PARAMEDIC CLINICAL DECISION MAKING

by

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ABSTRACT

Paramedics are responsible for the care of patients requiring emergency assistance in the out of hospital setting. These health care providers need to make many decisions during the course of an emergency call. This thesis on paramedic clinical decision-making includes two studies, intended to determine which decisions paramedics make that are most important for patient safety and clinical outcome, and what thinking strategies paramedics rely on to make decisions. Forty-two decisions were found to be most important for outcome and safety. The highest decision density of an emergency call is during the on-scene treatment phase. Paramedics use a mix of thinking strategies, including rule out worst scenario, algorithmic, and exhaustive thinking. The results of these studies have implications for future research, paramedic practice and training.

LIST OF ABBREVIATIONS USED

ABCs	Airway, Breathing, Circulation
ACP	Advanced Care Paramedic
ASA	Aspirin
AVPU	Alert, Verbal, Pain, Unconscious (level of consciousness scale)
BMV	Bag Mask Ventilation
CCP	Critical Care Paramedic
CDM	Clinical Decision Making
CPAP	Continuous Positive Airway Pressure
CPR	Cardiopulmonary Resuscitation
CQI	Continuous Quality Improvement
DCAP BLS	Deformities, Contusions, Abrasions, Penetrations, Burns, Lacerations, Swelling
DPT	Dual Processing Theory
ECG	Electrocardiogram
ED	Emergency Department
EHS	Emergency Health Services
EM	Emergency Medicine
EMS	Emergency Medical Services
KCD	Key Clinical Decision
KT	Knowledge Translation
LMA	Laryngeal Mask Airway
LOC	Level of Consciousness
LT	Laryngeal Tube
M&Ms	Mortality and Morbidity Rounds
NS	Not Significant
PCP	Primary Care Paramedic
PEARL	Pupils Equal And Reactive to Light
ROWS	Rule Out Worst Scenario
STEMI	ST Elevation Myocardial Infarction
SVT	Supraventricular Tachycardia
TA	Think Aloud
TI	Tracheal Intubation
TNK	Tenecteplase

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CHAPTER 1
INTRODUCTION

Paramedics are responsible for treating and transporting patients in need of urgent care. They are the ‘backbone of the out-of-hospital emergency care” system, and likely reduce morbidity and mortality of their patients (Institute of Medicine, 2006). The scope of practice continues to evolve and expand, as the paramedic profession develops (EMS Chiefs of Canada, 2006; Paramedic Association of Canada, 2001). Undoubtedly, the decisions paramedics make while assessing and treating their patients can have a major impact on their clinical outcome and safety. This is especially true as the diagnostics and interventions paramedics administer become more complex. Patients who require assistance from the emergency medical services (EMS) system are found in a variety of locations, making the practice of paramedicine less controlled and more chaotic than in-hospital settings, including the emergency department. Paramedics often have limited resources in these situations, including a lack of other skilled clinicians, complete patient medical histories, and frequently, even descriptions of the events leading to the 911 call are not available. In combination with this, many emergency patients have high acuity, time-sensitive conditions (whether medical or trauma). As a result of all these factors, it is essential to learn more about paramedic clinical decision-making (CDM). A review of the relevant literature on CDM as it pertains to paramedic practice and the research plan for this thesis is discussed in this introductory chapter.

PATIENT SAFETY AND CLINICAL DECISION MAKING

Over the last decade, interest in decision-making and patient safety has gained significant momentum. The 1999 United States Institute of Medicine report, *To Err is Human* propelled the patient safety movement forward (Kohn, Corrigan, & Molla, 1999). This report raised awareness about the extent of clinical error, and its likely impact on patient safety and clinical outcome. As a result, there has been a proliferation of publications on these topics, both in the peer-reviewed literature and in popular media. In 2000, the *British Medical Journal* produced a special edition on patient safety. The same year, *Academic Emergency Medicine* also published an edition focused on errors in emergency medicine and continues to issue articles in a dedicated section titled, “Profiles in Patient Safety”. Patient safety is inextricably linked to decision making by clinicians. The importance of decision-making and how it occurs, both by health care providers (Groopman, 2007a; Montgomery, 2006) and the lay public has been acknowledged. In the popular book, *Blink*, Gladwell (2005) discusses the intuitive nature of decision-making, which invariably occurs without conscious deliberation. Likewise, authors Brafman and Brafman (2008) write about the same unconscious thinking that drives decisions in everyday life, business, health care and other major industries. LeGault (2006) and others have argued that people should actively engage their analytical mind, and not allow emotions and intuitions to drive decision-making. Evidence of this increased interest in medical decision-making is found in a New Yorker magazine article, titled, “What’s the Trouble: How Doctors Think” (Groopman, 2007b). This report described errors made by emergency physicians due to biases, mental shortcuts and heuristics.

CLINICAL DECISION MAKING RESEARCH

The impact of CDM on patient safety has been studied in emergency medicine (EM) (Campbell, Croskerry, & Bond, 2007; Croskerry, 2002), which can be considered the closest cousin to EMS of all the medical specialties. In a prospective study of adverse events in a Canadian emergency department, it was found the majority were caused by problems in decision making; including diagnosis, management or disposition decisions (Forster, Rose, van Walraven, & Stiell, 2007). Croskerry and Sinclair (2001) identify the unique operating characteristics that make EM prone to clinical errors. EMS shares some of these characteristics, many of which are directly related to CDM, including: high levels of diagnostic uncertainty, many decisions required to be made in a short time period (i.e., high decision density), inexperience of some staff members, time restrictions, shift work, sub-optimal teamwork and a lack of feedback to providers. Croskerry, Shapiro, Perry and Wears (2006) have identified potential sources of error in emergency departments, and located them in a linear fashion on a process map. This mapping exposes areas where potential error is concentrated. The map is a facilitator for research and education on error in EM.

DECISION MAKING THEORY

Decision-making is inherently uncertain (Matlin, 2003; Tversky & Kahneman, 1974). Often, information is missing and at times the outcome of the decision is unknown. Research on decision-making is often conducted by analyzing real-life scenarios, in contrast to abstract problems encountered in the study of logic (Matlin, 2003). When decisions are made, it is not always possible to use a systematic approach.

Dual Process Theory

In a recent review, Evans (2008) found most theories on reasoning are in agreement that there are two cognitive processing systems at play. Dual Process Theory (DPT) is the current predominant theory in cognitive psychology. System One is ‘subconscious’ decision making, and System Two refers to conscious, rational deliberation. System One is employed when heuristics and short cuts are used to make decisions, often without conscious thought, and is essential for minimizing effort and increasing cognitive efficiency (Evans, 2008). Decisions that require significant contemplation are handled by System. Two, but as the thinker is exposed to the same decision repeatedly, the decision becomes automatic and instead, be processed by System One. While System One is more prone to error, it also is effective in minimizing time to action, avoiding ‘paralysis by analysis’ (Croskerry, personal communication, 2009). For example, a novice paramedic may feel unsure about how to approach an unresponsive trauma patient, but as they gain experience, the cervical spine is immediately held still without conscious deliberation. System Two is activated in more complex situations, when a decision cannot be made quickly. In this mode of thinking, the thinker must weigh the pros and cons of each option and make a conscious decision on the best fit. A paramedic may decide a patient’s chest pain is cardiac in origin, rather than musculoskeletal, if the collection of presenting symptoms matches a typical cardiac chest pain patient (such as crushing pain, nausea, sweatiness). This decision is made with purposeful deliberation between the competing possibilities. Subsequent actions are based on this pivotal decision. Table 1 outlines the contrasting characteristics of these two systems (Croskerry, 2009b).

Table 1 Characteristics of the Dual Processing Theory

Characteristic	System One	System Two
Cognitive Style	Intuitive/Heuristic	Analytical/Systematic
Awareness	Low	High
Conscious Control	Low	High
Automaticity	High	Low
Cost/Effort	Low	High
Rate	Fast	Slow
Reliability	Low	High
Errors	Vulnerable to error	Few but large
Predictive Power	Low	High
Emotional Valiance	High	Low
Detail on Judgment Process	Low	High
Scientific Rigour	Low	High

Adapted from (Croskerry, 2009b, p. 214)

Thinking Strategies

Psychological research on clinical thinking began in the early 1970s in an effort to understand the process of CDM (Norman, 2005). At that time, two predominant methods were used: the think aloud (TA) technique, where participants would describe their reasoning process while they worked their way through a scenario; and simulated recall, where participants would watch video-tapes of their performance and attempt to recall what they were thinking at the time. From both types of research, it was found physicians widely relied on the hypotheticodeductive method, in which a list of competing diagnoses was devised and subsequent information used to determine the most plausible hypothesis. This thinking strategy was found to be used by most study participants, regardless of level of expertise or experience. The notion of illness scripts was adopted from cognitive psychology (Charlin, Tardif, & Boshuizen, 2000; Schmidt, Norman, & Boshuizen, 1990; Schmidt & Rikers, 2007). Clinicians memorize clinical features of various illnesses, and attempt to recognize these. It became apparent that experts use illness exemplars; ideal representations of clinical conditions, developed from academic knowledge and clinical experiences. It was hypothesized that clinicians use intuition to make decisions (Hogarth, 2005; Paley, 1996). It is impossible, however, to actually measure the extent to which a clinician relies on intuitive thinking with either the TA or simulated recall methods (Hogarth, 2001).

The TA technique has been used to study CDM in medical residents, physicians and nurses, in both qualitative and quantitative studies. The technique has been used in the clinical setting (Aitken & Mardegan, 2000; Ericsson & Simon, 1980; Fowler, 1997) and during scenarios (Backlund, Skaner, Montgomery, Bring, & Strender, 2004; Offredy, 2002; Offredy & Meerabeau, 2005; Skaner, Backlund, Montgomery, Bring, & Strender, 2005; Young, Smith, Guerlain, & Nolley, 2007). In TA studies, participants are told to explain why they are making each decision. The researchers identify reasoning strategies for each decision made. For example, Young et al (2007) conducted a study with medical residents using scenarios to determine participant recall and decision-making (Young et al., 2007). In the decision-making tests, the investigators abstracted specific statements from the sessions, as indications of different types of reasoning, including inferences, forward reasoning, backward reasoning and cognitive errors. Statistical analysis was conducted to compare differences in cognitive strategies and cognitive errors between novice, intermediate and expert residents. These authors found that experience played a role in cognitive errors made and strategies used (the experienced participants used forward reasoning (i.e., hypothesis generation) more often than novices).

Six main CDM thinking strategies used in EM have been described (Sandhu & Carpenter, 2006), each of which fit into either System One or System Two of the DPT (Table 2).

Table 2 Thinking Strategies

Name	System	Details
Event driven	I	Treat symptoms and then re-evaluate with further evaluation, depending on response to therapy
Intuition	I	System I thinking. Decisions made without conscious thought.
Pattern Recognition	I	Combination of salient features establish likely diagnosis with corresponding evaluation and management plan
Exhaustive	II	Accumulate facts indiscriminately and then sift through them for diagnosis
Hypotheticodeductive	II	Inference based on preliminary findings, idea modification based on subsequent findings, response to therapy & exclusion of competing possibilities
Algorithmic	II by proxy	Preset diagnosis or treatment pathway, based on pre-established criteria
Rule out worse-case scenario	II by proxy	Consideration of pre-existing 'can't miss' list of diagnosis for presenting condition

Adapted from (Sandhu & Carpenter, 2006, p. 716)

Pattern recognition and event-driven thinking are part of System One thinking. Pattern recognition is used when a clinician is able to make a diagnosis right away, because the collection of symptoms distinctively matches the typical presentation (Barrows & Feltovich, 1987; Sandhu & Carpenter, 2006). Event-driven thinking is often used in emergency situations, to quickly act to treat the most urgent symptoms (Sandhu & Carpenter, 2006).

The hypotheticodeductive method, ruling out the worse case scenario (ROWS), and exhaustive thinking engage System Two. The hypotheticodeductive method is used when clinicians develop a 'working diagnosis' based on the information found in the patient assessment and is modified based on subsequent information (Sandhu & Carpenter, 2006). The exhaustive method is time intensive. The clinician will gather as much information as possible, and sort through it to determine the most likely diagnosis (Sandhu & Carpenter, 2006). For example, clinicians use this method if they are inexperienced or when an unusual etiology is suspected.

Algorithmic thinking is System Two 'by proxy'. That is, algorithms are developed from research evidence and patient data in a systematic fashion. Clinicians commit algorithms to memory, and depending on how familiar they are with them, use System One or System Two when they have a patient presentation that fits the algorhythm. A prime example of this is using the well-established Advanced Cardiac Life Support algorithms to determine treatment for a patient in cardiac arrest (Weingart, 2009; Williamson & Runciman, 2009). Ruling out the worse scenario is employed when a clinician runs through a list of 'can't miss' conditions (Weingart, 2009). The symptoms of the presenting patient are compared with those in the list; to ensure conditions at high risk for poor outcome are not missed. Using the ROWS strategy is a cognitive forcing strategy; it forces the clinician to consider other possibilities before taking action (Croskerry, 2005). It is also System Two 'by proxy', as the list of conditions is memorized and used rapidly by clinicians in practice, but was developed by experts based on what is known about the various pathophysiologies.

Paramedics have clinical protocols they follow as guidelines to help decide what interventions are needed. A traditional assumption has been that paramedics make most of their clinical decisions by choosing the most appropriate protocol and following it from memory (i.e., algorithmic thinking). This supposition is probably not a sufficient explanation for how paramedics make decisions in practice (Bigham et al., 2010). Paramedics likely use other thinking strategies to make clinical decisions.

PATIENT SAFETY IN EMS AND PARAMEDIC CDM

As awareness about adverse events in medicine began to increase through the late 1990s and early 2000s, focus on clinical error in EMS began to sharpen as well (Hobgood, Bowen, Brice, Overby, & Tamayo-Sarver, 2006; Wang, Fairbanks, Shah, Abo, & Yealy, 2008). O'Connor and colleagues (2002) published a paper outlining errors in EMS, and made recommendations for improvement. The authors listed the elements of an EMS response that are prone to error, but they noted the frequency or impact of errors in EMS is unknown (Table 3).

