0.03$). Larger agencies (>10 vehicles) were able to implement the guidelines more quickly than smaller agencies (mean 386 vs. 442 days, $p = 0.03$). On average, it took 8.9 fewer days to implement the guidelines for every 50% increase in EMS-treated runs/year to which an agency responded. Conclusion. ROC EMS agencies required an average of 416 days to implement the 2005 AHA guidelines for OHCA. Small EMS agencies, BLS-only agencies, and nontransport agencies took longer than large agencies, agencies providing ALS care, and transport agencies, respectively, to implement the guidelines. Causes of delays to guideline implementation and effective methods for rapid EMS knowledge translation deserve investigation.</p>	<p>Bigam, B.L., Koprowicz, K., Aufderheide, T.P., Davis, D.P., Donn, S., Powell, J. et al. (2010). Delayed prehospital implementation of the 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiac care. <i>Prehospital Emergency Care</i>, 14(3), 355-60.</p>

No.	Description	Reference
14.	<p>Objectives: To date, most patient safety studies have been conducted in relation to the hospital rather than the pre-hospital setting and data regarding emergency medical services (EMS)-related errors are limited. To address this gap, a study was conducted to gain an in-depth understanding of the views of highly experienced EMS practitioners, educators, administrators, and physicians on major issues pertaining to EMS patient safety. The intent of the study was to identify key issues to give direction to the development of best practices in education, policy, and fieldwork. Methods: A qualitative study was conducted using processes described by Lincoln and Guba (1985) to enhance the quality and credibility of data and analysis. Purposive sampling was used to identify informants with knowledge and expertise regarding policy, practice, and research who could speak to the issue of patient safety. Sixteen participants, the majority of whom were Canadian (14) - the remaining were from the United States (1) and Europe (1)- participated in in-depth interviews. The average number of years of experience in EMS or health care was 27 years, and the range was from 20 to 32 years. Results: Informants were asked to identify key issues in patient safety from their perspectives. The overriding theme that emerged was that a broad view of factors influencing patient safety is required. While the perspectives of EMS personnel and physicians naturally differed, there was remarkable consistency in the issues they identified as major factors influencing patient safety. Two major themes were identified under the category of key issues: clinical decision making and EMS's focus and relationship with health care. An education gap has developed in EMS, and there is tension between the traditional stabilize-and-transport role and the increasingly complex role that has come about through "scope creep." If, as expected, EMS aligns increasingly with the health sector, then change is needed in the EMS educational structure and process to develop stronger clinical decision-making skills. Conclusion: The results of this study indicate that many individual organizations and health regions are addressing issues related to patient safety in EMS, and there are important lessons to be learned from these groups. The broader issues identified, however, are system-wide and best addressed through policy change from health regions and government.</p>	<p>Atack, L. & Maher, J. (2010). Emergency medical and health providers' perceptions of key issues in prehospital patient safety. <i>Prehospital Emergency Care</i>, 14(1), 95-102.</p>
15.	<p>Introduction: Workplace attitude, beliefs and culture may impact the safety of patient care. This study characterized perceptions of safety culture in a nationwide sample of Emergency Medical Services (EMS) agencies. Methods: The authors conducted a cross-sectional survey involving 61 Advanced Life Support EMS agencies in North America. They administered a modified version of the Safety Attitudes Questionnaire (SAQ), a survey instrument measuring dimensions of workplace safety culture (Safety Climate, Teamwork Climate, Perceptions of Management, Job Satisfaction, Working Conditions, and Stress Recognition). The authors included full-time and part-time paramedics and Emergency Medical Technicians. They determined the variation in safety culture scores across EMS agencies. Using Hierarchical Linear Models (HLM), the authors determined associations between safety culture scores and individual and EMS agency characteristics. Results: The authors received 1,715 completed surveys from 61 EMS agencies (mean agency response rate 47%; 95% CI 10%, 83%). There was wide variation in safety culture scores across EMS agencies [mean (min, max)]: Safety Climate 74.5 (Min 49.9, Max 89.7), Teamwork Climate 71.2 (Min 45.1, Max 90.1), Perceptions of Management 67.2 (Min 31.1, Max 92.2), Job Satisfaction 75.4 (Min 47.5, Max 93.8), Working Conditions 66.9 (Min 36.6, Max 91.4), Stress Recognition 55.1 (Min 31.3, Max 70.6). Air medical EMS agencies tended to score higher across all safety culture domains. Lower safety culture scores were associated with increased annual patient contacts. Safety climate domain scores were not associated with other individual or EMS agency characteristics. Conclusion: In this sample, workplace safety culture varies between EMS agencies.</p>	<p>Patterson, P.D., Huang, D.T., Fairbanks, R.J., Simeone, S., Weaver, M., & Wang, H.E. (2010a). Variation in emergency medical services workplace safety culture. <i>Prehospital Emergency Care</i>, 14(4), 448-460.</p>

