Patient Safety in Emergency Medical Services

Advancing and Aligning the Culture of Patient Safety in EMS

Emergency Medical Services Chiefs of Canada
Directeurs des services médicaux d'urgence du Canada

EMS FOUNDATION
In Calgary, For Life

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Canadian Patient Safety Institute
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"It's so horribly simplistic – it doesn't involve technology, doesn't involve enormous capital investment, doesn't involve restructuring healthcare bottom to top, and doesn't involve government legislation. What it does involve is profoundly courageous and powerful leaders, compassionate caregivers, and the fearless humility to admit when one is wrong."

—John Lewis

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Executive Summary

Background

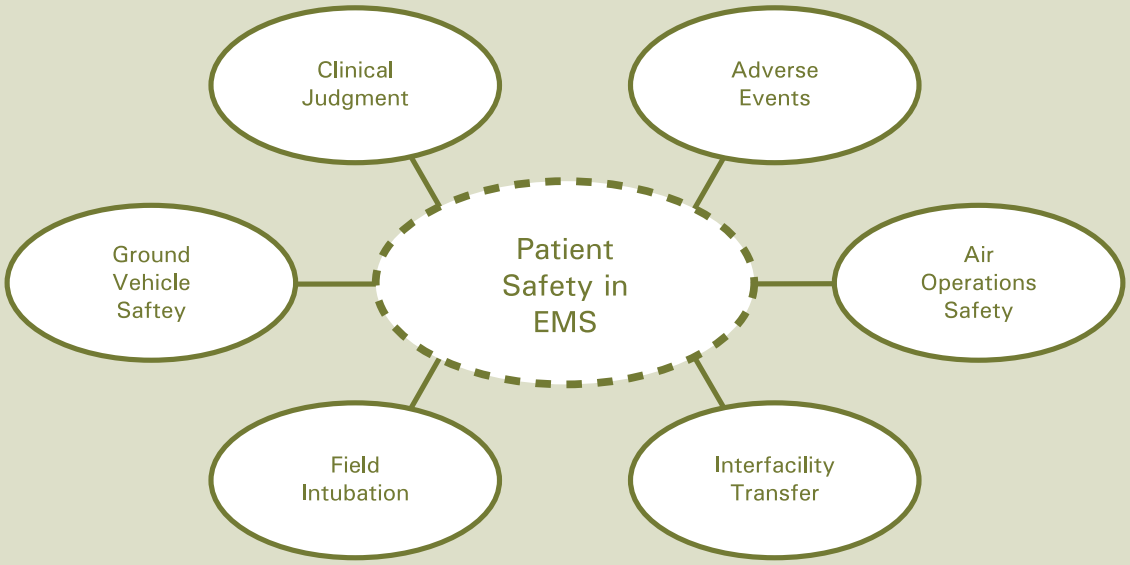
Every day, patients are at risk of harm in the healthcare system. Emergency medical services (EMS) personnel often care for patients in challenging and dynamic environments, leading to a milieu ripe with potential patient safety hazards. To begin to formally address current patient safety issues in EMS, 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 prehospital care.

Patient Safety:
Patient safety is the reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum. An acceptable minimum refers to the collective notions of given current knowledge, resources available and the context in which care was delivered weighed against the risk of non-treatment or other treatment[2].

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. In consultation with a Canadian team of experts, CPSI's librarian developed a search strategy which was run in the electronic databases Medline, Embase, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL), yielding 4274 results. Sixty-nine articles were selected for inclusion within the review and two additional articles were nominated by the reviewers, and data abstraction identified six patient safety themes: clinical judgment and training, adverse events (including medication incidents), field intubation, ground vehicle safety, air operations safety, and interfacility transportation (Figure 1). Of the 71 resources included in the review, 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.

Figure 1: The six themes that emerged from the systematic review.



Key Informant Interviews

We used a qualitative approach to identify additional patient safety issues in EMS. We 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[3]. 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.

Clinical judgment and the training required to make coherent decisions was profoundly identified as the greatest risk to patient safety.

Roundtable Event

We 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.

…align EMS with the healthcare system as a health profession and distance it from its public safety roots…

Participants focused heavily on minimizing adversity through enhanced clinical judgment and training. This would further align EMS with the healthcare system as a health profession and distance it from its public safety roots. Further, participants committed to making patient safety a value of significant importance to all EMS professionals. Initial steps include adopting the patient *Safety Competencies* framework into the **National Occupational Competencies Profile** and ongoing training. Participants gave high priority to a Canadian Adverse Event Reporting and Learning System for EMS utilizing standardized definitions to support and guide future interventions and research. Finally, it was highlighted that graduate-level trained educators in paramedicine and dedicated EMS researchers with expertise in patient safety, public health policy and interventional studies are needed to address the gaps.

The National Occupational Competencies Profile was developed by the Paramedic Association of Canada and is used for accreditation by the Canadian Medical Association. The Profile describes the competencies that make up primary, advanced and critical care paramedic scope of practice.

Nine strategic priorities were agreed upon by participants and the summation of the roundtable event:

Strategic Priorities

1. Make patient safety a strategic priority/corporate value within the organization and the profession.
2. Include patient safety domains identified in The Safety Competencies framework[4] in the National Occupational Competency Profile[5] and paramedic curriculums and in ongoing service based Continuing Medical Education sessions.
3. Create a web based reporting and learning system accessible 24-7 which records adverse events and close calls unique to the prehospital setting.
4. Support more EMS research in patient safety and operations through increased funding for studies and research infrastructure including salary support of those with research expertise.
5. Create or contribute to the development of standardized definitions, indicators and outcomes relating to patient safety in EMS.
6. Support the concept that the paramedic is part of the healthcare team, capable of decision making and judgment through advocacy, research and operational structuring.
7. Examine the literature from other disciplines with similarities in patient care to EMS for patient safety interventions that could be applied directly or modified slightly to the prehospital setting.
8. Build human resource capacity in EMS research, education and patient safety (for example, MSc and PhD trained paramedics and administrators) capable of facilitating change. Examples of support that have worked in other disciplines include salary support, reduced clinical hours, tuition support and scholarships.
9. Promote the identification and reporting of high-risk activities performed by paramedics through an EMS sensitive data capture tool such as a web based reporting and learning system and a culture of support and engagement of the providers without fear of deactivation, decertification and discipline.

Very little is known about patient safety in emergency medical services.

Findings

Patient safety in the EMS setting has been poorly studied; there is a paucity of evidence, and very few experimental trials of interventions designed to make EMS safer. The topics that have been explored observationally or through chart review in the literature to date, such as medication incidents and vehicle collisions, are viewed by experts as being simpler to study but may not hold significant improvement opportunities for patient safety in EMS. Experts present at the roundtable believe the greatest harm to patients stems from something far more challenging to study: flawed decision making by EMS providers, who have seen their scope of practice evolve under a public safety model while education in the foundations of clinical medicine has lagged behind. This knowledge gap creates opportunities for compromised care to be delivered to acutely ill patients. Collaboration across Canada is required to better define and understand patient safety incidents in the prehospital setting, and an investment in high quality research is required to improve prehospital patient safety.

Experts believe flawed decision making by EMS providers is overlooked too often when considering safety.

To better understand patient safety and adverse events in Canadian EMS, collaboration and research is required.

Patient Safety in Emergency Medical Services

Background

Thousands of patients are treated by medical professionals each day. For most of these patients, their exposure to the healthcare system will improve their health and their quality of life. However, some experience unintentional harms or are put at risk for harm. This can occur in any number of ways. These risks and harms were highlighted in a sentinel Institute of Medicine paper, *To Err is Human: Building a Safer Health System*, which identified three domains of quality in healthcare[1]: 1) ensuring patient safety, defined as freedom from accidental injury; 2) providing "best practices" consistent with current medical knowledge; and 3) having the ability to meet customer-specific expectations[1]. Since the release of this paper in 1999, healthcare systems and practitioners from a broad spectrum of fields have worked towards understanding the threats to patient safety, researching factors that contribute to unintentional harm, and developing methods to reduce, eliminate or mitigate patient safety risks. Known as adverse events, these risks have detrimental, though unintended, impacts on the morbidity and mortality of patients[6]. Adverse events are thought to stem from systemic weaknesses, individual behaviours, or a combination of the two. In Canada, it has been estimated that 7.5% of patients admitted to acute care hospitals experienced at least one adverse event in the year 2000, 36.9% of which were deemed to be highly preventable[6]. Similar statistics in the prehospital setting are not available in the current literature.

"To Err Is Human" was published by the Institute of Medicine in 1999 and sparked a revolution to make healthcare safer[1].

The uncontrolled prehospital setting offers unique environmental challenges that make adverse events all the more likely to occur. Emergency medical services (EMS) personnel often work in small, poorly lit spaces in environments that are chaotic, unfriendly and challenging for emergent or urgent healthcare interventions; indeed, it is often the dangerous nature of the environment that has led to the call for help. Unlike a hospital, emergency scenes are often loud, cluttered, and unfamiliar places to prehospital care providers. In addition to these challenging environmental factors, emotional stressors are often heightened by the presence of panicked family members, curious bystanders and a lack of human and medical resources. These physical and emotional stressors are further compounded by the time-sensitive nature of EMS care. The arena in which EMS providers work is rich with opportunities for adverse events attributed to both provider and system error.

Emergency medical services (EMS) personnel often work in small, poorly lit spaces in environments that are chaotic, unfriendly and challenging for emergent or urgent health care interventions; indeed, it is often the dangerous nature of the environment that has led to the call for help.

There is currently very little information regarding prehospital adverse events and the factors that lead to their occurrence. In contrast to hospital settings, there is a stunning lack of epidemiologic data pertaining to adverse events in the prehospital setting despite a recognized need to better understand patient safety in EMS systems[7, 8]. While there is some evidence documenting medical error by prehospital care providers[9], research from time sensitive areas such as the critical care unit or emergency department can also shine a light on adverse events that likely occur in the field as well. In one retrospective chart review of 15,000 cases, the emergency department was the most prevalent location in the hospital for an adverse event to occur[10]. Others have made efforts to establish definitions and measurements for error in emergency medicine[11] which could have some transferability to EMS.

In one retrospective chart review of 15,000 cases, the emergency department was the most prevalent location in the hospital for an adverse event to occur[10].

In a coordinated effort to understand and address the lack of knowledge surrounding adverse events in the EMS setting, the Canadian Patient Safety Institute partnered with the EMS Chiefs of Canada and the Calgary EMS Foundation and commissioned, through a competitive peer-reviewed process, the Rescu team at the University of Toronto to form a background paper on patient safety in EMS. A pan-Canadian Advisory Group provided leadership and expertise throughout the development of the paper. Three methodologies were employed to inform this background paper and to ensure a comprehensive approach to synthesizing the current understanding of patient safety in EMS: 1) a systematic review was undertaken to identify all published and grey literature pertaining to patient safety in the EMS setting; 2) qualitative interviews were completed with patient safety and EMS experts from across Canada and the world; and 3) a Canadian roundtable event to discuss the findings and put them into context.

Defining Patient Safety in EMS

Patients receiving care from EMS providers are exposed to risks uniquely or strongly associated with the prehospital care environment and system of care, such as ambulance crashes[12] or environmental agents (hazards). However, there is no common language used to define adverse events in the EMS setting making general discussion and comparisons challenging. With a lack of standard definitions in the literature, the Advisory Group and research team collaborated to establish definitions by drawing on the broader EMS and patient safety literature. For example, the development of a Canadian EMS adverse event reporting system may benefit from concepts delineated in the World Health Organization's International Classification for Patient Safety[2]. For the purposes of this paper, the research team defined **"emergency medical services"** as ground and air ambulances staffed by fire fighters, emergency medical technicians, paramedics, nurses or physicians responding to emergency calls for help or interfacility transfer. The term **"patient"** is used to describe the casualty, victim, caller, or ill or injured person to whom EMS personnel responded and no age was excluded. **Patient safety** was defined as the reduction and mitigation of unsafe acts within the healthcare system. Excluded from this definition are discussions of best practices for specific diseases (such as the administration of midazolam for treatment of seizure suppression, early identification of an acute myocardial infarction employing 12-lead electrocardiograph or the therapeutic procedure of needle thoracostomy for pneumothorax decompression).

Calculating Adverse Event Rates in EMS

Currently a Canadian dataset to measure adverse event rates in Canadian EMS systems does not exist, nor are there any local data sets that could provide estimates of adverse event rates for even some of the anticipated events. Further, the lack of a common language to define adverse events in EMS makes comparing literature difficult. Few EMS systems have attempted to measure the incidence of adverse events, and those that have, have relied on self-reported error rates provided in retrospective surveys[9, 13-15]. Without an EMS framework for defining, classifying and reporting adverse events, there is no way of knowing the reported incidence of adverse events in the prehospital setting. This problem is not unique to EMS, and has been described in the hospital, long term care and mental health setting as well[1, 16, 17]. Trigger tools which cue the reviewer of a chart to search deeper within the record for potential harm from care do not currently exist for the EMS setting, but would further support measurement and understanding of adverse events in EMS.

The current state of patient safety in emergency medical services is very much a mystery; there is almost no data describing prehospital adverse events.

The final challenge to measuring adverse events in EMS lies in the very nature of EMS itself. Providers transport approximately 70% of their patients to an emergency department, or seldom to an inpatient bed, and return to service in their community and do not transport approximately 30%. Providers deliver patients to different destination hospitals within the span of a shift. These aspects of EMS work make patient follow-up difficult, and adverse events that do not present immediately are difficult if not impossible to relate to prehospital actions. In addition, privacy legislation often prohibits EMS services from accessing outcomes on patients transported to hospital as some interpret the legislation in such a way that it excludes the paramedic and the EMS service from the 'circle of care'. Emergency department staff caring for individuals may not realize the role EMS played in an adverse event and may not be familiar with a process to report such events even if they suspected it was attributed to EMS care. Any effort to understand adverse events in EMS must extend into the emergency department and include hospital outcomes to truly understand the scope of adverse events associated with prehospital care.

Privacy legislation often prohibits EMS services from accessing outcomes on patients transported to hospital as some interpret the legislation in such a way that it excludes the paramedic and the EMS service from the 'circle of care'.

Factors Contributing to Adverse Events

Several factors can affect patient safety in EMS, and rarely does any one factor act alone to create an adverse event. These factors may be human, relying on people to either commit or omit certain functions, or systemic, depending on procedures, administrative controls, engineering and design. When people and systems function properly, these functions work to protect patients from hazards. However, weaknesses can be present as active failures, where unsafe acts are committed by people, or latent conditions described as systemic flaws in design or processes that allow hazards to be present[18]. When active failures and latent conditions align, an adverse event can occur.

The EMS Environment

Emergency scenes can be filled with distracters that can increase the odds an adverse event will occur. Physical characteristics of these scenes include loud noises, poor lighting, uncontrolled movement of people and vehicles and small spaces. Providers often work from compact bags rather than large, well labeled cupboard and drawers. This limitation reduces the opportunity to place visual cues or organize equipment optimally. Further, EMS work can be complicated by multiple handoffs from basic life support providers to advanced life support providers to air ambulance crews and finally to hospital staff. Lastly, EMS work is round-the-clock, and often EMS workers endure 12, 14 or 24 hour shifts with few opportunities for meals or rest. This can lead to fatigue, which is known to play a role in adverse event incident rates in EMS settings[19].