Table 3 Sources of Potential Error in EMS

Bystander recognition
EMS access
EMS and dispatch communications
Pre-arrival instructions
Dispatch priorities
EMS system status management
EMS response
Arrival at scene and patient
Limiting further harm
Patient assessment
Destination decision
Transport from scene to hospital (e.g.; driving errors)
Treatment en route
Transfer of care to emergency department (ED) staff
Recording event
Transitioning back into service

Adapted from (O'Connor, Slovis, Pirallo & Sayre, 2002, p. 108)

The EMS Chiefs of Canada (2006) have recommended for improved error reporting among services to improve patient safety in EMS. Additional evidence of this increased interest was the recent partnership between the EMS Chiefs of Canada and the Canadian Patient Safety Institute to fund a research project on patient safety in EMS (Canadian Patient Safety Institute, 2009). The most prominent safety issue found in this study was paramedic CDM. The authors state the current model of protocol-driven decision-making by paramedics is not adequate for the widening scope of clinical care and complexity of decisions required by these health care providers (Bigham et al., 2010, p. 6-7).

One of the most written about topics in EMS is paramedic-administered tracheal intubation (TI). This intervention is administered to patients of the highest acuity, who require this invasive procedure to assist their breathing. The time sensitive nature of such conditions, along with the complexity of completing the intervention correctly, has led to considerable discussion about the benefits and harms of this intervention (Wang, Lave, Sirio, & Yealy, 2006). Evidence has been mounting that outcomes are worsened in trauma patients who receive TI by paramedics (Davis, Peay, Sise, Vilke, Kennedy, Eastman, Velky, & Hoyt, 2005; Eckstein, Chan, Schneir, & Palmer, 2000; Murray et al., 2000; Stiell et al., 2008). When TI is performed incorrectly, a detrimental outcome is extremely likely, especially if the tube is placed in the wrong location (i.e., the esophagus instead of the trachea), which is often fatal if undetected (Bair, Smith, & Lichty, 2005; Jemmett, Kendal, Fourre, & Burton, 2003; Jones, Murphy, Dickson, Somerville, & Brizendine, 2004; Katz & Falk, 2001). It may be intuitive for medical directors to decide to remove this intervention from the paramedic scope of practice, in order to improve patient outcomes and safety. However, Davis (2008), a leading researcher on this topic, challenges EMS leaders to not consider the intervention innately harmful, but rather consider other factors that should be improved, such as paramedic education, patient selection and decision-making.

Some research has been done on decision making during a single paramedic-administered clinical intervention. In one recent Canadian EMS study, a process analysis map was created of all the tasks and decisions that are required for a paramedic to manage a patient requiring rapid sequence induction tracheal intubation in the out-of-hospital setting (Blanchard, Clayden, Vogelaar, Klein-Swormink, & Anton, 2009). In this situation, advanced care paramedics are required to administer medications to sedate and paralyze the patient so that a tracheal tube can be passed into their trachea, allowing the patient to be ventilated. They found the procedure to be very complex, consisting of eighteen major steps and 288 subprocesses. Of the subprocesses, 52 (18%) were identified as decisions.

Wang and Katz (2007) also analyzed paramedic-administered tracheal intubation. They broke the process down to each potential decision, and categorized each decision according to whether it is rule-based (i.e., following a protocol), skill-based or knowledge-based cognitive decision. Similar to Blanchard, these authors found this procedure to be cognitively complex, and paramedics relied on both rule-based and knowledge-based decisions. These two studies analyzed one specific intervention in great detail to learn *what* decisions are made during the process (Blanchard et al., 2009) and *how* those decision are made (Wang & Katz, 2007).

PARAMEDIC CDM: OPPORTUNITIES FOR RESEARCH

While there has been some focused study on paramedic decision making during a specific intervention, there is opportunity to learn more about CDM during typical emergency calls. Taking a more general approach will allow for hypothesis generation and will be a springboard for future research.

When O'Connor's (2002) elements of potential error during ambulance calls are mapped to a draft process analysis, there are significant gaps, and elements that can be expanded (Figure 1). For example, there were no errors related to 'no transport' decisions by paramedics in the list, a common occurrence in many EMS systems. Prospective investigation of procedures, such as emergency calls, allows for areas of vulnerability for error, high decision density and decision complexities to be identified. This is recommended over retrospective analysis of adverse events after they occur (DeRosier, Stalhandske, Bagian, & Nudell, 2002).

Figure 1 Draft Process Model for EMS

QuickTime™ and a
decompressor
are needed to see this picture.

EMS = emergency medical services; SSP = system status plan
Adapted from (O'Connor et al., 2002)

The Research Plan

The first study in this thesis on paramedic CDM is titled, “Consensus on paramedic clinical decisions during high acuity emergency calls: results of a Canadian Delphi study”. The objective of this study is to achieve consensus among a group of Canadian EMS experts on the most important decisions paramedics make during typical high acuity emergency calls, in terms of clinical outcome and patient safety. The decisions found to be most important were sorted into clinical categories and plotted on a process map. Chapter two outlines the methods of this study, and chapter three is a manuscript of the results.

The second study is titled, “Clinical decision making by advanced care paramedics: a think aloud study”. This objective of this exploratory study on paramedic clinical decision-making is to provide insight into the different thinking strategies used by advanced care paramedics during typical emergency calls. The methods of this study are described in a manuscript in chapter four, and the results are found in chapter five.

These two studies provide data on *what* decisions paramedics make that are most important for clinical outcome and patient safety, and *how* these decisions are made. The implications of these two studies for current paramedic practice, paramedic training and continuing medical education, and future research will be discussed in chapter six.

CHAPTER 2
PARAMEDIC CLINICAL DECISION-MAKING DURING HIGH ACUITY EMERGENCY CALLS: DESIGN AND METHODOLOGY OF A DELPHI STUDY

ABSTRACT

Background

The scope of practice of paramedics in Canada has steadily evolved to include increasingly complex interventions in the out-of-hospital setting, which likely have repercussions on clinical outcome and patient safety. Clinical decision-making has been evaluated in several health professions, but there is a paucity of work in this area on paramedics. This study utilized the Delphi technique to establish consensus on the most important instances of paramedic clinical decision-making during high acuity emergency calls, as they relate to clinical outcome and patient safety.

Methods

Participants in this multi-round survey study were paramedic leaders and emergency medical services medical directors/physicians from across Canada. In the first round, participants identified clinical decisions they felt are important for patient outcome and safety. In the second round, the panel scored each decision in terms of its importance. In the third and fourth round, participants had the opportunity to revise the score they assigned to each decision. Consensus was considered achieved for the most important decisions if 80% of the panel scored it as important or extremely important. The most important decisions were plotted on a process analysis map.

Discussion

The process analysis map that resulted from this Delphi study will enable gaps in research, knowledge and practice to be identified.

BACKGROUND

Clinical Decision Making

Clinical decision-making (CDM) (also known as clinical reasoning, clinical judgment) has been defined and formally studied in medicine over the last few decades (Norman, 2005). Other health professions, such as nursing, have also investigated how practitioners made decisions (Aitken, 2003; Banning, 2008a). However, to date, very little research on CDM has been conducted in the paramedic population. Presumably, weak abilities in CDM lead to clinical errors, which are prevalent in healthcare (Kohn et al., 1999) and are often the causes compromised patient safety. Therefore, CDM is an essential component of the body of research on patient safety, as it relates to emergency medical services (EMS).

The care that patients receive in the out-of-hospital setting likely has important repercussions on clinical outcome and patient safety. Patient assessment and treatment can vary substantially, from simple ambulance runs to calls that require expedient decision-making and action by paramedical personnel. There are many factors that can influence outcome, including the acuity of the patient's injury or illness, the location of the patient, the wants and needs of the patient and their family, the resources available to the paramedics, the level of care provided by practitioners, and the number, complexity and time dependence of interventions required, both on scene and *en route* to the hospital. As the scope of practice of paramedics continues to expand and the sophistication of EMS systems evolves, it is essential to evaluate and expand the current state of knowledge on paramedic CDM.

Paramedics and EMS in Canada

In Canada, there are three recognized levels of paramedics: Primary Care Paramedics (PCP), Advanced Care Paramedics (ACP), and Critical Care Paramedics (CCP) (Paramedic Association of Canada, 2001). The ACP scope of practice has traditionally included advanced airway management, intravenous (IV) access, IV drug administration, and other skills. Across Canada, recent changes have seen ACPs provide additional interventions, such as 12-lead electrocardiogram interpretation, administration of thrombolytics for acute myocardial infarction and application of continuous positive airway pressure ventilation for acute shortness of breath (Dalhousie University Division of Emergency Medical Services, 2009; Myers et al., 2008).

There is a paucity of literature related to EMS patient safety and paramedic CDM. Some work has been done on errors on specific clinical interventions, such as endotracheal intubation (Wang et al., 2006; Wang & Katz, 2007), and on error reporting patterns of paramedics (Hobgood et al., 2006). There are isolated reports on paramedics' decisions to initiate an intervention (Pace, Fuller, & Dahlgren, 1999). Given the expanding role of paramedics, this area would assume increasing importance.

The Delphi Technique

Delphi studies are frequently used in healthcare, with the goal of establishing consensus on a particular topic (Hasson, Keeney, & McKenna, 2000). Iterative rounds of structured surveys are administered to a group of experts on the topic, who rank each item (Fink, Kosecoff, Chassin, & Brook, 1984). On subsequent rounds, each panel member views the score they assigned to each item, as well as the group mean score. Participants have the opportunity to revise their score, taking into consideration the group mean. The rounds continue until consensus is achieved, or a predetermined end point is met. The technique is beneficial because consensus can occur without physically bringing experts together. There are four key features of Delphi studies: anonymity of responses; iteration with controlled feedback; statistical group response; and, the use of experts (Fink et al., 1984). The results of a Delphi study can help direct future research, continuing education and allocation of resources. The obvious limitation of such a consensus study is the results are not linked to actual patient outcomes, and therefore the results only reflect the panel members' opinions. Nevertheless, the opinion and experiences of EMS experts is useful to inform the most important decisions paramedics make during high acuity emergency calls.

Process mapping originated in the business sector (Klotz, 2008), and is used in other industries, including health care (Victorian Quality Council, 2007). Process mapping allows for events that occur during a particular situation to be viewed in a linear fashion, which can increase understanding of factors during a particular process. They are valuable not only to recognize areas where errors currently occur, but more importantly, to prospectively identify processes most vulnerable to adverse events (DeRosier et al., 2002). Process maps have been created to find areas susceptible to clinical error in the emergency department (Croskerry et al., 2006), and to outline all the sub-processes that are required during out-of-hospital rapid sequence intubation, a specific complex intervention conducted by advanced level paramedics (Blanchard et al., 2009). The decisions found to be important in this Delphi study will be plotted on a map of a typical emergency ambulance call.

Objective

Using expert consensus, the most important clinical decisions made by paramedics on typical high acuity ambulance calls will be determined, in terms of their importance to clinical outcome and patient safety.

METHODS

Study Design

This cross-sectional study used the Delphi technique to achieve consensus amongst EMS experts on the most important decisions made by paramedics during high acuity emergency calls, in the ground ambulance setting. These decisions were scored on importance, based on their anticipated impact on patient clinical outcome and patient safety. The final consensus was used to develop a process analysis map of paramedic clinical decision-making.

Setting and Population

Subjects for this study were recruited using purposive and criterion sampling. The goal was to have a sample of EMS medical directors and paramedic leaders from across Canada. Two key organizations were targeted for recruitment: The Canadian Association of Emergency Physicians EMS Committee and the EMS Chiefs of Canada. An expression of interest posting was distributed throughout these two organizations. Recipients of the posting were invited to distribute it to paramedics or EMS medical directors likely to be interested and willing to participate. Those interested were invited to email one of the investigators.

Delphi studies recruit experts to give their opinion on a particular subject, with the goal of achieving consensus amongst the group (Fink et al., 1984). The choice of participants in a Delphi study is essential to its success, and the validity of the results (Duffield, 1993). Paramedics may work primarily in a clinical out-of-hospital setting (ground or air ambulance), or in a quality and learning/quality assurance division, and must be of the ACP level or higher. This latter requirement was established to ensure external validity for all levels of paramedics. As the vast majority of ACPs were PCP prior to their ACP training, they can incorporate this perspective in their responses, and it is assumed ACPs need to make more complex clinical decisions, given their broader scope of practice. EMS medical directors must currently oversee a paramedic service, and/or be actively involved in providing clinical quality assurance feedback to paramedics on their clinical performance.

The investigators selected participants from those who emailed their interest to participate. Participants were anonymously described in dissemination of the results, so readers can have an awareness of the panel composition. In keeping with the typical sample size for Delphi studies, 15 – 25 participants were recruited for this study.

This study has received approval from the Capital District Health Authority REB (Halifax, Nova Scotia): CDHA-RS/2009-372. All participants provided written informed consent via fax to our office in Halifax.

Method of Measurement

Participants were emailed a link to an online survey site (Dalhousie University, 2007) for anonymous responding - a key aspect of the Delphi method. This is especially important in this panel, which will be a mix of paramedics and medical directors. Anonymous responses (among the panel) will help to ensure that participants are responding according to their own thoughts and beliefs, and not because they are influenced by opinion leaders on the panel (Hasson et al., 2000).

The first round of the Delphi study was open for two weeks. Participants entered any decisions that they felt are important during a high acuity emergency call in a free text box. An additional text box was provided for respondents to enter any further thoughts or elaborations. The decisions were analyzed and categorized, maintaining the original wording of the respondent as much as possible (Goodman, 1987).

The second round of the survey was sent back out for the panel to review, and also was open for two weeks. Participants scored each decision on a Likert scale, in terms of its importance to patient clinical outcome and safety (Table 4). They were given the opportunity to add new decisions, and provide additional free-text comments.

In the third round, the mean scores for each decision and the respondents own score was available for each of the participants to review. As the investigators returned each respondents score on each item from the previous round to them, along with the mean score from the group, the responses were not anonymous to the investigators, but were kept confidential. In the third and forth round, participants revised their score for any of the decisions, based on viewing the group mean and their own score. The survey was re-sent until this consensus is achieved, to a maximum of four rounds. This limit was instituted to avoid sample fatigue (Williams & Webb, 1994).

