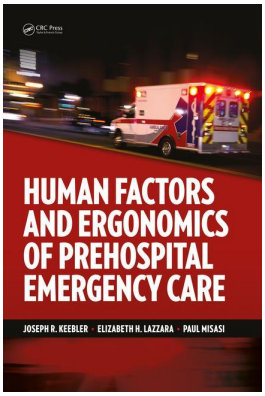

Human Factors and Ergonomics of Prehospital Emergency Care
Critical Essays in Human Geography

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Expertise and Decision-Making in Emergency Medical Services

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Stuart Donn

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INTRODUCTION

In the context of EMS practice, the characteristics identified with the naturalistic decision-making (NDM) enterprise are clearly applicable. Time pressures, high stakes, competing priorities, incomplete information, changing conditions, and vague goals can all be applied to the context in which paramedics operate. Their decision-making is bounded by two broad frameworks: first, situational awareness and, second, patient treatment.

The first, situation awareness (SA), is a necessary but not sufficient condition for good decision-making. The second, seen as primary in the EMS role, is to provide appropriate patient treatment within the scope of practice that delimits paramedic care. As part of the healthcare team, paramedics have the same aim as physicians—do no harm. But there are differences in the decision-making that the two practitioners engage in. Both kinds of decision-making are based on the expertise of their specific practices. For example, paramedics do not need to make a definitive diagnosis as a physician does, nor is it even possible most of the time. The paramedic diagnosis is sufficient when the decision can be made as to what they can do in the field setting, within their scope of practice, given considerations to their differential considerations and which of those represents the biggest life threat.

The constraints imposed by the field setting include limitations on resources and imposition of physical elements. The resource limitation may be an aspect such as

a definitive diagnostic procedure—the X-ray or ultrasound identification of specific injuries. These will not be available before patient extrication from an automobile crash. What can be established is that there are injuries, and treatment can be provided for some of the injuries, but for others, the definitive treatment is in a hospital setting.

In other instances, even with the appropriate diagnosis of the issue, the scope of practice limits what the paramedic can actually do. At various levels of licensure, IV treatment can be offered or the patient intubated or certain drugs administered. But not all paramedic license levels have the same capability to engage in these interventions. The result is that the EMS decisions are bounded by both the availability of resources and the limitations on their particular practice.

The emerging aspects involved in expert decision-making in EMS reflect a number of changes that are currently taking place in paramedic practice. The historical role for EMS evolved from the ambulance service provided, in many instances, as a sideline to other ventures, such as funeral services. A seminal document establishing the creation of EMS systems in the United States (National Academy of Sciences, 1966) provides a description of the emergent situations to which the response was the development of a specific curriculum to provide training for responders to trauma. Other descriptions of early ambulance services, such as provision of medical treatment during wars and following disasters, provide a picture of relatively untrained individuals offering services to patients in very needy situations.

The lack of equipment and training in the past minimized what kind of treatments could be provided. The expert decision-making required in these situations was limited—relegated to mostly identifying the fastest route to the source of care. With changes in thinking about the kind of care that paramedics could provide also came the need for changes in the expert decision-making that were required. As the remainder of this chapter details, the continuation of that trend has invoked increasing need for competence not only in medical treatment skills but also in decision-making skills. Equipping today's EMS practitioners with those needed attributes is an increasing challenge.

GENERAL ISSUES REGARDING EXPERTISE IN EMS

Paramedic practice is consistent with the premises of NDM. The parameters that influence a decision in the high-stress, high-stakes, and time-pressured circumstances of EMS practice preclude the possibility of applying an analytic method to making the decision. The factors involved are illustrated in Figure 6.1, which identifies specific confounding elements.

The early work in the NDM field recognized that the analysis of decision-making in laboratory settings, with contrived experiments, was not an accurate reflection of how practitioners actually made decisions in the real world. The development of the recognition-primed decision (RPD) model (Klein, 1998, 2008; Ross et al., 2004) was a result of taking the study of decision-making to the area of practice. There has been some work done on experts within EMS and their decision-making, as distinct from novices (Ryan and Halliwell, 2012).