Patient Factors

People call 911 for a myriad of emergencies. Patients influence their own outcomes in a number of ways. First, patients may not recognize that ambulance transport has an inherent risk with regards to vehicle collision and may activate a 911 call when an emergency response is unwarranted. Second, patients rarely understand the impact of environmental and emotional stressors on EMS providers, and are unlikely to minimize these stressors through effective communication about their disease process or traumatic injury. A complete list of current medications including dosages and frequency and a copy of discharge summaries, electrocardiograms or other healthcare documents can help to minimize medication, history taking and interpretation errors and fill in important knowledge gaps when language, lack of comprehension, confusion or other communication barriers exist, or if the patient is unable to respond.

Provider Factors

EMS providers working in stressful emergency scenes must be aware of the potential for miscommunication between providers and patients, their families or others who are at the scene. Failure to communicate, listen and understand accounts for a large number of adverse events. The Joint Commission in the United States has documented that communication is a contributing cause in upwards of 70% of all sentinel events (or critical incidents)[20]. Providers should also be aware of their own limitations as they practice at stressful, uncontrolled emergency scenes. The need to protect themselves, the patient and other providers from risks and hazards in addition to dealing with crowd control, coping with the environment and attempting to communicate clearly all compete for the provider's attention and can lead to a very chaotic situation. Any one of these stressors increases the risk of an adverse event. A patient safety culture encouraging clear communication where the use of tools such as protocol books, calculators, dosing charts, clinical decision rules and voice prompts is viewed positively and may help to reduce these potential risks.

System Factors

Many different organizations work together to ensure EMS services are provided to the community. This includes all the partner organizations that contribute to a tiered response including municipal fire and police agencies, ambulance dispatch centres, base hospitals providing medical oversight and receiving hospitals. With these multiple groups come inherent opportunities for miscommunication and adverse events to occur. As different organizations employ different practices, policies and quality improvement programs, the gaps in culture and communication may go unrecognized or ignored by various groups. The discontinuity and the fragmented oversight of the overall system could lead to a situation where similar adverse events occur repeatedly, or the same root causal factors of adverse events go unrecognized. Collaboration and unification of care policies amongst responding agencies will contribute to a safer patient care environment.

Safety Concerns for Both Patients and Providers

Provider safety was not specifically investigated in any of the three methodologies used to formulate this paper. However, the safety of both the provider and the patient are often intertwined[1]. Examples of this overlap include vehicle collisions, restraint systems, and infection control. Human performance can be affected by poor working conditions, increased workload, and staffing levels, which can have harmful effects not only on staff safety, but on patient safety as well[21]. Further, EMS providers involved in adverse events may be distracted from performing their clinical duties as they develop feelings of guilt and shame or fear of punitive action. It follows that attempting to improve safety for one of these populations may improve the safety for the other.

Discussion

The EMS industry is fraught with challenges by the very nature of responding to emergencies in the field. Physical and emotional stressors can challenge providers in their technical skills, cognitive thinking, and communication tasks. Several latent environmental and system factors exist that make EMS scenes ripe with opportunity for adverse events to occur, and the system of care involves several organizations that do not share common leadership policy or practice. This fragmented characteristic of EMS delivery and its interface with other healthcare organizations requires extensive collaboration amongst many agencies to: recognize potential system attributes that can lead to adverse events; recognize adverse events themselves; define how to capture these events without creating a culture of fear and to engineer and implement solutions that can prevent adverse events from occurring.

Systematic Review

Background

A systematic review of the academic and grey literature was conducted to capture all previously published data relating to patient safety in EMS. A systematic review approach was chosen for its reproducibility and recognized rigorous methodology.

Methodology

A systematic review of the literature following the Cochrane methodology[22] was conducted to identify risks to the safety of patients treated by EMS personnel and reports of strategies aimed to mitigate risk related to patient safety events in EMS settings. The electronic databases Medline, Embase, and the Cumulative Index of Nursing and Allied Health Literature (CINAHL) were searched from January 1, 1999 to January 26, 2009 for all relevant resources. The date limit was set to 1999, the year the Institute of Medicine published *To Err Is Human: Building a Safer Health System*[1], which is widely considered to be the start of the patient safety movement. To locate all relevant citations related to patient safety in EMS, complex search strategies were formulated using medical subject headings and text words that combined terms related to both patient safety and emergency medical services (Appendix A).

Systematic Review Methodology

- ☑ **Develop and test strategy with Pan-Canadian Advisory Group**
- ☑ **Search electronic databases**
- ☑ **Two reviewers independently screen titles, followed by abstracts and finally full articles**
- ☑ **Reviewers hand-search reference lists**
- ☑ **Two reviewers independently abstract data from included resources**

The search strategy was developed by the CPSI librarian and reviewed by the pan-Canadian Advisory Group of EMS experts to ensure the search terms had face validity and the preliminary search retrieved known results. Additional potential articles were identified by hand-searching reference lists of all included articles and contacting experts in both EMS and patient safety.

Data Selection

All studies that addressed a patient safety issue in the EMS setting were included in the systematic review. Patient safety was defined as the reduction and mitigation of unsafe acts within the healthcare system and patient safety issues included any component of EMS care that could harm a patient, but did not include studies of specific therapies or specific illnesses[16]. Studies which examined an intervention aimed at reducing the risk of identified patient safety incidents were also included. Excluded from the review were abstract-only publications, opinion articles, commentaries and letters to the editor. Two investigators (BB and SB) reviewed all citations independently in a hierarchical manner. Titles classified as 'include' or 'indeterminate' by at least one of the investigators were included in the next iteration. The investigators then used the same methods to review abstracts, and then full text articles. Disagreements at the full article stage were resolved by consensus between the two authors.

Data Extraction

Two investigators (BB, MM) independently abstracted the following information from each article using a data abstraction tool*: the study design (if applicable), the population demographics, the patient safety concern examined (control), the intervention (if applicable), outcome data, the type of EMS provider and the EMS setting involved. Any abstraction differences were resolved through consensus. All patient safety concerns abstracted were categorized into common themes through consensus between the two abstracting authors. The organization of the articles in themes was reviewed for face validity by two other investigators.

* To review the data abstraction tables of all articles reviewed, refer to the CPSI and EMSCC websites.

Results

Four thousand two hundred seventy-four citations were identified by the search strategy (Figure 1). Eight hundred ninety-four abstracts were reviewed, and 207 articles were identified to undergo full-text review. Of these, 69 papers met inclusion criteria and were included in the study and categorized into six themes (Table 1). The kappa measuring interrater agreement for selection of title, abstract and full text articles was 0.65, 0.79, and 0.87 respectively. Two additional articles[23, 24] were reviewer-nominated and related to ambulance collisions. A total of 71 articles are included in the review. The heterogeneous nature of the included studies did not lend themselves to a metaanalysis; thus, results were synthesized by theme.

Figure 1: Accounting for all citations identified by the search strategy.

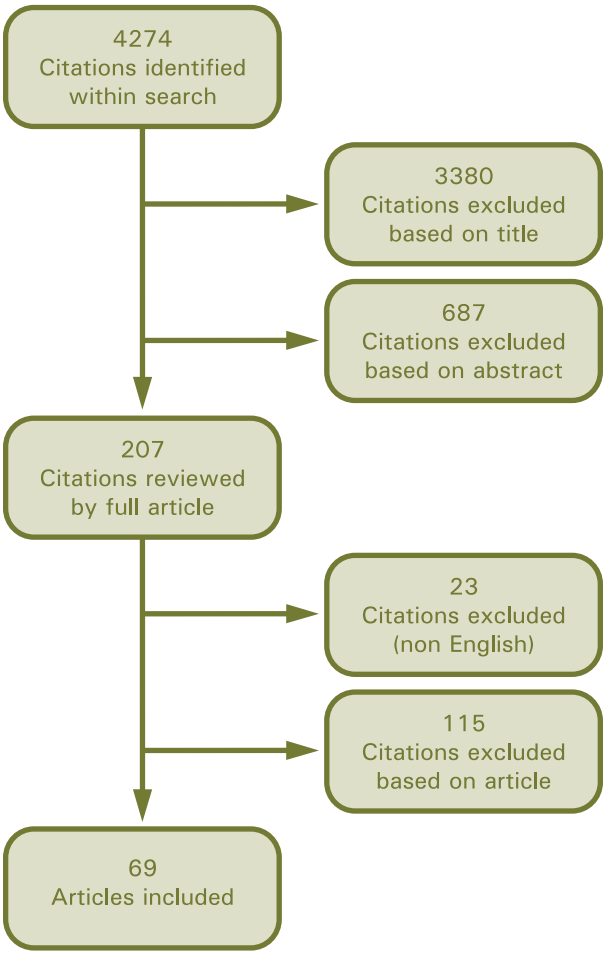


Table 1: Patient safety themes emerging from the literature

Theme	Number of Articles
Clinical Judgment	9[25-33]
Adverse Events - medication incidents, reporting	16[9, 13-15, 34-45]
Intubation	15[46-59]
Ground Vehicle Safety	7[12, 23, 24, 60-65]
Aircraft Safety	6[66-71]
Interfacility Transport	16[72-86]

Emerging Themes

Decision Making and Clinical Judgment

Several studies looked at the ability of EMS providers to make clinical decisions related to patient care. The literature regarding clinical decision making by EMS providers is varied and difficult to metaanalyse given regional differences in training and education (Table 2).

Clinical Judgment:
The application of information based on actual observation of a patient combined with subjective and objective data that lead to a conclusion.

Table 2: Theme 1 – Clinical Judgment (n=9)

Citation	Method	N	Population	Intervention (I)	Control (C)	Outcome
Pringle 2005[25]	Retrospective review	310	Ground emergency patients not transported by EMS	N/A	N/A	Patients not transported were followed up to determine if additional care was sought.
Hauswald 2002[30]	Prospective survey tool and chart review	151	Ground emergency paramedics	N/A	N/A	Paramedics commented on appropriateness of alternate transport or destination.
Haines 2006[29]	Prospective observational study	527	Ground emergency pediatric patients (<21years)	Pediatric Transport Guidelines	N/A	Outcomes of patients who met non-transport guideline.
Cone 2001[27]	Prospective observational study	69	Ground emergency BLS crews	N/A	N/A	Inappropriate cancellation of ALS crews prior to ALS arrival on scene was assessed.
Clesham 2008[26]	Prospective survey tool	149 staff completed 396 surveys	Ground EMS providers	N/A	N/A	Ability of paramedics to predict admission or discharge in non-trauma and trauma patients was assessed.
Gray 2007[28]	Retrospective review	354	Patients treated by ground EMS providers	4 non-transport guidelines were introduced	N/A	EMS provider ability to apply a non-transport guideline was assessed.
Mason 2008[31]	Cluster randomized controlled trial	3018 C: 1469 I: 1549	Patients >59 years of age presenting ground EMS	Paramedic practitioner with extended scope of practice	Standard paramedic care	Effectiveness of paramedic practitioner scope of practice was assessed.
Dale 2004[33]	Prospective observational study that was part of a randomized trial	239	Nurses and ALS paramedics working in a ground emergency dispatch centre	Dispatch triage tool applied by nurses and paramedics	N/A	The safety of paramedics and nurses using a telephone triage tool to determine that an ambulance is not needed was assessed.
McDermott 2005[32]	Prospective cohort study	243	Consecutive road trauma fatalities treated by a ground EMS service	N/A	N/A	Analysis of adverse events.

However, four categories of clinical decision making emerged from the literature: whether or not a patient could be safely discharged from the care of a paramedic without being transported to an emergency department; whether or not basic life support providers could determine the need for advanced life support providers; whether paramedics can be trained to offer extended services beyond those traditionally offered by EMS; and whether paramedics in dispatch centres can determine response levels.

The ability of EMS providers to correctly identify if a patient requires EMS transport to an emergency department has been studied both prospectively and retrospectively. In one study by Hauswald, paramedics were asked "could this patient have been safely transported by a non-medical transport service?" Physicians agreed with the paramedics response 53% of the time (kappa 0.47)[30]. A study by Pringle identified that 34% of non-transports were 'EMS refusals' according to posthoc interviews with the patient (p=0.002)[25]. Of these, 56.2% sought medical care within 7 days, and 9.5% were admitted to hospital with zero deaths. Of the patients who refused transport, 55.1% sought medical care within 7 days, and 7.3% required admission (no p value reported). Haines found that paramedics could apply pediatric non-transport guidelines correctly, with 2% of cases being overruled by physician patch, and 100% of the overruled cases being discharged from the emergency department after ED evaluation. Admission rates for non-transport patients was 2.4%, and none required ICU admission[29]. Gray introduced non-transport guidelines for patients without injury, patients with limb injuries, resolved hypoglycemia and resolved seizure with patients with known epilepsy and found that the hypoglycemia and epilepsy protocols were well applied with 2.9% and 4.3% inappropriate application respectively. He reported that the protocols designed for cases where there was no apparent injury or limb injury were correctly employed in only 20.2% and 48.3% of eligible cases respectively. The author acknowledged poor documentation in these two patient groups may be to blame for these low levels of utilization rather than the ability of paramedics to appropriately apply the protocol.

In a retrospective review, Cone examined if basic life support providers can determine whether or not advanced life support providers were required[27]. His study found 69 patients who had an advanced life support response cancelled before they arrived by BLS providers on scene and determined that the cancellation was inappropriate in 77% of those cases. Of the inappropriately cancelled cases, 87% received an advanced life support intervention immediately on arrival at hospital.

Mason randomized 3000 patients who were >59 years of age and requesting an emergency response through 911 to either a standard paramedic or a 'paramedic practitioner' trained in additional clinical topics[31]. Expanded services included wound care, suturing and local anesthetic, antibiotic dispensing, analgesia, referrals to radiology, and advanced assessment skills. Patients were not transported if the paramedic practitioner and patient felt such action was appropriate. The two groups did not differ in physician-rated suboptimal care, unplanned emergency department visits, or 28 day mortality. Patients treated by a paramedic practitioner were more likely to report being highly satisfied (RR 1.6, 95% CI 1.09-1.23), less likely to require hospital admission within 28 days (RR 0.87, 95% CI 0.81-0.94), and were less likely to be transported to the emergency department (RR 0.72, 95% CI 0.68-0.75). The author concludes that paramedic practitioners offer many advantages to the healthcare system without compromising patient safety.

A prospective observational study by Dale found that advanced life support paramedics working in 911 dispatch centres could apply a tool to determine the need for immediate versus delayed ambulance response, and only 4/239 patients (1.7%) were judged by an expert panel to have been inappropriately categorized as delayed[33].

Medication Incidents and Other Adverse Events

Table 3: Theme 2 – Adverse Events, Medication Errors and Error Reporting (n=16)

Citation	Method	N	Population	Intervention (I)	Control (C)	Outcome
Bernius 2008[34]	Randomized trial	523	Ground paramedics	Pediatric code card N = 246	Standard of care (no code card) N = 277	Accuracy of drug dosage calculation on a written test was assessed.
Vilke 2007[15]	Survey tool, retrospective review	352/425	Ground paramedics	N/A	N/A	Paramedics described their error reporting habits.
LeBlanc 2005[39]	Observational before-after study	30	Flight paramedic students	Simulation with panicked bystander	Normal (no stressor) simulation	Accuracy of drug dosage calculation in a practical scenario was compared.
Seymour 2008[42]	Retrospective review	190	Mechanically ventilated interfacility patients transported by air paramedics and nurses	N/A	N/A	In-flight adverse events were measured and analysed.
Dewhurst 2001[35]	Retrospective and prospective cohort study	414 retro-spective and 69 prospective	Interfacility patients transported by air ambulance	N/A	N/A	Major adverse events (deaths) were recorded.
MacDonald 2008[40]	Retrospective review	723 (complete records for 680)	Adverse events from interfacility and emergency air calls	N/A	N/A	Adverse events were measured and categorized.
Fairbanks 2008[36]	Qualitative interviews, Focus groups, Prospective observational study	Interview: 15, Focus group: 23, Prospective observation11	EMS providers in 40 response agencies	Online anonymous adverse event reporting system	N/A	Qualitative interviews explored issues surrounding adverse event reporting; prospective online database recorded adverse event details; chart review measured unreported adverse events.
Hobgood 2006[9]	Survey tool	283	EMS providers at statewide conference	N/A	N/A	Self-reported adverse event rates were sought and types of errors were recorded.

