CLINICAL DECISION MAKING IN PARAMEDICINE

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By MICHAEL EBY, H.B.A

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LAY ABSTRACT

Paramedics work in a fast-paced, dynamic environment. The types of patients, and the situations paramedics encounter are different every day. Paramedic practice is based on a series of provincial medical directives that outline the different proceedures, medications and types of patients that can be treated. While these directives cover many of the cases paramedics encounter, there will always be cases that don't "fit". The purose of this study is to see if paramedics approach those types of cases in a different way, and if their years of experience or level of training change how good they are at idenfiying what patients require treatment. As there is very little paramedic specific research on this topic, this study will serve as a starting point for future research and hopefully stimulate discussion about paramedic practice, and how to support paramedics getting better at their jobs.

ABSTRACT

Title:
Clinical Decision Making in Paramedicine

Author(s) & affiliation(s):
Michael Eby – McMaster University, Hamilton, ON, Canada
Sandra Monteiro – McMaster University, Hamilton, ON, Canada
Geoffrey Norman – McMaster University, Hamilton, ON, Canada
Walter Tavares – McMaster University, Hamilton, ON, Canada

Background:
Paramedics are frequently required to make rapid decisions in an uncontrolled, dynamic environment, often with limited diagnostic information. In Ontario, paramedic practice is based on a set of provincial medical directives that provide diagnostic and treatment criteria. Unsupervised deviation from these directives is classified as a form of error and highly discouraged. To date, there is little known about how years of clinical experience or level of certification affect the way these medical directives are used. The purpose of this study was to examine the relationship between paramedic experience, training and accuracy of treatment decisions when faced with patients who meet and fall outside of the existing medical directives.

Methods:
Thirty-one participants (16 experienced / 15 novice) were recruited from two paramedic services in Ontario. "Experienced" was defined as in-practice for 5 years or more. Participants were presented with 9 scenarios; in 6 scenarios, the patient presentation fit within the existing directives, while in 3 scenarios, the patient presentation fell outside the medical directives. Multiple-choice responses were used to capture participants' decisions to treat or not treat the patients. Responses were scored and submitted to a mixed-factorial ANOVA to evaluate differences in accuracy between case types, years of experience and level of training.

Results:
There was a significant effect of case type ($p < 0.004$). Accuracy was lower when the patient presentation did not meet the criteria of the medical directive (76.34% (CI = 67.15% to 85.53%) vs. 98.35% (CI = 96.55% to 100%) when they did. There was no effect of years of clinical practice or level of certification.

Conclusion:
The results suggest both novice and experienced paramedics are able to accurately apply medical directives, however, there is a significant decrease in accuracy when the patient presentation does not fit one. This variation in practice may have a significant impact on patient safety, and further research is required to determine what factors may be causing this decreased accuracy.

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CHAPTER 1: LITERATURE REVIEW

The concept of "expertise" is complex. In every domain, there exist individuals who are objectively better than the general population. Though usually easy to identify, trying to understand why that variation in performance occurs can be extremely challenging.

Our understanding of the origins of expertise has changed many times though human history. Once regarded simply as gifts or powers given to some individuals by the gods, our present day understanding of why some individuals excel at certain tasks has become much richer. Regardless of the source, there existed for thousands of years the notion that expertise was an innate, deterministic quality (Ericsson, 1993). Some individuals were born with "Greatness", whereas others were not. In that paradigm, there was little reason to study variations in performance – you were either born with it, or not. It wasn't until the 1950s that the notion of *experience* and the role it played in the development of expertise started to work its way into the mainstream. With this shift, the traits which led to expertise became something that could be studied and emulated, rather than innate. Instead of just being "born with it", there was something experts were doing *differently* from novices, and if that was true, those differences could be studied and translated into something that could be taught. Researchers like Ericsson led a series of ground-breaking studies that showed expertise has more to do with deliberate practice, feedback and experience than pre-determined genetics (Ericsson, 1993). These studies opened the door to our modern understanding of exceptional performance and expertise, and have led to an explosion of research on the subject.

While there has been a significant amount of research on the general subject of expertise, the majority of this research has been limited to domains outside of medicine. The study of chess masters revealed impressive feats of memory (though specific to chess) and the ability to draw on huge numbers of possible positions (de Groot 1966; Chase & Simon, 1973). The study of elite musicians showed that the biggest difference between the true "rockstars" of the violin world and other elite performers can likely be attributed to the number of hours they practiced (Ericsson, 1993; Coughlan et al. 2014). Even elite performance in sports, after meeting some genetic requirements (e.g. height for basketball players), also seems to come down to practice (Williams & Ford, 2008). From this, the concept of deliberate practice, self-reflection, and the importance of appropriate feedback grew, and have been applied to a wide variety of domains, from music to sport to medicine (Ericsson, 2007).

When outcomes are clear (like winning a chess game), differentiating between experts and novices is relatively straight forward. More importantly, in many domains, we have access to the *process* of that performance. It is relatively easy to identify a chess master's thought process when trying to understand the steps involved in choosing the next move in a game. As it turns out, expertise in chess largely rests in the ability to draw on a large amounts of stored moves / positions. Experts run through a multitude of possible outcomes and choose the next move based on the most likely or beneficial set of outcomes (Holding, 1992). This technique for decision making is likely the reason IBM's super-computer "Deep Blue" was able to beat a human opponent. The computer was simply able to run though more possibilities than its human opponent, and there was little more involved in the decision making process than that (Campbell et al., 2002).

Unlike researching the relatively accessible process of decision making in something like chess, diagnostic reasoning, or clinical decision making (CDM) in medicine is a much more challenging process to study. It may be that part of the confusion in CDM research stems from a disagreement of what of the term actually means. As noted by Norman (2005), research into clinical reasoning and decision making has been focused primarily on the process by which physicians arrive at their initial diagnosis. In that sense, CDM involves collecting data (through physical examination, history taking, diagnostic tools like imagining and blood work etc.) and making a choice between a series of alternatives or options (Sandhu et al, 2006). The difficulty in trying to define CDM comes from trying to narrow down what that *process* involves. Words like "judgement", "deliberate", "choice", "prioritize" and "plan" (Durning et al., 2013, Elstein & Schwarz, 2002) seem to be central to many definitions of CDM. Though specific to nurse practitioners, one of the only systematic reviews of the literature and attempts to create a definition and framework for CDM ultimately defined it as:

> Clinical decision making is a contextual, continuous, and evolving process, where data are gathered, interpreted, and evaluated in order to select an evidence-based choice of action (Tiffin, 2013).

This definition is a good example of the tendency for CDM researchers to focus on *conscious control* of the processes involved in decision making, excluding the potential role played by unconscious processes. To understand the importance of the distinction between conscious and unconscious processes, it is important to briefly trace the history of CDM research from the early hypothetico-deductive model, to the current discussion of dual-process theory and non-anlytical reasoning.

Research in clinical decision making tends to focus primarily on diagnostic accuracy, arguably because it is the easiest outcome to measure. Like the research into expertise in general, research in CDM has worked to identify what experts do differently from novices when it comes to making decisions (or specifically arriving at diagnoses). In the hypothetico-deductive model developed in the mid-70s, the difference was thought to lay in expert clinicians' ability to more quickly generate high numbers of diagnostic hypotheses than novice practitioners (Groen et al., 1985). This model largely lost favour as additional research showed that both novices and experts generated hypothesis, but experts tended to generate *better* (content) ones (McGuire, 1985, Mandin et al., 2007).

Because of this, rather than focus on the *process* of clinical reasoning, research in the field shifted onto trying to understand the content knowledge of experts. Largely motivated by psychology, this new focus attempted to show experts simply had more knowledge than novices, or organized that knowledge in a different way. Like many points in expertise research, this new direction makes intuitive sense. It is appealing to describe experts as simply "knowing more" than novices, and certainly fits with much of the previous expertise research (e.g. chess). Unfortunately, attempts to show this effect in medicine were largely unsuccessful, with the conclusion being "most kinds of medical expertise may not be particularly related to the ability to recall patient data" (Norman, 2005). If the raw amount of data was not the key difference between expert and novice performance, perhaps the difference lay in in how experts organized and accessed that information. This belief led to the important notion of "illness scripts", "mental representation", "encapsulated knowledge" and "probability matrixes"; all variations of a similar concept (Schmidt et al, 2007). In these cases, experts (often unconsciously) compare the current case to mental representations derived from experience and create hypotheses from them.

The process of comparing and organizing current cases based on previous experience is at the core of what will be explored in this research project. In its most basic sense, "categorization" is simply the way ideas and objects are organized, differentiated and understood (Rosch, E., et al. 1976). In medicine, initial diagnosis can be understood as primarily a categorization task, with practitioners combining and sorting features of a patient's presentation to determine the cause of their illness (Brooks et al., 1991). To understand the role of prior experience in this activity, it is important to understand two similar, but different theories about categorization in cognitive psychology. Both prototype and exemplar theory are primarily concerned with the way experience contributes to the categorization of new stimuli, but differ in the way that new stimulus is compared to previous experience. According to prototype theory, examples of a category are collected and combined over time to create a central, "averaged" representation (Geeraerts, D. 1989, Bordage, 2007). In this sense, a new stimulus is compared to a single representation, which becomes more complex over time. In contrast, exemplar theory states that a new stimulus is compared to a series of individual exemplars and with features from any individual one influencing the decision to add the new stimulus to that category (Norman et al., 2007).

When applied to categorization tasks in medicine, this concept forms an important basis of the classical medical education model. During their initial training, most medical students are taught basic science along with textbook examples of disease processes / illnesses, which are used to build the initial features of a category. As students progress though their training, they begin to build clinical experience (in clerkship / residency) and those categories become enriched or deepen as exemplars are added and prototypes evolve (depending on which theory you believe). Some programs (e.g. PBL) have been designed to expose students to simulated clinical situations in an effort to help build those exemplars at an earlier stage of training (Barrows, 1996). Repeating cases, with slight differences (or in different contexts) can help enrich those categories, but the majority of those exemplars are derived from real clinical experience, which is arguably why experience is a defining feature that separates expert and novice physicians (Hmelo-Silver, 2004).

Where that experience comes from and how it is used forms the basis of "dual-process theory", which is the current dominant model of clinical reasoning. In this model, there exist two systems of reasoning that operate independently of each other (Paley, 2007). System 1 (S1) is generally considered to be non-analytic - unconscious, faster and largely based on previous experience (e.g. prototypes and exemplars). Using this type of reasoning, practitioners generally draw unconsciously on their experience and make fast, intuitive judgments (Kahneman, 2003). System 2 (S2) is considered to be analytical reasoning - deliberate, conscious, and slower. Decision support tools such as feature lists, medical directives, clinical practice guidelines etc. are often associated with this type of reasoning (Croskerry, 2001). While there is much debate about the diagnostic accuracy of these processes, and how they interact (do they happen in serial or tandem, how and when does one switch between processes, does one "supersede" the other etc.), they remain as useful labels and a way of discussing these concepts (Croskerry, 2001; Norman, 2009; Marcum, 2012; Evans et al., 2013; Norman, 2015).