No.	Description	Reference
16.	<p>Background: Fatigue is common among medical professionals and has been linked to poor performance and medical error. Objective: To characterize sleep quality and its association with severe fatigue in emergency medical services (EMS) providers. Methods: The authors studied a convenience sample of EMS providers who completed three surveys: the Pittsburgh Sleep Quality Index (PSQI), the Chalder Fatigue Questionnaire (CFQ), and a demographic survey. They used established measures to examine survey psychometrics and performed t-tests, analysis of variance (ANOVA), and chi-square tests to identify differences in PSQI and CFQ scores. Results: One hundred nineteen surveys were completed. The eight-hour shift was most commonly reported (35.4%). A majority of subjects were overweight (41.9%) or obese (42.7%), and 59.6% had been diagnosed with one or more health conditions (e.g., diabetes). Results from psychometric tests were positive. The mean (\pm standard deviation) PSQI score was 9.2 (\pm 3.7). A CFQ score ≥ 4, indicating severe mental and physical fatigue, was present in 44.5% of the subjects. The mean PSQI score was higher among those reporting severe fatigue (11.3 ± 3.2) than among those not reporting fatigue (7.5 ± 3.0, $p < 0.0001$). Conclusions: The results from this study suggest that the sleep quality and fatigue status of EMS workers are at unhealthy levels. The health and safety of the EMS worker and patient population should be considered in light of these results. Limitations: A large proportion of subjects (39.3%) in this study were between the ages of 40 and 49 years, which based on previous EMS workforce research, are representative of the older and slightly less prevalent EMS worker.</p>	<p>Patterson, P.D., Suffoletto, B.P., Kupas, D.F., Weaver, M.D., & Hostler, D. (2010b). Sleep quality and fatigue among prehospital providers. <i>Prehospital Emergency Care</i>, 14 (2), 187–93.</p>
17.	<p>Background: Emergency airway management is an important component of resuscitation of critically ill patients. Multiple studies demonstrate variable endotracheal intubation (ETI) success by pre-hospital providers. Data describing how many ETI training experiences are required to achieve high success rates are sparse. Objectives: To describe the relationship between the number of pre-hospital ETI experiences and the likelihood of success on subsequent ETI and to specifically look at uncomplicated first-pass ETI in a university-based training program with substantial resources. Methods: The authors conducted a secondary analysis of a prospectively collected cohort of paramedic student pre-hospital intubation attempts. Data collected on pre-hospital ETIs included indication, induction agents, number of direct laryngoscopy attempts, and advanced airway procedures performed. They used multivariable generalized estimating equations (GEE) analysis to determine the effect of cumulative ETI experience on first-pass and overall ETI success rates. Results: Over a period of three years, 56 paramedic students attempted 576 pre-hospital ETIs. The odds of overall ETI success were associated with cumulative ETI experience (odds ratio [OR] 1.097 per encounter, 95% confidence interval [CI] = 1.026– 1.173, $p = 0.006$). The odds of first-pass ETI success were associated with cumulative ETI experience (OR 1.061 per encounter, 95% CI = 1.014–1.109, $p = 0.009$). Conclusion: In a training program with substantial clinical opportunities and resources, increased ETI success rates were associated with increasing clinical exposure. However, first-pass placement of the ETT with a high success rate requires high numbers of ETI training experiences that may exceed the number available in many training programs.</p>	<p>Warner, K.J., Carlom, D., Cooke, C.R., Bulger, E.M., Copass, M.K., & Sharar, S.R. (2010). Paramedic training for proficient prehospital endotracheal intubation. <i>Prehospital Emergency Care</i>, 14, 103-108.</p>

No.	Description	Reference