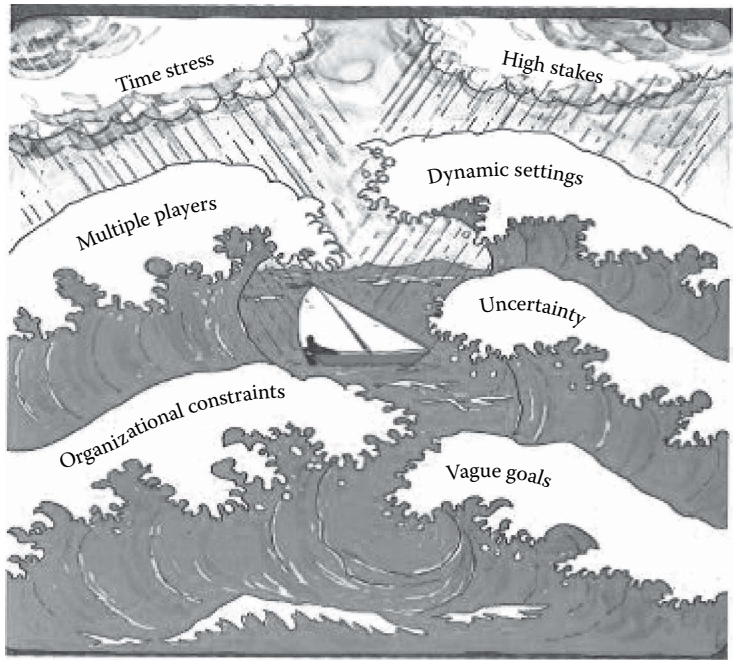

FIGURE 6.1 Confounding elements. (From Klein, G.A. et al., 1993, *Decision making in Action: Models and Methods (Cognition and Literacy)*. Praeger.)

Much of the work done on decision-making in healthcare has been associated with physician decision-making, based on their expertise. There has been a transfer of the findings, at least to an extent, to the decision-making of EMS practitioners. The comparisons are reasonable—particularly for the expertise-based decision-making of emergency physicians and EMS paramedics.

ROLE EVOLUTION IN EMS

There are some issues that confound aspects of decision-making for EMS. One of the common aspects facing many professions is the demographic shift, as individuals with accumulated experience are retiring, and the newer generation of practitioners has less experience to draw upon for their decision-making. In the provision of air transport, the patient profile gives insight into the complex presentation of this patient population (Andrew et al., 2015) and the challenges of providing safe treatment for this group can be enhanced by evidence-based guidelines (Thomas et al., 2013). In the absence of "corporate memory" in these complex specialized facets of practice, such reliance on protocols is reasonable. This has been recognized as a significant factor which, when combined with the changing role of technology and complexity of practice, necessitates a closer look at accelerating the acquisition of expertise (Hoffman et al., 2014).

One of the trends in paramedic education is toward a degree-based qualification. This has been the case for some jurisdictions, mainly in English-speaking countries, but the increasing educational requirements for paramedic practice seem more broadly based. The perceived differences between degree-qualified and vocationally trained paramedics present some challenges (O'Meara et al., 2015), but the main contention seems on the skill level rather than on decision-making ability. The differing views of students as to their preparedness for clinical settings are reflected in the study of Hickson et al. (2015) and are potentially a consequence of the move to degree qualifications. The differences in perception may be construed as being theoretical versus practical experience. More broadly, the education of physicians is, first, as a generalist followed by specialization. For paramedics, the trend has been, first, as a specialist, now being followed by the generalist aspect as the education is adjusted to meet the expanding role into community first-line healthcare provision.