The true challenge in trying to understand expert performance in diagnostic reasoning lies in the "black box" nature of the process (Sandhu et al, 2006). While think-aloud studies – where participants work though a case while trying to talk through their thought process - may offer some insight into CDM (Fonteyn et al., 1993, Ericsson, 2006), they are not without their detractors (Yang, 2003). Like Schrödinger's ill-fated cat, any real attempt to have participants describe an unconscious process, effectively changes the process itself. The reality of how inaccessible these processes are means researchers have been forced to focus on outcomes and attempt to infer what steps led to them.

While the development of expertise in medicine shares many similarities to other domains (e.g. chess, sports, music), there are unique challenges to understanding the development of a skill such as clinical decision making. The importance of appropriate, timely feedback is a universal requirement for the development of expertise, regardless of the domain. Paramedics – likely even more than other fields within medicine – very rarely receive this type of feedback. The next chapter will explore this concept in more detail, as well as some features of paramedic practice and education that were the motivation for this study.

CHAPTER 2: PARAMEDICINE

In Ontario, paramedic practice is primarly goverened by two documents, the Basic Life Support Patient Care Standards (BLS PCS) and the Advanced Life Support Patient Care Standards (ALS PCS). These Standards provide "practice and patient care parameters needed to provide high quality patient care…" (Ontario MOHLTC, 2011). The ALS PCS contains medical directives that delegate medical acts used in the treatment of various medical conditions (e.g. suspected cardiac ischemia, allergic reactions, pain control etc.) (Ontario MOHLTC, 2011).

The ALS PCS exists in part to help guide the treatment decisions of paramedics, but also for legislative / legal reasons (Regulated Health Professions Act). As paramedicine is not a regulated health profession in Ontario, to perform delegated medical acts, paramedics are required to work though the license of a physician, with medical oversight being provided by the "Base Hospital" system. The Base Hospital system in Ontario is responsible for the delegation of medical acts, initial certification, continuing education and ongoing quality assurance. The Regulated Health Professions Act that allows physicians to delegate controlled acts, stipulates that the physician "delegating" the act must be present for the patient interaction, or see the patient afterwards. As this is unrealistic in the pre-hospital environment, the medical directives essentially act as standing orders that allow paramedics to practice autonomously, provided the patient meets the criteria outlined in the directive. The legal importance of adhering to these directives is one of the main reasons for the emphasis placed on them by the Base Hospital system.

With this in mind, initial training and continuing medical education of paramedics often focuses on the application of the ALS PCS medical directives to various patient presentations. From an auditing perspective, medical oversight is almost entirely concerned with adherence to the directives, with calls being investigated and feedback given when a 'variance' from the directive is found.

This focus on the directives not only affects practicing paramedics, but potentially has a "trickle down" effect on the initial education as well. Certification as a Primary Care Paramedic in Ontario requires a 1-2 year college program that meets the "Paramedic Program Standard" set out by the provincial Ministry of Training, Colleges and University (Ontario MTCU, 2008). In addition, many college programs in the province base much of their curriculum on a National Occupancy Competency Profile (NOCP) established by the Paramedic Association of Canada (PAC, 2011). While neither of these documents make explicit reference to medical directives, upon graduation from an approved college program, paramedics must also complete a written licensure exam and a certification process (usually OSCE / scenario based) by the Base Hospital. The written and scenario exams are almost entirely based on the provincial medical directives (and the patho-physiology involved with them), so many college programs informally focus on teaching students based on those directives.

Unlike physicians and their use of guidelines, paramedics do not have the autonomy to apply the medical directives at their discretion. If they decide optimal patient care requires deviation from the directive, they must call ("patch") to an on-call physician for permission. This process creates a challenge for individual practitioners, who are often faced with the choice to not treat the patient, re-interpret the patient presentation in a way that "fits" the directive, or to call a physician to obtain permission to deviate from the directive. Furthermore, these patches are often challenging due to technical difficulties, and the fact that they occur in complicated, high acuity situations. Lastly, paramedics are often required to "sell" their decision to a physician with whom they have little to no previous relationship. (Stewart, 1990).

While there are attempts by the base hospital system to encourage paramedic CDM beyond the medical directives, the reality of the system often does not reflect that message. Although the decision to apply a medical directive is always at the paramedic's discretion, that decision requires justification in the form of additional paperwork, or often a discussion after the fact with a supervisor from the base hospital system. This emphasis on the medical directives has created a system that (explicitly or not) may have the effect of encouraging paramedics to think about their patients in terms of "fitting" into those directives.

Despite the important role directives and guidelines play in clinical decision-making, they are not without their drawbacks. Most notably, while guidelines may be effective in capturing the majority of patients who require treatment, even the best-written set of rules will fail to capture all types of patients. Furthermore, these black and white rules cannot effectively account for context, especially in ambiguous or complex cases. In these cases, the medical professional must draw on experience to make diagnostic and treatment decisions, but unlike physicians, paramedics have limited autonomy in these circumstances.

As a relatively new profession, there is little paramedic specific literature, and even less related to paramedic CDM. In contrast, there is a large body of literature exploring experience, expertise and the process of decision making for both physicians and nurses. Much can be learned from physician and nursing specific literature as there are many similarities between the roles. All three groups deal with similar patient populations, specifically high acuity patients that require rapid decisions, often based on limited diagnostic information.

Over the past decade, much work has been done with Emergency Department (ED) physicians to explore their approach to CDM. Generally speaking, physicians are understood to use a combination of heuristics, categorization and decision making strategies to arrive at their diagnostic and treatment decisions. These strategies can be adapted depending on the situation, with a combination of non-analytical and analytical reasoning being used at various points in the process (Norman, 2007).

Similar to physicians, there is also a large body of CDM research in the field of nursing. Though much of the nursing literature seems to have a strong undertone of differentiating nursing practice from that of physicians (Cioffi, 2001), there is agreement on the importance of clinical experience, and varied strategies depending on the type of problem (Evans, 2005).

While the importance of experience and allowing medical practitioners to use their own judgment is widely recognized, clinical practice guidelines (CPGs) are still a cornerstone of modern medical practice. CPGs provide criteria for the diagnosis and treatment of illnesses to help guide decisions regarding patient care. Modern guidelines, created using evidence-based medicine, are touted as the best way to ensure patient safety and consistent delivery of medical care (Grimshaw et al., 2004; Lenzer, et al. 2013). While still a foundational aspect of CDM, many problems exist with CPGs, and adherence to CPGs by health care providers remains inconsistent (Lomas et al., 1989; Woolf et al., 1999; Timmermans, S. & A. Mauck 2005).

Over the past three decades, there has been a large amount of CDM research specific to physicians and their use of CPGs. A systematic review of literature from 1980 – 1991 by Grilli et al. found the mean compliance to practice guidelines by physicians was 54.5%, with higher complexity cases resulting in even less compliance to the guidelines. A 1991 review by Cabana et al. attempted to identify barriers to physician adherence as, "…guidelines had limited effect on changing physician behavior" (p. 1458). They identified "…lack of awareness, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, the inertia of previous practice, and external barriers." as the full spectrum of reasons physicians do not follow practice guidelines (p.1461).

These systematic reviews seem to start with the assumption that adherence to CPGs is the best way for physicians to make decisions regarding patient care, but CPGs are not without their detractors. In her 2002 discussion paper on intuition and evidence, Greenhalgh asks whether evidence based medicine could be considered "intellectual imperialism", with her concern of CPGs summed up as, "…the patient's unique and complex predicament is poorly served by applying a recommendation derived, however objectively, from an average result in a select population sample." (p. 396). This sentiment is echoed in Lugtenberg et al.'s 2009 review to evaluate the effectiveness of Dutch CPGs on both the structure of care, and patient outcomes. For the purposes of the review, they defined "structures of care", as "human, physical and financial resources that are needed to provide medical care" and found that CPGs created significant improvement in those areas (p. 386). Conversely, the review found “Evidence on the effectiveness of guidelines on patient outcomes is less convincing.”, calling for additional research to determine which CPG factors are important for improving patient outcomes (p. 391). While there may be benefits to the consistence of CPGs for an organization at system level, there is still much debate about their application to individual patients.

The importance of context in CDM was recently examined in a 2015 study by Mercuri et al. This study set out to examine the relationship between physician’s adherence to CPGs and patient context. Physicians were provided with a series of written cases, with half the cases containing a “context variable” designed to provide a reason to deviate from the CPG inserted into the patient history. The other half of the cases mirrored the first, but excluded the context variable. In cases without the context variable, both novice and expert (defined as at least 5 years of EM experience) tended to follow CPGs. In cases where the context variable was presented, expert physicians were more likely to deviate from the CPGs in their treatment decisions. The results of this study show that with experience, physicians are more likely to incorporate context into their decisions, rather than simply following CPGs which though important at a population level, are “…not designed to account for the unique needs of individual patients” (p. 5).

The challenge in applying generalized CPGs to individual patients is one that health care providers will always face. Part of the expertise in medical practice is the ability to distinguish between patients who meet the criteria and will benefit from the treatment outlined in the CPG, vs. those who fall outside the recommendation.

While there are similarities in terms of patient population and general thought processes, there are also major differences between paramedic and physician practice.

The setting in which paramedics work is vastly different from that of that of the hospital. The environmental factors faced by paramedics create a more dynamic setting, and limited diagnostic tools make decisions about definitive care difficult (Attak & Maher, 2009; Campeau, 2009; Bigham, 2015). Furthermore, and fundamental to this discussion, is that paramedics lack the autonomy to provide treatment to patients who do not fit the existing medical directives, requiring them to "patch" to treat those patients. While the structure of the medical directives and the ability to patch when they do not apply provide some opportunity to treat patients who fall outside the directives, the difficulties involved in the patch process, and the additional work required (documentation, quality assurance audits, justification to the base hospital etc.) often make the process so onerous, many paramedics may simply choose to transport the patient to the ED.

Although they form the basis of paramedic practice in Ontario, there is limited literature on paramedics and the use of medical directives. A 2013 systematic review of the literature found less than 500 articles related to guidelines and the pre-hospital care environment. Of those articles, only 30 met the inclusion criteria of the review, with only 10 being specific to paramedic practice. The authors found, that "…a gap between recommended care and clinical practice often exists.", and a "wide variation in adherence" existed between different pre-hospital organizations (Ebben et al., 2013). The authors go on to suggest a number of factors that could be influencing this "gap", from poorly designed guidelines (both in terms of their evidence base and applicability) to guidelines containing too many recommendations. Interestingly, the authors also noted that there may exist "…barriers specifically for individual recommendations rather than guidelines as a whole", which echoes the classic challenge of system level guidelines being applied at an individual level discussed above (p. 13). The authors conclude by recognizing the need for additional research to determine why this variation exists, and the relationship between guideline adherence and patient outcomes (p. 14).

A chart audit of 1246 cases over a two-month period done by Salerno et al. found that 16% of the calls reviewed contained deviations from the guidelines. Of those deviations, they concluded that "most protocol deviations (94%) in prehospital care did not cause patients to suffer complications…" (Salerno et al., 2013). Despite finding that the vast majority of deviations did not cause patient harm, the authors conclude that adherence to properly defined protocols is necessary to ensure the highest standard of patient care. The authors suggested annual or semi-annual reviews of the protocols, and continued quality assurance by reviewing all protocol deviations as ways to help ensure adherence to the protocols. It is unclear in the article if this is a novel suggestion for the organization, or if these feedback systems are already in place.