Shaw 2005[43]	Retrospective review	156	18 health trusts with an adverse event reporting system	N/A	N/A	Adverse event rates are reported for health trusts, which include ambulance service.
Hobgood 2006[13]	Cross-sectional survey tool	103 (Response rate 89%)	ED physicians, nurses and EMS providers	Case studies of adverse events	N/A	Based on case studies, respondents were surveyed regarding their willingness to disclose an adverse event.
Wang 2008[45]	Retrospective review	326	Insurance claims against EMS	N/A	N/A	Adverse event types and rates are described and outcomes are reported.
Hobgood 2004[14]	Survey tool	116	ED physicians, nurses, ground EMTs	N/A	N/A	Percentage of self-reported identification, disclosure and reporting of medical errors by provider types is reported.
Stella 2008[44]	Prospective observational study	41	Reported adverse events in a ground EMS system	Anonymous adverse event report form; chart review; debriefing	N/A	Rates, types and contributors to adverse events were recorded as well as outcomes.
Kaji 2006[38]	Before-after observational study	141 C: 104 I: 37	Cardiac arrest patients < 13 yrs with ground paramedic care	Pediatric drug dosage charts, Broselow tape supplied	Pediatric drug dosage charts, Broselow tape not supplied.	Drug doses and ETT sizing was compared between the two groups.
Hubble 2000[37]	Survey and test tool	109	Ground paramedics at education forum	N/A	N/A	Survey of frequency of medication calculation training; measurement of accuracy of medication calculation on a written test.
Ricard-Hibon 2003[41]	Prospective observational study	603	Patients given sedation by a physician-based ground service	Adverse event monitoring tool	N/A	Clinical adverse events related to anesthesia/ sedation were measured.

Adverse events were studied in 16 papers (Table 3). In a retrospective study of tort claims brought against EMS, 326 cases identified an adverse event. Of these, vehicle collisions accounted for 37% of these events, 36% were related to patient handling, 12% to clinical management and 8% to delayed responses[45]. In a prospective observational study, anonymous web and paper forms were made available for providers to self-report adverse events[44]. Lack of available resources was noted to be the cause of 27% of adverse events, followed by communication problems (18%), prolonged response times (16%), resuscitation difficulties (16%), other treatment problems (10%) and equipment problems (5%). A retrospective review of an aeromedical adverse event database of cases identified voluntarily or by mandated review reported a rate of adverse events with possible or actual harm was 11.53 per 1000. Communication was listed as the root cause of 34% of events while 20% were attributed to patient management and clinical care.

...during observed medical simulations, drug dosage calculation errors increased when a stressor (in this case, a panicked bystander) was introduced to the scenario (43.1% vs. 57.9%, p<0.01)[39].

LeBlanc found that during observed medical simulations, drug dosage calculation errors increased when a stressor (in this case, a panicked bystander) was introduced to the scenario (43.1% vs. 57.9%, p<0.01)[39]. Critical care paramedics were less likely to make an error than advanced care paramedics (61.1% vs. 39.8%, p<0.01). Fairbanks identified in a series of interviews and focus groups that EMS providers self-report that inadequate training and lack of experience in pediatrics leads to provider discomfort and adverse events when treating these patients[36].

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Dosing cards are a common patient safety intervention used to reduce errors resulting in medication incidents. A randomized controlled trial in the classroom setting tested the ability of advanced life support paramedics to calculate pediatric drug doses[34]. Five hundred and twenty-three paramedics were randomized to either standard practice (pen, paper and mental math) or a pediatric "code" card with drug dosages and endotracheal tube sizes listed for different age groups. Accuracy improved with use of the code card (65% vs. 94%, p<0.001), 'severe' errors (overdosing by >5kg) were reduced (20.9% vs. 4.9%, p<0.001), and the tenfold error rate (giving ten times the dose) was reduced (6.2% to 0.8%, p<0.001). The correct endotracheal tube size was calculated correctly in 23% of control cases vs. 98% of code card cases (p<0.001). In a before-after trial, pediatric cardiac arrest dosing charts were supplied to rescuers after a three year observational period. Rates of correctly giving the right dose of IV epinephrine increased from 28% to 59% (no p value reported)[38].

Accuracy improved with use of the code card...

In a series of interviews and focus groups, Fairbanks found that EMS providers felt non-punitive reporting systems were important for a culture of self-reporting to thrive. Further, a lack of standardization between agencies and facilities led to adverse events. Interrelationships were noted to be adversarial between EMS providers and allied agency staff and hospital staff, and participants self-reported that this led to communication breakdown and adverse events[36]. A survey tool in a different system found that self reported incidents were reported by 9.1% of advanced life support paramedics in a 12 month period and that 63% of those incidents were medication dose errors; 79% of errors were self-reported to the quality assurance manager of the EMS service, 8% were identified by the receiving hospital staff, 8% during chart review and 4% were not found until the researchers completed a second chart review[15].

...EMS providers felt non-punitive reporting systems were important for a culture of self-reporting to thrive.

Hobgood has done extensive survey research into self-reporting of adverse events by prehospital care providers[9, 13, 14]. In a 2006 convenience sample survey of providers, 55% had not reported an error in the previous year, 35% had reported one or two errors and 9% had reported more than two errors[9]. In a 2004 survey, basic life support paramedics reported errors most commonly to physicians (52%) and nurses (38%)[14]. Compared to nurses, basic life support providers were more likely to report at least one error in the previous year (55% vs. 44%, no p value reported) but less likely to report an error than physicians (79%). In the previous 12 months, 19% of EMTs self reported that they disclosed error to patients compared to 23% of nurses and 74% of physicians. More experienced providers (>10 years) were more likely than novice providers (<1 year) to report at least one error in the previous 12 months (30% vs. 6%, no p value reported). When presented with clinical vignettes of adverse events, prehospital providers correctly identified 68% of medication errors and 55% of cognitive errors[13].

Ground Vehicle Safety

EMS providers transport ill patients from the scene of the emergency to the hospital in ambulances, which are often vans or cube trucks modified for prehospital care and patient transport. Often, lights and sirens will be used to shorten transit times. Ground collision articles are listed in Table 4.

Table 4: Theme 3 - Ground Vehicle Safety (n=9)

Citation	Method	N	Population	Intervention (I)	Control (C)	Outcome
Bull 2001[61]	Prospective Experiment	30	Infant manikins (8kg), 3 year old manikins (18kg) 6 year old manikins (27kg)	Various backrest and seatbelt positions	N/A	Quality of restraint was described.
Levick 2005[65]	Prospective observational study	36 ambulances >250 drivers	Ground EMS	Real-time auditory feedback to driver	No feedback	Frequency of traffic rule violations were measured.
Kahn 2001[60]	Retrospective review	339 events, 405 deaths, 838 other injuries	All fatalities and injuries from US ambulance crash database 1987-1997	N/A	N/A	Characteristics of ambulance crashes was described.
Becker 2003[60]	Retrospective review	305	Ambulances, fire apparatus, police cars in US crash databases 1988-1997	N/A	N/A	Comparison of vehicle collisions between fire, police and EMS.
De Graeve 2003[62]	Observational before-after study	N not reported	Ground 911 - Intensive Care Units (2nd tier) staffed by physicians	Briefing with drivers on driving habits	"Fleetlogger" onboard data recorder installed on MICUs	Occurrence of "Risky" behaviours: speed and harsh braking were compared between cohorts.
Johnson 2006[63]	Survey tool	302/446	Ground EMS providers	N/A	N/A	Knowledge and training patterns regarding paediatric restraints was self-reported.
King 2002[64]	Survey tool	90/153	Managers from ground and air pediatric transfer services	N/A	N/A	Adverse event rates and safety practices were self-reported.

Ray 2005[23]	Retrospective review	2038 EMS and 23155 controls	Collisions of EMS and similar sized vehicles	N/A	N/A	Collisions between EMS and similar-sized vehicles were compared.
Ray 2007[24]	Retrospective review	311 rural and 1434 urban	Collisions of EMS vehicles	N/A	N/A	EMS collisions in rural and urban areas were compared.

Two large retrospective reviews have analysed the incidence and characteristics of ambulance crashes in the United States. Kahn and Becker both analysed data from the National Highway Traffic Safety Administration using data from 1987 to 1997 and 1988 to 1997 respectively[12, 60]. They found that in an 11 year period, there were approximately 340 ambulance crashes resulting in the deaths of 405 people, though they did not distinguish between EMS providers, patients, and other ambulance passengers (nurse escorts, family members, etc). In addition there were over 800 other injuries to ambulance occupants.

...in an 11 year period, there were approximately 340 ambulance crashes resulting in the deaths of 405 people...

When analyzing characteristics of these collisions, they found that 77% occurred during clear weather and that year, season, and day of week were not associated with increased collision incidence (p =0.33, 0.74, 0.57 respectively). Lights and sirens, which are only used on occasion, were active in 60% of crashes and 58% of fatalities[12]. Compared to fire and police vehicle collisions, ambulance collisions are more often fatal (0.82% compared to 0.55% for fire and 0.60 for police)[60].

In a comparison of collisions between ambulances and similar sized vehicles, Ray and Kupas found that ambulances are more likely to be involved in collisions at intersections (43% vs 23%, p=0.001), at traffic signals (37% vs 18%, p=0.001) and involved 3 or more people 84% of the time. Injuries were more frequently reported in ambulances (76% vs 61%, p=0.001)[23]. In a second study, Ray and Kupas found that rural crashes occurred more often at night on unlit roadways and in inclement weather, while urban collisions were more common in intersections and more often involved more than one vehicle[24]. These differences in collision characteristic could provide direction for prevention programs.

King et al surveyed 153 program managers from ground and air pediatric and neonatal transfer services, and found a transport related incident occurred once every 1000 transports (0.1%) and an injury rate of 0.546 injuries per 1000 transports[64]. Of the 66 collisions reported during the survey 57 occurred on ground ambulances and 9 on aircraft. There were no deaths associated with ground vehicle transportation. King reported a range of 0-8 and a mean of 4 safety policies in the participating services pertaining to inclement weather travel restriction (59.6%), speed restrictions (42.6%), adhering to traffic rules during transport (65.4%), having specific safety rules (78.8%), maintaining vehicles (69.2%) and limiting shift work by personnel (36.5%).

Driving behaviours of EMS providers have also been studied to understand how this could contribute to patient safety risk. Johnston found through a survey that 56.6% of EMS providers self-report knowing 'nothing, little or some' about how to secure an ill infant or child (52.3%) for transport, and that 9.3% never received training on securing children[63]. Coupled with a study by Bull which found that no restraint position for infant, 3-year old or 6-year old manikins provided 'satisfactory' safety during a collision, a dangerous picture of pediatric transport in ambulances is painted. Two other studies attempted to modify risky driving behaviour. Levick measured miles between 'penalty counts', which assigned points to risky behaviour such as speeding, forceful braking, high turning forces and seat belt use, and found that adding real-time auditory feedback reduced penalty counts from one for every 0.018 miles to one for every 15.8 miles[65]. De Graeve reported that driving habits for mobile intensive care units improved when drivers were provided weekly feedback from onboard computers that captured data on speed and harsh breaking[62]. Maximum highway speeds decreased from 167 to 143km/hr (p<0.0001) and harsh breaking decreased from 18.25 to 10.51 events per 10km (p value not reported).

Air Operations Safety

Table 5: Theme 4 – Aircraft Safety (n=6)

Citation	Method	N	Population	Intervention (I)	Control (C)	Outcome
De Lorenzo 1999[67]	Retrospective review	13.13 million flight hours	Records pertaining to all flight hours between 1987 and 1995 flown by the US Army	Medical flight hours	Non-medical flight hours	Crash rates were compared.
Bledsoe 2004[66]	Retrospective review	84	All medical helicopter accidents in two US databases 1993-2002	N/A	N/A	Rates of and contributors to air crashes were described.
Thies 2006[70]	Survey tool and retrospective review		Civil EMS helicopter crashes reported to the German Aviation Authority 1980-2001	N/A	N/A	Rates of and contributors to air crashes were described.
Frakes 2007[69]	Survey tool	126/200	US helicopter EMS employees	N/A	N/A	Adherence to best safety practices was self-reported.
Dery 2007[68]	Survey tool	806 complete	Non randomized sampling of US helicopter EMS pilots	N/A	N/A	Data regarding Crew Resource Management training and opinions for factors involved in EMS accidents was self reported.
Thomas 2005[71]	Survey tool	508	Administrators, aviation experts and clinicians involved in aeromedical transport	N/A	N/A	Perceived issues in aeromedical safety were self reported.

Table 5 lists aeromedical safety publications. Two studies were included that examine the incidence rate of medical aircraft accidents. A retrospective review by Bledsoe found that 84 air ambulance collisions occurred between 1993 and 2002[66]. Excluded from these numbers were birdstrikes and precautionary landings. These accidents involved 260 people and were caused by pilot error in 64% of cases. There were 72 fatalities (0.84 per event) and 64 injuries (0.76 per event) resulting from 56% of cases; the remaining 44% had no injuries or fatalities associated with the accident. Patient, providers and pilots were not differentiated, although 23% of crashes killed all persons onboard the aircraft. In a military study, De Lorenzo found that aeromedical crashes were more common than non-aeromedical crashes (2.02 vs. 1.86 per 100 000 flight hours for serious collisions resulting in loss of life or permanent disability, and 7.41 vs. 7.37 for moderate or minor injuries. No p values are reported[67].

Several surveys have been executed to determine causes of air accidents and measures that make air medical transport safer[68, 69, 71]. These surveys conclude that aircraft personnel feel that crew resource management/air medical resource management training is an effective tool to promote safety, flight simulators and night vision goggles are important tools for pilots to have access to, and complacency leads to errors. Air crews identify communication as being critically important. Further, flight crews expressed an opinion that a culture of competition and flying during inclement weather are involved in more than half of all helicopter accidents.

Field Intubation

Endotracheal intubation is considered a cornerstone of the paramedic skill set. The literature discusses three aspects of the safety of paramedic-performed endotracheal intubation (Table 6).

Table 6: Theme 5 – Intubation (n=15)

Citation	Method	N	Population	Intervention (I)	Control (C)	Outcome
Svenson 2007[54]	Retrospective study	62	Adult patients transported by air paramedics, physicians	N/A	N/A	Mean endotracheal tube cuff pressures were recorded at receiving facility.
Parwani 2007[52]	Prospective observational manikin study	53	Ground emergency paramedics at training session	N/A	N/A	Mean endotracheal tube cuff pressures were recorded on manikins.
Jemmet 2003[49]	Prospective observational study	109	Patients intubated by ground paramedics	N/A	N/A	Endotracheal tube placement was assessed on arrival at hospital by ED physician.
Jones 2004[50]	Prospective observational study	208 Oral: 180 Nasal: 28	Patients intubated by ground paramedics	N/A	N/A	Endotracheal tube placement was assessed on arrival at hospital by ED physician.
Wirtz 2007[59]	Prospective observational study	132	Patients intubated by ground EMS paramedics	N/A	N/A	Endotracheal tube placement was assessed on arrival at hospital by ED physician.
Wang 2001[58]	Retrospective chart review	592	Patients intubated by ground EMS paramedics	N/A	N/A	Endotracheal tube placement was assessed on arrival at hospital by ED physician.
Bair 2005[46]	Retrospective chart/database review	1643 intubations	Patients intubated by ground EMS paramedics	N/A	N/A	Endotracheal tube placement was assessed on arrival at hospital by ED physician.
Pratt 2005[53]	Prospective Observational Study	32 patients where ETI was attempted	Patients >15 yrs intubated by ground BLS EMTs	BLS EMTs trained in endo-tracheal intubation	N/A	Endotracheal tube placement was assessed by ED physician. When none established in the field, alternate ventilation methods were assessed.