The educational trend parallels the increasing expectation that status as a profession has been attained (Joyce et al., 2009; O'Meara, 2009; Williams and Brown, 2010). With a greater alignment to a "professional" designation comes a change in practice to permit greater autonomy in decision-making (e.g., a shift to guidelines from protocols in some areas), as well as broader demands for decision-making when the breadth of practice has increased. There are additional expectations of professionals with respect to an enhanced understanding of the larger context in which they operate. As Atack and Maher (2010) point out that as the expected alignment of EMS with the health sector continues, there will be a need to adjust the EMS education to include increased emphasis on clinical decision-making. However, the differences in the roles, beyond those of scope of practice, include elements such as the diagnosis scope—for physicians, a definitive view, and for paramedics, a diagnosis bounded by what they can do within their scope of practice. Physicians have access to a full range of equipment, tests, and assistance, while paramedics are bounded by the field context—limited in equipment, diagnostic procedures, and availability of assistance.

Thus, the expertise on which paramedics rely is informed by a knowledge translation from medical research to the bounded circumstances of their practice (Bigham and Welsford, 2015). As these authors point out, the translation is not always successful, and a thorough analysis of hospital-based therapeutic success needs to also include the recognition of the different mobile environments of EMS practice. Understanding that the ambulance environment is not simply an extension of the ER means that one cannot assume that what is good in the ER is necessarily good in the field. Similarly, the relationship between the expanded scope of practice for EMS practitioners and the potential impact on patient safety can be mitigated by an increased focus on the decision-making of paramedics, but the research has yet to confirm whether there are negative impacts on patient safety (O'Hara et al., 2015).

Some approaches to instilling the required skills in critical thinking for EMS practitioners can be deduced from the proposal of Facione and Facione (2008). They concluded that the potential for overconfidence errors is acknowledged as a reason to focus on developing suitable critical thinking skills. This element of risk, perhaps

as found in the old adage "a little knowledge is a dangerous thing," is echoed in the discussion of medical errors (e.g., Kruger and Dunning, 1998; Berner and Graber, 2008; Croskerry and Norman, 2008; Graber, 2009; Phua and Tan, 2013). Another potential approach is in the development of heuristics that would provide guidance for decision-making in healthcare (Gigerenzer and Gaissmaier, 2011). The appeal of heuristics to improve expert decision-making in EMS is the saving of effort and time, important considerations in their high-stakes, time-pressured work setting. However, the trade-off that frequently accompanies heuristics is that of accuracy over effort reduction. With the emerging increased scope of practice for EMS, the default option of transport for the patient becomes less of an option, and the need for both accuracy and reduced effort in decision-making is necessary.

SPECIFIC ASPECTS OF EXPERTISE FOR EMS

As the importance of decision-making and expertise in EMS continues to expand, so too does the notion of professionalism, and the emergence of increased focus on degree programs in EMS reflects this change. While the concept of increased education for practitioners is sound, the implementation of university-educated graduates into the existing workforce is not entirely smooth (O'Meara 2009, 2011; O'Meara and Grbich, 2009; O'Meara et al., 2015). One element of disagreement is over "book learning" as opposed to "doing the work." While there may be echoes of the 10,000 hours (Ericsson, 1996) in the acquisition of expertise at the base of this disagreement, a question remains as to what skill set is required to meet the expanding scope, increased trend to EMS as a profession, and the increased need for sound decision-making in the practice of EMS.

Woolard's (2012) review of professionalism in UK paramedic practice also raises the notion of "systematic learning from untoward incidents." Here, a basic issue would appear to be identified in the reports of Hobgood et al. (2004) that error identification and reporting are a challenge for all elements of the emergency department (ED) care delivery team. As the role of paramedics is expanded, such disclosures would be a necessary part of individual continuing education identified as part of professional practice. While the capacity to identify and report errors seems available (Hobgood et al., 2006), the application in practice will require additional education and support.