A number of retrospective studies of Emergency Medical Technicians (EMTs) in the United States examined the relationship between protocols and the administration of aspirin (ASA). Hooker et al. found over an eight-week period, only 25% of patients who met the protocol for administration of ASA actually received the drug (Hooker et al., 2006). In their discussion, the authors noted that while the protocol was appropriate for "classic" chest pain presentation, paramedics tended to underutilize the medication in patients presenting with atypical chest pain. The authors concluded that "A more restrictive protocol is likely to result in some patients with ACS not receiving aspirin…" (p. 103). While there was no discussion in the article about paramedic autonomy, and decisions to deviate from the protocol, this article highlights the risk of overly restrictive protocols. In the case of EMTs in the US, a large number of patients experiencing chest pain did not receive treatment because the protocol was too narrow, and it is possible the paramedics lacked the training and autonomy to use their own experience when patients did not meet its criteria. Another study on the administration of ASA in the US done by Snider et al. compared rates of ASA administration before and after a protocol change and additional education. The results of this study were even more dramatic than Hooker et al., with the authors finding that only 15.1% of patients requiring ASA administration received the drug. A change in the protocol increased that number to 26.8%, and education surrounding the new protocol further increased appropriate administration to 37% (Snider et al., 2004). While this increase is promising, the majority of patients requiring ASA administration in the study did not receive the drug. For this intervention, there still exists a large gap in care that does not seem to be solved by simply updating protocols and educating paramedics about their use. Further research to explore the decision-making process of EMTs is required to understand why so many chest pain patients are still not receiving ASA, and propose solutions for ways to close that gap.

Two recent qualitative studies done in the U.K explored decision-making through interviews with paramedics. A study by Burrell et al., found that decisions about the treatment and transportation of patients with epilepsy were "substantially guided by ambulance clinician experience rather than by robust training and guidelines" (Burrell et al., 2013). A similar study by Halter et al. focused on paramedic decision making regarding elderly patient who have fallen. Their study involved interviews with paramedics who were trailling a new clinical assessment tool (CAT) (effectively a practice guideline) for patients who had fallen and determined that, "…interviewees generally were clear that they did not use the CAT as an aid to patient assessment and the subsequent decision making" (Halter et al., 2011). The authors did not suggest reasons for the lack of utilization of the tool, but emphasized the tension between the "formal" decision making process based on procedures, and the more "informal" process based on experience and intuition (p. 49).

A number of themes emerge from the limited literature that exists regarding paramedic practice and the use of guidelines. First, and similarly to physician based literature, there exists a tension between system or population level guidelines and incorporating context when trying apply them at the individual patient level. While evidence-based guidelines may statistically be the most appropriate treatment for the average person, any experienced clinician knows that the "average" patients rarely exists. The second theme that can be drawn from the literature is that paramedics seem to inconsistently follow practice guidelines. Like physicians, they seem to make decisions based on their experience, and in the case of EMTs in the U.S, changes in protocols and further education about them seem to have limited effect. Part of the motivation for this study was to use the context of Ontario paramedic practice to contribute to both paramedic-specific CDM literature, and to the overall body of CDM literature from the relatively understudied perspective of paramedics.

CHAPTER 3: METHODS

The intent of this mixed factorial study was to explore the relationship between paramedics and the use of the provincial medical directives in their decision making process. In particular, is experience or level of certification related to how well paramedics make appropriate decisions to either treat or not treat patients who do not fit all the criteria of a given medical directive?

Research Questions

1. Are paramedics able to make appropriate treatment decisions for patients who do not meet the criteria of an existing medical directive?
2. Is experience (years of clinical practice) related to the accuracy with which paramedics make these decisions?
3. Is level of paramedic certification (Primary vs. Advanced Care) related to this accuracy?

Study Design

This experiment was conducted using written clinical scenarios with multiple choice (MC) responses in an online format. Cases were designed to test the initial decision to treat or not treat the patient, whether or not they met the conditions of the provincial medical directives.

Paramedics from the York Region and Simcoe County in Ontario were recruited to participate in this study. Participants in this study were presented with 10 written clinical scenarios online and asked to make an initial treatment decision. All scenarios were similar in format to those used in paramedic testing, so was familiar to the participants. In 6 scenarios, all relevant patient and clinical features were matched to specific medical directives. In 4 scenarios, the majority of relevant features were matched to specific medical directives, however some did not match. For 8 of the scenarios the appropriate course of action was to treat the patient, and for the remaining 2, the appropriate course of action was to not treat the patient. For the scenarios requiring treatment, responses were coded as correct if participants opted to treat or "patch" for treatment, and incorrect if they opted not to treat. For scenarios requiring no treatment, responses were coded as correct if they opted to "monitor and transport" or not to treat the patient. This was a within-subjects design with one within-subjects factor of case type (meets directive or does not) and 2 between-subjects factors of experience (experienced or novice) and level of certification (ACP and PCP).

Materials

Scenario design and pilot

Sixteen initial scenarios were created in consultation with a PGY5 resident emergency medicine (EM) physician to ensure content validity and to establish the correct diagnosis / course of action for each case. The scenarios were created based on personal experience, and represent situations that paramedics are likely to encounter in their regular practice. Each scenario included background information, patient presentation, patient health history, initial vital signs and applicable information from a physical exam.

All sixteen scenarios were pilot tested with five practicing paramedics (See Figure 2 for pilot results) to determine both construct and content validity. Participants in the pilot process had a general understanding of the project, but were not aware of what the questions were measuring. The pilot group completed the scenarios in the same online format as the final study. After each scenario, they were asked to make notes about both the content and format of the questions. Feedback on the scenarios was collected via informal interviews that were conducted in person and on the phone with four of the participants, and written feedback on each question was obtained from the final member of the pilot group. Based on their feedback, ten of the scenarios were selected, then reviewed independently by an additional EM physician with experience working with paramedics. Agreement was reached between the two physicians on the diagnosis, the most appropriate course of action (treatment or no treatment) for each case, and that all ten case presentations were similar in difficulty. See Appendix A for full scenarios.

Written clinical scenarios with MCQs were used in this study for a number of reasons. As this is a novel study, there is no paramedic specific literature with which to compare. Written cases have been used in CDM studies involving physicians (Mercuri et al., 2015), and clinical vignette MCQs are the psychometric basis of many medical education and licensure exams (Wass et al., 2001; Coderre et al., 2004). MCQs have long been studied and shown to be a valid form of psychometric testing for clinical competence (Hansen & Dexter, 1997; Haladyna et al., 2002; Tarrant & Ware, 2010). Paramedics in Ontario are familiar with the written case with MC question format as it forms the basis for the AEMCA Exam (provincial licensure), and the test format often used in the Ontario college system.

Participants and Recruitment

Participants were recruited from two large paramedic services in the province of Ontario. The County of Simcoe Paramedic Services (352 active paramedics) and York Region Paramedic Services (511 active paramedics) received an invitation to participate in the study via their internal distribution lists (see Appendix B). Both of these paramedic services contain a mixture of urban and rural practice, so are a good representation of the majority of clinical settings in the province. Participants in this study were either practicing "Primary" (PCP) or "Advanced" Care Paramedics (ACP). In the province of Ontario, certification as a PCP requires a 12-month private college or 2-year public college training program, and successful completion of the provincial licensure exam (AEMCA). A PCP is defined in the Ambulance Act (Section 6(1) of Regulation 257/00) as able to perform "Schedule 1" and some "Schedule 2" controlled acts (as authorized by a medical director). "Advanced Care Paramedic" (ACP) is a PCP who has completed an additional year of training (college program) and passed the Advanced Care Paramedic provincial licensure exam. ACPs are able to perform "Schedule 2" controlled acts and some "Schedule 3" as authorized by a medical director (Ambulance Act, 2011). Estimating a sample size for this study based on previous paramedic specific literature was not possible. A similar study with physician participants done by Mercuri et al. in 2015, established a difference in accuracy between case types with 56 participants (in 2 groups) (Mercuri et al., 2015). Based on normative effect sizes within the larger body of cognitive psychology literature (Norman, Monteiro, & Salama, 2012), we assumed an alpha of 0.05, an assumed power of 0.8, and a predicted effect size of 0.8. A sample size of 20 per group (novice PCP, experienced PCP, novice ACP, experienced ACP) was estimated be sufficient to find an effect. With this in mind, the initial recruitment goal of the study was set at 80 participants.

Procedure

Once participants responded to the invitation, a unique link generated by the online software and sent to the email they provided allowing them to access and complete the online survey only once. Their email address was then deleted and the remainder of the results were completely anonymous.

Before gaining access to the online survey (via LimeSurvey) participants were presented with an online consent form (Appendix C). Once consent was obtained, they were asked basic demographic information then presented with 10 clinical scenarios. In an effort to help control for knowledge of the medical directives themselves, participants were told to reference the medical directives during the survey, and provided with a link to an electronic version of the ALS PCS that could be used during the study.

The scenarios were presented at random, but fell into 2 categories where either:

- The patient presentation met the clinical conditions outlined by the current provincial medical directives (6 scenarios). "Meets Directive"
- The patient presentation did not meet the criteria for treatment under the current provincial medical directives (4 scenarios). "Does not meet Directive"

Despite not meeting the criteria for treatment outlined in the provincial medical directives, the appropriate course of care for each case in the second category ("Does not meet Directive") was to provide treatment to the patient.

At the end of each scenario, participants were presented with the same list of multiple choice (MC) options to determine their initial course of action ((1) do not treat (leave the patient at home or monitor and transport), or (2) treat the patient). For every scenario, participants were given the option to "patch" in the list of multiple-choice answers. If that option was selected, a "free-text" field required the participants to explain their reason for the patch. Lastly, every scenario had two (optional) free text fields where participants were asked to provide a working diagnosis of the patient, and identify which (if any) medical directive could apply to the scenario. See Appendix D for screen shots of LimeSurvey.

Follow-up

Upon completion of the survey, participants were given the option to provide their email address, which was not linked to their answers. Once the study was complete, an email debrief futher explaining the purpose and results of the study was sent to all participants who requested further information.

Scoring

For the scenarios where treating the patient was the correct course of action, participant answers were coded in binary as either "no treatment" (incorrect) or "treatment" (correct). For the scenarios where not treating the patient was the correct course of action, participant answers were coded in binary as "no treatment" (correct) or "treatment" (incorrect). If the participant made the decision to patch and request treatment orders, that was considered analogous to a treatment decision, as the act of patching implies the participant recognized the patient required treatment, despite not meeting the criteria of the medical directive. The breakdown of the specific coding is listed in Figure 1.

In addition to the MC options, the free text fields were reviewed and coded as either "correct" or "incorrect" by one reviewer (ME) for secondary analysis. For each case, the field "Working Diagnosis" was compared to the correct diagnosis agreed upon by the EM physicians during the scenario design process. Responses were coded as “correct” if the participant correctly identified the diagnosis, and “incorrect” if they did not.

For the field “what medical directive (if any) applies to this scenario”, in cases where there was a medical directive that applied, responses were coded as correct if the participant correctly identified the directive and incorrect if they did not. In the cases where no medical directive applied, responses were coded as correct if participants noted there was no directive that applied and incorrect if they identified a directive. For both fields, if the participant did not answer, the response was excluded from the analysis.