Wang 2006 [57]	Prospective Observational Study	1953	Patients with intubation attempt by ground or air paramedics (95%), nurses, physicians (5%)	N/A	N/A	Adverse events associated with endotracheal tubes were recorded.
Tiamfook-Morgan 2006[55]	Prospective Observational Study	170 of 200 had SpO2 recorded	Patients with intubation attempt by flight paramedics or nurses	Policy tracking SpO2 when intubating	N/A	Endotracheal tube adverse events, specifically desaturation, were recorded.
Wang 2003[56]	Prospective Observational study	663/783	Patients with intubation attempt by ground and air paramedics, nurses and physicians	N/A	N/A	Endotracheal tube success rates and variables related to unsuccessful placement were analysed.
Fakhry 2006[48]	Retrospective review	175	Trauma patients who underwent rapid sequence intubation attempt by a flight paramedic	N/A	N/A	Adverse events associated with endotracheal tubes were recorded.
Newton 2008[51]	Retrospective review	175	Trauma patients who received attempted RSI in a helicopter EMS service by a physician	N/A	N/A	Adverse events (hypoxemia and hypotension) associated with rapid sequence intubation was recorded.
Mackay 2001[87]	Retrospective review	359	All trauma patients undergoing RSI by physicians in an air service	Emergency Physician performed RSI	Anesthesiologist performed RSI	Endotracheal tube success rates and variables related to unsuccessful placement were analysed and compared.
DiRusso 2005[47]	Retrospective Review		Trauma patients <20 yrs transported to paediatric trauma centre	N/A	N/A	Relation of endotracheal intubation to clinical and operational outcomes was assessed.

Two studies identified in the review examined endotracheal tube cuff pressure in intubated patients. Safe pressures are considered to be between 20 and 30 centimeters of water (cmH_2O)[54]. The first study measured the cuff pressures of adult patients intubated by physicians and paramedics prior to arrival at a tertiary care centre and found that mean cuff pressure was 63 +/- 34 cmH_2O[54]. Pressures were higher than recommended in 79% of patients, and greater than 40cmH_2O in 58% of patients. The second study, a prospective manikin study of 53 intubations, found that advanced life support paramedics inflated the endotracheal tube cuff to greater than 120cmH_2O in 66% of all episodes and great than 25cmH_2O in 100% of episodes[52].

The second safety aspect reported in the literature is that of proper placement of endotracheal tubes by paramedics. Five studies were identified that examined the rate of esophageal or right mainstem placement by paramedics as determined by the attending emergency physician[46, 49, 50, 53, 59]. Misplacement rates varied from 0% in 32 patients intubated by basic life support paramedics, to 12% in 109 patients intubated by advanced life support paramedics. Most of these misplacements were determined to be placed in the esophagus, while some were noted to be above the glottis or in the right mainstem bronchus. One study found that nasal tubes are twice as likely to be misplaced than oral tubes (5% vs. 10.7%, p value not reported)[50]. Three other studies have reported on the overall success of securing an endotracheal tube[56-58]. In these studies of patients intubated by advanced life support paramedics, success rates vary. One prospective observational study found that endotracheal tube insertion attempts were successful in 93.0% of cardiac arrests compared to 72.5% success rate for patients not in cardiac arrest. Factors associated with failed endotracheal insertion include trismus, inability to pass through cords, poor visualization, gag reflex, and increased weight[56]. Another study found that 90.5% of endotracheal insertion attempts were successful, and that 49% of failed endotracheal insertion attempts were due to insufficient relaxation. In this group of 592 patients, 0.3% of endotracheal tube insertions were unrecognized esophageal intubations[58]. The remaining study of 1953 endotracheal insertion attempts found that failure rates varied between 0% and 40% depending on the EMS service. Failure rates were lower in services that performed more endotracheal insertions annually but higher for services with greater numbers of patient contacts.

The remaining study of 1953 endotracheal insertion attempts found that failure rates varied between 0% and 40% depending on the EMS service.

Finally, the safety of rapid sequence induction to facilitate endotracheal insertion in the field was examined by two studies in the aeromedical rotor wing environment[48, 51]. One study examined advanced life support paramedic endotracheal insertion attempts while the other examined EMS physician attempts. Advanced life support paramedics were successful on the first attempt 70% of the time, and this increased to 89% of the second attempt and 96% on the third attempt. Cricothyroidotomy was utilized in 2.3% of cases and the remaining patients who had unsuccessful endotracheal insertions were successfully ventilated with a bag valve mask. In this population, there were zero esophageal intubations and 2.9% of endotracheal insertion attempts resulted in a right mainstem bronchus intubation. In the physician study, it was found that 18% of patients became hypoxemic after endotracheal insertion and hypotension occurred in 13% of patients. No patient became both hypoxemic and hypotensive[49].

Interfacility Transportation

Ambulances often transport critically ill patients from community hospitals to tertiary hospitals offering specialized care, such as stroke care, cardiac catheterization, trauma surgery and intensive care and these are referred to as interfacility transfers. These patients often have undergone laboratory and radiologic investigations, been diagnosed by a physician, and are undergoing extensive care while being transferred. Usually, a nurse or physician, or sometimes, a critical care-trained paramedic, will care for the patient in the treatment compartment of the ambulance. The majority of the literature relating to this patient population explores the outcomes of patients who are transferred from the vantage point of the care provided in either sending or receiving facility, and does not focus on in-transit care (Table 7). Thus, the literature related to interfacility transport is not truly reflective of patient safety in EMS, but rather patient safety in the healthcare system as a whole. We summarize it briefly for this report.

Several studies have documented adverse events specific to interfacility transportation[76-78, 81, 82, 86]. As interfacility patients are critically ill, hemodynamic instability as measured by bradycardia, hypotension, and hypoxia is common. Other adverse events include equipment failure or medication error, or dislodgement of either an IV or endotracheal tube. Finally, vehicle malfunction and delays in arriving at the receiving facility have been attributed to adverse effects and increased morbidity. Many studies have sought to measure the incidence of these events during transport, with incidence rates varying between 25 and 36%. Despite this seemingly high rate, very few deaths occur intratransport.[74, 80, 82, 84, 86] No interventional studies examining methods to improve patient safety during interfacility transport were retrieved through the search strategy.

Table 7: Theme 6 – Interfacility Transportation (n=13)

Citation	Method	N	Population	Intervention (I)	Control (C)	Outcome
Lim 2008[82]	Prospective cohort study	346	All emergent neonatal interhospital transfers	Adverse event reporting form	N/A	Rates and contributors to adverse events were recorded.
Flabouris 2006[76]	Prospective cohort study	272	Patients from 4 ground and air interfacility transport groups	Adverse event report form	N/A	Rates and contributors to adverse events were recorded.
Hatherill 2003[78]	Retrospective review	202	Pediatric patients transferred by air or ground paramedics or physicians to intensive care	N/A	N/A	Adverse event rates were recorded.
Belway 2006[72]	Systematic review	6 cohort studies	Air and ground interfacility transfer patients	N/A	N/A	A systematic review of adverse events in interfacility transport.
Deasy 2007[73]	Retrospective review	105	Interfacility transfer patients	N/A	N/A	Adherence to best practices was recorded.
Fan 2006[75]	Systematic review	5 studies	Air and ground interfacility transfer patients	N/A	N/A	A systematic review of adverse events in interfacility transport.
Ligtenberg 2005[81]	Prospective cohort study	100	Interfacility transfer patients by a physician	N/A	N/A	Adverse event rates were recorded.
Moss 2005[85]	Retrospective cohort study	2402	Neonatal interfacility ground transports by a physician	Partnerships to ensure ambulance availability	Partnership not in place	Adverse event rates were compared between the two cohorts.
Lees 2008[80]	Retrospective review	555	Cardiac patients transferred by a nurse, paramedic or physician via ground or air	N/A	N/A	Requirement for medical intervention during transport was recorded.

Limprayoon 2005[83]	Retrospective review	36	Interfacility patients <14 yrs transported by ground nurses and paramedics	N/A	N/A	Adverse event rates were recorded.
Lee 2008[79]	Prospective observational study	102	Adult patients transferred by a physician ground interfacility team	Application of scores to predict deterioration	N/A	Two scores were applied to interfacility patients, and compared between patients who deteriorated and those who did not.
Uusaro 2002[86]	Retrospective review	66	Interfacility respiratory failure patients transferred by a physician	N/A	N/A	Adverse event rates were recorded.
Duke 2001[74]	Retrospective case-control	73 cases	Adult interfacility patients transferred by ground medical crew	Transferred patients who could have received interventions at the sending facility	Transferred patients admitted to ICU	Reasons for and outcomes after interfacility transport were reported.
Linden 2001[84]	Prospective observational study	29	Patients on extracorporeal membrane oxygenation (ECMO) transported by a mobile ECMO team by ground or air	N/A	N/A	Adverse event rates during transport were recorded.
Gebremichael 2000[77]	Retrospective review	39	Interfacility patients transferred by physicians	N/A	N/A	Adverse event rates during transport were recorded.

Discussion

In a systematic review of the literature to identify all published articles on the topic of patient safety in EMS, six themes were identified including clinical judgment, adverse events (medication incidents and adverse event reporting), intubation, land vehicle safety, aircraft safety, and interfacility transport. Existing literature is scanty and likely fails completely to address significant safety issues. To address safety in EMS, providers, operators, regulators and researchers must dedicate resources to measure adverse event rates, evaluate interventions and generate new knowledge specific to patient safety in EMS so that the EMS community can access a broad pool of knowledge and implement effective strategies to keep patients treated by EMS safe.

Key Informant Interviews

Background

The paucity of scientific study uncovered by the systematic review required the use of a second methodology. Key informant interviews exploring patient safety issues in the prehospital setting allowed experts to discuss challenges and trends that have not received formal scientific study or been identified in peer reviewed publications[3].

Method

A qualitative study using processes described by Lincoln and Guba to enhance the quality and credibility of data and analysis was conducted[88]. 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. Ethics approval was gained from the researchers' educational institution and informants gave informed consent. Informants were identified by the members of the pan-Canadian Advisory Group together with representatives from the Canadian Patient Safety Institute, Emergency Medical Services Chiefs of Canada and the Calgary EMS Foundation.

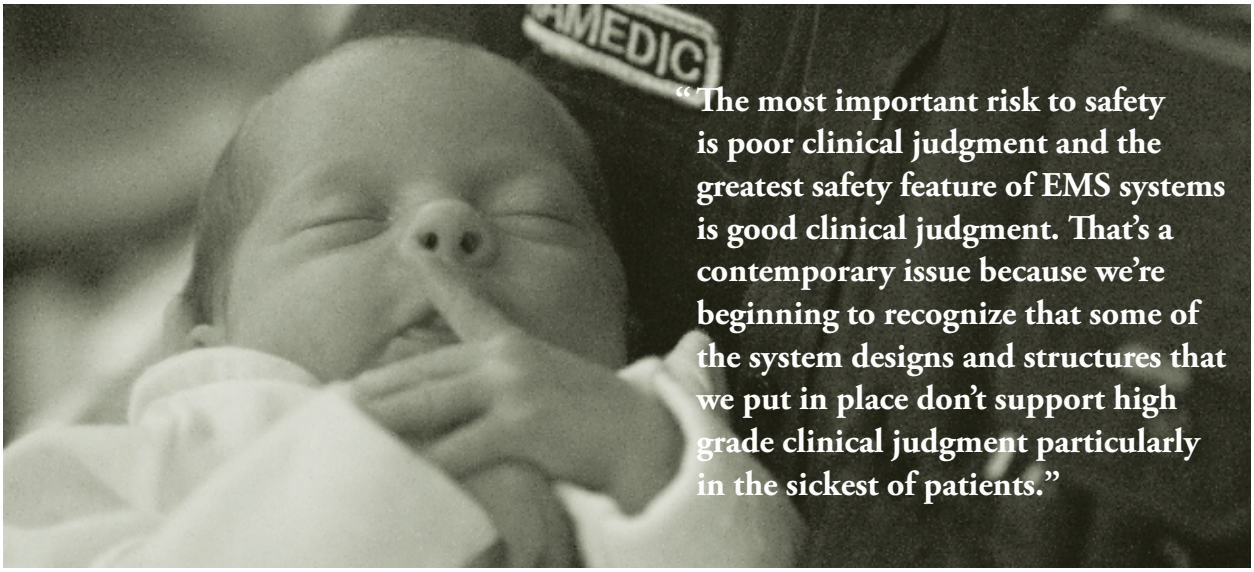
All potential informants were emailed a description of the study and were invited to participate in an interview. The final sample consisted of 16 informants, 14 (88%) of whom were from Western, Central and Atlantic Canada and the remaining were from the United States (1) and Europe (1). The group included paramedics, emergency physicians, EMS researchers and administrators and, providing the patient experience, a parent whose daughter's health required frequent EMS calls. Ten informants worked in the EMS and five were physicians working closely with EMS personnel as Medical Directors or in the Emergency Room. The average number of years of experience in EMS or healthcare was 27 and ranged from 20 to 32 years. The process of collecting data from multiple professional perspectives is known as 'source triangulation[89]. This approach enhances the credibility of study results because it enhances the truthfulness or validity of findings[88]. The decision to stop at 16 informants was based on data saturation; no new data were emerging at that point from the interviews.

Analysis

In-depth interviews were conducted by telephone to facilitate data collection with informants who were situated across Canada and in Europe and the United States. An interview guide was developed by the research team to facilitate the discussion (Appendix B). The interviewer began by asking two broad opening questions which allowed the informant to raise topics they deemed as relevant and important for discussion: *"What do you see as the most important issues regarding patient safety in EMS today?"* and, *"What factors in the EMS environment might adversely affect patient safety?"* Informants were then asked to comment on two safety issues that had been identified as important issues in the literature review conducted as part of the larger study: medication incidents and vehicle accidents. They were also asked to discuss knowledge gaps, implications for practice, future research and recommendations for change.

Method for Key Informant Interviews

- ☑ **Invite participant**
- ☑ **Record phone interview**
- ☑ **Transcribe interview**
- ☑ **Participant reviews transcript**
- ☑ **Transcripts coded and categories analysed by investigators**
- ☑ **Themes developed**



The interviews were audio-taped and lasted 40 minutes on average. The tapes were transcribed. The researchers began by reading through all the transcripts to gain an overall understanding of the issues informants had shared and to develop a preliminary categorization scheme. The transcripts were then read in their entirety and coded for correspondence to the identified categories, while allowing for the emergence of new categories as data were analysed in depth. Member checking, suggested by Lincoln and Guba[88] to enhance the quality and trustworthiness of the data collection and analysis process, was also conducted. Informants received a copy of the transcript and were asked to review it to validate the accuracy of the interview from their perspective.

Major themes regarding key issues were developed based on all transcripts and reviewed by both researchers. Once completed, a search for themes and patterns of experience across the different groups of informants and regions took place to identify similarities and diversity in patient safety issues. Attention was paid in particular to the influence of informants' roles and geographical location. The transcripts were reviewed a final time to ensure key themes had been identified. The final step involved highlighting findings, conclusions and connections to existing literature.

"Poor clinical judgment is a far greater risk to patients than getting the wrong drug out of the bag."