Table 4 Likert Scale

1	Decision not important, very unlikely to impact patient clinical outcome or safety
2	Decision not very important, unlikely to impact patient clinical outcome or safety
3	Decision possibly important, may impact clinical outcome or safety
4	Decision important, in most instances will impact patient clinical outcome or safety
5	Extremely important, very likely these decisions will impact patient clinical outcome or safety

Data Analysis

It was essential to define the meaning of 'consensus' *a priori* (62). For this study, consensus for each decision will be set at 80% or more of respondents grading it as 4 (Important - in most instances these decisions will impact patient clinical outcome or patient safety), or, 5 (Extremely important -very likely to impact patient clinical outcome or patient safety). Once an item has reached this level of consensus, it was removed from the list and did not appear for re-scoring in subsequent rounds.

Data was downloaded from the survey tool into a Microsoft Excel spreadsheet (Redwood CA), in which descriptive analysis of panel characteristics, categorization of free text, and preliminary analysis (mean scores and level of consensus) of each decision in each round was conducted. Scores for included decisions were entered into the statistical software program SPSS 15.0 (Chicago IL). Independent sample *t*-tests were conducted to determine differences in paramedic and medical director scoring for each included decision, and for each decision category. Significance was set at $p<0.05$.

Pilot Study

A pilot study has been conducted. Three paramedics and two emergency physicians, one of who is a study investigator (AT) completed three rounds. The online surveys were edited based on pilot participant feedback. Results from the pilot were not used in the actual study.

Process Map

The decisions that are found to be the most important will be organized in a process analysis map. The model will enable gaps in research, knowledge and practice to be identified.

DISCUSSION

This study provided insight into the most important clinical decisions paramedics make during high acuity emergency calls. The implications for such knowledge include exposing research and education gaps, establishing priorities for paramedic practice, and providing direction for professional development and patient safety initiatives in the EMS setting.

CHAPTER 3
CONSENSUS ON PARAMEDIC CLINICAL DECISIONS DURING HIGH ACUITY EMERGENCY CALLS: RESULTS OF A CANADIAN DELPHI STUDY

ABSTRACT

Introduction

Paramedics make decisions during emergency calls that have an impact on clinical outcome and patient safety. This Delphi study sought to establish consensus on the most important clinical decisions paramedics make during high acuity emergency calls.

Methods

Canadian paramedics and medical directors participated in this multi-round online survey. In Round I, participants listed important clinical decisions. In Round II, participants scored each decision in terms of its importance for patient outcome and safety on a 5-point Likert scale. In Rounds III and IV, participants could revise their scores. Consensus was defined *a priori:* if 80% or more of the panel scored a decision important or extremely important, it was included. The included decisions were plotted on a process map of a typical emergency call. Differences in scoring between paramedic and medical directors were detected with *t*-tests.

Results

The panel (17 paramedics, 7 medical directors) had a mean 16.5 years experience. Response rates were: Round I: 96%; II: 92%; III: 83%; IV: 96%. Consensus was reached on 42 decisions, grouped into 6 categories: *Airway management* (n = 13); *Assessment* (n = 3); *Cardiac management* (n = 7); *Drug administration* (n = 9); *Scene* *management* ($n = 4$); *General treatment* ($n = 6$). The highest level of consensus was the *Assessment* category (97% scored *Assessment* decisions important or extremely important). Paramedics scored four decisions higher than medical directors: *Decide on airway device* ($p < 0.04$); *Perform chest decompression* ($p < 0.01$); *Begin chest compressions on decompensated child* ($p < 0.04$); *Decide when to leave scene versus stay* ($p < 0.02$). Medical directors scored one decision higher than paramedics: *Give epinephrine for anaphylaxis* ($p < 0.04$). *On-scene treatment* was the phase of the process map with the highest decision density.

Conclusion

In a Delphi study of paramedic clinical decision-making during high acuity emergency calls, consensus was reached on 42 decisions in 6 categories. The highest level of consensus was the *Assessment* category; the highest number of decisions was in the *Airway management* category, and the highest decision density during the *on-scene treatment* phase of the process map. The decisions found to be most important for patient outcome and safety should be a focus of paramedic training, continuing education and clinical auditing.

BACKGROUND

Clinical decision-making (CDM) by health care professionals, including paramedics, is undoubtedly related to patient safety and clinical outcomes. CDM is also linked to clinical errors and adverse events. There has been a relatively small amount of research conducted to date on CDM by paramedics during high acuity emergency calls. Research has been conducted on cognitive processes during tracheal intubation by paramedics, a complex intervention (Wang & Katz, 2007). This author has also examined errors made by paramedics during airway management (Wang et al., 2006). O'Connor (2002) and Hobgood (2004) have studied clinical errors by paramedics more generally (Hobgood, Xie, Weiner, & Hooker, 2004; O'Connor et al., 2002). During a typical ambulance call, paramedics may be presented with a wide spectrum of clinical complaints, scene complexities, and assessment and management demands. To best determine how to minimize the chance of adverse events and errors, it is first necessary to identify which clinical decisions paramedics make that are likely to have the greatest impact on patient outcome and safety.

Delphi studies are used frequently in healthcare, with the goal of establishing consensus on a particular topic (Hasson et al., 2000). The decisions this Delphi panel finds to be most important will be applied to a process map. In this study, the process map will be created from the decisions identified by the Delphi panel as important for patient safety and outcome during a typical high acuity emergency call.

Objective

The objective of this study was to achieve consensus among a group of Canadian EMS experts on the most important decisions paramedics make during typical high acuity emergency calls, in terms of clinical outcome and patient safety.

METHODS

Sample and Setting

A purposeful sample of paramedics and EMS medical directors from across Canada were recruited through two national associations. This study received approval from the Capital District Health Authority Research Ethics Board in Halifax, Nova Scotia, Canada (# CDHA-RS/2009-113).

Methods of Measurement

An online survey tool was used to deliver the surveys (Dalhousie University, 2007). Each round of the Delphi study was open for two weeks. In the first round, participants entered any clinical decisions that they felt are important during a high acuity ambulance call in a free text box. The responses were analyzed and categorized, maintaining the original wording of the respondent as much as possible (Goodman, 1987). The second round of the survey was sent back out for the panel, in which they scored each decision on a Likert scale (Table 4). Consensus for the most important clinical decisions was considered to be achieved if 80% of the panel scored each decision as 4 ('important') or 5 ('extremely important'). Decisions that achieved panel consensus in Round II were removed from the list for Round III, and the same process was followed for Round IV. In Rounds II and III, participants were asked to add any new decisions they thought of, and provide free-text comments. In Rounds III and IV, participants viewed their own scores for each decision, as well as the panel mean score for each decision. Participants could change their scores from the previous on any decision, in light of the panel mean. It was decided *a priori* the study would conclude after a maximum of four rounds, to avoid sample fatigue (Williams & Webb, 1994).

Data Analysis

Data was entered into the statistical software program SPSS 15.0 (Chicago IL). Response rate for each round was reported, as well as descriptive statistics of the panel demographics. Differences in scoring between paramedic and medical director respondents were analyzed with *t*-tests.

The paramedic clinical decisions included after the final round were plotted onto a process analysis map, in the order of when they would arise during a typical emergency call. The methods for this study have been previously described in detail (Jensen, Croskerry, & Travers, 2009).

RESULTS

The panel consisted of 24 paramedics and medical directors from across Canada, with a mean 16.5 years of experience (range 3 – 40 years). There were seven medical directors, who were either directly responsible for medical oversight for an EMS system, or are regional or provincial medical directors. The 17 paramedics worked a variety of roles: ground ambulance paramedic, supervisor/manager, quality assurance, clinical development and educator. Most panel members were from the province of Ontario, with some from Alberta, British Columbia, Manitoba, Nova Scotia and Saskatchewan (Table 5). The panel response rate was excellent for all rounds of the study: Round I, 96%; Round II 92%; Round III 83%; Round IV 96%.

Table 5 Panel Characteristics

Panel	n = 24		
Paramedics	17		
Ground Ambulance Supervisor/Management Quality Assurance Clinical Development Educator	3 2 4 5 3		
Medical Directors	7		
Direct Oversight Regional/Provincial	3 4		
Experience	mean (years)	min (years)	max (years)
Panel Paramedics Medical Directors	16.53 20.15 10.62	3 3 4	40 40 18
Province	Panel	Paramedics	Medical Directors
Alberta British Columbia Manitoba Nova Scotia Ontario Saskatchewan	3 2 3 1 13 2	3 1 2 - 9 2	- 1 1 1 4 -

Forty-two clinical decisions were determined to be important. Consensus was achieved for 19 decisions in Round II (Table 6); 18 decisions in Round III (Table 7); and 5 decisions in Round IV (Tables 8). Clinical decisions were sorted into the following decision categories: *Airway management* (n = 13); *Assessment* (n = 3); *Cardiac management* (n = 7); *Drug administration* (n = 9); *General treatment* (n = 6); *Scene management* (n = 4). The category with the highest mean score was: *General treatment* (4.60). The category with the highest consensus among the panel was *Assessment* (97% of panel scored items in this category as 4 or 5) (Table 9).

Table 6 Consensus Achieved in Round II
(22 respondents, n = 19 decisions)

Clinical Decision	Consensus (%)	Panel Mean	Category
Recognize signs of life-threatening trauma	100	4.6	Assess
Decide how to confirm intubation	95	4.6	Airway
Decide whether to perform cricothyroidotomy	95	4.9	Airway
Decide to perform chest needle decompression	95	4.8	Airway
Begin chest compressions on decompensated child (shock)	95	4.5	Cardiac
Decide whether to attempt intubation in major trauma patient	91	4.3	Airway
Decision to defibrillate	91	4.7	Cardiac
Start CPR	91	4.6	Cardiac
Interpreting 12 lead ECG	91	4.3	Cardiac
Decide to use supraglottic device (King LT, Combitube, LMA), TI or BMV	86	4	Airway
Provide positive pressure ventilation with BVM in respiratory distress	86	4.3	Airway
Failed attempt at intubation - try again for ETI or switch to supraglottic device or BVM	86	4.2	Airway
Give epinephrine for anaphylaxis	86	4.5	Drug
Decide to give TNK for STEMI	86	4.4	Drug
Decide to use CPAP	82	4.1	Airway
Provide ASA	82	4.1	Drug
Provide bronchodilators	82	4	Drug
Decide when to leave scene vs. manage/tx on scene (load & go vs. stay & play)	82	4	Scene
Decide most appropriate destination (trauma, heart, stroke centre, community ED, other)	82	4.3	Scene

CPR = cardiopulmonary resuscitation; ECG = electrocardiogram; LT = laryngeal tube; LMA = laryngeal mask airway; TI = endotracheal intubation; BMV = bag mask ventilation; TNK = Tenecteplase; STEMI = ST-elevation myocardial infarction; CPAP = continuous positive airway pressure; ASA = aspirin; ED = emergency department

Table 7 Consensus Achieved in Round III
(20 respondents, n = 18 decisions)

Clinical Decision	Consensus (%)	Panel Mean	Category
Give epinephrine for severe asthma	100	4.35	Drug
Decide to extubate if unsure of placement	100	4.5	Airway
Deciding on appropriate treatment	95	4.5	General Treatment
Recognize contraindications/reason to withhold therapy	95	4.55	General Treatment
Decision to change care plan (switch protocol/med directive) based on patient changes	95	4.1	General Treatment
Decide if patient has capacity to refuse or consent	95	4.3	Assess
Initial assessment: is patient critical or not; level of distress/acuity, decide whether to start treatment right away, or complete assessment	95	4.4	Assess
Decide to use drugs to facilitate intubation (sedation, opiates, paralytics)	90	4.15	Drug
How to clear obstructed airway (Heimlich maneuver, suction, forceps)	90	4.65	Airway
Determine if patient requires immediate treatment or can wait til en route, arrival at ED	90	4.2	General Treatment
Give epinephrine for pediatric shock	90	4.2	Drug
Remind/correct chest compressor on CPR quality; have chest compressors switch	90	4.05	Cardiac
Decide on manual airway positioning - if necessary and how (head tilt, jaw thrust, etc)	85	4	Airway
Reassess patient after giving a treatment - decision on next action (stop drug, change, give another dose, etc)	85	4.15	General Treatment
Decide on drug for tachycardia (amiodarone/lidocaine/adenosine)	85	3.95	Drug
Decide to check for/triage patients at scene with several patients	85	3.95	Scene
Analyze cardiac rhythm (3 or 4 lead strip)	80	3.9	Cardiac
Recognize potential hazards (e.g., people, animals, environment, chemical/radiological/biological risks) - Scene safety	80	3.9	Scene

CPR = cardiopulmonary resuscitation; ED = emergency department

Table 8 Consensus Achieved in Round IV
(23 respondents, n = 5 decisions)

Clinical Decision	Consensus (%)	Panel Mean	Category
Decide whether to attempt intubation in pediatric	91	4.90	Airway
Decide to insert airway adjuncts (OPA, NPA)	82	4.75	Airway
Decide whether to administer vasopressor	82	4.60	Drug
Decide on electrical cardioversion or medications for SVT	82	4.70	Cardiac
Decide how to manage labour & delivery	82	4.60	General Treatment

OPA = oral pharyngeal airway; NPA = nasopharyngeal airway; SVT = supraventricular tachycardia

Table 9 Decision Categories

Category	n	Mean consensus for category (%)	Mean score for category	Mean round consensus was achieved in for category
Airway management decisions	13	90	4.46	2.54
Assessment decisions	3	97	4.43	3.00
Cardiac management decisions	7	89	4.39	2.57
Decisions about administering a drug	9	87	4.25	2.67
Scene management decisions	4	82	4.04	2.50
General treatment decisions	6	82	4.60	3.00

Paramedics scored four decisions higher than medical directors: *Decide on airway device* ($p < 0.05$); *Perform chest decompression* ($p < 0.01$); *Begin chest compressions on decompensated child* ($p < 0.05$); *Decide when to leave scene versus stay* ($p < 0.05$). Medical directors scored one decision higher than paramedics: *Give epinephrine for anaphylaxis* ($p < 0.05$). No differences were found in paramedic or medical director mean scores in the decision categories.