Based on normative effect sizes within the larger body of cognitive psychology literature (Norman, Monteiro, & Salama, 2012, the initial recruitment target was set at 80 participants (20 per group). After one month, recruitment and participation in the study had slowed dramatically. In strategizing recruitment options, a preliminary analysis of the emerging data was conducted. At that point, the trend in the data made it clear that the number of participants required to show a statistically significant difference between levels of experience or certification was unfeasible. For this reason, the study was stopped and data from thirty-one participants was used in the analysis and evaluation of the study design. Of the 31 participants, 17 (55%) were Primary Care Paramedics, while 14 (45%) were Advanced Care. Years of clinical experience was captured in ranges, with 2 (6%) of participants having <1 year of experience, 11 (36%) of participants having >1 to <5 years of experience, 5 (16%) with >5 to <10 years of experience and 13 (42%) with >10 years of experience. For the purpose of this study, “Novice” was defined as < 5 years of clinical experience, with “Experienced” being defined as > 5 years. This differentiation has been used in similar studies (Mercuri et al., 2015) and is roughly based in the "10 000 hour" rule originally discussed in Ericsson (1990, 1993).

During the initial analysis of the results, an error was discovered in Scenario 2 (Sepsis – marked with an asterisk in Appendix A). The decision was made to remove the responses to that scenario and conduct the final analysis with results from the remaining 9 cases.

To address the possibility of a relationship between knowledge of the directives and how to apply them (which may be different from a treatment decision or working diagnosis), the free text fields were reviewed and coded binarily as either "correct" or "incorrect" by one reviewer (ME), then analyzed to determine if there was a correlation between the accuracy of treatment decision, working diagnosis and ability to identify the correct medical directive.

Analysis

Individual cases were scored correct or incorrect (i.e. 1 or 0) and average scores for each case were submitted to a single repeated measures ANOVA (2x2x2) with one within-subject factor, case type (meets directives vs. does not meet directives) and two between subject factors; experience at 2 levels (novice and experienced) and level of training (Primary Care (PCP) and Advanced Care (ACP) Paramedic.

CHAPTER 4: RESULTS

Does case-type affect the accuracy of treatment decisions?

Participants overall were able to make the appropriate treatment decisions for cases where patients met the criteria outlined in the medical directive with a high degree of accuracy 98.35% (CI = 96.55% to 100%), but that accuracy decreased to 76.34% (CI = 67.15% to 85.53%) when the patient presentation did not meet the criteria of an existing medical directives. The main effect of case type was meaningfully and statistically significant; $F_{(1,28)} = 20.5$, $p < 0.001$. See Figure 3.

Does experience (years of clinical practice) affect this accuracy?

Years of clinical experience had no statistically significant effect on accuracy; $F_{(1,28)} = 0.038$, $p > 0.3$, with the mean novice group score of 89.87% (CI = 82.48% to 97.22%) compared with the experienced group score of 85.27% (CI = 77.5% to 93.04%). See Figure 4.

Does level of certification (Primary vs. Advanced Care) affect this accuracy?

Level of paramedic certification also had no statistically significant effect on accuracy $F_{(1,28)} = 0.165$, $p > 0.3$. The mean PCP score of 88.87% (CI = 82.63% to 95.11%) compared with the mean ACP score of 85.24% (CI = 75.60% to 94.88%). See Figure 5. There were no interactions between years of clinical experience and level of certification.

Free-text fields

There was no correlation between the accuracy of treatment decision, working diagnosis and ability to identify the correct medical directive (if applicable). Overall, participants were able to identify the appropriate medical directive when applicable with an accuracy of 88.5 %. Neither years of clinical experience, or level of certification had any statistically significant effect on this accuracy. Case type had a significant effect on the accuracy, with participants identifying the correct directive 98.4% of the time when the case type met the conditions of a medical directives. When it did not, only 68.8% of participants correctly identified there was no directive that applied to the case. See Figure 6.

CHAPTER 5: DISCUSSION

The purpose of this study was to examine the diagnostic accuracy of paramedics. Specifically, the initial decision of whether or not to treat the patient, and the relationship between the patient presentation and the Ontario Provincial Medical Directives. We sought to establish if years of clinical practice, or level of certification, had any effect on the decision to treat patients, whether they met the medical directives or not. The results of this study show that all paramedics, regardless of their level of experience or training, recognize patients who require treatment when their presentations meet the conditions of one of the provincial medical directives. When patient presentations fall outside the medical directives, the accuracy with which paramedics make appropriate treatment decisions decreases. These results may be explained given the context in which paramedics practice, and our understanding of how diagnostic expertise is developed.

Analysis of the free-text responses to working diagnosis and what medical directive (if any) applies to the cases showed that both novice and experienced paramedics were able to identify the correct diagnosis and medical directive with a higher degree of accuracy when the case presentation met the criteria of an existing medical directive. These results are not suprising as "novel" cases (those whose features do not fit the pattern of the medical directives) should be more difficult to recognize than the ones that fit the medical directives. Of interest, is that while we would expect novice clinicians to find novel cases more challenging, the decrease in accuracy was seen for both novice and experienced paramedics.

This study was not designed to explain *why* the accuracy of treatment decisions decreased – rather, we sought to simply identify a behaviour. This discussion section will situate the study in the context of how CDM expertise is developed, then outline some features of paramedic practice that may explain the decrease in accuracy. While there are a number of possible reasons for the behaviour of participants in this study, it is possible that an emphasis on adherence to guidelines, combined with a system that provides very little feedback to paramedics has resulted in the limited development of experiential knowledge, especially for cases that do not fit the existing directives. Finally, a number of questions that have arisen from this initial study will be discussed, and possible follow up studies to explore them will be presented.

Fundamentally, the results of this study may show that clinical experience or level of initial training alone are not sufficient for the development of expertise. There is little debate in the literature regarding the importance of appropriate, timely feedback, and lack of feedback has predictable consequences on the accuracy of diagnostic reasoning. As discussed earlier, if initial diagnosis is considered to be a categorization task, the role of prior experience (and feedback) can be best understood in the context of prototypes and exemplars. Prototypes in this case can be thought of as an aggregate of examples, essentially an average of possible features of a representation (Bordage, 2007). There are many parallels that can be drawn between prototypes and the guidelines used by medical professionals. Clinical practice guidelines are built from average or system level data, and are used as a starting point for the diagnosis and treatment of patients. In many cases, these guidelines contain feature lists that can be used to aid in diagnosis. Similarly, the medical directives used by paramedics in Ontario are based on system level data and contain criteria (features) under which paramedics can initiate treatment for patients. In this sense, paramedics may use the medical directives as prototypes for the illnesses they represent. While there is undoubtedly a place for guidelines and feature lists, studies with physicians have shown they do not increase diagnostic accuracy (Dreyfus & Dreyfus, 2005; Norman, 2009; During et al., 2015), and experienced physicians tend to deviate from those guidelines and incorporate patient context in their decision making (Mercuri et al., 2015; Wieringa & Greenhalgh, 2015). Importantly, paramedics do not have the same autonomy to treat patients who do not meet the guidelines of the medical directives, and this distinction may play an important role in how paramedics categorize their patients.

In contrast to the single "average" prototype, exemplars are best thought of as a series of prior experiences to which new experiences (stimuli) are compared. Though subtle, this distinction is important, as exemplar knowledge is based more on prior experience, and provides a more flexible way to interpret new stimuli. The difference between these two ways of categorizing can be explained using an example in medical diagnosis. Imagine a novice paramedic who comes across a patient having a heart attack or myocardial infarction (MI). Having very little clinical experience (exemplar knowledge) to draw on, the novice paramedic would quickly have to rely on the "classic" or "typical" criteria for an MI, likely learned in their initial training. This "classic" presentation may include things like crushing chest pain radiating to the left arm, shortness of breath, nausea etc.; average features which make up the prototype of an MI. Should the patient present with these features, the novice paramedic will quickly categorize the patient as having an MI and begin treatment accordingly. The problem for our paramedic (and patient!) arises when their presentation does *not* contain the features of an average MI (e.g. the patient is complaining of upper abdominal pain, shortness of breath and dizziness). In this case, the features of the prototype may not be sufficient for the paramedic to recognize the patient is having a heart attack. When presented with an atypical case, we would expect more experienced paramedics to draw on their previous encounters (exemplar knowledge) with MI patients and recognize the patient was having a heart attack. In this sense, exemplars allow flexibility that prototypes do not; but they require the proper conditions (namely appropriate feedback, not just initial training or years of experience) to develop. It is possible that paramedics are using the provincial medical directives as prototypes, and therefore struggle to recognize patients requiring treatment when their presentation does not match those features.

It is important to note that this discussion is not a critique of guidelines. On the contrary, there is little debate that guidelines are an important and necessary component of medical practice. That being said, even the best written guidelines cannot capture every patient encounter, as they are based on system level or average data. The very nature of system level practice guidelines means they cannot account for the context of the individual patient, and as any clinician knows, that context is an important factor in the diagnosis and decision to treat patients. The challenge faced by medical professionals and their application of guidelines is summed by well British physician NW Goodman who states, "just because the average woman in the United Kingdom is a dress size 16 it does not mean that all women should wear that size clothes." (Goodman, 1998).

While there is an early emphasis and focus on the use of guidelines for new physicians, experts tend to incorporate context and deviate from the guidelines when appropriate (Mercuri et al., 2015). In addition, feature lists (a common component of guidelines), have been shown to be problematic for both novices and experts. A series of dermatology studies done by Brooks, Norman and Allen showed that physicians relied more on past examples than feature lists and rules for diagnosis (Norman et al., 1989; Brooks et al., 1991). These studies played an important role in solidifying the importance of prior experience in diagnosis and decision making. Similar to thinking of the directives as prototypes, a possible explanation for this decrease in accuracy seen in this study is that paramedics are using the provincial medical directives as feature lists for their decision making. The near perfect accuracy of participants when the cases fit the medical directives means that paramedics are very good at applying the directives, but struggle when the patient presentation contains different features.

With experience, physicians are able to recognize patients who require treatment, even when the guideline does not recommend it (Mercuri et al., 2015). It is important to contrast this with the paramedics in this study, who seem to be behaving in a very different way. Importantly, if the study participants behaved the same way physicians do, we would expect to see a drop in accuracy for novice (inexperienced) paramedics, with experienced paramedics making more accurate treatment decisions. Interestingly, the experienced paramedics in this study behaved almost identically to novice paramedics (they were in fact, slightly *less* likely to treat patients who did not meet the directives), despite the fact they required treatment. While these results seem contradictory on the surface, there are a number of possible explanations that can be hypothesized, but require an understanding of the context in which paramedics are educated and practice.

As discussed in previous chapters, while there is an extensive body of literature on the development of physician expertise and their use of guidelines, there exists very little paramedic specific literature on the subject; making it challenging to situate the results of this study in the current literature. The system in which paramedics work is very different from physicians, as is the level of autonomy they have to make clinical decisions. This environment may affect the way paramedics approach initial diagnosis of a patient, and it certainly affects the type of feedback they receive.

As discussed above, paramedic practice in Ontario is largely based on a series of provincial medical directives, and it is possible that the focus on adherence to these directives is part of what is driving the results of this study. These medical directives exist in part to help guide the treatment decisions of paramedics, but also for legislative / legal reasons (Regulated Health Professions Act). From personal experience, this emphasis on the directives, from early education through the initial certification process teaches paramedics to think in terms of categorizing patients into various medical directives. Once a paramedic enters practice, these categories are only further reinforced by the feedback they receive from the base hospital system.