Results

Key Issues

Informants were asked to identify key issues in patient safety from their perspective. The overriding theme that emerged was that a broad view of factors influencing patient safety is required; it is important to look beyond the usual culprits such as vehicle accidents and medication incidents. The primary issue identified by informants was the critical importance of developing and supporting good clinical judgment. As one informant noted, "Poor clinical judgment is a far greater risk to patients than getting the wrong drug out of the bag." The second key issue that was identified was the focus of EMS and its relationship to healthcare.

Clinical Judgment and Training

The key issue identified by 12 of the 16 (75%) informants was clinical judgment and by association, EMS training. One informant, a paramedic and Deputy Chief, EMS noted, "The most important risk to safety is poor clinical judgment and the greatest safety feature of EMS systems is good clinical judgment. That's a contemporary issue because we're beginning to recognize that some of the system designs and structures that we put in place don't support high grade clinical judgment particularly in the sickest of patients." Informants noted that all too frequently, clinical decisions are made by well-intentioned but inexperienced or unsupervised EMS personnel with significant consequences to patients.

EMS practice has changed considerably in recent years. While patient care protocols have been developed to guide practice, patient situations, technology and treatment options have become much more complex. An increase in inter-facility transfers with regionalization of specialty care means EMS personnel are dealing with much greater patient acuity. Some informants reported that 'scope creep' has become an issue, with EMS personnel gradually giving more complex drugs and treatments. Twenty-five to thirty years ago most EMS were not trained in, or asked to carry out any particularly hazardous interventions. As skills, medications and technology have been added to professional practice, some informants suggest that a training gap has developed.

Protocol-based care is useful and necessary; however, it is not sufficient given the current pre-hospital clinical environment. EMS education needs to develop stronger critical thinking skills to enable personnel to apply protocols using sound judgment. An EMS Deputy Chief, noted, "It is not just the technical skill that is at issue: it is the decision making around the skill that is critical. We can teach your mother to intubate people, probably intubate them safely, but knowing when to do it is the skill." Once staff have been taught higher level skills such as intubation, the more they are inclined to practice them. Informants speculated that patient safety was jeopardized at times as paramedics, eager to practice these skills, took on a more complex role without sufficient training and supervision.

" It is not just the technical skill that is at issue: it is the decision making around the skill that is critical. We can teach your mother to intubate people, probably intubate them safely, but knowing when to do it is the skill."

Another factor identified as influencing patient safety is overcrowding in the emergency room (ER). EMS personnel sometimes have to wait several hours before they can discharge a patient to ER staff, requiring them to provide continuing care for unstable patients in the interim, something they were never trained to do.

The training process itself was reported as problematic. The EMS environment is not like the ER department or ICU where other clinicians supervise practice, assist and make recommendations, where quality monitoring and improvement is an ongoing process because staff work in teams. Informants commented that too often staff are trained, experience a single episode of evaluation, are certified and sent out to practice – unsupervised. Subsequent opportunities for practice may not be sufficient to develop the expertise required for safe practice as many services have a high staff turnover and there is limited opportunity to provide supervised, mentored training.

An outcome of the training and experience gap is that decisions are made that compromise patient safety. Several informants suggested that lack of training, resulting in weak assessment skills, leads to transport cancellations. One informant, a paramedic, commented, "…as we always say, the most dangerous calls in EMS from a patient safety point of view are ones where we do not transport, not the ones where we do."

" …as we always say, the most dangerous calls in EMS from a patient safety point of view are ones where we do not transport, not the ones where we do."

It was also suggested that the length and complexity of training be increased.

Recommendations regarding education were made by several informants. They suggested evaluating EMS education programs as a first step to improving assessment skills and clinical decision making. It was also suggested that the length and complexity of training be increased. Simulation is being used by some organizations in Canada and Europe with very encouraging results and the further use and study of the impact of simulation was suggested. One informant, an EMS Deputy Chief, commented on the need for mentorship models and residency programs where paramedics practice under the direct supervision of more experienced staff. Issues regarding continuing education that require further study were also raised such as determining the length of time before retraining is needed and exploring the different continuing education requirements across the country.

One informant, an EMS Deputy Chief, commented on the need for mentorship models and residency programs where paramedics practice under the direct supervision of more experienced staff.

Focus of EMS and Relationship to Healthcare

At the heart of the training adequacy issue is the issue of the focus of EMS. Seven (46%) informants reported that the underlying cause of patient safety problems stems from the EMS arising from a culture of public safety, not healthcare. They noted that the focus of EMS is currently unclear: some suggest the EMS focus is more aligned with healthcare and includes developing a clinical impression and treatment plan, while others believe EMS should "scoop and run" as they did in the past, when service aligned clearly with public safety, such as policing and firefighting. With the increased use of technology and medical interventions, EMS has shifted to the healthcare domain, however, true integration with that system is lacking. The lack of alignment between the public safety and healthcare systems has led to a large constellation of service delivery that lacks consistency in technology, language and knowledge that could help patients.

...EMS has shifted to the healthcare domain, however, true integration with that system is lacking.

Vehicle Collisions

After identifying key issues from their perspective, the study participants were asked to comment on two patient safety issues that had been identified in a literature review as part of the larger study: vehicle collisions and medication errors. Vehicle collisions present a risk to patient safety, however, perceptions of the degree of risk varied greatly among informants and reflected jurisdictional differences. Some informants felt their province or organization had made considerable progress in recent years in reducing collisions, others felt that major work still needs to be done. While viewed as important, some informants urged the researchers to put collisions in context. An EMS Deputy Chief noted, *"I know they're the things that EMS people talk about but compared to poor provider judgment these technical issues are only part of a picture."*

Some informants felt that their dispatch protocols needed to be updated as there were still far too many calls where lights and sirens were deployed. The risk of collision is considerably increased by 'running hot', driving at high speed with lights and sirens. Informants described several initiatives and strategies they had adopted that have had a positive impact on reducing collisions. Some participants identified that the implementation of validated dispatch algorithms were very helpful; a good initial dispatch assessment is essential in identifying a serious emergency and reduces the overuse of lights and sirens.

Some participants specifically cited the Advanced Medical Priority Dispatch System software as a tool that can safely reduce unnecessary lights and siren use while being able to identify life-threatening calls that require the most urgent emergency response.

Another factor that was identified as contributing to vehicle collision is the culture of speed in EMS. Driver training programs that emphasize low force, safe driving techniques have been implemented in some organizations and informants supported the use of tracking to evaluate these road safety programs. Some agencies implement random monitoring and issue reports with report card driving scores and some are testing ambulances that provide real-time, personalized feedback to crew regarding their driving practices.

Crew fatigue was also identified as contributing to collision. Crews work long shifts and experience sleep inertia, characterized by a decline in motor dexterity and a feeling of grogginess, after an abrupt awakening. The lack of driving experience and skills was also identified as a contributing factor by a paramedic educator. "We now have inexperienced people with inexperienced people."

"We now have inexperienced people with inexperienced people."

Medication Incidents

Medication incidents, such as giving the wrong dose or the wrong medication, exist within EMS settings and can inflict unintended harm on the patient. However, several informants noted that giving medications is a relatively small part of the whole EMS process. One informant, a Chief of Air Rescue in Europe noted, "It's the complexity of the work, it's the treatment itself, it's the interaction between the personnel, it's the decision making, choosing the right hospital and so on… medication errors are sort of a bright shiny object in terms of safety." Informants emphasized that poor clinical judgment is the far greater risk, for example, not recognizing when somebody is clearly sick and intervening immediately, or deciding they do not need to go to hospital when in fact they did. These are the types of situations that lead to fatalities.

"It's the complexity of the work, it's the treatment itself, it's the interaction between the personnel, it's the decision making, choosing the right hospital and so on… medication errors are sort of a bright shiny object in terms of safety."

Some of the factors related to medication incidents are technical and environmental: drawing up and administering medication in the back of a dark, moving ambulance is hugely challenging and there is lack of standardization regarding the contents and placement of items in drug boxes and how ambulances are stocked. As well, poor packaging design for vials and ampoules contributes to medication incidents when drugs are administered in a hurry. While drugs are increasingly packaged to reduce error, paramedics sometimes remove bulky packaging to make their bags lighter, increasing the risk of a medication incident. Work is underway to include checklists to track medication administration and to convince manufacturers to redesign medication vials. Crew fatigue was also identified as a factor contributing to medication incidents.

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While technical and environmental factors are a concern, a greater issue was reported: medication incidents are seriously underreported. The exact extent and type of medication incidents made is unknown. One paramedic educator commented, "*I'd be guessing that one percent of those probably actually get reported.*" Events happen quickly and an individual may not even be aware an adverse event has occurred. EMS crews work in a non- controlled environment. There is no post procedure checklist which alerts personnel that a medication incident has occurred or resulted in an adverse event. The environment is unlike a hospital where someone acts as scribe, recording events in an emergency. Further, personnel are reluctant to report adverse events, for fear of the consequences and even if they can bring themselves to do it, sometimes it is difficult to know whom to report to. For example, Fire First responders might have a municipal mandate whereas ambulance might operate for the province. Often, EMS personnel are deployed by multiple agencies and they may not view themselves as part of a system nor are they governed as part of a system which makes follow-up and remediation difficult.

All informants acknowledged that the way to reduce medication incidents is through better tracking and reporting. Only by knowing the full extent of this issue can the underlying causes or contributing factors be addressed. Some organizations are using electronic adverse event reporting systems with good outcomes. The most effective way to reduce medication incidents, identified by a large number of informants, is to move away from a 'culture of blame' and create a work environment that more effectively improves patient safety through risk mitigation and surveillance. The focus needs to be on encouraging reporting rather than assigning blame. One ER physician with a specialty in patient safety noted, *"We have yet to evolve as learning organizations where we feel free to discuss in an open forum without progressive retribution or blame the areas of threat to safety. And so my strong sense is that there remains too much of a finger pointing perspective on safety issues and not enough of a system understanding of safety issues."* Clearly written protocols, system checks, and routine auditing of high risk medications are needed. Recording close calls is just as important for learning purposes as documenting actual adverse events. Some health regions use a critical incident review or conduct a root cause analysis for close calls or adverse events to ensure that actions are taken to prevent future occurrences. One informant suggested that a pan-Canadian database of adverse events and close calls would reduce the feeling of operating in isolation and provide useful educational opportunities for EMS and other healthcare providers.

The most effective way to reduce medication incidents, identified by a large number of informants, is to move away from a 'culture of blame' and create a work environment that more effectively improves patient safety through risk mitigation and surveillance.

"We have yet to evolve as learning organizations where we feel free to discuss in an open forum without progressive retribution or blame the areas of threat to safety. And so my strong sense is that there remains too much of a finger pointing perspective on safety issues and not enough of a system understanding of safety issues."

The second major issue identified regarding medication incidents is lack of judgment, for example, failing to give what is needed or the overuse of sedation with a patient with head injury. Several informants noted that as the EMS scope of practice increases, training has not kept pace and the more medications given, the greater the incidence of medication incidents. The suggestion to use more simulations with debriefing during training, recommended from those with aviation experience, was also made. Improving communication with patients and family members to gain a better understanding of what was normal practice was also suggested as means of reducing adverse events.

Knowledge Gaps

Informants were also asked to reflect on what they considered as current knowledge gaps regarding patient safety in the EMS. Their suggestions ranged from broader, system-level work that needs to be done to more specific recommendations. Informants spoke of the need to develop a framework for classifying patient safety information relevant to the prehospital environment. A common understanding of issues and goals would help remedy policy gaps, support patient care report audits and help practitioners address causal factors.

A major issue, which emerged under previous topics, is that there is little knowledge of what is actually going on in practice, and decision-making in particular. Comparisons were made with the healthcare system where, for example, if a surgeon takes steps to address an adverse event in surgery, notes are left in the medical record. This kind of recording, which leads to review and improvement in practice, is absent in EMS. Data regarding decision making in practice come largely from two points in time: at the scene in the field and on arrival in the ER. Events that occur in between were described as a 'black box' that needs to be explored. The suggestion was made to capture front line workers' stories about how they make decisions so that organizations could build on providers' experiences. This would help with the development of sufficiently complex models to uncover factors influencing decision making regarding safety. Some organizations have implemented strong quality improvement frameworks that have had a positive impact on patient safety. Knowledge gaps regarding specific clinical situations were also identified: vehicle design to withstand crashes, protocols for vehicle lights and siren, airway management, and best practices in the treatment of shock.

Some organizations have implemented strong quality improvement frameworks that have had a positive impact on patient safety.

A second major theme that emerged related to knowledge gaps was EMS education. Informants noted that there is a need to study best practices in educating paramedics and to clarify what constitutes adequate clinical experience, exposure and judgment.

...there is a need to study best practices in educating paramedics and to clarify what constitutes adequate clinical experience, exposure and judgment.

Discussion

The perceptions of patient safety issues of highly experienced personnel in EMS were not wholly congruent with the findings of the systematic review. Two major themes were identified under the category of key issues: clinical decision making and the EMS's focus and relationship with healthcare. It was interesting to note that the topics of vehicle collisions and medication incidents, which had been identified as key issues in patient safety from a literature review conducted as part of a larger study, did not emerge as key issues for most informants who urged researchers to take a broader view of patient safety. 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. The same finding applies to results from the European and American participants who practice in different systems but reported similar issues.

Clinical decision making was the factor most informants identified as contributing to patient safety incidents in EMS. An earlier study on pre-hospital safety supports this finding; the researchers classified close calls and adverse events with EMS personnel and reported that the majority (54%) were determined to be adverse events in clinical judgment, 21% were related to skill performance and 15% to medication administration[36].

The theme of clinical decision making is closely connected with the issue of EMS focus, the second major issue raised by informants. They noted that the role of EMS is not clear; there is tension between the traditional 'stabilize and transport' role and the increasingly complex clinical role that has come about through 'scope creep'. If EMS remains true to its public safety roots, education and practice should focus on patient stabilization and transport. If, as expected, EMS aligns increasingly with the health sector, then change is needed in the EMS educational structure and process to develop better clinical decision making and interprofessional skills. Further, as the number of EMS personnel rises, the opportunity to practice technical skills decreases, impacting on competency levels[90]. The literature suggests that

technical skills start to 'erode' as soon as six to twelve months after basic education programs are completed[91]. Informants in this study recommended longer training periods, more complex learning situations, more supervised practice, and regular practice audits to maintain competence. The call to re-evaluate education in response to change in clinical practice is a sign of continuing development within the profession and is also being raised in other countries[92]. Adopting the language and culture of healthcare and improving the integration of care between EMS and the healthcare system was recommended as essential to improving patient safety across the health continuum.

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Vehicle collisions were also identified as an important patient safety issue. Some organizations have reduced the number of vehicles dispatched in emergency mode considerably through the use of dispatch systems and stronger protocols; a result that has been reported in earlier studies[93]. 'Running hot' and the other factors contributing to collision such as the lack of vehicle design and performance standards, the need for better fleet maintenance and driver training have also been identified in previous studies[94]. Improved driver education programs, stronger safety policies and vehicle design changes were all recommended.

Numerous factors were identified as contributing to medication incidents. Informants strongly recommended that the way to address these issues is by supporting a culture of proactive risk mitigation and surveillance. Only by gaining a clearer understanding of the extent and types of adverse events can change occur. Ten years ago, the Institute of Medicine recommended mandatory incident reporting and voluntary near miss reporting[1]. The healthcare system, when compared with industry, has been a relatively slow adopter of incident reporting[95] and EMS has lagged even more so. A protected reporting and learning culture is needed in EMS education programs and practice settings to address the multiple causes of harm at the individual and systems level. This finding is similar to results from an earlier study where the authors proposed an injury prevention model which reduces the emphasis on finding fault and focuses on modifying products or system factors to increase patient safety[96]. This approach has been recommended in recent studies[6] and by organizations whose efforts are aimed at improving patient safety, such as the Canadian Patient Safety Institute.