18.	<p>Background. Prior studies have highlighted wide variation in emergency medical services (EMS) workplace safety culture across agencies. Objective. To determine the association between EMS workplace safety culture scores and patient or provider safety outcomes. Methods. The authors administered a cross-sectional survey to EMS workers affiliated with a convenience sample of agencies. They recruited these agencies from a national EMS management organization. The authors used the EMS Safety Attitudes Questionnaire (EMS-SAQ) to measure workplace safety culture and the EMS Safety Inventory (EMS-SI), a tool developed to capture self-reported safety outcomes from EMS workers. The EMS-SAQ provides reliable and valid measures of six domains: safety climate, teamwork climate, perceptions of management, working conditions, stress recognition, and job satisfaction. A panel of medical directors, emergency medical technicians and paramedics, and occupational epidemiologists developed the EMS-SI to measure self-reported injury, medical errors and adverse events, and safety-compromising behaviors. The authors used hierarchical linear models to evaluate the association between EMS-SAQ scores and EMS-SI safety outcome measures. Results. Sixteen percent of all respondents reported experiencing an injury in the past three months, four of every 10 respondents reported an error or adverse event (AE), and 89% reported safety-compromising behaviors. Respondents reporting injury scored lower on five of the six domains of safety culture. Respondents reporting an error or AE scored lower for four of the six domains, while respondents reporting safety-compromising behavior had lower safety culture scores for five of the six domains. Conclusions. Individual EMS worker perceptions of workplace safety culture are associated with composite measures of patient and provider safety outcomes. This study is preliminary evidence of the association between safety culture and patient or provider safety outcomes. Limitations: Study findings may have limited generalizability to EMS workers from certain types of EMS delivery models (e.g., fire-based models). Part-time employees and volunteers are more common among non-respondents suggesting possible limited generalizability to these EMS workers.</p>	<p>Weaver, M.D., Wang, H.E., Fairbanks, R.J., & Patterson, D. (2012). The association between EMS workplace safety culture and safety outcomes. <i>Prehospital Emergency Care</i>, 16(1), 43-52.</p>
19.	<p>Background: The purpose of this national survey of UK ambulance services was to provide an up-to-date assessment of service provision for children in the pre-hospital setting and to identify the challenges faced in providing optimal services to this group. Methods: Questionnaires were sent to clinical directors of the 16 UK NHS ambulance services in April 2009. Results: Questionnaires were returned by 13 (81%) respondents. Paramedics and most emergency medical technicians receive a limited amount of pediatric training. An increasing amount of equipment suitable for children is becoming available, but services for children vary depending on location. For example, pediatric airway adjuncts (short of intubation) were often lacking, and only 62% reported having pulse oximetry suitable for use in children. Four of the 13 respondents (31%) considered it 'possible or highly likely' that someone with no specific training could be the first to respond to a child in an emergency, and seven (54%) indicated that the likelihood that the first response to a child could be someone with no current qualification specific to pediatrics was 'high'. There are large areas of the country where no formal medical support is available at any time of day. Conclusions: Despite improvements, pediatric care by front-line personnel is limited by resource and availability of staff with key skills. Accepted standards are often lacking. Collaborative audit, research and training initiatives should be carried out between services and acute trusts to meet local service requirements. This will reduce variation and maintain the safety of patients and quality of care.</p>	<p>Houston, R. & Pearson, G.A. (2010). Ambulance provision for children: A UK national survey. <i>Emergency Medicine Journal</i>, 27, 631-636.</p>

No.	Description	Reference
20.	<p>Background: Ventricular fibrillation occurs in 10-20% of pediatric cardiac arrests. Survival rates in children with ventricular fibrillation can be as high as 30% when the rhythm is identified and treated promptly. In the last 5 years, recommendations have been made for the use of automated external defibrillators in children between one and eight years of age. Objective: The goal of this study was to determine the awareness of the ILCOR guidelines and statewide protocols concerning AED use in children ages one and eight among emergency medical providers after new guideline release. Availability of pediatric capable AED equipment was also assessed. Methods: Surveys were distributed to EMS providers in Iowa and Montana within one year of the ILCOR advisory statement in 2003 recommending use of AEDs in children ages one and eight, and again approximately one year after the 2005 ILCOR guidelines on cardiopulmonary resuscitation were published. In Iowa, there were concentrated efforts to disseminate information about AED use in children, while there were minimal efforts in Montana. Results: Awareness of ILCOR guidelines for use of AEDs in children was low in both states in 2003 (29% in Iowa vs. 9% in Montana, $p < 0.001$). After release of the 2005 guidelines, awareness improved significantly in both states but was still significantly greater in Iowa (83% vs. 60%, $p < 0.002$). In 2003, less