The vast majority of feedback paramedics receive on their practice is centered on whether they adhered or deviated from the medical directives. In most systems, an automatic message is triggered as soon as a "variance" is discovered, which is then reviewed by an auditor and sent to the paramedic. Depending on the severity of the variance, the paramedic is often required to contact the auditor and discuss the call. To date, there has been no research showing what effect this system has on the way paramedics approach decision making – but it is reasonable to infer that this type of feedback would have an effect.

In addition, the environment in which paramedics practice makes it difficult to receive any feedback on the diagnosis and ultimate outcome of their patients. Often paramedics drop a patient off at an ED, never see them again, and receive no follow-up about their condition. For paramedics, this lack of feedback makes the development of diagnostic expertise difficult if not impossible to achieve, and may be another factor influencing the results of this study.

Another possible factor driving the results of this study has to do with what happens when a paramedic encounters a patient whose presentation does not meet any existing directive. In these cases, paramedics can call (or "patch") to a physician to discuss and potentially receive orders. While patching is (almost) always an option, there are a number of factors that may deter paramedics from doing so. First, patching often requires the paramedic to make a case for why they want to treat the patient who does not meet the medical directive. There is an inherent stress in these discussions, as the paramedic essentially has to "sell" their request to the physician and faces the possibility of rejection, and in some cases embarrassment for making the request. Furthermore, this process requires the use of cellular telephones, which pose logistical and technological problems. Often paramedics are calling from locations with poor cell signal (e.g. basements, loud environments, rural areas with minimal cell coverage etc.). From the outset, this makes communication difficult, and paramedics are sometimes required to leave the patient to make these calls. Lastly, and quite simply, there is work involved in the patch process (the initial organization, discussion with the physician, carrying out the orders and additional paperwork). While it is tempting to say all paramedics are willing to put the extra work in if they believe the patient requires treatment, it is possible that this added effort tips the scales, and may be motivating the decision to simply transport the patient to the ED. If these factors affect paramedic decisions about treatment or transport of patients in the real world, they subsequently would have an effect on the results of the study.

A fundamental question that has been raised by this study is the role of feedback in the development of expertise in paramedicine. As experience seems to have no effect on accuracy when patients do not fit the existing directives, it is clear that years of clinical experience alone are not enough to recognize these types of patients. The near perfect accuracy of patients who fit the directives means both novice and experienced paramedics are good at applying the directives. When a patient no longer fits a directive, we would expect participants to draw on experience to recognize and treat the condition anyway. The fact that participants were not doing this with the same degree of accuracy, may indicate a deficit in this type of knowledge. One possible explanation for this deficit in knowledge is the lack of feedback provided to paramedics in their practice. A series of follow-up studies could be designed to explore this question by presenting participants with similar cases, then providing feedback on their results. A second set of written cases could then be presented at a later time and accuracy could be compared to see what (if any) change occurred.

As discussed above, this study was not designed to answer questions about *why* there is a difference in accuracy of these treatment decisions. While it is possible the results of this study are being driven the lack feedback, paramedic culture or nuances of the patch process, there are a multitude of other possibilities to explain these results. The experiment design itself (the cases, survey instrument etc.) may be affecting the results of this study.

Regardless of the *cause* of the decrease in accuracy, there are potential patient safety concerns the arise from the results of this study. In a real-world context, these results indicate that if a patient's presentation does not fit one of the existing medical directives, they have a 24% chance of not being treated, even if treatment is the best course of action. While medical directives are necessary, there will inevitably be situations where they do not apply. In these cases, it is important for paramedics to be able to use their experience to make decisions about patient care. These results seem to indicate that paramedics are not doing so with the same degree of accuracy, which is a problem. While there are a number of possible cultural, educational and system level explanations for this decrease in accuracy – the fact that it exists is enough to call for more research, and to at least start a discussion about changing the way the system can support paramedics in building expertise from their experience.

CHAPTER 6: LIMITATIONS

This study has several limitations, the first of which being sample size. Although the initial recruitment goal was set at 80, only 31 participants completed the study. While this number of participants make this a relatively small study, there was still a statistically significant effect noted between case types. As discussed above, the number of participants required to show a statistically significant effect in the between-subjects factors was far greater than could have been reasonably recruited.

One possible confounding factor in the results of this study is the participant's knowledge of the medical directives. Given the central role these directives play in the study, any issue surrounding knowledge of those directives would have a large impact on the results. Although efforts were made to control for this factor (participants were encouraged to reference the directives and were provided with an electronic version of the ALS PCS), there is no way of guaranteeing this document was referenced. While it is still possible knowledge of the directives affected the results, it is unlikely given the high degree of accuracy with which participants were able to recognize patient presentations that met the existing directives. The difference in accuracy between case-types (regardless of level of experience or training) is not likely due to knowledge of the directives, but a simple test of the medical directives prior to being shown the cases could be used in future studies to address this concern.

Another possible confounding factor of the results of this study is that the cases in which the patient presentation did not fit the medical directives are simply more difficult. Cases that do not fit the "usual" pattern are inherently more challenging to identify, so the effect of case-type (decreased accuracy) could be be a result of that complexity. All the cases used in the study were independently reviewed by two experts (emergency physicians with experience working with paramedics), and piloted with 5 practicing paramedics. Part of the design and pilot process included ensuring all the cases used in the study were of similar difficulty, but the nature of patient presentations that do not fit the existing medical directives still could have make them more challenging to the participants. That said, if case difficulty was the cause of the decreased accuracy, we would expect novice paramedics to be less accurate than the more experienced paramedics. As the experienced participants in the study performed almost the same as the novices on the cases that did not fit the directive, it is unlikely case difficulty alone was the cause. To address this potential confounding factor in follow-up studies, more attention could be given to validate the cases for difficulty (eg. item analysis, inter-rater agreement, more extensive pilot process etc.). A follow up study could be done using a series of paired cases (A and B) that are identical except for one feature that made case A meet an existing directive, and case B fall outside a directive. This case design would help ensure consistency in the difficult of the cases and potentially eliminate that variable.

Another limitation to this study is its potential generalizability. The pre-hospital care environment in Ontario is relatively unique, with other provinces and countries operating under different systems. As such, it may be difficult to generalize the results of this study to paramedic practice outside of the province. While there are differences, many of the fundamental aspects of paramedic practice remain the same, and these results may still be used to contribute to the overall discussion and body of CDM (in particular paramedic specific CDM) literature.

As part of the secondary analysis, having one reviewer code the responses from the free-text fields is a potential limitation in this study. Data from these fields was not used to answer the research questions of the study, so having one reviewer code them does not change the validty of the overall study. That said, if future studies on this topic contain similar free-text responses, coding them with multiple reviewers could increase the validity of that process.

A major question that has come out of this study is the role of paramedic culture surrounding the use (and deviation from) medical directives. As discussed above, the process of patching carries an additional workload, as well as potential fear of being denied the order or reprimanded (by the patch physician or base hospital audit) for attempting to deviate from the existing medical directives. While very little research has been done on the patch process, anecdotally, there is a culture of avoiding patches amongst practicing paramedics. This results in one of two outcomes; first, provided the intervention is not life-saving, the paramedic may recognize the need for treatment, but simply choose to monitor the patient and transport them to the hospital. Secondly, experienced practitioners may become experts in finding work-arounds that allow them to make the patient "fit" an existing directive and practice autonomously. If these issues affect paramedic practice in the field, it is reasonable to assume they would impact the results of the study as well. This initial study was not designed capture these types of cultural issues, which may be affecting the overall results. That said, these patch issues affect both novice and experienced paramedics, so it is unlikely the patch process alone is driving the results of this study. A follow up, qualitative study could be done to explore paramedic practice in general as well as paramedics' experience with the patch process and the use of medical directives.

CHAPTER 7: CONCLUSION

The motivation for this study came largely from personal experience as a practicing paramedic in the province of Ontario. The emphasis placed on adherence to the provincial medical directives from early education through to continuing medical education makes them central to paramedic practice in the province. While these medical directives undoubtedly capture a large number of patients and provide good direction for their management, like all guidelines they cannot account for the context of individual patients. The question of how much the emphasis on adhering to the directives affects the way paramedics approach patient care decisions is an important one that has yet to be explored. While there is a large body of literature regarding the use of clinical practice guidelines, the development of expertise and the role of feedback in medicine – the majority of it focuses on physician (or nurse) practice in the hospital setting. While some conclusions can be drawn from the parallels between those groups, the environment and setting in which paramedics practice is relatively unique and requires specific research programs.

The purpose of this study was to examine the accuracy with which paramedics in the province of Ontario are able to make treatment decisions about patients who both meet and fall outside the existing medical directives. The effect of the provincial medical directives, years of clinical experience and level of certification were explored in relation to treatment decision accuracy.

The results of this study show that paramedics are able to recognize patients who require treatment with a very high degree of accuracy when a patient meets the conditions set out in the medical directives. When the patient presentation does not "fit" the directive, that accuracy decreases - years of clinical practice and level of training have no effect on that accuracy.

Given the setting in which paramedics practice, and our understanding of how expertise is developed, these findings are not unexpected. That said, they raise important questions about the way we education and support paramedics in their development as clinicians. The importance of timely, appropriate feedback is undisputed in the literature, and it is possible these results paint a picture of what happens when that feedback is lacking or focused entirely on one facet of the decision making process; namely, adherence to the directives.

This study was designed to identify a behaviour, rather than explain the reasons behind it. While some causes for the decrease in accuracy like the ones discussed above can be suggested, further research is required to explore what factors actually contribute to this difference.

A qualitative approach to explore in more detail how paramedics perceive the medical directives, and how they incorporate them into their practice, would provide an interesting starting point for further quantitative research. Focus groups or interviews with practicing paramedics may provide insight into their decision making process, as well as their experience with feedback in their role.

The role of feedback on the development of expertise (in particular, novel cases that do not "fit" the medical directives) could be explored in another study using either written cases or higher fidelity scenarios with a "think-aloud" component. A two-stage study and incorporating feedback to one group of participants would be a straight-forward way of showing what effect that type of feedback may have on future performance and decision making.

Ultimately, this study raises important concerns for patient safety in a real-world context. While it is encouraging that paramedics seem able to follow the medical directives and make appropriate treatment decisions with a very high degree of accuracy, the reality of paramedic practice is that many patients do not fall into this category. These results seem to indicate that almost 1 in 4 patients who do not "fit" the medical directives, will not receive appropriate treatment. Furthermore, level of training and years of clinical practice do not have a significant effect on these decisions. While there are undoubtedly many factors influencing this decrease in accuracy, the fact that it exists and is not affected by education or years of experience is enough to call for further research and to start a discussion about the way we education and support paramedics in the development of their expertise.

Paramedic practice takes place in a dynamic, uncontrolled, fast-paced environment – often with limited diagnostic tools and information. Paramedics are required to use their judgement and experience to make decisions, and those decisions have genuine life and death consequences. While paramedic practice in Ontario has evolved dramatically over the past few decades, there exist many opportunities to improve the way we teach paramedics and support them in developing expertise. Limited research, limited feedback and a system that requires a strict adherence to the medical directives may be limiting the ability of paramedics to build and use their experience in their clinical decision making. With the costs of restricting this componant of decision making being so high, it is imperative to build on this initial study and continue research in the domain of paramedic clinical decision making.