The included decisions were plotted on a process map of an emergency call (Figure 2, Table 10). Visualization of this map shows the majority of decisions that have implications for clinical outcome and safety occur during the *on-scene treatment* phase. Decisions in the *Airway management*, *Cardiac management* and *Drug administration* categories predominate this phase of the process map.

Figure 2 Process Map

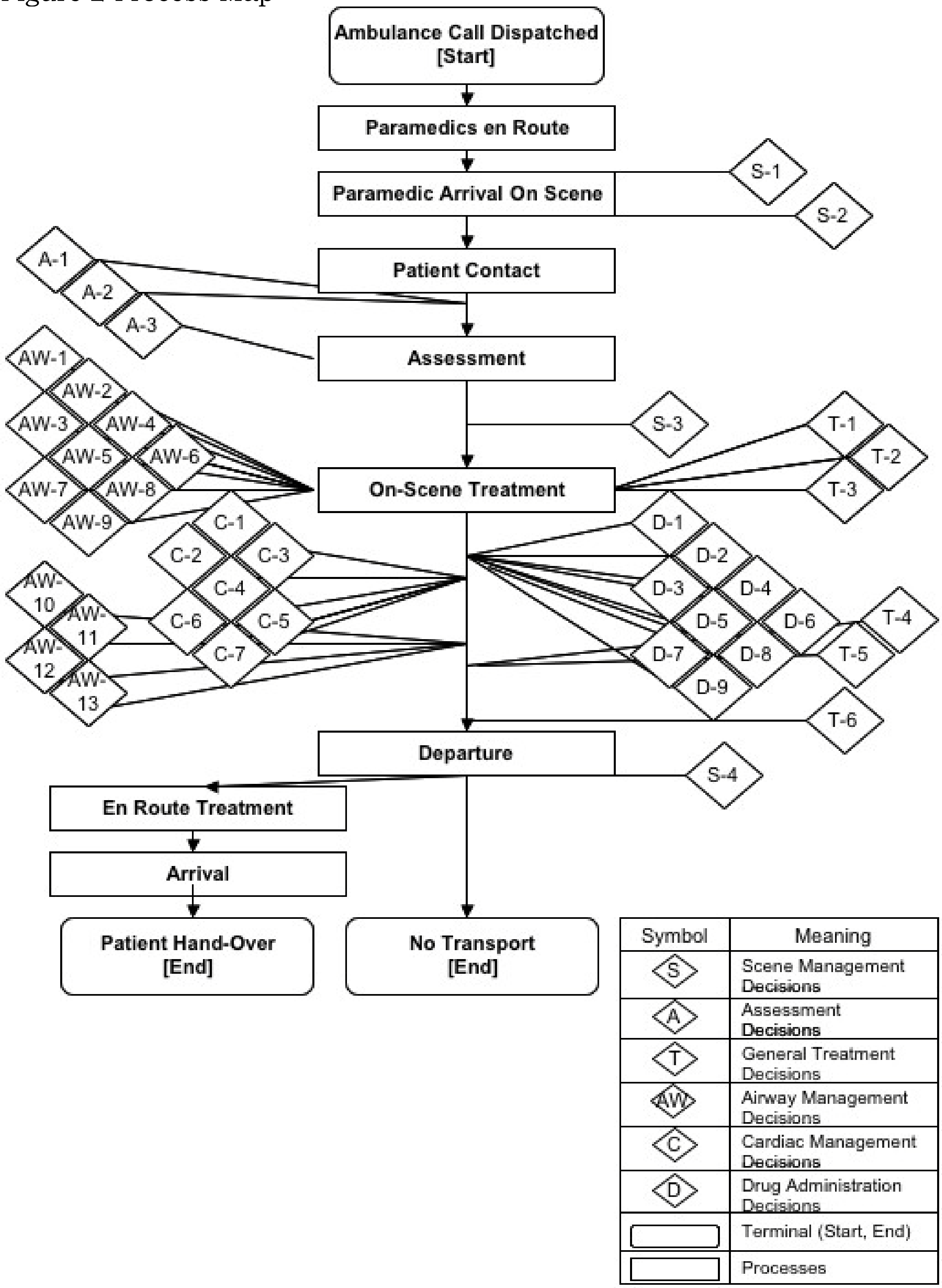


Table 10 Included decisions, in order on Process Map

Code	Decision
S-1	Recognize potential hazards (e.g., people, animals, environment, chemical/radiological/biological risks) - Scene safety
S-2	Decide to check for/triage patients at scene with several patients
A-1	Initial assessment: is patient critical or not; level of distress/acuity, decide whether to start treatment right away, or complete assessment
A-2	Recognize signs of life-threatening trauma
A-3	Decide if patient has capacity to refuse or consent
S-3	Decide when to leave scene vs. manage/tx on scene (load & go vs. stay & play)
T-1	Deciding on appropriate treatment
T-2	Determine if patient requires immediate treatment or can wait til en route, arrival at ED
T-3	Recognize contraindications/reason to withhold therapy
T-4	Reassess patient after giving a treatment - decision on next action (stop drug, change, give another dose, etc)
T-5	Decision to change care plan (switch protocol/med directive) based on patient changes
T-6	Decide how to manage labour & delivery
D-1	Provide ASA
D-2	Give epinephrine for anaphylaxis
D-3	Give epinephrine for severe asthma
D-4	Give epinephrine for pediatric shock
D-5	Decide to give TNK for STEMI
D-6	Provide bronchodilators
D-7	Decide to use drugs to facilitate intubation (sedation, opiates, paralytics)
D-8	Decide on drug for tachycardia (amiodarone/lidocaine/adenosine)
D-9	Decide whether to administer vasopressor
AW-1	Decide on manual airway positioning - if necessary and how (head tilt, jaw thrust, etc)
AW-2	Decide to insert airway adjuncts (OPA, NPA)
AW-3	Decide to use supraglottic device (King LT, Combitube, LMA), ETI or BMV
AW-4	Provide positive pressure ventilation with BVM in respiratory distress
AW-5	Decide whether to attempt intubation in pediatric patient
AW-6	Decide whether to attempt intubation in major trauma patient
AW-7	Decide to use CPAP
AW-8	Decide to perform chest needle decompression
AW-9	How to clear obstructed airway (Heimlich maneuver, suction, forceps)
C-1	Start CPR
C-2	Begin chest compressions on decompensated child (shock)
C-3	Remind/correct chest compressor on CPR quality; have chest compressors switch
C-4	Decision to defibrillate
C-5	Analyze cardiac rhythm (3 or 4 lead strip)
C-6	Interpreting 12 lead ECG
C-7	Decide on electrical cardioversion or medications for SVT
AW-10	Decide how to confirm intubation
AW-11	Decide to extubate if unsure of placement
AW-12	Failed attempt at intubation - try again for ETI or switch to supraglottic device or BVM
AW-13	Decide whether to perform cricothyroidotomy
S-4	Decide most appropriate destination (trauma, heart, stroke centre, community ED, other)

DISCUSSION

This purpose of this study was to determine the most important clinical decisions paramedics make during high acuity emergency calls. This was achieved by consensus among twenty-four Canadian paramedics and EMS medical directors. *General treatment*, *Airway management* and *Assessment* decisions categories were considered to be the most important in terms of patient safety and clinical outcome (these categories had the highest panel mean scores). The categories that contained the most decisions were *Airway management*, *Drug administration* and *Cardiac management*. The results of this study confirm that decisions on airway management, administration of drugs, and management of cardiac complaints can have an impact on patient safety and clinical outcome are more significant than any other type of important decision a paramedic makes. While making the right decision may not necessarily improve patient outcome, making the wrong choice on these decisions could certainly lead to adverse events.

Interestingly, paramedics and medical directors differed on their scoring on only five decisions out of the included 42. This demonstrates that the medical directors and paramedics who participated in this study think similarly about the importance of the included decisions on outcome and safety. The paramedics who participated were all ACPs with considerable EMS experience. The same level of agreement may not be found between all paramedics and medical directors.

The decisions found to be important for clinical outcome and patient safety by the Delphi panel were plotted onto an emergency call process map. This representation of the processes and decisions involved in a typical call allows one to determine the point of the call most likely to be susceptible to adverse events or errors. It is apparent from this process map that most of the decisions are consolidated around the *on-scene treatment* process of the call. While not all of the decisions on the map happen during each emergency call, the map is valuable for increasing awareness of when paramedics are inundated with many decisions that are high risk for lapses in patient safety or outcome. Situations of high decision density are susceptible to provider error (Croskerry & Sinclair, 2001). During the on-scene phase of a call, paramedics should increase their attention to their metacognition, in order to minimize clinical errors.

The results of this Delphi study and this process map have implications for paramedic training and continuing education. Paramedics, especially those practicing at an advanced level, should be aware of these decisions and the time period in a typical call when they can expect to make most decisions that have high risk for patient safety and outcome. It also has implications for future research on paramedic CDM. Process mapping of specific interventions, such as Blanchard's (2009) work on rapid sequence intubation by paramedics, is valuable for determining the complexities and potential sources of error. This Delphi study has provided direction for similar studies on specific interventions, namely those that fall in the categories with the highest scoring important decisions (*Assessment, Airway management and Cardiac management*).

Limitations

The results of this study should be considered along with the methodological limitations of a Delphi study. The researchers had to make decisions when designing this Delphi study that may have implications for the generalizability of the results (Crisp, Pelletier, Duffield, Adams, & Nagy, 1997). The composition of the panel (medical directors and paramedics) was determined by the researchers. The decisions found to be important may have differed if the panel was entirely made up of paramedics or medical directors, rather than a mix of these groups. Only opinions submitted by panel members were scored, so some important decisions may be missing from this collection. The study was terminated at four rounds, regardless of the number of decisions in which consensus was achieved, to minimize sample fatigue and decreasing response rates. Potentially, additional decisions would have been found to be important if the panel had the opportunity to review their scores and the panel scores one more time. The Delphi technique calls for panel members to be given the opportunity to re-score items, after viewing the panel mean score and their individual previous score for each item. Viewing the group mean may have caused some panel members to score items closer to the group mean, while others may have inflated their score to a more extreme value, to contradict the group mean.

Decisions were categorized based on the judgment one of the authors (JLJ). Some items could have been placed in other categories, such as putting 'Decide to use drugs to facilitate intubation (sedation, opiates, paralytics)' in the *Airway management* or *Drug administration* category decision (it was placed in the *Drug administration* category). This could be improved with independent analysis by two authors, with third party adjudication.

Panel members may have scored some decisions in terms of perceived clinical importance, and not specifically in terms of patient safety and clinical outcome. Finally, and most importantly, the decisions selected as most important for patient safety and clinical outcome were determined by consensus, and are not verified by actual patient outcomes or safety data.

CONCLUSION

In a Delphi study of clinical decision-making by paramedics during high acuity emergency calls, consensus was reached on 42 decisions in six categories, with the highest level of consensus on *Assessment* decisions. The category with the greatest number of decisions was *Airway management*. The phase of the emergency call map with the highest decision density is *on-scene treatment*. The decisions found to be most important for patient outcome and safety should be a focus of paramedic training, continuing education and clinical auditing.

CHAPTER 4
CLINICAL DECISION MAKING BY ADVANCED CARE PARAMEDICS: DESIGN AND METHODOLOGY OF A THINK ALOUD STUDY

ABSTRACT

Background

Ground ambulance paramedics are required to make many clinical decisions in order to assess, treat and transport patients presenting with various complaints in a variety of settings. As the paramedic scope of practice continues to expand, it is essential to determine *how* this population of health care providers makes clinical decisions. This exploratory study will utilize the Think Aloud technique to identify thinking strategies paramedics use to make clinical decisions during high acuity emergency calls.

Methods

A small sample of advanced care paramedics verbally worked through trauma and medical scenarios. The interviewer encouraged each participant to explain why he or she made each assessment, treatment and transport decision. Transcripts of interviews were analyzed by identifying each clinical decision and the thinking strategy used. Analysis included descriptive statistics of the sample, frequency of decisions and thinking strategies, and *t*-tests to detect differences in decisions and thinking strategies between novice and experienced participants and between scenario types by all participants.

Discussion

The thinking strategies used by paramedics in this Think Aloud study will inform future research on paramedic clinical decision-

making. It will also be valuable for paramedic training, continuing education and quality improvement.

BACKGROUND

Paramedic Decision-Making

Ground ambulance paramedics are required to make many clinical decisions in order to assess, treat and transport patients with a variety of clinical complaints in the out-of-hospital setting. Paramedics may receive extra help from first responders, but are usually considered the decision-makers on the call, as they have the highest level of clinical training (Campeau, 2008). This is especially true for advanced level paramedics. The quality of clinical decision-making (CDM) is a likely determinant of clinical errors, which are known to be of significant proportions in healthcare, including in emergency medical services (EMS) (Kohn et al., 1999). As the paramedic scope of practice continues to expand (Institute of Medicine, 2006, Paramedic Association of Canada, 2001), it is essential to determine *how* this population of health care providers makes clinical decisions. This is especially important, given the multi-faceted nature of many emergency calls that require expedient and effective decision-making, unique among paramedics compared to other health care professionals.

EMS systems provide paramedics with clinical protocols to use as a guide for how to manage emergency calls. It may be assumed paramedics make most of their clinical decisions by choosing the most appropriate protocol for the symptoms their patient is presenting with, and then following the steps in the protocol from memory. This supposition may not be a sufficient explanation for how paramedics actually make decisions (Bigham et al, 2010). Wang and Katz (2007) found paramedics relied on both rules-based (algorithmic) and knowledge-based reasoning to perform tracheal intubation (Wang & Katz, 2007). The incentive for this project was our local experiences with apparent failures in paramedic decision-making, leading to adverse outcomes for EMS patients. If paramedics do indeed solely use algorithmic thinking, the errors must lie in protocol selection, following the protocol incorrectly, the protocol not containing direction for what to do when unexpected changes in patient condition occur, or the protocol being simply incorrect. However, it cannot be assumed that paramedics only use this type of thinking strategy. As a result of this, we sought to learn more about paramedic CDM.