There continues to be a dichotomy in terms of the placement of EMS—are they a public safety service or part of the healthcare system? The question may be framed as "the emergency part of the healthcare system or the health part of the emergency system." For those organizations in which the trend has been to incorporate EMS as part of the healthcare system, reflecting the expansion of the EMS role (O'Hara et al., 2015), there is a recognition that practitioners do not see themselves as full members of the healthcare system, nor are they recognized as full partners by current healthcare practitioners. For the interprofessional education required to enhance functioning in this expanded role, some research indicates that there is readiness on the part of students for interprofessional learning (Williams & Webb, 2015). The authors make reference to other studies on the implementation of interprofessional learning that confirm the need

for clear objectives with supporting activities to consolidate the concept. And, as will be noted later, the use of simulation-based activities may be of particular value in this arena.

The expansion of paramedic practice into the area identified as community paramedic appears promising. This appellation has almost as many versions as the communities in which the paramedics serve, and the EPIC study (Expanding Paramedicine in the Community, Drennan et al., 2014) is one attempt to clarify the effectiveness of the community paramedic concept. Others, such as Craig (2015a,b), suggest that there may be alternate approaches to providing care in the community and advocate further study to identify and adopt the better strategy.

SPECIFIC INSTANCE OF WORKING ON EXPERTISE IN SA

In 2007, a tragic accident occurred. Paramedics were called to a mine pumping station aboveground that, unknown to them, was oxygen depleted. The shed had been regularly monitored for a period of 5 years with no indication of a safety issue. The ambulance service was called when the engineer responsible for monitoring the station did not return from his operational check. The first paramedic entered the shed, spotted the downed engineer, and quickly lost consciousness. The second paramedic entered the shed to rescue his partner and was also rendered unconscious. Fortunately, the other paramedics had the good sense not to enter the shed; they called for additional resources. Safety reviews following this accident generated several recommendations to the British Columbia Ambulance Service. Some of these recommendations focused on operational changes to enhance identification of high-risk situations. Some addressed communication issues, specifically on the issue of interagency cooperation. The report from the Ministry of Mines indicated that the circumstances leading to the event were exceedingly rare, and the likelihood of prior identification of the specific risk was small. This incident led to a set of recommendations dealing with the provision of training and education for paramedics to prevent similar incidents in the future.

Discussion within the British Columbia Ambulance Service attempted to match an existing program with the identified needs within the service to no avail. The existing courses tended to have scene hazard recognition as a core element, prescribing specific approaches to known hazardous situations (e.g., drug labs, specific industrial settings, and particular environmental dangers) but providing little in terms of dealing with novel situations (personal communication Toronto EMS, Seattle Fire, and other agencies). The consensus was that a program designed to provide education that would enable paramedics to make informed decisions in high-risk situations that were novel was potentially of greater benefit to their safety than a course which cataloged dangerous contexts and provided specific approaches for them.

Two relevant aspects were established in reviewing the literature pertaining to SA (Endsley, 1995) and decision-making (Klein, 1998). First, the concepts of SA had identified elements that were applicable to paramedic practice although they had not been derived from specific study of paramedics. Aspects such as tunneling,

information overload, and lack of recognition of changes to relevant factors were applied for paramedic practice both to the patient being treated and to the context in which the patient was being treated, a potentially hazardous one. Later work (Hamid et al., 2009) is supportive of this approach.

Second, the identification of factors for NDM readily described circumstances in which prehospital practice takes place. The concepts of competing goals, incomplete information, high risk, multiple players, changing conditions, irreducible uncertainty, and organizational constraints all pertained to paramedic practice. The Situation Awareness for Emergency Responders (SAFER) course that was developed utilized the RPD model (Klein, 1998, 2008) and had as a major objective providing a guide for paramedics to use in making safe decisions in their practice.

Initially, participants were given 12 scenarios and asked to indicate which of four possible responses they would choose and which response they believed was what the organization would wish them to choose. The scenarios had been developed by practicing paramedics as were the options for action and reasonably reflected situations that could be encountered in practice. The options were ranked by a group of experienced practitioners from riskiest to safest.