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APPENDIX A: SCENARIOS

Scenario 1 – Hypoglycemia

Call Information	You are dispatched to a residence for a 40 year-old male patient with an altered level of consciousness.
Patient Presentation	Upon arrival, you are met by the patient's wife who states the patient is acting strange and she thinks his sugars are low. You find the patient in the living room, slightly agitated and unable to answer any of your questions. Patient is not oriented to person, place or time and appears to be in and out of consciousness.
Incident history	The wife of the patient states he has a history of non-insulin dependent diabetes, and takes metformin (500mg x 2 / day) to control his blood sugar. She also states he has recently changed his dose and she isn't sure if he had taken more than usual. The wife states she has been with him the whole day and he has not experienced any trauma. She also states he has acted like this in the past when his sugar gets low.
Health History	Non-insulin dependent diabetes, hypertension
Medications	Glucophage (metformin), Vasotec (enalapril)
Allergies	None
Vital Signs	HR: 90, RR: 20, BP: 130/90, Spo2: 98% (room air), Temp 37.0C, GCS 9 (E3V2M4), Pupils 3mm PEARL, Skin cold, flushed and ++ diaphoretic. BGL: 4.2 mmol **Cardiac monitor:** NSR
Physical Exam	**Head/Neck**: No visible injury. **Chest**: No visible injury. **Lungs:** Clear in all fields. **Abdomen**: No visible injury. **Extremities**: Strong radial pulse. Good CSM x 4.
Treatment	Treatment options: a) Oxygen and transport patient to the ED b) Treat patient with 1.0mg glucagon IM c) Treat patient with 25g D50W IV d) Call for ALS backup (if applicable) e) Patch to BHP

* Scenario 2 – Sepsis

Call Information	You are dispatched to an assisted living home for an 80 year-old female patient with an altered level of consciousness.
Patient Presentation	Upon arrival you are met by a staff RN who directs you to the patient's room where you find the patient in bed. As you approach her you note she is flushed, dry and warm to the touch. She opens her eyes and moans to your introduction.
Incident history	The staff RN tells you the patient was "fine" yesterday, but today hasn't been able to get out of bed and isn't acting herself. The RN also tells you the patient was diagnosed with a UTI last week but stopped taking her antibiotics after 2 days because they made her nauseated.
Health History	Dementia, hypertension, osteoporosis, anxiety
Medications	Aricept (donepezil), Lopressor (metoprolol), hydrochlorothiazide, Actonal (risedronate), Ativan (lorazepam), Cipro (ciprofloxacin) (rx last week)
Allergies	None
Vital Signs	HR: 130, RR: 26, BP: 102/50, Spo2: 95% (room air), Temp 40.0C, GCS 12 (E4V2M6), Pupils 3mm PEARL, Skin hot, flushed and ++ dry. BGL: 5.0 mmol **Cardiac monitor:** Sinus Tachycardia.
Physical Exam	**Head/Neck**: No visible injury. **Chest**: No visible injury. **Lungs:** Clear in all fields. **Abdomen**: No visible injury. **Extremities**: Strong radial pulse. Good CSM x 4.
Treatment	Treatment options: a) Oxygen and transport patient to the ED b) Treat patient with 20mg / kg normal saline (if applicable) c) Call for ALS backup (if applicable) d) Patch to BHP

Scenario 3 – Croup

Call Information	You are dispatched to a residence for a 9 year-old male patient with shortness of breath.
Patient Presentation	Upon arrival you are met by the patient's parents who direct you to an upstairs bedroom. As you enter the bedroom, you hear audible stridor from the patient between bouts of coughing. The patient appears visibly short of breath, pale and diaphoretic.
Incident history	The patient's parents say he has had a cough for the last 2 days, but woke up in the middle of the night with difficulty breathing. They also state he usually gets this same barking cough every few years, but it's never been this bad. The patient is able to answer your questions between breaths and says he can't breath.
Health History	None
Medications	None
Allergies	None
Vital Signs	HR: 150, RR: 40, BP: 105/60, Spo2: 88% (room air), Temp 39.0C, GCS 15, Pupils 2mm PEARL, Skin warm, pale and diaphoretic. **Cardiac monitor:** Sinus Tachycardia.
Physical Exam	**Head/Neck**: No visible injury. **Chest**: No visible injury. **Lungs**: Clear in all fields with referred stridor in the apices. You note accessory muscle use with each inhalation. **Abdomen**: No visible injury. No nausea / vomiting. **Extremities**: Strong radial pulse. Good CSM x 4.
Treatment	Treatment options: a) Oxygen and transport patient to the ED b) Oxygen and ventolin MDI (600ug) c) Oxygen, ventolin MDI (800ug) d) Oxygen, nebulized epinephrine (5mg/5ml) e) Patch to BHP

Scenario 4 - ? Cardiac

Call Information	You are dispatched to a college campus for an 18 year-old male patient complaining of chest pain and shortness of breath.
Patient Presentation	Upon arrival you find the patient sitting on the edge of his bed in his dorm room. The patient appears pale, diaphoretic and restless.
Incident history	The patient tells you he developed a gradual onset of retrosternal chest pain at rest, and it has been getting worse over the last 2 hours. Nothing seems to be making the pain better or worse. He describes his pain as a dull ache that is now an 8/10. He started feeling short of breath when he called 911 and has never experienced pain like this before.
Health History	Depression
Medications	Celexa (citalopram)
Allergies	None
Vital Signs	HR: 105, RR: 20, BP: 130/90, Spo2: 98% (room air), Temp 37.0C, GCS 15, Pupils 3mm PEARL, Skin warm, pale and diaphoretic. **Cardiac monitor:** Sinus Tachycardia. **12-Lead ECG:** No signs of injury or ischemia
Physical Exam	**Head/Neck**: No visible injury. **Chest**: No visible injury. **Lungs:** Clear in all fields. **Abdomen**: No visible injury. No nausea / vomiting**. Extremities**: Strong radial pulse. Good CSM x 4.
Treatment	Treatment options: a) Oxygen and transport to ED b) Oxygen, ASA (80mg), withhold nitro (call for IV / ALS backup) c) Oxygen, Initiate IV, ASA (80mg) and Nitro (0.4mg SL) d) Transport to ED e) Patch to BHP

Scenario 5 – Allergic reaction

Call Information	You are dispatched to an elementary school for a 12 year-old male patient having a possible allergic reaction.
Patient Presentation	Upon arrival you are met by school principal, who directs you to the office where you find the patient sitting in a chair. As you approach the patient he appears flushed, anxious and is visibly itching his chest.
Incident history	The staff state the patient has an allergy to peanuts and began complaining of itchiness and abdominal pain after eating a chocolate bar that contained nuts. The patient states he is itchy all over and his stomach hurts. He says he vomited prior to EMS arrival, but states his abdominal pain returned after a few minutes and he feels nauseated again. He states he is not short of breath. During the physical exam, the patient vomits again (no blood in vomit).
Health History	None
Medications	None
Allergies	Peanuts
Vital Signs	HR: 120, RR: 24, BP: 100/70, Spo2: 98% (room air), Temp 37.5C, GCS 15, Pupils 3mm PEARL, Skin flushed, warm and dry. **Cardiac monitor:** NSR.
Physical Exam	**Head/Neck**: Rash on patient's neck. No visible swelling of tongue / throat. **Chest**: Extensive rash / redness. **Lungs:** Clear in all fields. **Abdomen**: Rash. Nausea / vomiting x 2**. Extremities**: Rash on arms. Good CSM x 4.
Treatment	Treatment options: a) Epinephrine (0.3mg IM) b) Diphenhydramine (25mg IM) and Epinephrine (0.3mg IM) c) Diphenhydramine (25mg IM) d) Monitor and transport to ED e) Patch to BHP

Scenario 6 – Cardiac Ischemia

Call Information	You're dispatched to a residence for a 60 year-old male patient complaining of chest pain and shortness of breath.
Patient Presentation	Upon arrival you are met by the patient's wife who directs you to the kitchen where you find the patient sitting at the table. As you approach the patient, you note he is pale and diaphoretic. No obvious shortness of breath, but appears restless.
Incident history	The patient tells you he has been experiencing 4 / 10 retro-sternal chest pain for the past 2 hours. The pain came on gradually while he was moving some boxes in the garage, and nothing makes it better or worse. He states it feels like a tightness and similar to his angina pain, but constant and getting worse.
Health History	Angina, hypertension, high cholesterol
Medications	ASA, Nitro (spray) PRN, Lopressor (metoprolol), Coversyl (perindopril), Lipitor (atorvastatin),
Allergies	Sulfa drugs
Vital Signs	HR: 76, RR: 18, BP: 110/60, Spo2: 98% (room air), Temp 37.0C, GCS 15, Pupils 3mm PEARL, Skin cool, pale and diaphoretic. **Cardiac monitor:** NSR. **12-Lead ECG:** 1mm ST depression in II, III, aVf.
Physical Exam	**Head/Neck**: No visible injury. **Chest**: No visible injury. **Lungs:** Clear in all fields. **Abdomen**: No visible injury. No nausea / vomiting**. Extremities**: Strong radial pulse. Good CSM x 4.
Treatment	Treatment options: a) Oxygen, transport to ED b) ASA PO (80mg), Nitro SL (0.4mg) c) ASA PO (80mg) d) Patch to BHP

Scenario 7 – ACPE

Call Information	You are dispatched to a residence for a 68 year-old male patient complaining of shortness of breath.
Patient Presentation	Upon arrival you are met by the patient's daughter who directs you into a bedroom where you find the patient sitting up in a reclining chair. The patient appears pale, diaphoretic and visibly working hard to breath. The patient is on home O2 (3L/min).
Incident history	The daughter states her dad has been increasingly short of breath all day, especially when he gets up. The patient says his home O2 doesn't seem to be helping. He states his shortness of breath has been getting progressively worse all day, but denies any chest pain. He also says his legs have been more swollen than usual for the past 2 days.
Health History	CHF, A-fib, hypothyroid, enlarged prostate
Medications	Digoxin, Lasix (furosemide), Coumadin (warfarin), O2, Mevacor (lovastatin), Synthroid (levothyroxine), Tylenol (acetaminophen), Flomax (tamsulosin)
Allergies	None
Vital Signs	HR: 110, RR: 28, BP: 170/110, Spo2: 90% (3L NC), Temp 37.0C, GCS 15, Pupils 3mm PEARL, Skin cool, pale and diaphoretic. **Cardiac monitor:** Atrial fibrillation. **12 Lead ECG:** A-fib with no signs of ischemia or injury.
Physical Exam	**Head/Neck**: No visible injury. JVD noted. **Chest**: No visible injury. **Lungs:** Bilateral crackles in bases. **Abdomen**: Distension. Soft, non-tender on palpation. No nausea / vomiting**. Extremities**: Peripheral edema in both feet (pitting) up to mid-lower leg.
Treatment	Treatment options: a) Oxygen, Transport to ED b) Oxygen, Nitro SL (0.4mg), transport to ED c) Oxygen, Nitro SL (0.8mg), transport to ED d) CPAP e) Patch to BHP