Clinical Decision-Making

The current predominant decision making model in cognitive psychology is the Dual Process Theory (Croskerry, 2009b; Evans, 2008; Norman, 2009). This theory proposes that thinking occurs through one of two cognitive pathways. System I is reflexive, intuitive decision making that largely occurs without conscious thought (Croskerry, 2009b). System II is more deliberate and handles decisions that require the thinker to pay closer attention in an analytical fashion. 'System II by proxy' refers to strategies used to make a decision, created from the System II-type thinking usually done by experts. For example, algorithms are standard procedures that are largely developed by reviewing research evidence, current practice standards, and other considerations. The clinician using the algorithmic thinking strategy does not sift through all this information while making the decision, but rather remembers the algorithm. Ruling out the worse scenario thinking is similar. Clinicians learn lists of differential diagnoses for presenting complaints. When they are making a decision, they rule out the worst-case diagnoses from this list that is already in their memory.

Six main thinking strategies for CDM have been well described, each of which fall within one of the two systems: the *hypotheticodeductive* method, *algorithmic* thinking, *pattern recognition*, *ruling-out the worse scenario* (ROWS), *exhaustive* thinking and *event-driven* thinking (Sandhu & Carpenter, 2006). It is likely that paramedics rely on one or more of these thinking strategies while working their way through an emergency call. Each thinking strategy has key features (see Table 2).

Think Aloud Method

The think aloud (TA) technique has been used to study CDM in medical residents, physicians and nurses (Backlund et al., 2004; Davison, Vogel, & Coffman, 1997; M. Fonteyn & Fisher, 1995; Laing Gillam, Fargo, & St Clair Robertson, 2008; Young et al., 2007). Young et al (2007) conducted a study with medical residents, using scenarios to determine participant recall and decision-making. In the decision-making tests, the investigators abstracted specific statements from the recorded sessions, as indications of different types of reasoning, including inferences, forward reasoning, backward reasoning and cognitive errors. Statistical analysis was conducted to compare differences in cognitive strategies and cognitive error between novice, intermediate and expert residents. Similarly, Coderre et al (2004) conducted a study with gastroenterology specialists (considered experts) and first year medical students (considered non-experts), who were given a multiple-choice test, and were asked to think aloud while making their selections (Coderre, Harasym, Mandin, & Fick, 2004). The taped interviews were analyzed by scoring each decision by the cognitive strategy used (pattern recognition, creating a scheme, chunking information together, using the hypotheticodeductive method, and ruling out each alternative). Experts and non-experts were compared.

Objective

This study seeks to explore the thinking strategies paramedics use to make clinical decisions during high acuity emergency calls. The secondary purpose is to explore the impact of experience and type of call (medical or trauma) on thinking strategy used and key clinical decisions accomplished.

METHODS

Study Design

This study is an exploratory pilot of novice and experienced ground ambulance advanced care paramedics (ACPs). Paramedic participants were given two clinical scenarios and were asked to think aloud while working through the calls.

Participants

Purposive sampling was used to recruit paramedics from the population of ACPs who work in the Emergency Health Services (EHS) ground ambulance system in Halifax, Nova Scotia, Canada. There are approximately fifty ACPs working in this region (personal correspondence, EHS Central Region Administrative Coordinator, November 24, 2008). All were invited to participate with a letter emailed to their work email address. The researchers chose a mix of novice and experienced ACPs from those who volunteered to participate. Novice ACPs were defined as having less than two years experience practicing at that level. Experienced participants were defined as paramedics having over four years experience at the ACP level. As this study is exploratory, the sample size was small. This study received approval from the Capital District Health Authority REB (Halifax, Nova Scotia): CDHA-RS/2010-148. All participants provided written informed consent. In appreciation of their time, participants were given a shopping gift card upon completion of the interview session.

Scenarios

Paramedic participants worked through two typical clinical scenarios using the TA method. The first scenario was of a thirty-year old male who fell from a roof of a two-storey house. The patient had an altered level of consciousness, and vomited once. This scenario ended upon arrival at the emergency department (Table 11). The second scenario was of a middle-aged male complaining of vague abdominal pain. The patient was arrested for public intoxication and was at the regional police cells. The patient did not want to be transported to the emergency department (Table 12). These particular scenarios were chosen because of recent anecdotal experiences of poor decision-making in our system with these types of calls. The scenarios were developed by the investigators and reviewed by a group of local EMS experts for face validity with typical local emergency calls.

The scenarios were read to the participants. The same person administered all sessions (JLJ). The participants were given paper and pen, and were instructed they could use any resource materials normally used in their clinical practice. Participants were instructed to describe their reasoning process by verbalizing their thoughts as they proceeded through the each scenario. After introducing the scenario, no further information was given unless the paramedic asked for it. After giving more information, the investigator inquired, “How will you proceed?” When there was a pause lasting approximately 15 seconds or longer, the investigator inquired, “What are you thinking?” (Offredy, 2002). Each time the participant verbalized a decision, which included any assessment, treatment or transport action; they were prompted to try to explain why they were making the decision. Each scenario ended at a pre-designated end-point. The interviews were audio-taped and transcribed by a third party.

Table 11 Trauma Scenario

Scenario #1: Trauma
You and your primary care paramedic partner have been dispatched to a fall. It is mid-afternoon on a summer day. The call is located in Lawrencetown (approximately 20 minutes away). *En* route, you are updated with the following information: 'you are responding for an approximately 30-year old male who has fallen from the roof of his house. He is conscious and lying on the ground.' *On Arrival –* 30 year old male, lying prone on ground No blood Bystanders yell that he slipped from roof. House is 2-stories Patient moaning, some movements of extremities *1st Vital Signs –* Heart Rate: 110 radial pulse Respiratory Rate: 12, normal depth and effort Blood Pressure: 100/70 Glasgow Coma Scale: 13 (eyes = open spontaneously, movement = purposeful, verbal = utters inappropriate words to questions); AVPU = verbal Blood Glucose: 5.3 mmol/L Pupils PEARL When patient rolled, face bloody, mouth contains blood and 2 broken front teeth No past medical history available (no medical alert) *2nd Vital Signs –* Heart Rate: 125, normal sinus rhythm Respiratory Rate: 8 (hypoventilating without effort) Blood Pressure: 90/58 Oxygen Saturation: 94% Glasgow Coma Scale: 10 (eyes = open with verbal stimulus; movement = purposeful towards stimulus; verbal = incomprehensible sounds) Vomits x 1 Skin: pale, warm, dry. No cyanosis noted *Further Assessment* Swollen right eye Deformed nose Deformed right clavicle Air entry clear Thorax stable Abdomen soft, non-tender Pelvis stable Legs no DCAP BLS Left wrist deformed Scenario ends at patch to receiving hospital

AVPU = alert, verbal, pain, unconscious; PEARL = pupils equal and responsive to light; DCAP BLS = deformities, contusions, abrasions, penetrations, burns, lacerations and swelling

Table 12 Medical Scenario

Scenario #2 Medical
You and your partner have been dispatched to Halifax Regional Police cells. *En* route, dispatch updates you, ‘you are going for a 45-year old male, intoxicated, complaining of abdominal pain. Code 2 (no lights and sirens response)’. *On Arrival –* Booking officer says ‘It’s Joe, a regular, picked him up drunk on Spring Garden. Just clear him, would ya.’ You are informed he was picked up for public intoxication. Will be released in 4 or 6 hours. Patient is sitting on bench outside of cells Appears dishevelled, smells of alcohol Patient is complaining of vague abdominal pain *1st Vital Signs –* Heart Rate: 90, radial pulse Respiratory Rate: 14, normal depth and effort Blood Pressure: 142/90 Glasgow Coma Scale: 15 Blood Glucose: 6.7 Skin: slightly diaphoretic, cheeks flushed, otherwise normal colour, warm *Interview information* Has not seen a doctor in months Duration – ‘about a week’ Speech slurred, staggered gait Alert and oriented x 3 (to person, place and time) Denies past medical history or allergies Has not eaten for 2 days Patient reports he drank 2 bottles of wine today Patient reports bowel movements and urinary normal No shortness of breath, denies chest pain *Further Assessment* Air entry clear & equal Abdomen soft, tender in lower left and right quadrants Extremities normal *Further Information* Arrested for public intoxication Will be released in 4 hours Officer will not accompany if he goes to emergency department Patient states he wants a sandwich Refuses transport, although cooperative with all assessments Patient is homeless, stayed at Metro Turning Point (a homeless shelter) the night before last. Was on street last night (intoxicated) Call ends at no transport, call to online medical control, or transport, whichever occurs first.

Method of Measurement

The following demographic information was collected from each participant: age, gender, years as an ACP, total years of experience as a paramedic, and type of ACP training program (full-time or part-time). The analysis procedure for each scenario in each transcript followed an iterative process. Upon first review of the transcripts, every clinical decision was identified, listed in a spreadsheet, and given a numerical identifier. On second review of the transcripts, each was analyzed to determine if the decisions were made. Additional decisions were added to the list if they appeared in subsequent transcripts. If a decision wasn't verbalized, the decision was identified as 'not made'. On the last review of the transcripts, the thinking strategy for each decision made was determined by how the participant explained their decision-making. If the strategy was not explained, it was inferred by the timing and context of the decision. For example, if a participant did not explain why they obtained a set of vital signs, it was assumed algorithmic thinking was used, such as obtaining vital signs is part of the clinical algorithm for every call type (Emergency Health Services, 2009).

Decisions

A list of key clinical decisions (KCDs) was created *a priori* (Table 13). These decisions were assessment, treatment, or transport decisions essential to the proper treatment of the patient (Young et al., 2007). The list was developed by the investigators and verified by local EMS experts.

During the interview conducted at the end of the scenarios, participants were asked to identify the easiest and most difficult decision made in each scenario.

Table 13 Key Clinical Decisions

Scenario #1: Trauma	Vital signs C-spine assessment C-spine immobilization Full body assessment Oxygen application IV initiation Suction Airway assessment Transport decision Destination decision
Scenario #2: Medical	Vital signs Past medical history History of present illness Pain assessment Informed Consent to no transport

Statistical Analysis

Descriptive analyses of the sample characteristics, the thinking strategies used, and percentage of KCDs made for each scenario were conducted in Microsoft Excel spreadsheet (Redwood CA). In the statistical software program SPSS 15.0 (Chicago IL), chi-squared tests were used to determine the differences in nominal characteristics (full or part-time training of the novice and experienced ACPs). Independent samples *t*-tests were conducted to determine differences in the continuous sample characteristics of the groups (years of experience as an ACP and total years of experience as a paramedic). *t*-tests were also used to detect differences in decisions and thinking strategies between novice and experienced participants and between scenario types by all participants.

DISCUSSION

This exploratory study on paramedic clinical decision-making will provide insight into the different thinking strategies paramedics use during typical high acuity emergency calls. These findings will be hypothesis generating and will have implications for future research on CDM, for paramedic training and continuing education. Strategies can be developed that will decrease the risk of cognitive error, and subsequently improve patient safety in EMS.

CHAPTER 5
CLINICAL DECISION MAKING BY ADVANCED CARE PARAMEDICS: A THINK ALOUD STUDY

ABSTRACT

Background

Paramedics make many clinical decisions while caring for patients in the out-of-hospital setting. As the paramedic scope of practice expands, it is essential to determine *how* these health care providers make decisions. The Think Aloud technique was used in this exploratory study to identify thinking strategies paramedics use to make decisions during emergency calls.

Methods

A sample of advanced care paramedics (ACPs) verbally worked through a trauma and medical scenario. Participants were encouraged to explain why they made each assessment, treatment and transport decision. Clinical decisions and thinking strategies were identified in the interview transcripts. Analysis included descriptive sample statistics, frequency of decisions and thinking strategies, and inferential statistics to identify differences in thinking strategies used in the two groups (novice and experienced participants), and by all participants in the different scenarios types.

Results

Eight ACPs with a mean 9.6 years of overall paramedic experience (SD 6.7) participated (novice group: mean 1.5 years ACP experience (SD 0.6); experienced group: 6.9 years ACP experience (SD 2.0)). Twenty-nine decisions were made in the trauma scenario. Eighteen decisions were made in the medical scenario. The most frequently

used thinking strategies in both scenarios were *Rule Out the Worst Scenario* and *Exhaustive* thinking. In the trauma scenario, participants used *Event-driven* and *Algorithmic* thinking most frequently. In the medical scenario, *Algorithmic* and *Rule Out the Worse Scenario* were employed the most. *Event-driven* thinking was used more often in the trauma scenario compared to the medical scenario ($p<0.001$). Experienced participants made more decisions than novices ($p<0.05$).

Conclusion

This exploratory study examined and described the variety of thinking strategies paramedics use in trauma and medical scenarios. The results of this Think Aloud study will be valuable for paramedic training, quality improvement and future research.

BACKGROUND

Clinical decision-making (CDM) clearly can have an impact on the safety and outcome of patients requiring care within the health system. This is especially true in chaotic environments, which includes emergency medicine (EM) (Croskerry & Sinclair, 2001). Physicians and other healthcare providers who work in this setting need to deal with high acuity patients who often present without a complete medical history, and at times, without a detailed description about what led to the current complaint. The uncertainty and time pressures that impact decision-making in these situations can lead to error. It has been suggested that EM has the highest decision density of all medical specialities (Croskerry, 2000), and might lead to clinician reasoning failures

(Brennan et al., 1991). If CDM is this complex in EM, it is likely just as difficult in emergency medical services (EMS), where paramedics encounter a wide variety of patients in many locations in the out-of-hospital setting, often with little help, and less medical education than physicians. Reviews have been published on applicability of CDM to EM (Campbell et al., 2007; Croskerry, 2009b; Kovacs & Croskerry, 1999), but there have been few prospective research studies. Even less study has been conducted on the impact of reasoning on the quality of care paramedics deliver (Wang & Katz, 2007).

It may be that most paramedics make decisions by choosing a protocol that fits their patient's complaint, and recalling the standing orders contained within the protocol (i.e. algorithmic thinking), but other thinking strategies may also be used during an emergency call.