Informants also called for a strong quality improvement processes including the need for more complete clinical review, record audits and medical oversight; recommendations that have been made, and found effective, in earlier research[38]. A national database of adverse events and close calls was recommended to help EMS providers across the country. Another issue that needs to be addressed is the deployment of EMS personnel by multiple agencies. The current system of governance impedes the ability to track adverse events and close calls and to introduce and evaluate measures to bolster patient safety. Most of the issues identified in this study are system-wide and best addressed through health policy reform and system restructuring from health regions and governments. This result is similar to hospital-based studies on patient safety[97].

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Roundtable Event

Introduction

To highlight the findings of both the systematic review and key informant interviews, and to validate the findings of these two methodologies while capturing additional information, an invitational roundtable discussion was employed as the third and final methodology of this project. The Patient Safety in EMS Roundtable was held June 1, 2009, in Niagara Falls, Ontario, and included 52 patient safety, EMS and research experts from Canada and the USA.

Results from the systematic review and key informant interviews were presented to the participants, who were encouraged to read, analyse and discuss the results and contribute their own perspectives in both small groups and as a collective. Information that emerged from the participants was captured using personalized touch pad technology (electronic voting) and through notetaking by the research team. The objectives for the Roundtable Event were identified by the pan-Canadian Advisory Group:

- To consider and provide feedback on the themes, priority issues and actions for patient safety in EMS identified in the research findings.
- To identify best practices, tools, programs and initiatives that are currently in use, for the themes that have been identified/endorsed.
- To provide an opportunity for knowledge exchange and networking.
- To engage stakeholders and raise awareness about patient safety in EMS across Canada.
- To identify next steps that can be acted on.

Method

The participants of the roundtable were selected by the pan-Canadian Advisory Group, CPSI, EMSCC and the research team because of their expertise in either patient safety and/or emergency medical services. The event was coordinated by a professional facilitator. In advance of the event, each participant was provided the preliminary systematic review and qualitative interview results to read, and these results were also presented by the research team at the Roundtable Event.

Roundtable Event Methodology

- ☑ **Invitations were sent to experts**
- ☑ **Participants gathered in Niagara Falls**
- ☑ **Results of the systematic review and qualitative interviews were presented**
- ☑ **Small group discussions were facilitated and brainstorming was encouraged**
- ☑ **Large group discussions were then facilitated and included presentations from the breakout groups**
- ☑ **The entire group was brought together to discuss future directions**

Following the presentation, the participants broke into eight small groups to discuss the issues facing patient safety in EMS, solutions that address these issues, and future directions to mitigate or reduce the occurrence of adverse events, using a Participant Guide for structure and direction (Appendix C). These small breakout groups were populated with a mix of expertise from different geographic regions. Each small group was assigned a facilitator from the Advisory Group to guide the conversation and a scribe from the research team to capture data. Following the small group discussions, a large discussion was facilitated to share the perspectives of all participants.

The Participants

The group was asked to self-report their current primary role, with participants identifying themselves as patient safety experts (8%), EMS administrators (61%), physicians (16%), other healthcare professionals (5%), educators (3%) or other (8%). Although none of the participants were self-identified primarily as practicing paramedics (0%), it was acknowledged that several of the participants have functioned as practicing paramedics in the past and/or do not currently practice paramedicine in their current primary professional role. Two-thirds of participants reported having > 20 years of experience in their prospective fields.

Analysis

Data analysis utilized the notes and flip charts of the eight groups from the small roundtable discussions and identified common themes from each breakout session. Content analysis of these notes led to the categorization and discussion of ideas and captured the essence of the conversations at the roundtable event as a whole.

The Issues

Participants were asked to rate the themes that emerged from the quantitative and qualitative research for importance and feasibility on a 5-point Likert scale (1 = not important or feasible, 5 = very important or feasible, 6 = not sure) using personalized touch pad technology (Table 8). Responses 4 and 5 were combined to calculate "importance" and "feasibility".

The most prominent patient safety issue discussed was clinical judgment and decision-making, identified as important by 95% of attendees.

The most prominent patient safety issue discussed was clinical judgment and decision-making, identified as important by 95% of attendees. There was a consensus that paramedics in Canada are providing increasingly complex and time sensitive care to acute patients in the field; examples include new CPR process measures for cardiac arrest, STEMI identification and bypass, early stroke identification and bypass and therapeutic interventions (drugs and devices) in trauma. There may be a lag in building the educational foundation required to support the complex protocols and supplemental thinking required to make clinical decisions regarding diagnosis and treatment and this lag in education may contribute to patient safety issues. Alternatively, it was also felt that paramedics are occasionally penalized for exercising good clinical judgment under the current model of protocol-driven care and disciplinary action. While the importance of protocols was recognized, they were viewed as a double-edged sword and some suggested that guidelines offering flexibility to include clinical decisions and judgment may be more appropriate when coupled with timely medical oversight, enhanced education and point of care feedback.

...it was also felt that paramedics are occasionally penalized for exercising good clinical judgment under the current model of protocol-driven care and disciplinary action.

Table 8 – Participant Ranking of Themes on Importance and Feasibility

Theme	Importance (%)					Feasibility (%)				
	1	2	3	4	5	1	2	3	4	5
Clinical Judgment and Decision-Making	0	3	3	11	84	0	5	26	34	32
EMS and Relation to Healthcare	8	26	18	18	26	24	11	24	24	13
Vehicle Collisions	3	13	23	33	28	0	0	13	33	54
Medication Errors	0	13	18	28	41	0	5	31	36	28
Intubation	0	13	26	26	36	0	11	18	39	29
Aircraft Safety	10	26	18	31	10	8	21	8	28	33
Interfacility Transport	3	26	16	29	26	3	10	31	31	23

Currently, the delay to peer review, lack of timely medical director feedback, the tendency to focus on identification of the errors without identifying when things went well, and disciplinary actions may lead to a culture of fear and may jeopardize accurate reporting.

Currently, the delay to peer review, lack of timely medical director feedback, the tendency to focus on identification of the errors without identifying when things went well, and disciplinary actions may lead to a culture of fear and may jeopardize accurate reporting. The feasibility of tackling this issue was viewed positively, with 66% of participants declaring the issue feasible to pursue in terms of implementing and evaluating outcomes.

Medication incidents was the second most important (69%) patient safety issue identified, though many felt it caused few prehospital deaths. Sixty four percent of participants felt it was feasible to address. Participants agreed that the scope of medication incidents (commission and omission) is poorly understood since there is no standardized reporting infrastructure and universal data set. As mentioned above, the current culture regarding self-reported adverse events is seen as "blame and shame" and compromises efforts to define incidence and prevalence of medication incidents attributed to EMS care. In this culture, employees may not disclose when an adverse event has occurred for fear of disciplinary action or being ostracized by their peers. The need to identify systemic causal factors of risk and harm rather than addressing individual competency was emphasized as a beneficial strategy to engage the provider in making care safer. One example of system error was identified, where ampoules containing different medications were similarly labeled, leading to confusion and risk of harm at the point of care.

...the current culture regarding self-reported adverse events is seen as "blame and shame" and compromises efforts to define incidence and prevalence of medication incidents attributed to EMS care. In this culture, employees may not disclose when an adverse event has occurred for fear of disciplinary action or being ostracized by their peers.

Medication error and the occurrence of medication incidents can be reduced through use of appropriate and validated tools to support clinical decision making such as dosing charts and unit dose supplies. To better understand adverse events or close calls, a standardized pan-Canadian reporting and learning structure could be implemented which would facilitate the reporting of and learning from medication incidents. Lastly, standardized systems to log, label, distribute, stock and store medication can reduce systemic causes of medication incidents.

Despite the substantial volume of published retrospective and prospective cohort research investigating the safety of paramedic intubation[46-54, 56-58], there was skepticism that intubation failure leads to adverse outcomes outside of unrecognized esophageal placement.

Despite the substantial volume of published retrospective and prospective cohort research investigating the safety of paramedic intubation[46-54, 56-58], there was skepticism that intubation failure leads to adverse outcomes outside of unrecognized esophageal placement. Studies of paramedic intubation with credible methodologies such as randomized or concurrent control studies were not found. Many of the roundtable participants felt that the frequency at which the skill is performed is directly related to its proficiency; inexperienced paramedics who perform this skill infrequently are likely to be poor at it. What is lacking is a common set of definitions and standardized data on attempts at intubation and outcomes of successful intubation. Wang et al has used a

population based data set to try to identify the shortcomings of documentation with respect to intubation and these demonstrated shortcomings of data quality make description of adverse events related to advance airway techniques difficult[56, 57]. Participants voted intubation to be an important issue (62%) and felt it was feasible to address (68%). In the absence of good data to say otherwise, the skill of intubation and the ability to determine when intubation is appropriate were thought to be enhanced through human patient simulators, extended residency/preceptorship programs and additional clinical time in the operating room.

Participants noted that the safety of other interventions such as needle thoracostomy, supraglottic airways, cooling adjuncts and timing lights to avoid hyperventilation did not prominently appear in the literature, yet it was acknowledged there may be other interventions used by paramedics which put patients at risk and require further study.

The final major theme that was discussed was ground ambulance collisions. Many participants had anecdotes regarding vehicle collisions, but none could think of a Canadian database that tracked the incidence of ambulance collisions. Published causes of collisions included overuse of lights and siren responses, inexperienced staff, the effects of shift work and stress in EMS, and a lack of driver safety training[8, 12, 45, 60-62, 98]. More than half (61%) of participants thought this was an important issue and it was considered by 87% to be feasible to tackle. Ground ambulance collisions can be prevented by avoiding lights and siren responses through use of validated commercial dispatch software[99], with lower overtriage rates than other programs. The use of speed monitoring programs using tachometers was noted to be successfully implemented in a number of EMS services and was felt to reduce risky driving behaviour.

Ground ambulance collisions can be prevented by avoiding lights and siren responses through use of validated commercial dispatch software...

Identifying the Gaps and Potential Solutions

There was some confusion about the role of the paramedic in the healthcare system; some felt that the practice of paramedicine should be aligned with public safety services such as police and firefighting services, while others felt paramedicine was an allied health profession and extension of the hospital and healthcare system. These two paradigms of the EMS industry can best be summarized as "technical trade" vs. "clinical profession". Paramedic credentialing requirements are well established similar to other healthcare professions, and postsecondary education programs are accredited by the Canadian Medical Association. In fact, the paramedic competencies are defined by the Paramedic Association of Canada in the National Occupation Competency Profile[5] and the Paramedic Association of Canada has clearly defined EMS as a branch of the healthcare system tree**.** The majority of participants favoured the paradigm of clinical profession which is an important distinction as patient safety is pivotal to the mission of such a profession. *The Safety Competencies* framework[4] published by the Canadian Patient Safety Institute (Appendix C) provides a framework of six important core domains of patient safety knowledge, skills and attitudes for healthcare professionals and should be considered for inclusion in the competency profile[5] to ensure all paramedics receive this training.

The majority of participants favoured the paradigm of clinical profession which is an important distinction as patient safety is pivotal to the mission of such a profession.

Other patient safety interventions which have been proven to be effective in other health related disciplines such as critical care, pediatrics, emergency medicine, anesthesia and family medicine and non-health industries like aviation may be modified to suit paramedicine. There is no need to reevaluate proven interventions if they can be transferred into the prehospital setting. Many participants were surprised not to see more research evidence in the literature specific to EMS surrounding such "hot topics" as infection transmission, patient restraint and patient falls/drops. There was support from the roundtable participants for patient safety research on new interventions addressing safety issues unique to prehospital care. Participants were supportive of dedicating financial and human resources to better understand patient safety in the out-of-hospital setting.

A call for further high-quality research into these issues resonated with the participants, and the lack of human resource capacity in EMS to conduct this research is a substantial barrier requiring attention. Paramedicine is a growing profession, and high quality research is becoming increasingly common in the field. Community colleges are beginning to initiate applied research as an element in the curriculum, and paramedicine bachelor degrees are becoming more common along with the emergence of paramedics completing graduate-level education. The evolution towards greater academic preparation in paramedicine was identified as a key step in building human capacity to studying patient safety and implementing changes founded on scientific evidence. Graduate and post-graduate level training in research and leadership may improve data capture through heightened appreciation of its value to promote decision making based on more reliable measurements.

The evolution towards greater academic preparation in paramedicine was identified as a key step in building human capacity to studying patient safety and implementing changes founded on scientific evidence.

This focus on graduate training should be encouraged through staff tuition support and dedicated time while employed in the service. Models such as the Ontario Graduate Scholarship for EMS research at the University of Toronto could be replicated elsewhere. The University of Toronto scholarship was matched two for one by an initial investment of $50,000 from Emergency Health Services for an individual pursuing EMS research and is open to any graduate student in the faculty of Medicine including paramedics[100]. Dalhousie University's department of Emergency Medical Services has partnered with the provincial government and provincial EMS operator to offer training and research opportunities to paramedics and is creating a self-regulated College of Paramedics. This integrated academic program is unique to Canada and has fostered the growth of several paramedic researchers. The Heart and Stroke Foundation recently adjusted the eligibility criteria for scholarship awards to include paramedics pursuing graduate training or post doctoral training as a research fellow[101].

Dalhousie University's department of Emergency Medical Services has partnered with the provincial government and provincial EMS operator to offer training and research opportunities to paramedics and is creating a self-regulated College of Paramedics.

Improving clinical judgment requires better understanding of the cognitive process in making decisions. One way to address this it to enhance education delivery and retention in paramedic graduates. Other tools include morbidity and mortality rounds and root cause analysis, increasing the use of simulation in initial and ongoing education, and increasing interdisciplinary training. Building capacity in ongoing professional education and continuing competence can be supported through encouraging paramedic educators to pursue graduate degrees in education. This, in turn, will enhance the delivery of the continuing education programs and will lead to the accumulation of evidence and measurement which will change the way we deliver the curriculum and content of paramedicine.

Strategic Priorities

Participants identified nine strategic priorities to improve patient safety in EMS:

1. Make patient safety a strategic priority/corporate value within the organization and the profession.
2. Include patient safety domains identified in *The Safety Competencies* framework[4] in the National Occupational Competency Profile[5] and paramedic curriculums and in ongoing service based Continuing Medical Education sessions.
3. Create a web based reporting and learning system accessible 24-7 which records adverse events and close calls unique to the prehospital setting.
4. Support more EMS research in patient safety and operations through increased funding for studies and research infrastructure including salary support of those with research expertise.
5. Create or contribute to the development of standardized definitions, indicators and outcomes relating to patient safety in EMS.
6. Support the concept that the paramedic is part of the healthcare team, capable of decision making and judgment through advocacy, research and operational structuring.
7. Examine the literature from other disciplines with similarities in patient care to EMS for patient safety interventions that could be applied directly or modified slightly to the prehospital setting.
8. Build human resource capacity in EMS research, education and patient safety (for example, MSc and PhD trained paramedics and administrators) capable of facilitating change. Examples of support that have worked in other disciplines include salary support, reduced clinical hours, tuition support and scholarships.
9. Promote the identification and reporting of high-risk activities performed by paramedics through an EMS sensitive data capture tool such as a web based reporting and learning system and a culture of support and engagement of the providers without fear of deactivation, decertification and discipline.