Scenario 8 – Anaphylaxis

Call Information	You are dispatched to a restaurant for a 33 year-old female patient with a possible allergic reaction.
Patient Presentation	Upon arrival you directed to the patient who you find sitting at her table. As you approach, the patient appears flushed, diaphoretic and agitated. She is itching her neck and appears slightly short of breath.
Incident history	The patient tells you she has an allergy to shellfish. She says she told the restaurant that, but after a few minutes into her meal started to feel tingling in her mouth. Since then, she said her throat and tongue have started to feel "weird", and her chest feels tight. She has also developed severe abdominal pain and nausea. The restaurant confirmed there was shellfish in her meal. The patient states she normally carries an epi-pen, but forgot it at home.
Health History	Asthma, eczema
Medications	Ventolin (salbutamol), Betamethasone ointment
Allergies	Shellfish
Vital Signs	HR: 120, RR: 22, BP: 100/70, Spo2: 95%, Temp 36.5C, GCS 15, Pupils 3mm PEARL, Skin flushed, warm and diaphoretic. **Cardiac monitor:** Sinus tachycardia.
Physical Exam	**Head/Neck**: Redness and swelling to tongue and throat. Rash on neck. **Chest**: Redness / flushed chest. **Lungs:** Slight wheezing in bases. **Abdomen**: Distension. Soft, non-tender on palpation. Nausea (no vomiting). **Extremities**: Good CSM x 4.
Treatment	Treatment options: a) Oxygen, transport to ED. b) Epinephrine (0.3mg IM) c) Diphenhydramine (50mg IM) and Epinephrine (0.3mg IM) d) Diphenhydramine (50mg IM) e) Patch to BHP

Scenario 9 – Renal colic

Call Information	You are dispatched to a residence for a 55 year-old male patient complaining of lower back pain.
Patient Presentation	Upon arrival you enter the residence to find the patient lying on a couch in the living room. He is pale, diaphoretic and keeps shifting positions on the couch to stay comfortable.
Incident history	The patient tells you he started to develop left sided lower back pain a week ago. This morning, the pain got substantially worse and is now radiating up his flank and down into his groin. He says nothing seems to make the pain better and it is coming in waves (10/10 at its worst). The patient also states he started feeling nauseated this AM. He has had normal bowel movements and urine output for the past 24hrs.
Health History	Kidney stones, hypertension
Medications	Flomax (tamsulosin), Percocet (oxycodone / acetaminophen), Cozaar (losartan)
Allergies	None
Vital Signs	HR: 90, RR: 18, BP: 150/90, Spo2: 99%, Temp 36.0C, GCS 15, Pupils 3mm PEARL, Skin pale, warm and diaphoretic. **Cardiac monitor:** NSR.
Physical Exam	**Head/Neck**: No visible injury or complaint. **Chest**: No visible injury. **Lungs:** Clear in all fields. **Abdomen**: Soft, non-tender on palpation. Nausea (no vomiting)**.** Pain on percussion of left flank, no obvious injuries. **Extremities**: Good CSM x 4.
Treatment	Treatment options: a) Transport to ED b) acetaminophen PO (1000mg) / ibuprofen PO (400mg) c) acetaminophen PO (1000mg) / ketorolac IM/IV (15mg) (or morphine IV (2-5mg) if applicable) d) ketorolac IM/IV (15mg) (or morphine IV (2-5mg) if applicable) e) Patch to BHP

Scenario 10 – Abdominal pain

Call Information	You are dispatched to a residence for a 25 year-old male complaining of abdominal pain and drowsiness.
Patient Presentation	Upon arrival you are met by the patient who is pale and slightly diaphoretic.
Incident history	The patient states he feels "out of it" and has had worsening abdominal pain since last night. He denies any drug or alcohol use, has eaten a normal diet for the past 24 hours and has had normal BM / urine output. The patient states he feels like he is so drowsy he "can't even keep his eyes open". The patient is slow to respond to questions, but is alert and oriented to person, place and time.
Health History	Anxiety
Medications	Cipralex (escitalopram),
Allergies	None
Vital Signs	HR: 80, RR: 18, BP: 124/90, Spo2: 98% (room air), Temp 37.0C, GCS 15, Pupils 3mm PEARL, Skin warm, pale and diaphoretic. **Cardiac monitor:** NSR
Physical Exam	**Head/Neck**: No visible injury. **Chest**: No visible injury. **Lungs:** Clear in all fields. **Abdomen**: No visible injury. Soft, non-tender on palpation. No nausea / vomiting**.** **Extremities**: Strong radial pulse. Good CSM x 4.
Treatment	Treatment options: a) Sign patient off (has capacity) b) Oxygen, transport patient to ED c) Transport patient to ED d) Call for ALS backup (if applicable) e) Patch to BHP

APPENDIX B: INVITATION LETTER

You are being invited to participate in a research study on paramedic decision making. Please review the details below and email **Mike Eby (ebymj@mcmaster.ca)** if you are interested in participating.

Study Title
Clinical Decision Making in Paramedicine

Investigator(s)
Mike Eby (MSc Student)
Dr. Geoff Norman
Dr. Sandra Monteiro

Background:
In medical practice, health care professionals use a number of different tools when making decisions. Practice guidelines, experience, critical thinking and context are all factors in the process of choosing the appropriate course of care for patients. To date, very little research has been done to explore how paramedics approach clinical decision making, and what factors affect those decisions.

Purpose of study:
The purpose of this study is to examine how experience affects the way paramedics make patient care decisions.

Description of study:
This is an **anonymous online** survey where you will be presented with 10 written scenarios and asked for your decision via multiple choice (e.g. Monitor & transport to ED, Treatment / Intervention, "Patch" etc.). There will also be a field to write a working diagnosis as well as which medical directive (if any) applies to the case. They survey is expected to take **15-20 minutes.**

Confidentiality and Privacy:
After you have replied to the initial invitation to the study, a unique identifier (or "token") will be created and your email address will not be linked to your answers. From that point on, all data collected in the study will be completely anonymous.

Study results:
Upon completion of the survey, you will be given the option to provide an email address, which will **not** be linked to your responses. Once the study is complete, an email debrief futher explaining the purpose and results of the study will be sent to that address.

Compensation for participation
Although your participation is greatly appreciated, this is a voluntary study and provides no compensation for your time. The survey is estimated to take approximately 15-20 minutes.

Participation and Withdrawal
Participation in this study is voluntary. If you decide to participate, you are free to withdraw your consent and stop your participation **up to the completion of the study**. Once you have

completed the study, you may not be able to withdraw your data from the study as it will be automatically anonymized. If you wish to withdraw, simply do not complete the survey and the results will be detleted. If you have any questions you can contact the investigators: Mike Eby (ebymj@mcmaster.ca) or Dr. Sandra Monteiro (monteisd@mcmaster.ca).

Research Ethics Board Contact

This study has been reviewed by the Hamilton Integrated Research Ethics Board (HIREB). The HIREB is responsible for ensuring that participants are informed of the risks associated with the research, and that participants are free to decide if participation is right for them. If you have any questions about your rights as a research participant, please call the Office of the Chair, HIREB at 905.521.2100 x 42013.

If you are interested in participating in the study, please contact Mike Eby (ebymj@mcmaster.ca) to enroll.

Thank you in advance for your consideration!

APPENDIX C: CONSENT FORM

Consent to Participate in a Research Study

You are being invited to participate in a research study. Before you give your consent as a volunteer, it is important that you read the following information and ask as many questions as necessary to make sure you understand what you will be asked to do during the study.

Study Title
Clinical Decision Making in Paramedicine

Investigator(s)
Mike Eby (MSc Student)
Dr. Geoff Norman
Dr. Sandra Monteiro

Background:
In medical practice, health care professionals often rely on guidelines to assist in their diagnostic and treatment decisions. In Ontario, paramedic practice is based on two sets of medical guidelines that provide direction for the application of controlled medical acts to various medical conditions. While these guidelines apply to many of the situations seen in the field, paramedics also rely on their experience and critical thinking to make decisions about patient care.

Purpose of study:
The purpose of this study is to examine how experience affects the way paramedics make patient care decisions.

Description of study:
This is an **anonymous online** survey where you will be presented with 10 written scenarios and asked for your decision via multiple choice (e.g. Monitor & transport to ED, Treatment / Intervention, "Patch" etc.). There will also be a field to write a working diagnosis as well as which medical directive (if any) applies to the case. They survey is expected to take **15-20 minutes.**

Potential Risks or Discomforts:
There are no known harms associated with participation in this study. There are no consequences for declining to participate.

Potential Benefits:
Your participation in this study will provide us with data to help us understand the mechanisms and processes by which paramedics make decisions in the field. There are no direct benefits to you from participation but there may be some benefit in working through the cases and answering the questions.

Confidentiality and Privacy:
After you have replied to the initial invitation to the study, a unique identifier (or "token") will be created and your email address will not be linked to your answers. From that point on, all data collected in the study will be completely anonymous.

Study results:

Upon completion of the survey, you will be given the option to provide an email address, which will **not** be linked to your responses. Once the study is complete, an email debrief futher explaining the purpose and results of the study will be sent to that address.

Compensation for participation

Although your participation is greatly appreciated, this is a voluntary study and provides no compensation for your time. The survey is estimated to take approximately 15-20 minutes.

Participation and Withdrawal

Participation in this study is voluntary. If you decide to participate, you are free to withdraw your consent and stop your participation **up to the completion of the study**. Once you have completed the study, you may not be able to withdraw your data from the study as it will be automatically anonymized. If you wish to withdraw, simply do not complete the survey and the results will be detleted. If you have any questions you can contact the investigators: Mike Eby (ebymj@mcmaster.ca) or Dr. Sandra Monteiro (monteisd@mcmaster.ca).

Research Ethics Board Contact

This study has been reviewed by the Hamilton Integrated Research Ethics Board (HIREB). The HIREB is responsible for ensuring that participants are informed of the risks associated with the research, and that participants are free to decide if participation is right for them. If you have any questions about your rights as a research participant, please call the Office of the Chair, HIREB at 905.521.2100 x 42013.

CONSENT (online)

I have read and understand the above, and know that I may leave the study at any time.

[ ] I agree to take part in this study.

[ ] I do **NOT** agree to take part in this study.

APPENDIX D: LIMESURVEY SCREENSHOTS

0% 100%

Call Information	You are dispatched to a residence for a 40 year-old male patient with an altered level of consciousness.
Patient Presentation	Upon arrival, you are met by the patient's wife who states the patient is acting strange and she thinks his sugars are low. You find the patient in the living room, slightly agitated and unable to answer any of your questions. Patient is not oriented to person, place or time and appears to be in and out of consciousness.
Incident history	The wife of the patient states he has a history of non-insulin dependent diabetes, and takes metformin (500mg x 2 / day) to control his blood sugar. She also states he has recently changed his dose and she isn't sure if he had taken more than usual. The wife states she has been with him the whole day and he has not experienced any trauma. She also states he has acted like this in the past when his sugar gets low.
Health History	Non-insulin dependent diabetes, hypertension
Medications	Glucophage (metformin), Vasotec (enalapril)
Allergies	None

* **General options**

- Sign patient off
- Monitor and transport to ED
- Treatment / intervention
- Patch (please explain reason for patch)

What is your working diagnosis for this patient?

What medical directive (if any) applies to this scenario?