than 20% of respondents in both states reported access to pediatric capable AEDs. Availability of pediatric pads and cables increased significantly in 2006 but remained low in Montana (74% in Iowa vs. 37% in Montana, $p < 0.001$). Conclusions: At the present time, publication of new or interim guidelines in the scientific literature alone is insufficient to ensure that new protocols are implemented. An effective and efficient method to disseminate new pediatric out-of-hospital protocols emergency care to become standard of care in a timely matter must be developed. Limitations: Limitations of this study include a smaller sample size with the repeat survey in 2006. Approximately one-third to one half fewer responses were received compared to initial survey. Those providers with greater awareness and access may have disproportionately responded to the survey. This would result in an overestimation of both awareness and access.</p>	<p>Haskell, S.E., Kenney, M.A., Patel, S., Sanddal, T.L., Altenhofen, K.L., Sanddal, N.D., & Atkins DL. (2008). Awareness of guidelines for use of automated external defibrillators in children within emergency medical services. <i>Resuscitation</i>, 76(3), 354–359.</p>
21.	<p>Background: The role of paramedics with extended skills is evolving, enabling them to assess and treat patients in the community. A United Kingdom service led by extended-role paramedic practitioners (PPs) is aimed at managing minor acute illness and injury among older people in the home when appropriate, avoiding unnecessary transfer to the emergency department (ED). Objectives: The objectives were to evaluate the safety of clinical decisions made by PPs operating within the new service. Methods: As part of a cluster-randomized controlled trial, patients aged >60 years contacting the emergency medical services (EMS) with a minor injury or illness were included in the study. The safety of the new PP intervention was compared with standard practice of EMS transfer and ED treatment. Outcomes included unplanned ED attendance within seven days of the index episode. Clinical records were rated independently by two senior ED clinicians to identify related episodes, avoidable subsequent episodes, and suboptimal care. Results: Of the 2,025 patients included in this analysis, 219 (10.9%) went on to have an unplanned ED attendance within seven days. Of these, 162 (74.0%) re-presented with a condition related to their index episode. The independent raters agreed on suboptimal care 83.4% of the time. There were 16 agreed upon episodes related to suboptimal care (0.80%). No significant differences were found between intervention and control groups in relation to re-presentation at hospital within seven days for a related condition or rates of assessed suboptimal care. Conclusions: This study suggests that appropriately trained paramedics with extended skills treating older people with minor acute conditions in the community are as safe as standard EMS transfer and treatment within the ED.</p>	<p>Mason, S., Knowles, E., Freeman, J., & Snooks, H. (2008). Safety of paramedics with extended skills. <i>Academic Emergency Medicine</i>, 15(7), 607–612.</p>

No.	Description	Reference
22.	<p>Study objective: Emergency medical services (EMS) provide care to acutely ill or injured patients in settings less controlled than other health care environments. Although reports describing individual EMS adverse events exist, few broader descriptions exist. The objective of the study is to characterize the types, frequencies, and outcomes of adverse events associated with insurance tort claims against EMS providers. Methods: The authors performed a retrospective review of insurance liability claims from a national insurer of EMS agencies. They studied closed and open insurance liability claims from January 1, 2003, to December 31, 2004, arising from EMS response to or provision of patient care and associated with injury to patients or other individuals. They excluded events associated with employee injuries only, events with property or vehicle damage only, and emergency vehicle crashes with less than \$10,000 in actual or predicted total incurred costs. These investigators identified the category of the adverse event, the characteristics of the treating emergency units, the injured individuals, the associated injuries, and the estimated or actual total incurred costs. Results: Among 326 claims included in the analysis, adverse events included emergency vehicle crash or movement (n=122; 37%; 95% confidence interval [CI] 32% to 43%), patient handling (n=118; 36%; 95% CI 31% to 41%), clinical management (n=40; 12%; 95% CI 9% to 16%), response or transport events (n=25, 8%; 95% CI 5% to 11%), and other events (n=33; 10%; 95% CI 7% to 14%). Associated injuries included death (n=54; 17%; 95% CI 13% to 21%), life-threatening or disabling injuries (n=25; 8%, 95% CI 5% to 11%), and non-life-threatening or other injuries (n=247; 76%; 95% CI 71% to 80%). The median estimated total incurred cost was \$17,000 (interquartile range \$7,000 to \$42,000). Conclusion: Emergency vehicle crashes and patient handling mishaps were the most common adverse events associated with tort claims against EMS agencies. Clinical management and other incidents were less common. This effort highlights potential areas for improving EMS operations and care.</p>	<p>Wang, H.E., Fairbanks, R.J., Shah, M.N., Abo, B.N., & Yealy, D.M. (2008). Tort claims and adverse events in emergency medical services. <i>Annals of Emergency Medicine</i>, 52(3), 256-262.</p>