Conclusion

Rather than waiting for a sentinel event to sound the alarms, the participants of the Patient Safety in EMS Roundtable have identified current issues and areas of focus related to prehospital patient safety in Canada and have described some potential next steps to improve patient safety in many aspects of EMS care. A review of the literature has identified a paucity of research related to patient safety in EMS and qualitative work and discussion at the roundtable event revealed knowledge gaps of important aspects of patient safety such as clinical decision making. Investing in patient safety research will generate a body of knowledge that can be applied to the EMS sector of the healthcare system, advance the practice of paramedicine and reduce preventable injury and death. Finally, a cultural shift towards policies and behaviours that support and reward self-disclosure of adverse events and near misses will bring light to systemic themes that can then be addressed. Systems, providers and patients all stand to gain from continued advances in patient safety and incorporating these concepts into health policy frameworks.

The Future

The Need for Collaboration

Our understanding of patient safety in the EMS setting is in its infancy. As local initiatives evolve and grow in number, there is a need to share information and learn from adverse events to develop evidence-based patient safety interventions for EMS. Advancing and aligning patient safety initiatives across Canada can bring these successful local initiatives to all Canadians who utilize emergency medical services. Provincial/territorial and national organizations as well as EMS services can play a leading role in unifying local efforts and pooling resources, data and experts so that significant advances can be made with the efficient use of resources. The recent collaborative efforts of the EMS Chiefs of Canada, the Calgary EMS Foundation and the Canadian Patient Safety Institute to commission this paper has been an important first step in bringing together many EMS and patient safety professionals and researchers. This paper can serve as a roadmap for local, provincial/territorial and national organizations to follow in continuing efforts to align EMS operators, regulators, medical oversight groups, patient safety experts, educators and researchers to generate new knowledge and strengthen patient safety initiatives in EMS.

This paper can serve as a roadmap for local, provincial/territorial and national organizations to follow in continuing efforts to align EMS operators, regulators, medical oversight groups, patient safety experts, educators and researchers to generate new knowledge and strengthen patient safety initiatives in EMS.

A key initiative identified in this report is the development of a Canadian adverse event reporting and learning system for EMS. Developing standardized terms and definitions is an important step to realizing an adverse event reporting and learning system. EMS leaders should look to aligning and integrating current or planned reporting and learning systems with those in healthcare to include and address the unique characteristics and challenges of an EMS system. Such a data capture tool would provide population based data to describe incidence and outcomes, and permit analysis to identify opportunities to reduce adverse events. This will also support future research into contributors to harm, interventions that can make EMS safer, and education gaps that require attention.

EMS leaders should look to aligning and integrating current or planned reporting and learning systems with those in healthcare to include and address the unique characteristics and challenges of an EMS system.

The Need for Enhanced Education

"Knowledge is power" is a common motivating phrase for some schools and centres of higher learning. The application to patient safety is direct; knowledge begets safe practice. Paramedics are trained to standards set by the Paramedic Association of Canada and accredited by the Canadian Medical Association. The National Occupational Competency Profile currently does not include specific competencies related to patient safety but can potentially align patient safety training across Canada. *The Safety Competencies*[23] provide a framework of six core domains of relevant knowledge, skills and attitudes for all healthcare professionals and are intended to contribute to the patient safety education and professional development of all healthcare providers (Appendix D).

These *Safety Competencies* should be integrated into the national list of competencies and into all paramedic student education...

These Safety Competencies should be integrated into the national list of competencies and into all paramedic student education, as well as into continuing education programs for paramedics who have already completed their career training. Appropriate evaluation methods to ensure competence should also be developed. Paramedics should teach paramedics as they alone understand the environment, the challenges and the culture of the prehospital providers, however, education programs should also include interdisciplinary or interprofessional learning opportunities to address this key patient safety challenge while supporting EMS inclusion in the healthcare system. Graduate studies in education are required to help paramedics further their education, and to obtain proficiency in educational methods and diversity in implementation strategies, while building partnerships with other industries and disciplines.

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Further, research is needed to determine optimal approaches to education in the area of patient safety for EMS providers, including approaches related to simulation. EMS training time is limited and precious, and education research is needed to ensure that training programs result in paramedics who are well versed in patient safety concepts and practices. Graduate training in education will improve the quality of paramedic education through scholarship and discovery.

When we impart knowledge in a way that engages the provider and produces behavioural and attitudinal change over time we make the practice of EMS safer.

The Need for Further Research

The literature to date addressing patient safety in EMS is less than inspiring, crippled with poor methodologies and evidence through association. Patient safety in EMS is in discovery and what we see and hear makes us fear the worst. We can look at the track record to date and lament that the cup is half empty or think of it as half full and see the opportunities to improve care. Years ago, the study of paramedicine was limited to a one year college degree. Now there are universities offering bachelor degrees in Paramedicine Science and graduate students include paramedics in both research and education. Traditional research in medicine is based on investing in people and providing infrastructure to further research. Only 2% of every graduating class in medicine pursues careers in research and graduate studies and we can assume it will be similar for paramedicine. Paramedics willing to pursue graduate training and a career in research are rare and precious resources that should be coveted. We can learn from traditional medicine to carefully select and support paramedics and operators to pursue graduate studies in research as a long term investment in EMS. Successful graduates will require infrastructure to help them succeed such as salary support, tuition support and post graduate positions to further their career. EMS services have the opportunity to partner with universities and granting agencies to help provide support to the individual and the infrastructure in patient safety research. This investment will improve the quality of patient care and minimize risk of harm.

We can learn from traditional medicine to carefully select and support paramedics and operators to pursue graduate studies in research as a long term investment in EMS.

The Need for a Cultural Shift

There is broad agreement in both the literature and among experts that a culture of safety is pivotal to reducing adverse events. Such a culture cannot exist when self-disclosure is met with punitive action or where patient safety best practices are not nurtured and encouraged. The "blame and shame" paradigm where persons are assigned fault for adverse events and where individuals are criticized for unsafe acts inhibits system-level recognition of contributors to harm and impedes efforts to engineer safer care systems. Deep-rooted attitudes towards hierarchy among different classes of EMS providers, dispatchers and hospital staff must be abandoned in favour of a culture where one is free to respectfully question authority, discuss adverse events openly and report actual or potential hazards. This shift is possible; the airline industry has greatly improved safety by embracing such a culture. By developing a patient safety culture, EMS systems can become safer.

Conclusion

The Canadian EMS community and patient safety experts have collaborated to take the first step in understanding and addressing patient safety in Canada's emergency medical services. By strengthening this pan-Canadian collaboration, measures of adverse events and data supporting safety interventions can be gathered and disseminated. Educating EMS providers, administrators and physicians in patient safety competencies will propel a cultural shift where patient safety best practices are embraced. Investing in the development of paramedic researchers and the generation of patient safety research will form a body of knowledge that can be applied to the EMS industry and advance the practice of paramedicine. Systems, providers and patients all will all benefit as the EMS community embarks down a path centred on patient safety.

Appendix A – Systematic Review Search Strategy

MEDLINE Search Strategy

#	Medline	Results
1	emergency medicine/	7390
2	emergency medical services/	23889
3	Emergency medical service communication systems/	1249
4	emergency medic$.tw.	10230
5	emergency service$.tw.	2964
6	ems.tw.	5626
7	ems.jw.	212
8	emergency treatment/	5909
9	(emergency adj6 treatment$).tw.	6395
10	prehospital$.tw.	4895
11	pre-hospital$.tw.	1416
12	prehospital$.jw.	1827
13	pre-hospital$.jw.	0
14	out of hospital$.tw.	3131
15	emergency medical technicians/	3903
16	emergency medic$ technician$.tw.	541
17	emt$2.tw.	2848
18	allied health personnel/	9185
19	paramedic$.tw.	4070
20	emergency technician$.tw.	7
21	emergency practitioner$.tw.	53
22	advance$ care provider$.tw.	0
23	emergency dispatch$.tw.	34
24	emergency despatch$.tw.	1
25	ambulances/	4195
26	air ambulances/	1235
27	ambulance$.tw.	4718
28	fixed wing$.tw.	155
29	airplane$.tw.	664
30	air plane$.tw.	10
31	helicopter$.tw.	1753
32	hems$.tw.	342
33	aeromedic$.tw.	794
34	(air$ adj6 transport$).tw.	2396
35	(air$ and transport$).jw.	163
36	"transportation of patients"/	7102
37	(transport$ adj4 patient$).tw.	3802
38	(transport$ adj6 medic$).tw.	1408
39	or/1-38	81779
40	safe$.sh.	37811
41	safety management/	9868
42	(safe$ adj3 manage$).tw.	2668
43	medical errors/	7697
44	medication errors/	7347
45	(medica$ adj3 error$).tw.	4000
46	(patient$ adj3 safe$).tw.	15423
47	patient safety.jw.	340
48	(adverse$ adj6 event$).tw.	42382
49	(health care adj3 error$).tw.	145
50	(healthcare adj3 error$).tw.	57
51	(sentinel adj3 event$).tw.	443
52	(critical$ adj3 incident$).tw.	1068
53	(critical$ adj3 outcome$).tw.	1548
54	(adverse$ adj3 outcome$).tw.	13728
55	(unanticipated$ adj4 outcome$).tw.	58
56	iatrogenic disease/	10639
57	diagnostic errors/	25738
58	(diagnos$ adj3 error$).mp.	28109
59	failure to diagnos$.tw.	463
60	failure of diagnose$.tw.	41
61	failure to recogni$.tw.	1164
62	lack of diagnos$.tw.	252
63	underdiagnos$.tw.	3277
64	under diagnos$.tw.	996
65	misdiagnos$.tw.	12238
66	(miss$ adj1 diagnos$).tw.	949
67	(nurs$ adj3 error$).tw.	251
68	(physician$ adj3 error$).tw.	293
69	(patient care adj3 error$).tw.	58
70	(surg$ adj3 error$).tw.	731
71	(human$ adj3 error$).tw.	1164
72	(safe$ adj3 cultur$).tw.	695
73	(safe$ adj3 climate$).tw.	138
74	equipment failure/	16168
75	(equipment adj6 fail$).tw.	412
76	near$ miss$2.tw.	706
77	close call.tw.	35
78	close calls.tw.	42
79	hand over$.tw.	471
80	Handover$.tw.	166
81	hand off$.tw.	95
82	handoff$.tw.	120
83	restraint, physical/	8259
84	restrain$.tw.	21059
85	Asphyxia/	3941
86	(position$ adj6 asphyx$).tw.	51
87	delirium/	3918
88	(excit$ adj6 delirium).tw.	56
89	lift$.tw.	10574
90	or/40-89	231342
91	39 and 90	3601
92	limit 91 to yr = 1999-2009	2389
93	limit 92 to animals	56
94	limit 93 to humans	21
95	92 not (93 not 94)	2354

EMBASE Search Strategy

#	Medline	Results
1	emergency medicine/	11245
2	emergency health service/	12999
3	emergency medic$.ti,ab.	8559
4	emergency service$.ti,ab.	1973
5	ems.ti,ab.	3446
6	ems.jx.	0
7	emergency treatment/	8635
8	(emergency adj6 treatment$).ti,ab.	4703
9	prehospital$.ti,ab.	3993
10	pre-hospital$.ti,ab.	1098
11	prehospital$.jx.	756
12	pre-hospital$.jx.	0
13	out of hospital$.ti,ab.	2950
14	rescue personnel/	1343
15	emergency medic$ technician$.ti,ab.	379
16	emt$2.ti,ab.	2233
17	paramedic$.ti,ab.	2551
18	emergency technician$.ti,ab.	6
19	emergency practitioner$.ti,ab.	55
20	advance$ care provider$.ti,ab.	0
21	emergency dispatch$.ti,ab.	30
22	emergency despatch$.ti,ab.	0
23	ambulance/	2634
24	air medical transport/	247
25	ambulance$.ti,ab.	3028
26	fixed wing$.ti,ab.	119
27	airplane$.ti,ab.	469
28	air plane$.ti,ab.	4
29	helicopter$.ti,ab.	1239
30	hems$.tw.	335
31	aeromedic$.ti,ab.	532
32	(air$ adj6 transport$).ti,ab.	2566
33	(air$ and transport$).jx.	0
34	patient transport/	6884
35	(transport$ adj4 patient$).ti,ab.	2988
36	(transport$ adj6 medic$).ti,ab.	1029
37	or/1-36	60257
38	safe$.sh.	47885
39	(safe$ adj3 manage$).ti,ab.	2441
40	medical error/	2958
41	medication error/	2709
42	(medica$ adj3 error$).ti,ab.	2785
43	patient safety/	11367
44	(patient$ adj3 safe$).ti,ab.	12472
45	patient safety.jx.	20
46	adverse event/	9
47	(adverse$ adj6 event$).ti,ab.	42792
48	(health care adj3 error$).ti,ab.	90
49	(healthcare adj3 error$).ti,ab.	31
50	sentinel event/	29
51	(sentinel adj3 event$).ti,ab.	241
52	(critical$ adj3 incident$).ti,ab.	684
53	(critical$ adj3 outcome$).ti,ab.	1379
54	(adverse$ adj3 outcome$).ti,ab.	12743
55	(unanticipated$ adj4 outcome$).ti,ab.	33
56	iatrogenic disease/	10481
57	diagnostic error/	18580
58	(diagnos$ adj3 error$).mp.	20265
59	failure to diagnos$.ti,ab.	332
60	failure of diagnos$.ti,ab.	27
61	failure to recogni$.ti,ab.	994
62	lack of diagnos$.ti,ab.	199
63	underdiagnos$.ti,ab.	3059
64	under diagnos$.ti,ab.	1015
65	misdiagnos$.ti,ab.	10655
66	(miss$ adj1 diagnos$).ti,ab.	799
67	(nurs$ adj3 error$).ti,ab.	83
68	(physician$ adj3 error$).ti,ab.	209
69	(patient care adj3 error$).ti,ab.	42
70	exp surgical error/	474
71	(surg$ adj3 error$).ti,ab.	510
72	(human$ adj3 error$).ti,ab.	1056
73	(safe$ adj3 cultur$).ti,ab.	439
74	(safe$ adj3 climate$).ti,ab.	125
75	(equipment adj6 fail$).ti,ab.	341
76	near$ miss$2.ti,ab.	595
77	close call.ti,ab.	19
78	close calls.ti,ab.	22
79	hand over$.ti,ab.	368
80	handover$.ti,ab.	79
81	hand off$.ti,ab.	85
82	handoff$.ti,ab.	47
83	restraint$.ti,ab.	10377
84	asphyxia/	3495
85	(position$ adj6 asphyx$).ti,ab.	53
86	delirium/	6544
87	(excit$ adj6 delirium).ti,ab.	45
88	lift$.ti,ab.	9315
89	or/38-88	200456
90	37 and 89	3873
91	limit 90 to yr = 1999-2009	3073
92	limit 91 to animals	21
93	limit 92 to humans	0
94	91 not (92 not 93)	3052