APPENDIX OF TABLES

Figure 1 – Response Coding

MC Option	Coding (Treatment vs. No Treatment)
"Sign the patient off"	No Treatment (Incorrect)
"Monitor and transport to ED"	No Treatment (Incorrect)
"Treatment / Intervention"	Treatment (Correct)
"Patch"	Treatment (Correct)

Figure 2 - Pilot Results

Years of Clinical Practice	Mean
Novice	85.4%
Experienced	90.6%

Certification Level	Mean
PCP	87.5%
ACP	87.5%

Case Type	Mean
Meets Directives	92.5%
Does not meet directives	82.5%

Figure 3 – Case-Type Results

Case Type	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Meets Directives	98.35%	0.92%	96.55%	100.00%
Does not meet directives	76.34%	4.69%	67.15%	85.53%

Figure 4 – Years of Clinical Practice Results

Years of Clinical Practice	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Novice	89.87%	3.97%	82.48%	97.22%
Experienced	85.27%	3.77%	77.5%	93.04%

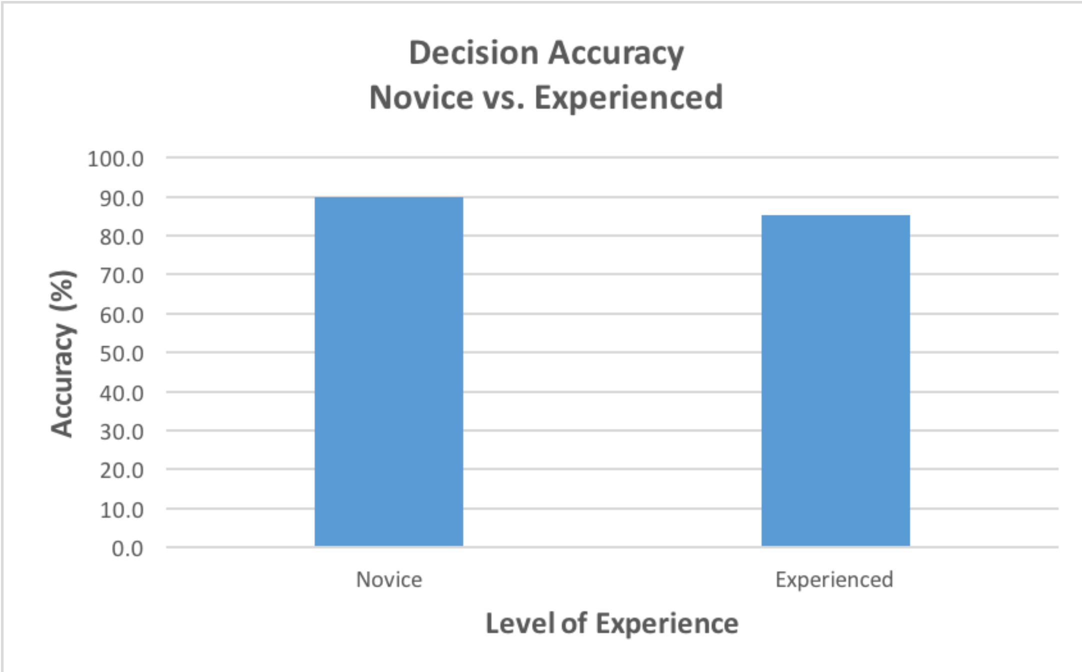
Figure 5 – Level of Certification Results

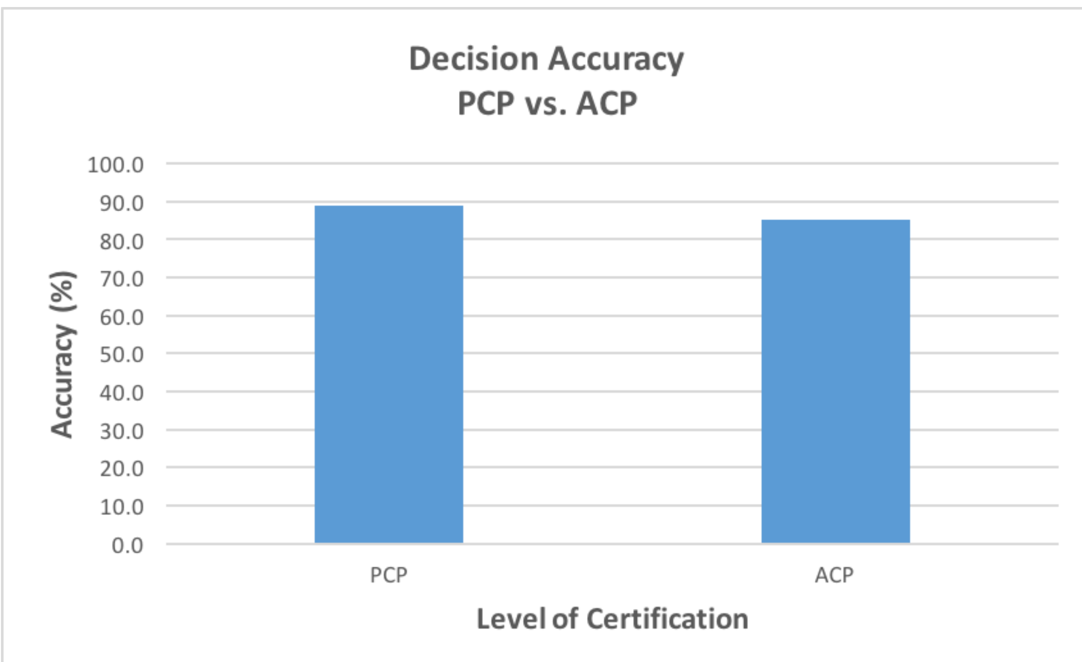
Certification Level	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
PCP	88.87%	3.19%	82.63%	95.11%
ACP	85.24%	4.92%	75.60%	94.88%

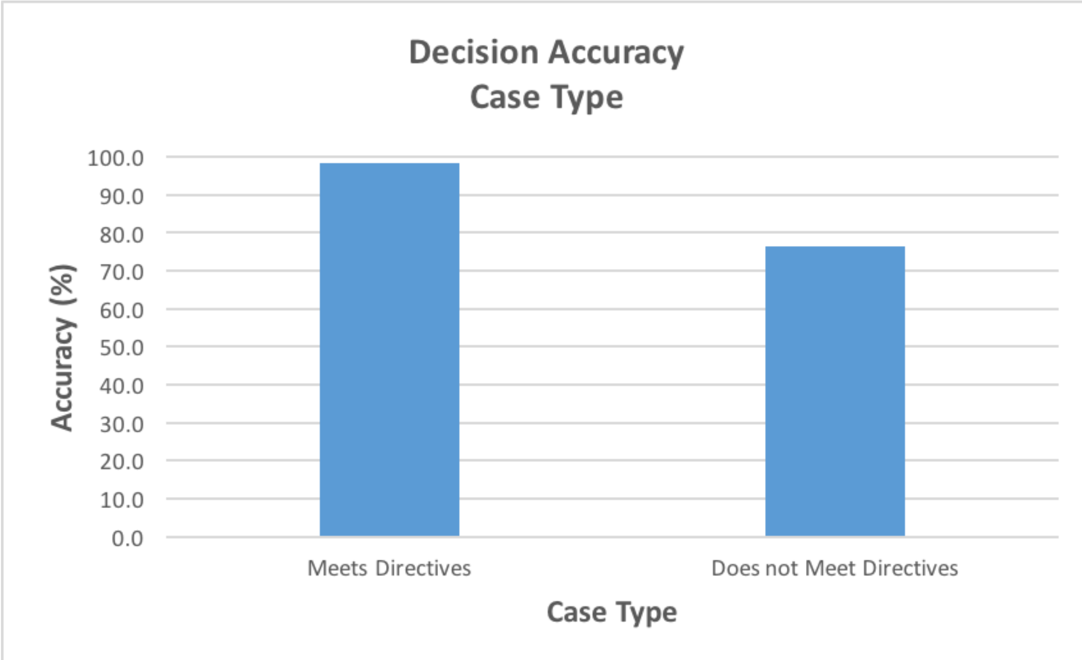
Figure 6 – Secondary Analaysis

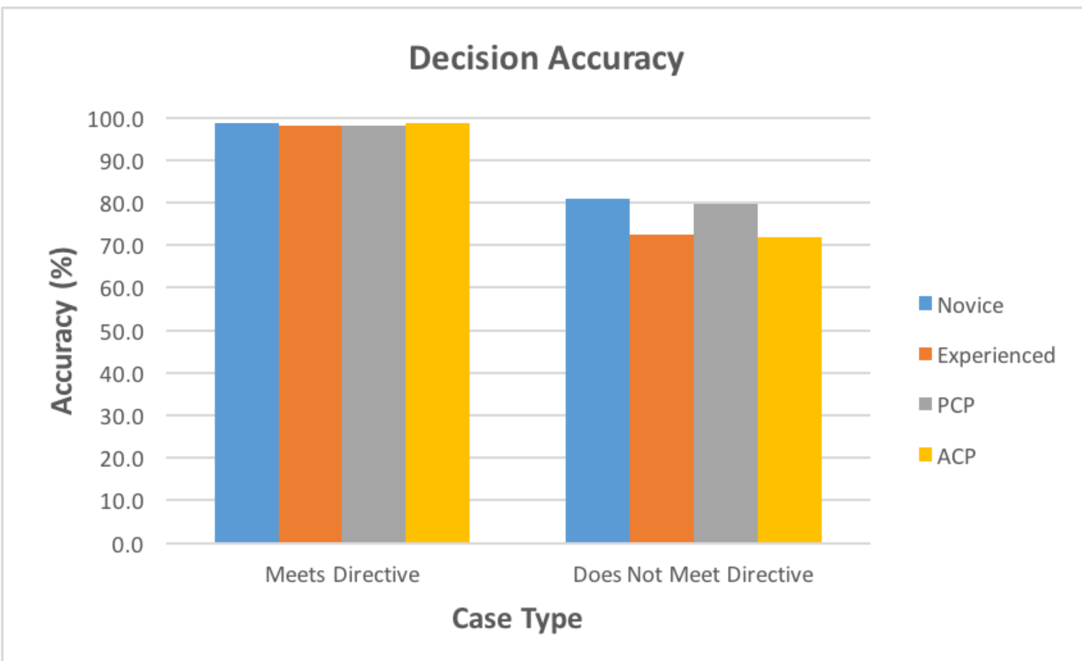
Case	Case Type	Correct Treatment	Correcting Working Dx	Correctly Identified Directive
1	No Directive	55.00%	67.70%	77.40%
2	No Directive	94.10%	96.80%	48.40%
3	No Directive	84.00%	58.10%	80.60%
	Average	**77.70%**	**74.20%**	**68.80%**
4	Directive	100.00%	100.00%	100.00%
5	Directive	93.60%	100.00%	100.00%
6	Directive	93.60%	100.00%	96.80%
7	Directive	100.00%	100.00%	100.00%
8	Directive	100.00%	96.80%	93.60%
9	Directive	100.00%	51.60%	100.00%
	Average	**97.87%**	**91.40%**	**98.40%**

Figure 7 - Graphs






Decision Accuracy
Case Type
Accuracy (%)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Meets Directives
Does not Meet Directives
Case Type


Decision Accuracy
Accuracy (%)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Meets Directive
Does Not Meet Directive
Case Type
Novice
Experienced
PCP
ACP