This study is similar in approach to a CDM study of surgical residents (Young et al., 2007). Participants were read scenarios and were asked to think aloud as they make decisions on how to diagnose and treat their 'paper patient'. As with the Young study, we were interested to know the impact of experience level on decision-making strategies and key clinical decisions (KCDs) (decisions important for proper management of the patient) completed. We also wanted to explore if scenario type (medical or trauma) made a difference in thinking strategies used by paramedics and the KCDs accomplished.

METHODS

Study Design

This project was an exploratory pilot study of novice and experienced ground ambulance advanced care paramedics (ACPs). Participants were given two pre-determined clinical scenarios and asked to think aloud (Ericsson & Simon, 1980; M. E. Fonteyn, Kuipers, & Grobe, 1993) while working through the calls.

Participants

A mix of novice (less than two years at the ACP level) and experienced (greater than four years ACP experience) paramedics were recruited from the ground ambulance system in Halifax, Nova Scotia, Canada.

Ethical Considerations

This study received approval from the Capital District Health Authority REB (Halifax, Nova Scotia): CDHA-RS/2010-148.

Procedure

After introducing each scenario (Tables 11 and 12), no further information was given unless the paramedic asked for it. Each time the participant verbalized a decision they were prompted to try to explain why they were making it. Each scenario ended at a pre-designated end-point. After the second scenario, participants were asked to identify the easiest and most difficult decision they made in each scenario.

Data Analysis

One author (JLJ) reviewed the interview transcripts, identifying each decision and the corresponding thinking strategy. Every decision was identified, even if it was only made by one participant. Subsequently, it was identified if a participant did not make a decision (if the participant did not verbalize anything about the decision). Descriptive analysis of the sample characteristics, the thinking strategies used, and percentage of KCDs made for each scenario was conducted in Microsoft Excel spreadsheet (Redwood CA). Statistical analysis was performed using the statistical software program SPSS 15.0 (Chicago IL). Continuous variables were analyzed using *t*-tests, and categorical data with chi-squared tests.

Key Clinical Decisions

The percentage of KCDs completed by each participant in each scenario was calculated. There were seven KCDs for the trauma scenario and five in the medical scenario, decided *a priori* (Table 13).

RESULTS

Sample Characteristics

The sample consisted of eight male ACPs. The novice and experienced groups differed in characteristics, including age, years as an ACP, total years experience, and type of ACP training (full time or part time program) (all $p < 0.05$). All of the novice ACPs had taken a full time training program, compared the experienced ACPs, who had mostly taken part-time programs (Table 14).

Table 14 Sample Characteristics

Entire Sample	Mean (SD)	Range (min – max)
Age	33 (6.7)	23 - 42
Years as ACP	4.2 (3.2)	8.0 (1.0 – 9.0)
Total Years Experience	9.6 (6.4)	20.0 (1.0 – 21.0)
	n	%
Gender (male)	8	100
Type of ACP Training (part-time)	3	37.5
Type of ACP Training (full-time)	5	62.5
Groups	Novice Participants	Experienced Participants
	Mean (SD)/ Range (min – max)	Mean (SD)/ Range (min – max)
Age	28.5 (5.8) / 13.0 (23.0 – 36.0)	37.8 (3.7) / 9.0 (33.0 – 42.0)
Years as ACP	1.5 (0.6) / 1.0 (1.0 – 2.0)	6.9 (2.0) / 4.5 (4.5 – 9.0)
Total Years Experience	4.9 (3.8) / 9.0 (1.0 – 10.0)	14.2 (4.7) / 11.0 (10.0 – 21.0)
	n (%)	n (%)
Gender (male)	4 (100)	4 (100)
Type of ACP Training (part-time)	0 (0)	3 (75.0)
Type of ACP Training (full-time)	4 (100)	1 (25.0)

SD = standard deviation; ACP = advanced care paramedic

Decisions

Twenty-nine decisions were identified to have been made by at least one of the participants in the trauma scenario and eighteen decisions in the medical scenario (Table 15). There were 47 decisions identified (376 decisions in total: 29 trauma decisions + 18 medical decisions x 8 participants). Of these, 101 were not made (26.7%) (i.e., a decision was identified as 'not made' if it was not mentioned by the participant). The novice paramedics failed to verbalize a significantly larger number of decisions than the experienced paramedics in both scenarios (mean 8.50 decisions not made per participant versus mean 4.12 decisions not made per participant, $p < 0.05$).

Six participants identified the easiest decision in the trauma scenario as *spinal immobilization*. The most difficult decision was described as *airway management* by seven. In the medical scenario, each of the following decisions were identified as the easiest, each by two participants: *consult medical control* (n = 2), *sign no transport form* (n = 2) and *take vital signs* (n = 2). *Not transporting patient* was the most difficult decision in this scenario (n = 7) (Tables 16 and 17).

Table 15 Decisions Made in Each Scenario

Decision Made in Trauma Scenario	Decisions Made in Medical Scenario
Cervical-spine assessment	Assess alcohol consumption
Spinal immobilization*	Assess competency
Assess airway	Assess airway
Assess level of consciousness	Assess colour
Assess breathing	Assess breathing
Assess pulse	Assess circulation
Primary/rapid body survey	History of present illness*
Move to ambulance	Assess abdominal pain*
Suction/clear airway of blood*	Vital signs*
Expose patient	Past medical history*
Secondary assessment*	Secondary assess
Listen to lungs	Discuss transport to Emergency Department
Trauma team activation*	Informed consent to no transport*
Destination	Consult online medical control
Vital signs*	Cardiac monitor
Cardiac monitor	Blood glucose level
Insert intravenous line*	Give direction to booking officers
Apply oxygen*	Sign no transport form
Assess pupils	
Collect past medical history	
Blood glucose level	
Administer fluid bolus	
Insert/consider oropharyngeal airway or nasopharyngeal airway	
Bag mask ventilate	
Consider advanced airway	
Splint fracture	
Administer analgesia (OR NOT)	
Determine working diagnosis	
Administer gravol (OR NOT)	

** = Key Clinical Decision*

Table 16 Easiest and Hardest Decisions in Each Scenario

	Trauma Scenario		Medical Scenario	
	Decision	n	Decision	n
Easiest Decision	Spinal immobilization	6	Consult online medical control	2
	Destination	1	Unusual assessment	1
			Sign no transport form	2
	Trauma Team Activation	1	Vital Signs	2
			No answer	1
Hardest Decision	Consider advanced airway	7	No transport	7
	Trauma Team Activation	1	Unusual assessment	1

The experienced paramedics completed more KCDs than the novices in the medical scenario (Table 17). None of the novice ACPs clearly had an informed discussion with the patient about not being transported to the ED, and one novice participant did not obtain the patient's past medical history.

Table 17 Key Clinical Decisions Completed

Scenario Type	Participant Group	Mean % KCDs Completed	SD	Significant Difference between Groups
Trauma	Experienced	1.00	0.00	NS
	Novice	0.93	0.08	
Medical	Experienced	0.95	0.10	*
	Novice	0.70	0.12	

*KCD = Key Clinical Decisions; SD = standard deviation; NS = not significant; * = $p < 0.05$*

Thinking Strategies

The most frequently used thinking strategies were *ROWS* (used in 17.3% of all decisions), *exhaustive* (used in 15.7% of all decisions), *algorithmic* (used in 14.1% of all decisions) and *event-driven (*used in 12.0% of all decisions). *Event-driven* thinking was used much more often in the trauma scenario, otherwise the thinking strategies did not differ significantly between scenarios or the experience of the participants (Table 18).

Table 18 Thinking Strategies Used

Thinking Strategy	Both Scenarios (total n decisions = 376)	Trauma Scenario (total n decisions = 232)	Medical Scenario (total n decisions = 144)	SD Scenario Types	Experien-ced (total n decisions = 188)	Novice (total n decisions = 188)	SD Groups
	n (%)	n (%)	n (%)		n (%)	n (%)	
Decision Not Made	101 (26.9)	58 (25.0)	43 (29.9)	NS	33 (18.0)	68 (36.2)	*
Rule Out Worse-case Scenario	65 (17.3)	37 (15.9)	28 (19.4)	NS	28 (14.9)	27 (14.4)	NS
Exhaustive	59 (15.7)	33 (14.2)	26 (18.0)	NS	26 (13.8)	27 (14.4)	NS
Algorithmic	72 (14.1)	43 (18.5)	29 (20.1)	NS	29 (15.4)	32 (17.0)	NS
Event Driven	45 (12.0)	45 (19.4)	0 (0.0)	***	0 (0.0)	0 (0.0)	NS
Pattern Recognition	33 (8.8)	15 (6.5)	18 (12.5)	NS	18 (9.6)	11 (5.4)	NS
Hypothetico-deductive	1 (0.3)	1 (0.0)	0 (0.0)	NS	0 (0.0)	0 (0.0)	NS

*SD = significant difference; NS = no significant difference; *** = $p < 0.001$; * = $p < 0.05$*

Paramedics rarely relied on hypotheticodeductive reasoning to make decisions during an emergency call. Here is the single instance of this type of reasoning that was used (in the trauma scenario):

Ok, so essentially what I am doing is I am going through my altered LOC differential diagnosis as we are going down the road. So, he doesn't smell like alcohol, he wasn't been witnessed to have had a seizure, we don't know if he has a seizure history, but he doesn't sound like he is a diabetic, so we are looking at the things such as insulin. We don't know about overdose or underdose. We do know he is a trauma patient he doesn't appear to be septic, he isn't a psych patient. But right now he falls into the trauma category for his differential diagnosis.

Participants seemed to often default to algorithmic thinking to get routine tasks accomplished during each scenario, such as obtaining vital signs. These decisions were routinely and subconsciously made, as part of a regular schema for emergency calls (Charlin et al., 2000).

Paramedics relied on pattern recognition thinking in both the trauma and medical calls. In the trauma scenario, paramedics used pattern recognition to quickly identify that the patient would require cervical spine immobilization. Many participants stated they decided to immobilize the patient because of ‘mechanism of injury’. The participants seemed to piece together the report of the patient falling from two stories, found in the prone position on the ground, with an altered level of consciousness to immediately identify he was a major trauma patient. Similarly, most paramedics decided to assess pupil reaction to see if it matched the pattern of severe head injury.

When the participants found they could not rule out the worst scenario, it prompted action. In the trauma scenario, one paramedic decided to obtain intravenous access because he was concerned about the cause of the patient’s condition:

Yeah, so, a blood pressure 90 on 58 is not a super great blood pressure, there is a chance he’s got some bleeding, he’s tachy, he’s shocky. So those are the reasons why I am going to start at least one IV. I am going to make one IV a priority and in the back of my mind I am thinking about a second IV as well.

Also in the trauma scenario, ROWS thinking propelled many participants to do a rapid body survey, quickly visualizing the patient’s body for obvious, life-threatening injuries. In the medical scenario, many participants had the medical patient sign a no transport form before leaving them in police cells, because they could not rule out the cause of his vague abdominal pain.

In both the trauma and medical scenarios, most participants completed a secondary, or more detailed, survey of the patient’s condition. This seems to be a result of exhaustive thinking. In the trauma scenario, some paramedics verbalized that they wanted to have this thorough assessment done before speaking with the emergency physician about requesting the trauma team:

The next thing we really want to do, is when we have the patient loaded [in the ambulance] is really get a good thorough hands-on visual assessment. Cause we really haven't gotten that yet. We have only just done the ABC's [airway, breathing, circulation], LOC [level of consciousness], and obvious injuries, so the next step we move to is really nailing down what injuries, how badly, and to what extent.

In certain situations, all participants used event-driven reasoning. In the trauma scenario, most of the paramedics immediately suctioned the patient's mouth out as soon as he vomited:

Ok, thank goodness we have him on a backboard. We are immediately able to roll him over on his side and clear the vomit from his airway, we will suction his airway out and bring him back onto his back.

Event-driven thinking caused the participant to interrupt other assessment or treatment actions they had planned, in order to take care of the most pressing concern.

DISCUSSION

This think aloud study explored how paramedics make clinical decisions. This research is the first of its kind, in which paramedics were asked to consider their decision-making during emergency calls. This unique study has provided valuable insight into the topic of paramedic CDM.

Sandhu and Carpenter (2006) reviewed several thinking strategies that emergency physicians likely use when making decisions while diagnosing and treating patients. Our exploratory study found that paramedics use a variety of these reasoning strategies. Generally speaking, the care delivered by paramedics in the EMS setting is guided by protocols. Paramedics learn these protocols during their initial training and continuing education. In EMS clinical quality is often determined by how closely paramedics follow the protocols (or conversely, poor care is identified by protocol deviation). As a result, it may be assumed that paramedics almost entirely rely on algorithmic thinking to guide their decision-making. While algorithmic thinking was found to be a predominant strategy used by participants in this study, others were used to a greater extent. This finding reflects earlier findings (Wang & Katz, 2007).

Implications for Future Research and Practice

This project was a preliminary study, to determine if the TA technique could be used to learn which thinking strategies paramedics rely on. The results of this study should be confirmed with a larger sample. Other variables could be included in a future TA study, including additional paramedic levels, setting (air or ground ambulance, or emergency department paramedics), and training type.

Teaching new paramedics how to make good quality clinical decisions is a difficult task (Kassirer, 1983; Sandhu & Carpenter, 2006). It is not, however, impossible. One participant in this study remarked after the interview that he had never actively thought about how he thinks before, that it is a worthwhile exercise that all paramedics should do. Thinking aloud causes one increase their own metacognition, or awareness about their thinking processes (Flavell, 1979). At the very least, paramedics should become more aware of how often and in which situations they make intuitive decisions, the best thinking strategies for particular decisions, and how heuristics and biases can help or hinder the quality of their clinical decisions. Currently, the document that guides Canadian paramedic training requirements, the Canadian National Occupational Competency Profile, does not include competencies on CDM (Paramedic Association of Canada, 2001).

In practice, decision-making by paramedics during emergency calls may be improved with increased focus on reasoning processes. Paramedics need to become more aware of the limitations of memorization of algorithms, and engage alternate thinking tactics and cognitive forcing strategies, as described by Croskerry (2003a). This awareness can be developed with cognitive autopsies, which are sessions of self-reflection, conducted after an episode when intense or difficult decision-making was required, or when it is known that patient outcome was adversely affected (Croskerry, 2005). The results of these cognitive autopsies should be openly shared among paramedic colleagues at mortality and morbidity sessions, to improve knowledge about how lapses in judgment can occur.