Participants were also given a 30-question survey on their perception of organizational commitment to safety, covering three areas—organizational attitude, aspects of patient safety, and aspects of paramedic safety. The survey was based on the University of Texas Health Sciences organizational safety survey and an instrument used by an Australian airline for similar purposes.

The course consisted of an introduction to SA, the aspects of common ground, the importance of feedback, and how the RPD model illustrates the approaches taken to decision-making in a circumstance embodying the elements of NDM. Several decision-making exercises were carried out during the course in which participants were asked to review decisions made for particular scenarios. The importance of experience and the sharing of experience during on-the-job training were emphasized, as was the benefit of postevent review and discussion, given the name of *bumper talk*, a term commonly used in the service.

The intention of the course was to focus on changing behavior rather than providing a list of circumstances in which dangerous elements had already been identified. This was a departure from previous occupational safety and health programs that outlined the common risk situations, parameters to be alert for, and a cataloging of high-risk potential. Following the course, the same 12 scenarios and forced-choice response questionnaire were administered, together with the participant indication of what course of action they believed that the management would wish them to choose for each scenario.

The course was well received by the participants who felt that the content was relevant to practice (85% agree, strongly agree), was well presented (92% agree, strongly agree), and was potentially useful to paramedics (85% agree, strongly agree) (Klein and Donn, manuscript in preparation). There was a strong correlation between what the paramedics indicated they would do and what they perceived the organization would wish them to do.

- The precourse and postcourse data indicate that there were changes in selection of options more closely aligning with the perceived safe option identified as a management desire. Similarly, the shift was toward safer options from riskier. The paramedic responses to the 12 risk scenarios changed to selecting a less risky alternative after taking the course, significant at the 0.001 level.
- The paramedic responses to the 12 risk scenarios after taking the course, representing their view of what management would wish them to do, shifted to a less risky choice (significant at .001 level).
- There was no statistically significant difference in injury rate between the group who took the course, before and after, and those who did not take the course, where injury rate is the proxy measure for risk avoidance (Donn, 2011).

The sustained adoption of the principles of the SAFER course has been at least anecdotally reported, with specific applications to a biological hazard situation and a carbon monoxide scene. In both instances, the paramedics recalled the concepts of SAFER and did not take the seemingly appropriate, though risky choice of immediately entering the scene. In the latter instance, two paramedics who did enter the scene and required subsequent medical treatment had not taken the SAFER course. The organization has not kept specific records detailing the impact of the course.

The Organizational Commitment to Safety Survey revealed a wide range of views, with a diffuse distribution on the questions pertaining to organization role, and a narrower range on questions dealing with patient safety aspects or with paramedic safety. The strong sense of duty to the patient is evident in the results.

In this instance, what seemed more relevant in response to the loss of life tragedy was to provide the learners with a better understanding of the characteristics of decision makers in high-stress situations, and how the approach—not presented as prescriptive but rather descriptive of what decision makers do—may enable individuals to make better decisions. The emphasis was on three factors.

- First, SA is key to identifying the elements that pose risk.
- Second, the benefit of openness and attentiveness to cues depended partly on experience, partly on understanding of common ground, and partly on resistance to a natural tendency of emergency service workers to act first then analyze.
- The third element was that debriefing following a comprehensive approach allowed for the benefit of learning from each episode that presented risk elements, either familiar or new.

The sharing of experiences enables individuals new to the setting to benefit from the lessons, learned through reflection, by those who had more practice. This was elaborated in the bumper talk and "on-the-job training" components of the course. The development of a comprehensive approach to decision analysis followed the approach taken in other NDM-based courses, outlining the aspects of "what makes the decision difficult," what are the cues, and what are the options. Application of

this approach in the course was less successful. Learners and instructors appeared more likely to consider the exercise as one in which the right answer was the important result, rather than acknowledging that the answer derived from analysis would be the right answer for the individual, and their benefit derived from considering what made the decision difficult for them, and then gaining new knowledge from what others considered.