CINAHL Search Strategy

S94	S38 and S92 Limiters – Publication Year from: 1999-2009
S93	S38 and S92
S92	S91 or S90 or S89 or S88 or S87 or S86 or S85 or S84 or S83 or S82 or S81 or S80 or S79 or S78 or S77 or S76 or S75 or S74 or S73 or S72 or S71 or S70 or S69 or S68 or S67 or S66 or S65 or S64 or S63 or S62 or S61 or S60 or S59 or S58 or S57 or S56 or S55 or S54 or S53 or S52 or S51 or S50 or S49 or S48 or S47 or S46 or S45 or S44 or S43 or S42 or S41 or S40 or S39
S91	TI lift* or AB lift*
S90	TI excit* N6 delirium or AB excit* N6 delirium
S89	MH delirium
S88	TI position* N6 asphyx* or AB position* N6 asphyx*
S87	MH asphyxia
S86	TI restrain* or AB restrain*
S85	MH restraint, physical
S84	TI handoff* or AB handoff*
S83	TI hand N1 off* or AB hand N1 off*
S82	TI handover* or AB handover*
S81	TI hand N1 over* or AB hand N1 over*
S80	TI close N1 calls or AB close N1 calls
S79	TI close N1 call or AB close N1 call
S78	TI near* N1 miss* or AB near* N1 miss*
S77	TI equipment N6 fail* or AB equipment N6 fail*
S76	MH equipment failure
S75	TI safe* N3 climate* or AB safe* N3 climate*
S74	TI safe* N3 cultur* or AB safe* N3 cultur*
S73	TI human* N3 error* or AB human* N3 error*
S72	TI surg* N3 error* or AB surg* N3 error*
S71	TI patient care N3 error* or AB patient care N3 error*
S70	TI physician* N3 error* or AB physician* N3 error*
S69	TI nurs* N3 error* or AB nurs* N3 error*
S68	TI miss* N3 diagnos* or AB miss* N3 diagnos*
S67	TI misdiagnos* or AB misdiagnos*
S66	TI under N1 diagnos* or AB under N1 diagnos*
S65	TI underdiagnos* or AB underdiagnos*
S64	TI lack N1 diagnos* or AB lack N1 diagnos*
S63	TI failure N1 recogni* or AB failure N1 recogni*
S62	TI failure N1 diagnos* or AB failure N1 diagnos*
S61	MH Failure to diagnose
S60	TI diagnos* N3 error* or AB diagnos* N3 error*
S59	MH Diagnostic Errors
S58	MH iatrogenic disease
S57	MH iatrogenic disease
S56	TI unanticipated N4 outcome* or AB unanticipated N4 outcome*
S55	TI adverse N3 outcome* or AB adverse N3 outcome*
S54	TI critical* N3 outcome* or AB critical* N3 outcome*
S53	TI critical* N3 incident* or AB critical* N3 incident*
S52	TI sentinel N3 event* or AB sentinel N3 event*
S51	MH sentinel event
S50	TI healthcare N3 error* or AB healthcare N3 error*
S49	TI health care N3 error* or AB health care N3 error*
S48	MH Health care errors+
S47	TI adverse* N6 event* or AB adverse* N6 event*

S46	MH Adverse Health Care Event+
S45	SO patient safety
S44	TI patient* N3 safe* or AB patient* N3 safe*
S43	MH patient safety+
S42	TI medica* N3 error* or AB medica* N3 error*
S41	MH medication errors
S40	TI safe* N3 manage* or AB safe* N3 manage*
S39	MW safe*
S38	S37 or S36 or S35 or S34 or S33 or S32 or S31 or S30 or S28 or S27 or S26 or S25 or S24 or S23 or S22 or S21 or S20 or S19 or S18 or S17 or S16 or S15 or S14 or S13 or S12 or S11 or S10 or S9 or S8 or S7 or S6 or S5 or S4 or S3 or S2 or S1
S37	TI transport* N6 medic* or AB transport* N6 medic*
S36	TI transport* N4 patient* or AB transport* N4 patient*
S35	MH transportation of patients
S34	SO air* and SO transport*
S33	TI air* N6 transport* or AB air* N6 transport*
S32	TI aeromedic* or AB aeromedic*
S31	TI hems* or AB hems*
S30	TI helicopter* or AB helicopter*
S29	TI air N1 plane* or AB air N1 plane*
S28	TI airplane* or AB airplane*
S27	TI fixed N1 wing* or AB fixed N1 wing*
S26	TI ambulance* or AB ambulance*
S25	MH ambulances
S24	TI emergency N1 despatch* or AB emergency N1 despatch*
S23	TI emergency N1 dispatch* or AB emergency N1 dispatch*
S22	TI advance* N1 care N1 provider* or AB advance* N1 care N1 provider*
S21	TI emergency N1 practitioner* or AB emergency N1 practitioner*
S20	TI emergency N1 technician* or AB emergency N1 technician*
S19	TI paramedic* or AB paramedic*
S18	TI emt* or AB emt*
S17	TI emergency N1 medic* N1 technician* or AB emergency N1 medic* N1 technician*
S16	MH emergency medical technician attitudes
S15	MH emergency medical technicians
S14	TI out N1 of N1 hospital* or AB out N1 of N1 hospital*
S13	SO pre-hospital*
S12	SO prehospital*
S11	TI pre-hospital* or AB pre-hospital*
S10	TI prehospital* or AB prehospital*
S9	TI emergency N6 treatment* or AB emergency N6 treatment*
S8	MH prehospital care
S7	SO ems
S6	TI ems or AB ems
S5	TI emergency N1 service* or AB emergency N1 service*
S4	TI emergency N1 medic* or AB emergency N1 medic*
S3	MH emergency medical service communication systems
S2	MH emergency medical services
S1	MH emergency medicine

Appendix B – Key Informant Interview Guide

Introduction

A. Thank you for agreeing to this interview, I will tape to assist in note-taking, and confirm explicitly with you later in the process if I intend to quote or attribute to you specifically. Please feel free to stop me at any point for questions. I have a series of 8 questions to guide our discussion and I expect that the interview should not take more than 45 minutes.

B. These interviews are part of a research project we are undertaking for a consortium involving the Canadian Patient Safety Institute, Emergency Medical Services Chiefs of Canada and the Calgary EMS Foundation to provide a comprehensive scan of issues relating to patient safety in pre-hospital care. You have been identified as a key informant and I am very pleased you were able to make time today.

1. **Background**

   Can you begin by telling me a little about yourself? Your role, background, and interest and experience in pre-hospital care as it relates to patient safety?

2. **Safety Issues in EMS**

   What do you see as the most important issues regarding patient safety in Canadian EMS systems today? (cues: medication error, infection, vehicle accidents or three main themes from the systematic review)

3. **Factors affecting patient safety in EMS**

   What is it about the EMS environment/practice that makes patient safety an issue? (cues: shift work, uncontrolled environment, high acuity, stress)

4. **Summary Statement about Vehicle Accidents**

   (a) Do you agree or disagree with this (cite author or identifying attribute). Why?

   (b) Is the situation any different in larger or smaller population centres?

   (c) Are there examples of excellent EMS practice you know of to respond to this issue? Can you describe them briefly for me? Why do you say that?

5. **Summary Statement about Medication Errors**

   (a) Do you agree or disagree with this. Why?

   (b) Is the situation any different in larger or smaller population centres?

   (c) Are there examples of excellent EMS practice you know of to respond to this issue? Can you describe them briefly for me? Why do you say that?

6. **Knowledge Gaps and Future Research**

   Are there other gaps in knowledge relating to patient safety in EMS that we should be considering? What research is needed to close these gaps? What are the implications for practice? Policy change? Education?

7. **Other/Wrap-up**

   Are there other issues, other 'lessons learned' or words of advice you have to share with us as we prepare our report?

Appendix C – Breakout Discussions Participant Guide

Patient Safety in EMS Breakout Discussions Participant Guide

The EMS patient safety roundtable discussions will provide the opportunity to share your unique perspectives and to guide the process of broadening the patient safety agenda in Canada. These discussions will complement the literature search and key informant interviews that have already taken place, under the guidance of the research team.

Over the course of the day, you will explore three topics in a small group discussion format. Table groups of 5–8 people as indicated on your handout package. Each Table has been assigned a Facilitator and a Scribe from the Advisory Group to support the discussion and capture the discussion input.

The key ideas from each of the breakout groups will be shared with the larger group after each topic. All of the Table input will be captured and shared with the researchers.

As your group begins each discussion topic, we invite you to keep these ideas in mind:

- Use the research findings and the context for Patient Safety described at the beginning of the meeting as the backdrop for the group's discussion.
- Keep the primary focus of the discussions on Patient Safety. If other/related topics arise that don't fit, but need to be captured, do so on a "Parking Lot" page.
- Consider your responses from a local, provincial territorial and national lens.
- Keep the ideas flowing. There is no such thing as a dumb idea in brainstorming.
- Draw on *evidence and best practices* during the discussions versus *anecdotes*.

Breakout #1 Questions

- Based on the themes identified in the research, provide your feedback on the relative importance of the themes using the clicker technology.
- Based on the themes identified in the research, provide your feedback on the feasibility of the themes using the clicker technology.
- Small group discussion to identify the surprises, highlights, ah ha's from the findings and collated clicker feedback.

Breakout #2 Questions

- For the key themes identified in the research, what innovations, tools, programs, and initiatives are currently being used with respect to patient safety in EMS?
- What can we learn from other fields or disciplines outside of EMS that we can use in EMS with respect to patient safety?
- What are the barriers and obstacles that need to be overcome in order to move forward?

Breakout #3 Questions

- What specific next steps could be considered that we could tackle right away? Nationally and also locally?
- Using clicker technology, communicate your degree of alignment to taking these next steps identified.
- Identify Champions for the specific next steps.

Appendix D – Patient Safety Competencies

The following excerpt was taken from The Safety Competencies, First Edition:

Frank JR, Brien S, (Editors) on behalf of The Safety Competencies Steering Committee. The Safety Competencies: Enhancing Patient Safety Across the Health Professions. Ottawa, ON: Canadian Patient Safety Institute; 2008.

An Overview of The Safety Competencies

The overall goal of The Safety Competencies initiative is to optimize patient safety by enhancing health professions education. This section describes in detail the six domains of patient safety competencies identified by this project. For each domain a definition and brief description are given, as well as a list of key and enabling competencies. These are organized into a competency framework that is intended to be useful to educators, practitioners, researchers, and learners alike.

The Safety Competencies Concept

In the early stages of The Safety Competencies project, the Steering Committee chose to use a competency framework as a vehicle to translate the identified patient safety ideas, good practices, proven interventions, and behaviours into training and practice. The competency-based educational approach involves defining the key abilities expected of graduates, and then planning a program backwards. This contrasts somewhat with other curricular approaches in the health professions, which have tended to be more teacher-centred and less oriented to the specific outcomes of the program[1,2,3,4]. Ideally, the identified competencies prepare the trainee for practice and are aligned with patient needs. The competencies need to be sufficiently explicit to be teachable observable and measurable, without overwhelming the user with overly specific detail. They are intended to be a guide.

In The Safety Competencies framework, each competency is a statement about an ability of health professionals that contributes to safe practice. The six domains are thematic, logical groupings made up of two or more related key competencies. Domains are synergistic and related, but are meant to be distinct enough to guide teaching, learning, research and practice. The key competencies are higher-order statements that describe a health professional's ability (e.g., "Health care professionals are able to describe the fundamental elements of patient safety"). Each key competency is made of smaller, contributory abilities, termed enabling competencies (e.g., "Health care professionals understand the use of evaluative strategies to promote patient safety"). Enabling competencies are essential to achieve a key competency. These in turn are made of constituent knowledge, skills, and attitudes[5]. The framework is therefore assembled, Russian doll fashion, to allow flexibility between specificity and practicality. Each ingredient runs like an educational tributary into the domains, which are deep rivers of safety competence.

The Six Domains of The Safety Competencies

Domain 1: Contribute to a Culture of Patient Safety

A commitment to applying core patient safety knowledge, skills and attitudes to everyday work.

Domain 2: Work in Teams for Patient Safety

Working within interprofessional teams to optimize both patient safety and quality of care.

Domain 3: Communicate Effectively for Patient Safety

Promoting patient safety through effective health care communication.

Domain 4: Manage Safety Risks

Anticipating, recognizing and managing situations that place patients at risk.

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Domain 5: Optimize Human and Environmental Factors

Managing the relationship between individual and environmental characteristics in order to optimize patient safety.

Domain 6: Recognize, Respond to and Disclose Adverse Events

Recognizing the occurrence of an adverse event or close call and responding effectively to mitigate harm to the patient, ensure disclosure, and prevent recurrence.

Appendix E – Glossary

This glossary is not intended to be an exhaustive list of terms, but rather a concise list of key terms used throughout this paper. Readers are suggested to refer to the Resources and Links listed in Appendix F and the following reference documents for additional information:

- World Health Organization's (WHO) International Classification for Patient Safety Key Concepts and Preferred Terms (Available at: http://www.who.int/patientsafety/taxonomy/icps_chapter3.pdf)
- The Safety Competencies (Available at: http://www.patientsafetyinstitute.ca/English/education/safetyCompetencies/Documents/Safety%20Competencies.pdf)
- The Canadian Patient Safety Dictionary (Available at: http://rcpsc.medical.org/publications/PatientSafetyDictionary_e.pdf)

Advanced Care Paramedic (ACP) – An advanced prehospital practitioner usually able to perform advanced airway management including intubation, surgical airways, intravenous therapy, place external jugular IV lines, perform needle thoracostomy, obtain and interpret 12-lead ECGs, perform synchronized and chemical cardioversion, transcutaneous pacing, and administer approximately 20 medications including narcotics, benzodiazepines, inotropes and antiarrhythmics.

Adverse Event – An event that results in unintended harm to the patient, and is related to the care and/or services provided to the patient rather than to the patient's underlying medical condition[4].

Clinical Judgment – The application of information based on actual observation of a patient combined with subjective and objective data that lead to a conclusion.

Close Call – The event did not reach the patient because of timely intervention or good fortune. (The term is often equated to a near miss or near hit.)[2]

Critical Care Paramedic (CCP) – The highest level of paramedic practitioner in Canada usually employed for interfacility or aeromedical transport. The CCP scope of practice includes advanced obstetric care, mechanical ventilation, blood product administration, transvenous pacing, intraaortic balloon pump operation and the administration of hundreds of medications including antibiotics, cardiac drugs and thrombolytics.

Harm – An outcome that negatively affects the patient's health and/or quality of life. Impairment of structure or function of the body and/or any deleterious effect arising there from. Harm includes disease, injury, suffering, disability and death[2].

National Occupational Competency Profile (NOCP) – Recognized by the Canadian Medical Association and Paramedic Association of Canada as the benchmark document that details the knowledge, skills and abilities outcomes that must be possessed by practitioners of each respective level of paramedic practice.

Near Miss – An incident which did not reach the patient[2].

Paramedic Association of Canada (PAC) – Formerly the Canadian Society of Ambulance Personnel is Canada's only EMS organization of prehospital regulators. The association has been in existence since 1988 and is currently comprised of over 14,000 practitioners. The Association is a national organization of prehospital regulators that exists to promote quality and professional patient care through working relationships among organizations with similar interests. Protection of the Public and development of the profession in the public interest is the foundation.

Patient Safety – Patient safety is the reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum. An acceptable minimum refers to the collective notions of given current knowledge, resources available and the context in which care was delivered weighed against the risk of non-treatment or other treatment[2].

Primary Care Paramedic (PCP) – The entry-level of paramedic practice in Canada. The scope of practice includes semi-automated external defibrillation, interpretation of 3-lead (or, in some locations, 12 lead) ECG, administration of oxygen, epinephrine, glucagon, salbutamol, aspirin, nitroglycerine and sometimes other medications, performing trauma immobilization, including cervical immobilization, and other medical care.

Sentinel Event – An unexpected occurrence involving death or serious physical or psychological injury, or the risk thereof. Serious injury specifically includes loss of limb or function. The phrase *or risk thereof* includes any process variation for which a recurrence would carry a significant chance of a serious adverse outcome. Such events are called 'sentinel' because they signal the need for immediate investigation and response[2].

Appendix F – Resources and Links

Accreditation Canada

http://www.accreditation.ca/

Calgary EMS Foundation

http://www.emsfoundation.ca/

Canadian Patient Safety Institute

http://www.patientsafetyinstitute.ca/

EMS Chiefs of Canada

http://www.emscc.ca/

Paramedic Association of Canada

http://www.paramedic.ca

Rescu

http://www.rescu.ca

Appendix G – List of References

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