Limitations

The most obvious limitation with the Think Aloud technique is that participants cannot verbalize their intuitive, System One thinking, and decisions made this way cannot be identified during analysis (Hogarth, 2001). Thinking aloud provides the conscious information held in working memory, not intuitive, subconscious thought. In essence, the TA method creates a Hawthorne effect; participants may report System Two thinking strategies, or state reasons why the decisions *should* be made, when in reality they might use System One in clinical practice.

A second major limitation of this study is the lack of ecological validity of verbal scenarios. Some decisions are made at least partly as a result of the context of a situation. The context of an emergency call was re-produced in this study. It may be possible to improve the ecological validity with the use of high-fidelity simulation, in the natural setting, during real emergency calls.

The thinking strategies used in this study are largely based on emergency physician decision-making (Sandhu & Carpenter, 2006). Physicians likely use different thinking strategies than paramedics, or use the same strategies in a different way. For example, it seems paramedics rarely use hypotheticodeductive reasoning. This may be due to a lack of clinical information available to them during emergency calls, or as a result of how paramedics are trained to make decisions. The thinking strategies used in this study may not be the most ideal for paramedics.

A single author identified the decisions and corresponding thinking strategies. This is a limitation of the analysis. This would be improved in a follow-up study with independent analysis by two authors with third party adjudication.

A final limitation, particularly when interpreting the inferential statistics, is the small sample size. The purpose of this study was to explore this topic, describe thinking strategies used, and establish the study method. Significant differences between groups and scenario types may not have been found due to the low power. The study needs to be replicated with a larger sample size.

CONCLUSION

This pilot study used the Think Aloud technique to explore thinking strategies used by Advanced Care Paramedics during typical trauma and medical scenarios. This research discovered that paramedics use thinking strategies other than simply algorithmic thinking, namely ruling out the worse case scenario and event-driven thinking. These results should trigger further research into paramedic clinical decision-making, and paramedics should learn about different thinking strategies during their educational experiences.

CHAPTER 6
DISCUSSION

This thesis on paramedic clinical decision-making (CDM) includes two research studies. The goal of this combined work was to learn more about *what* decisions paramedics make that are most important for patient safety and clinical outcome, and *how* paramedics make decisions. There has been little work done on paramedic CDM to date, so this research was intended to generate interest on this topic and be a catalyst for future research questions. This concluding chapter will relate the findings to the literature on CDM, and discuss the implications of these studies on paramedic practice, education, and future research.

The first study, "Consensus on paramedic clinical decisions during high acuity emergency calls: results of a Canadian Delphi study", had the objective of determining the most important decisions paramedics make, in terms of clinical outcome and patient safety, by a panel of emergency medical services (EMS) experts. Forty-two decisions were considered to be important or extremely important, with little difference in scoring between paramedics and medical directors. The category with the highest number of important decisions was Airway decisions. This fits with the mantra, 'A for airway'; that is decisions on airway management are likely the most important for patient safety and outcome.

The decisions found to be important in the Delphi study were plotted on a process map of an emergency call. The purpose of this activity was to determine the phases of a call in which the highest frequency of important decisions are likely to happen. By first determining which decisions were important, and plotting them in the locations where the decisions are most likely to be made, we analyzed the process of an emergency call in a prospective manner. The highest decision density is during the *on scene treatment* phase of the map, which is the most likely source of clinical errors (Croskerry & Sinclair, 2001). This is in contrast with the map that was drafted from a previously published list of sources for error in EMS. That list did not identify elements of the *on scene* phase as a likely source of error (O'Connor et al., 2002) (see Figure 1). It is essential to focus on this segment of emergency calls, given the context of many scenes. They are highly variable; a patient may be found in their bedroom, a car, a stadium or church, or in other places. Emergency calls are time-sensitive, both because of the nature of some patient conditions, and the limit imposed on scene times by EMS systems operators. Rarely is there sufficient additional clinical help available on scenes. These and other factors are why EMS is often called an 'uncontrolled setting' (Nelson, 1997).

In the second study, "Clinical decision-making by advanced care paramedics: a Think Aloud study", paramedic participants verbalized their reasoning while working their way through two scenarios of typical emergency calls. A variety of thinking strategies were used, the most prevalent being *rule out the worst scenario* (ROWS), *exhaustive* and *algorithmic*. Thinking strategies did not vary significantly between medical or trauma call types, except event-driven thinking, which was more frequently used in the trauma scenario. This study contributed evidence to dispel the assumption that paramedics simply use algorithmic thinking. This finding creates a new challenge: if paramedics don't solely use one type of thinking strategy, which are the best for what situations?

Also, how can we teach paramedics to recognize their own thinking strategies?

CLINICAL DECISION MAKING AND PARAMEDIC PRACTICE

Emergency Call Scene Management

Caring for a patient in the out-of-hospital setting can be challenging. What distinguish paramedics from another health care providers are not the interventions they use to assess and treat patients, but rather *where* they practice (Campeau, 2008, p. 286). Campeau (2008), a Canadian paramedic who conducted research on paramedic scene management, commented,

> Paramedics must 'fit' medical procedures into their work context; consequently, paramedic practice is a unique type of care … Paramedics achieve the remarkable objective of transforming everyday, uncontrolled locations where emergencies occur into settings that can be used to effectively deliver emergency care (p. 286).

For paramedics, scene management is a normal part of their duties. Metz (1981) stated, "the measure of a man or woman doing paramedic work is always decided at the scene" (p. 93). This concurs with our finding that decision density is highest during the *on scene* phase.

A schema is the general information or knowledge an individual acquires and organizes in their mind about a situation or event (Matlin, 2003). Schemas allow individuals to know what to expect when entering into a familiar situation. For example, most people understand the general schema of going to the hairdresser: walk in, greet the receptionist, sit and wait for the hairdresser, follow the hairdresser to the chair, discuss the style, have the cut done, pay the receptionist and leave. In a similar fashion, paramedic students quickly learn the schema of an emergency call, first through simulation, and later throughout their clinical training: receive dispatch information, arrive on scene, conduct an assessment, perform initial treatment, move the patient to ambulance, perform repeated assessments and treatments *en route*, arrive at destination, give report and transfer care of the patient. These phases of an emergency call schema formed the outline of our process map.

By structuring knowledge about what to expect during a situation like an emergency call in a schema, paramedics are able to manage these complex situations efficiently. When a call follows what is expected in the schema, many decisions likely don't make it out of System I cognitive processing (i.e., the decisions are made intuitively or unconsciously). Evidence of this is found by observing the interaction between paramedic partners during a call; they often have limited verbal consultation, even if they haven't worked together before. As paramedics likely all have a similar emergency call schema in mind, they have comparable expectations for how the call will unfold (Offredy & Meerabeau, 2005).

When something happens on a call that is unexpected, paramedics recognize it is out of the norm of the schema, and are required to plan and act (Greenwood, Sullivan, Spence, & McDonald, 2000). This happens with more active deliberation, by tapping into System II of the Dual Processing Theory (i.e., analytic thought). One paramedic reflected on this after the medical scenario of the Think Aloud (TA) study. In the scenario the patient complained of abdominal pain while being held in police cells, but he did not want to be transported to the emergency department, rather he wanted something to eat. The participant stated:

The majority of people we take, even the ones who might not necessarily need an ambulance, like a stubbed toe or whatever, we always take them. So it's a little bit different, it's kind of an unusual situation.

This participant felt uncomfortable that the scenario did not follow the normal schema of an emergency call: the patient did not want to be transported. An emergency call schema is theoretically similar to an illness script. Scripts are a narrower category of schemas; they describe a sequence of events in time, and what is to be done (Greenwood, 2000; Matlin, 2003).

Clinical Decision Making by other Health Care Providers

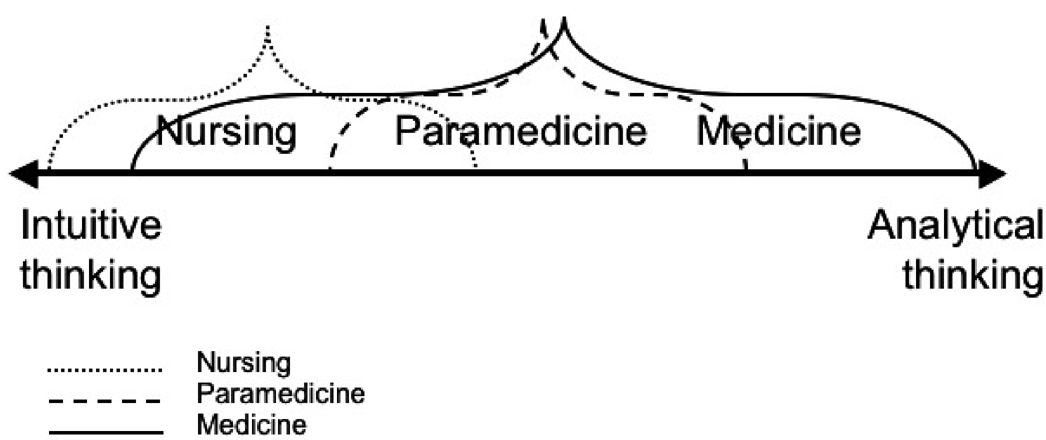
Different health professionals seem to make clinical decisions by using somewhat different strategies. Paley (2007) reviewed reasoning by nurses in the context of the Dual Process Theory (Paley, Cheyne, Dalgleish, Duncan, & Niven, 2007). He found that nurses put equal credence in intuitive, System I-type thinking as in analytical thinking. It has been argued that the use of intuition is a hallmark trait of an expert nurse (Banning, 2008a). In contrast, physicians put much more weight into the value of System II thinking. They are taught to collect data, form hypotheses, and rule each in or out, relying on the classic hypotheticodeductive method (Barrows, Norman, Neufeld, & Feightner, 1982; Offredy, 2002), in combination with intuitive reasoning. Depending on the setting, physicians use other cognitive strategies (Sandhu & Carpenter, 2006). Expert physicians have been found to incorporate their past experiences and clinical knowledge into illness scripts (Groves, O'Rourke, & Alexander, 2003a; Schmidt & Rikers, 2007). The ability to develop hypotheses increases with experience (Groves, O'Rourke, & Alexander, 2003b).

Of the decisions made by the paramedic participants in the TA study, System II 'by proxy' decisions were used most frequently, which includes algorithmic thinking and ROWS (Table 19). Of course, the use of intuition could not be directly measured with this method. The requirement to think aloud changes any intuitive thinking that might have occurred, and imposes a structure on it that may not have been present initially (Hogarth, 2005). It may be that in their clinical practice, paramedics rely on System I thinking to a greater extent than is apparent here. From the results of our small TA study, it appears that paramedics straddle the line between the intuitive reasoning strategies of nurses and the analytic processes physicians tend to use (Figure 3).

Table 19 Thinking Strategies Used by Paramedics

System	Total Decisions	Trauma Decisions	Medical Decisions
I (event-driven, pattern recognition, intuition)	78	50	18
II (hypotheticodeductive, exhaustive)	60	34	26
II by proxy (algorithmic, ROWS)	137	80	57

Figure 3 Thinking Strategies of Health Professionals



In time-sensitive conditions, System II thinking is not the most efficient. Reason (1990), an expert in human error, described pragmatic decision-making in real settings as Flesh and Blood decision-making. Croskerry (2005) elaborated on this:

> Clinicians do not take to reclining in armchairs to cogitate and consider their options at length, instead they respond to omnipresent time pressures and resource availability with expeditious decision and action. To make a Flesh and Blood decision is to think on one's feet and go with clinical intuition (p. 4).

Paramedic training is focused on clinical conditions that are most common and of the highest morbidity and mortality. As a result of this, and the emphasis on learning algorithms, paramedics often rely on System II-by proxy thinking strategies. Some health care professionals feel that algorithms and clinical prediction rules are a threat to their decision-making autonomy and lead to inflexibility. However, several reviews and one meta-analysis comparing clinical judgment to statistical predication rules found that the rules are almost always more accurate, and often require less clinical information (Grove, Zald, Lebow, Snitz, & Nelson, 2000). Therefore, in chaotic or time-sensitive situations, it is preferable for paramedics to use these decision tools, rather than rely on System I thinking, which can be influenced by bias, the affective state of the thinker, and inappropriate use of heuristics (Croskerry, 2005). It is also better than taking too much time to deliberate each competing hypothesis or decision option in System II before acting (Croskerry, 2009). Regardless of how paramedics think in comparison to other healthcare professionals, it is important to recognize that different thinking strategies will suit different clinical situations.

IMPLICATIONS

Future Paramedic and Applied Health Services Research

These two studies have generated further research questions about paramedic CDM. Clinical reasoning is a complex topic, and many studies are required to build a cohesive body of work in this area, as it applies to paramedic practice. Future paramedic research questions that can be asked with the TA technique include: the impact of paramedic variables on thinking strategy, such as: paramedic level, call volume (rural compared to urban service); ground ambulance versus air medical paramedics; and, type of paramedic training (full-time diploma, part-time diploma, undergraduate degree). Think aloud studies could be conducted in a simulation lab, to give participants a more realistic sense of an emergency call. Further, it would be possible to have paramedics think aloud while they are working the ambulance setting, in order to determine thought processes in real time (Aitken & Mardegan, 2000; M. Fonteyn & Fisher, 1995). Other aspects of clinical reasoning can be explored, including the use of heuristics and mental short cuts by paramedics (Croskerry, 2003b). Finally, paramedics likely think about factors during emergency calls that are unique to them, compared to other healthcare providers. These factors may include timing (how long to spend on scene, how many interventions can be done in the time it takes to get to the hospital) and clinical support (do I have the time or hands to call the medical director for advice, should I call for another paramedic crew or medical first responders to help, as an advanced care paramedic I am the lead decision-maker for any given call). These considerations also deserve to be explored in more depth. Other aspects of decision-making include the use of research evidence in paramedic CDM and the acceptance of changes in practice (such as guideline updates).