23.	<p>Objective: Despite the widespread use of standard treatment protocols, there are few published data regarding paramedic protocol adherence. In this descriptive study, the authors sought to assess the frequency and nature of deviations from a standardized treatment protocol for the chief complaint of chest pain. They also sought to quantify any time delays in treatment of potential ischemic cardiac chest pain. Methods: A retrospective review of written documentation obtained from four ambulance services in a mid-Atlantic state was completed. A convenience sample of consecutive emergency medical services (EMS) records was obtained from January 2001 to May 2002, and 75 calls were selected from each service (N = 300). Results: Neither the median scene times nor the response times varied among the four services in the study. However, the suburban ambulance service (service one) did have a significantly longer transport time (19 minutes) than the rural (14 minutes) and the urban (11 and 10 minutes) services (p < 0.05). Documentation of history and physical characteristics varied widely for each service. The patient took aspirin 10% of the time prior to EMS arrival, yet paramedics gave it additionally 50% of the time, while nitroglycerin was given in 73% of cases of suspected cardiac ischemia. Posttreatment vital signs for nitroglycerin were documented 30% of the time for three of the four services, while the other service documented these 75% of the time. Medical command contact varied by agency (80-100%), as did the receipt and completion of medical orders. Conclusions: Paramedics may delay transport of patients with potential cardiac ischemia. Deviations from protocol occur frequently and the care documented for prehospital patients with chest pain is variable. The expected care described by written protocols does not correlate with the treatment documented. Limitations: This study is limited to a descriptive and retrospective analysis of chest pain trip sheets. Moreover, it is limited to the assessment and treatment as documented by paramedics and may not truly represent the level of assessment and care provided on all calls.</p>	<p>Rittenberger, J.C., Beck, P.W., & Paris, P.M. (2005). Errors of omission in the treatment of pre-hospital chest pain patients. <i>Prehospital Emergency Care</i>, 9(1), 2-7.</p>
Grey Literature		

No.	Description	Reference
24.	<p>A number of national reports have raised concerns about pre-hospital care for seriously ill and injured patients and recognised that more lives could be saved. South East Coast Ambulance Service NHS Trust (SECAmb) has responded to this challenge by developing 'critical care paramedics' (CCPs) with enhanced clinical capabilities. This report outlines the key findings and lessons from an evaluation of the CCP programme. It looks at the achievements and challenges of this clinical innovation at SECAmb to treat high-risk patients. Numerous national reports have acknowledged the need to improve the quality of hospital and pre-hospital care for high-risk patients and to reduce the 450–770 preventable deaths in England each year. The US emergency medical system delivers 20 per cent lower mortality rates than the UK for trauma patients and is based on using paramedics rather than doctors in pre-hospital care; these systems sometimes include a 24/7 telemetric online 'virtual' medical presence at scene when required. This technology may have wider application in the UK. The system design in the US is often referred to as the 'Anglo-American Model,' as opposed to the 'Franco-German Model' which substitutes doctors in the paramedic role. The concept of operation used in this CCP study is based on the 'Anglo-American' model of ambulance service delivery, specifically the Melbourne, Australia variant which SECAmb is still developing towards, training paramedics to CCP level in order to treat high-risk patients in the pre-hospital environment more effectively. CCPs have developed a higher-level clinical knowledge base with an emphasis upon patient assessment together with some clinical skills relating to airways and cardiovascular management. CCPs are currently being under-utilised in the critical care transfers role, and opportunities exist to work more closely with secondary care (hospital) providers to make this service more widely available. International evidence is inconclusive as to whether doctors save more lives or achieve better clinical outcomes than paramedics operating at CCP level in pre-hospital care, but such medically-based systems, which substitute doctors in the paramedic role, are substantially more expensive to operate. Cost-benefit analysis shows 'value of life saved' is £34,000 for paramedics operating as CCPs, compared to £252,000 for doctors providing the same provision in the field. Medical input, while important to ambulance services, is likely to be most economically effective when focused upon 'high-level' clinical governance and education input, rather than duplicating what could be accomplished by paramedics at a much lower cost.</p>	<p>The National Institute for Health Research (NHS). (2011). Critical care paramedics. The Ambulance Service Network (ASN), The NHS; London, UK.</p>