These studies are merely scratching the surface of research questions that can be asked on CDM, not to mention related topics of patient safety, error, clinical quality improvement and others. The methods that were used in these projects can be replicated for other health disciplines in settings other than ground ambulance. For example, the Delphi study could be conducted for paramedics who work in the air medical transport setting or the emergency department. Likewise, a process map of a patient's visit to the emergency department could be created, and a Delphi study conducted of the most important decisions emergency nurses make, in terms of patient safety and clinical outcome. The phases of an emergency department patient visit could be visualized for decision density. In a follow-up TA study, paramedics, nurses and physicians could be enrolled. Their thinking strategies could be compared the same way we compared the experience level of our participants.

Studies like these are important for developing the field of clinical decision-making further, in order to understand more about how reasoning varies, and the impact on patient outcome and safety. The field of decision-making is multi-faceted, and includes theory and research evidence from psychology, philosophy, neuroscience, statistics, computer science and others (Croskerry, 2000). The academic work of these scientific disciplines needs to be interpreted and applied to the real time settings of health care providers, in an effort to improve the care that is delivered.

Paramedic Education

Through didactic learning, and even more so, during their clinical preceptorship, student paramedics learn how to manage an emergency call in a routine fashion. This occurs with the establishment of an emergency call schema in their memory. This seems to happen naturally over the course of the preceptorship, which involves observation, repetition, and following the actions of experts (their paramedic preceptors).

While students may quickly learn the process of an emergency call, it is unlikely they easily comprehend how decisions are made. Much has been written about medical education and the importance of teaching quality clinical reasoning through examples (Kassirer & Kopelman, 1989). In typical paramedic training, students learn and are tested extensively with scenarios and simulation. These scenarios should test thinking strategies, not just clinical conditions and treatment paths (Kassirer & Kopelman, 1989). Paramedic educators should feed information to the paramedic student slowly, to replicate how it is uncovered in practice (Kassirer, 1983). Every time a student asks a question, requests more information, or performs an assessment or treatment task, the scenario should pause, and the student explain why they are making the decision, and ideally recognize the pitfalls with the process used. Through this type of exercise, students can learn how to use different thinking strategies (Banning, 2008b). For instance, they can increase their ability to tap into System II thinking by pausing, developing hypotheses, and ruling them in or out as new information becomes available. This would be a departure from the tradition of teaching decision-making by following algorithms. Similarly, when paramedic students are in the clinical phase of their training, their preceptors should probe them about why they are making each decision, and discuss different thinking strategies. If this is not possible to do in real-time during the call, the questioning and discussion should ensue immediately after the call is complete.

In addition to teaching paramedics how to appreciate different thinking strategies, paramedic educators should specifically discuss which clinical decisions are important, and require deliberate, conscious decision-making, versus those decisions that are safely made with intuitive or unconscious decision-making. Given that the decisions paramedics make can have a major impact on some patients' outcomes, it is important for all students to learn about how decisions are made. A randomized trial should be conducted, comparing student CDM between a group that has received a module on reasoning and those who have not. If a difference in found in the quality of decision-making, paramedic CDM should become a mandatory competency for training, and be included in the National Occupational Competency Profile (Paramedic Association of Canada, 2001).

Currently, paramedic educators likely have little insight into their own metacognition. It is possible that they are passing on poor decision-making habits to their students, such as the inappropriate use of heuristics, and allowing biases to affect CDM. It is essential paramedic educators and clinical preceptors learn more about paramedic reasoning and how to incorporate it into paramedic training.

Paramedic Practice

Croskerry, Wears and Binder (2000) stated that each health discipline should identify meaningful patterns in practice that are prone to error. The process map created from the decisions identified as important in the Delphi study has done this. The *on scene treatment* phase of EMS care has the highest decision density, and is therefore prone to error and subsequent adverse events. This knowledge has important repercussions for current paramedic practice. Continuous quality improvement (CQI) paramedics and medical directors are tasked with ensuring the quality of care is high and risk of error is low. They need to work closely with paramedics who have made clinical errors. It would be desirable for these leaders to encourage paramedics to reflect on their thinking, and try new strategies, instead of only focusing on the clinical aspect of the error. It is imperative for CQI paramedics to be aware of the decisions that were found to be the most important for patient outcome and safety, and seek these out while conducting clinical audits of emergency calls.

Morbidity and mortality (M&M) rounds have a long-standing tradition in EMS. In these sessions, paramedics and medical directors gather to discuss emergency calls that were challenging or resulted in an adverse event (Cosby, 2009). The operational and clinical aspects of the call are discussed, and consensus is reached between the presenting paramedic and his or her colleagues on what the most ideal interventions (including assessment, treatment and transport) would have been. It is rare for a presenter to discuss what they were thinking at the time of the call, or the reasoning strategies they used. Presenters should be encouraged to conduct a cognitive autopsy as soon as possible after the call, in order to maximize recall. Cognitive autopsies are “a form of cognitive and affective root cause analysis” (Croskerry, 2005, p. 10). During the M&M sessions, the paramedic should focus on the events of the call and the decisions made, and also what they were thinking and feeling at the time. This metacognitive exercise would inevitably lead to improvements in clinical practice as paramedics learn more about how they make decisions during emergency situations. This information is at least as important to share in the rounds as the clinical details. Further to this, paramedics should be encouraged to write up case reports of calls that required challenging decision-making. As an example, Campbell et al (2007) published a case report that included a thorough analysis of the cognitive biases that caused a diagnosis to be missed in an emergency patient. Perhaps through the incentive of continuing education credits, paramedics should be encouraged to submit and share case reports of this nature.

In relation to case reports, a particular factor in EMS that makes it difficult for paramedics to improve their diagnostic skills is the almost complete lack of patient follow up and feedback. Very rarely, other than when adverse events are under investigation, do paramedics learn of their patients’ clinical outcome or final diagnosis. EMS operators should work closely with hospitals improve feedback and communication, to allow paramedics access to patient records in the spirit of continuing education.

KNOWLEDGE TRANSLATION

It appears important to change the way that front-line paramedics, educators, clinical quality leaders and medical directors think about paramedic clinical decision-making. During a TA interview, one paramedic stated,

I don't think know how I make decisions! I haven't thought about that before. I am too busy thinking about what to do next, not how to make a decision.

There are several different approaches for getting the results of this research to those who can use it. Publication in peer-reviewed journals is a passive knowledge translation (KT) activity because the timing of publication is not under the control of the researcher and readers must actively seek out these types of articles (Lomas, 1993). Paramedics often are not affiliated with universities, and have difficulty accessing academic journals. However, there is inherent value in the peer-review process as the first step in KT. It is important that researchers subject their work to peer-review, to ensure the scientific community considers the results to be trustworthy and valid. Therefore, one of the primary steps in this KT plan is to publish the results of each study in an academic journal. Journal selection should be considered with the reviewer expertise and audience in mind. Some reasonable examples are: *Prehospital Emergency Care, Academic Emergency Medicine* and *Annals of Emergency Medicine.*

Disseminating the results to the target audience involves purposeful activities, including synthesis of research information into a reader friendly format (Lomas, 1993). This KT plan includes writing an article on this topic for publication in a paramedic trade journal. The language and style of such an article would be more casual, but remain educational. The benefit of submitting to such a magazine is making contact with the target audience. These magazines are often found in EMS bases, where paramedics pick them up and read through during their down time. An example of such a magazine is *Canadian Emergency News*.

This KT strategy also includes interactive education sessions with paramedics. There are several opportunities for this, including paramedic conferences, education sessions, and mandatory in-service training. The key to success of such sessions is to include meaningful participation, in contrast to didactic presentations (Bero et al., 1998; Lomas, 1993). An example of an interactive session is where an emergency call is described. Audience members break into small groups and identify the most important clinical decisions in that call and how the paramedic made the decision (i.e., did they follow an algorithm? Did they rule out the worst-case scenario? Did they put together a pattern in the symptoms?). The best messengers for this are not the researchers, but rather paramedic education facilitators, to utilize their presentation and audience expertise, and to increase buy-in from the paramedics.

To increase the success of each of these KT activities, they will be purposefully planned to build on each other. The KT strategy is presented (Table 20).

Table 20 Knowledge Translation Strategy

Activity	Purpose	Estimated Timeline
Defend thesis	Complete research, present to academic community. Improve thesis based on recommendations.	Spring 2010
Public research presentation	Present the results of research, ideally to paramedic research audience (Dal EMS Research Day)	Spring 2010
Present studies at scientific assembly	Formally present research to relevant audience. Receive feedback from experts.	Summer & Fall 2010
Submit studies to academic journal	Receive feedback through formal peer-review and make results available to scientific community.	Winter 2011
Submit article to trade journal	Present information on topic to end-user audience. Include results of research with an emphasis on implications.	Spring 2011
Paramedic education sessions	Interactive education sessions. Use journal articles, and trade magazine article as resource materials. Create scenario activities to enforce the main messages.	Fall 2011

CONCLUSION

As the paramedic profession evolves and matures, it is essential for research to be conducted that looks inward and evaluates the processes of delivering care to our patients. High quality care includes decisions that are safe and effective. This thesis research on paramedic clinical decision-making was an important step forward. While there are many other research questions to be asked, these two studies have important implications for paramedic practice and training. Paramedics, like other health care professionals, must be open to continuously learning throughout their careers, to improve their practice. Decision-making is a critical feature of all clinical topics paramedics must stay current in. Increasing awareness of the importance of decision-making among paramedics is essential to improve care and minimize adverse events. Clinical decision-making is a topic of utmost importance to the development of the profession.

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APPENDIX A: INSTRUCTIONS TO DELPI STUDY PARTICIPANTS

ROUND I

Thank you for participating in this Delphi study on paramedic clinical decision making. This study is seeking your opinion on the decisions paramedics make during high acuity emergency calls that are most important.

IMPORTANT is defined as decisions that are likely to impact a patient's clinical outcome or patient safety.
For this first round of the Delphi study, please list all the decisions that paramedics make during a high acuity emergency call you can think of.

This round will be open for 14 days (until midnight on Sun, July 5th). After this round closes, the responses will be categorized and listed. In the second round, you will score each decision on a Likert scale of its relative importance to patient outcome and safety.

ROUND II

Thank you for your participation in the first round of this Delphi study. Your responses about important decisions on typical high acuity emergency calls have been received and categorized.
In this second round of the Delphi study, you will be asked to score each decision on a Likert scale in terms of its importance.
Remember, IMPORTANT is defined as decisions that are likely to impact a patient's clinical outcome or patient safety.

The purpose of this study is to achieve expert consensus on the important paramedic decisions. After the responses are received back, they will be ordered in terms of mean score. In the next round of the study, you will review the order the decisions have been placed in, and will be given the opportunity to change your score for each. It may take a forth round to achieve consensus amongst the group.

Again, thank you for participating, and your continued input.

ROUND III

Thank you for your participation in the first and second round of this Delphi study. In the first round, you submitted a list of paramedic decisions you thought were important. Your responses about important decisions during a high acuity emergency call were received and categorized. In the second round, you scored each of decision, in terms of its importance. The panel reached consensus on some decisions.

In this third round of the Delphi study, you are to review the list of paramedic decisions. You will be able to view your scores from Round II, and the group mean responses. You can change your score for any of the decisions in this round. As well, you can submit new decisions or any comments.

Remember, IMPORTANT is considered decisions that are likely to impact a patient's clinical outcome or patient safety. The Likert scale is as follows:

1: not important, very unlikely to impact patient clinical outcome or patient safety;

2: not very important, unlikely to impact patient clinical outcome or patient safety;

3: possibly important, it may impact patient clinical outcome or patient safety;
4: important, in most instances these decisions will impact patient clinical outcome or patient safety;
5: extremely important, very likely these decisions will impact patient clinical outcome or patient safety

Again, thank you for participating, and for your continued input.

ROUND IV

Thank you for your participation in the first three rounds of this Delphi study. In the first round, you submitted a list of paramedic decisions you thought were important. Your responses about important decisions on a high acuity emergency call have been received and categorized. In the second and third round, you scored each of the decisions, in terms of its importance. The panel reached consensus on some decisions. New decisions were added in each round by the panel members.

In this forth and LAST round of the Delphi study, you are to review the list of paramedic decisions. You will be able to view your scores from Round III (which you received in a separate email - please have this document when you complete this round), and the group mean scores. You can change your score for any of the decisions in this round.

Remember, IMPORTANT is considered decisions likely to impact a patient's clinical outcome or patient safety. The Likert scale is as follows:
1: not important, very unlikely to impact patient clinical outcome or patient safety;

2: not very important, unlikely to impact patient clinical outcome or patient safety;
3: possibly important, it may impact patient clinical outcome or patient safety;
4: important, in most instances these decisions will impact patient clinical outcome or patient safety;
5: extremely important, very likely these decisions will impact patient clinical outcome or patient safety.

Again, thank you for participating, and for your continued input.

APPENDIX B: INSTRUCTIONS TO THINK ALOUD STUDY PARTICIPANTS

Thank you for participating in this research study on Clinical Decision Making in Advanced Care Paramedics.

As a reminder, the purpose of this study is to learn more about how ACPs make clinical decisions. As such, you will not be evaluated for making the right or wrong decisions in the calls, so do not worry about this.

To evaluate how you make clinical decisions, we ask you to 'think aloud'. This technique has been used to study clinical decision making in other health professions. I will read you the introduction information for the scenario. No further information will be given without you asking for it. Each time you decide to conduct a key clinical task, which includes any assessment, treatment or transport actions, try to verbalize why you are making the decision. Each of the scenarios will end at pre-designated end-points.

I have a number of questions that I would like to ask you. This interview may take as long as 60 minutes to complete, and it will be tape recorded. In recognition of your time, you will receive a gift card for $25, following the interview.

Are you interested in participating?
Do you have any questions or concerns, before we start?

APPENDIX C: COPYRIGHT PERMISSION LETTER

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Jan L Jensen, Pat Croskerry, Andrew H Travers. Paramedic clinical decision making during high acuity emergency calls: design and methodology of a Delphi study. BMC Emergency Medicine 2009, 9:17 (21 September 2009)

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