No.	Description	Reference
25.	<p>Every day, patients are at risk of harm in the healthcare system. Emergency medical services (EMS) personnel often care for patients in challenging and dynamic environments, leading to a milieu ripe with potential patient safety hazards. To begin to formally address current patient safety issues in EMS, the Emergency Medical Services Chiefs of Canada (EMSCC) and the Calgary EMS Foundation partnered with the Canadian Patient Safety Institute (CPSI) to fund research exploring patient safety in the unique EMS setting. The project included three phases: a systematic review of the literature, qualitative interviews of key informants from Canada and abroad, and a roundtable event that brought together leaders in EMS and patient safety experts to discuss the successes, challenges and future direction of the patient safety movement in Canadian pre-hospital care. Systematic Review: The first phase of the research involved a comprehensive systematic review of the literature to collate all current knowledge of patient safety specific to emergency medical services, yielding 4274 results. Seventy one resources included in the review, in which only two were randomized controlled trials and most were retrospective chart reviews. Aside from a paucity of high quality research, it was clear that many important and relevant patient safety areas in EMS were untouched by the literature. Key Informant Interviews: The authors contacted 20 key informants, selected by the pan-Canadian Advisory Group, from across Canada and abroad to gain their perspective on patient safety in EMS. Informants were paramedics, administrators, educators, physicians, patient safety experts or allied health professionals, and one patient perspective. Highly experienced qualitative researchers conducted interviews with 16 informants and analysed the data for commonly held views. Clinical judgment and the training required to make coherent decisions was profoundly identified as the greatest risk to patient safety, stemming mainly from the public safety roots from which EMS has emerged. EMS providers in Canada are educated to the primary care level through a one to two year diploma at a community college and can upgrade to advanced, critical care, or air medical transport certification through further study and on the job training. They are currently not a regulated health profession. In most provinces they perform medical acts delegated by a medical director and under his or her license with the respective provincial/territorial College of Physicians and Surgeons. Paramedic education is accredited by the Canadian Medical Association. Many participants were at odds with each other either in support of a regulated health profession versus protocolized medicine; however, both perspectives felt that their approach would reduce patient safety issues. Medication incidents and vehicle collisions were downplayed by the majority of key informants who felt that, although easy to capture and study, adverse events associated with these themes did not have the greatest impact on patient safety. Roundtable Event: The authors invited over 60 experts from the patient safety and EMS worlds to meet face-to-face in Niagara Falls, Ontario, for a one-day roundtable discussion on Patient Safety in EMS. The day featured presentations highlighting the findings of both the systematic review and qualitative research followed by three break-out sessions and large group discussions to engage participants in dialogue relevant to: the research findings and gaps associated with the results; current best practices, interventions and programs that can minimize or mitigate potential patient safety risks; and a path forward for shared efforts to improve patient safety in EMS in Canada. Participants focused heavily on minimizing adversity through enhanced clinical judgment and training. Nine strategic priorities were agreed upon by participants and the summation of the roundtable event (e.g., make patient safety a priority/corporate value within the organizations and profession, create a web based reporting and learning system accessible 24-7 which records adverse events and close calls unique to the pre-hospital setting).</p>	<p>Bigam, B.L., Morrison L.J., Maher, J., Brooks, S.C., Bull, E., Morrison, M., et al. (2009). Patient Safety in Emergency Medical Services: Advancing and Aligning the Culture of Patient Safety in EMS. Canadian Patient Safety Institute. The Canadian Patient Safety Institute. Canada.</p>

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