The results of the initial data collection provide an interesting insight into the difficulties of obtaining behavioral change with learners who are more inclined to an action-oriented approach in their work setting. The reaction of learners was positive to the course content and the presentation approach, and the relevance of the curriculum to practice was clear. However, there was a minority who saw adoption of the approach as likely for their own practice (34% attitude change; 37% knowledge change; 47% improved decision-making; 40% awareness of safety issues increased).

The seeming mismatch of relevance but nonadoption can be better understood by examining the results of the organizational climate of a safety survey where a large percentage of respondents indicated that their practice was safe (86%). Other paramedics (82%) were not perceived as safe in their actions as the individual respondent. It is thus understandable that the numbers who indicate their practice will change are lower than anticipated. They do not see the need to change what they believe is a safe practice. Within social psychology, this illusory superiority is common. And, the work of Wyatt (2003) is consistent with this view.

Similarly, the variation in perception of the organizational commitment to safety is at odds with the dedication of individuals to patient safety. Thus, while they perceive that the organization is not as committed to safe practice in terms of either policy, management action, or provision of suitable equipment, the individual paramedic will operate in a safe manner for the protection of the patient despite these shortcomings. There is a consistency of this dichotomy with the analysis of paramedics from a folklore perspective (Tangherlini, 2000).

The tales that paramedics tell reflect a bravado and belief that the individual practitioner overcomes the mistakes of management and the underappreciation of their skills by physicians and other practitioners and is, at all times, working for the benefit of the patient (Tangherlini, 2000). While these attributes contain an element of truth, for the average paramedic the sense of being the frontline, unsupported provider of prehospital healthcare almost dictates placing personal safety after that of patients, partners, and others. The individualism of practice supports the oft-prevailing view that individuals commit errors or mistakes as a result of their own incompetence or weakness (Misasi et al., 2014).

Adoption of the principles of NDM may encounter obstacles other than those inherent in the traditional role as seen by paramedics. Paramedic practice has, in general, been protocol driven—follow specific steps that are constructed on the basis of fitting with most cases, doing no harm, and ensuring that scope-of-practice boundaries are not violated. Moving to another frame wherein there is greater individual responsibility for decision-making about patient treatment presents new challenges, relevant to the adoption of the RPD model for making safe decisions in the field.

The security that comes from having a prescribed direction is strong. Following a standard scene assessment approach may increase the SA but does not ensure the quality of decisions for action. Reflection and mental simulation of potential outcomes, recognition of changing risks, and the impact of new information or changes in the time sensitivity for treatment based on patient condition all have an effect on the treatment options available and chosen. The tendency of learners was to consider that the RPD model was in the mode of a protocol—do this, do this, and do this, and the decision is readily apparent. Rather than seeing the benefit as coming from reflection of cues, decisions, and adjustments to actions, a protocol-like sense continues (see for example Schmidt et al., 2000).

More deeply, there may be a need to consider the nature of learning approaches that the individuals bring to the education that is attempting to change behavior (Dreyfus, 2004). Here, the work of Marton and Säljö (1976a,b) informs the analysis. Their work on "surface" and "deep" learners, originally with students of economics and later (Marton and Booth, 1997) with university courses and students, in general, seems particularly relevant. Surface learners concentrate on the text, while deep learners focus on the meaning of the text. Those who, in later work, became described as "strategic" learners were able to adjust their learning mode to match with the expectations of the instructor.

How does this help to explain the apparent lack of impact of the SAFER course on practice? The distribution of learners between the surface and deep groups is not known for the paramedic population, but there is no evidence that would indicate it to be other than that found in the general postsecondary population. Thus, surface learners will have greater difficulty in adopting the reflective approach that underlies the RPD model since it requires constant adjustment, and the expectation of the learner is for a prescribed path—a protocol for decision-making. Since they already believe their practice to be safe, there is little incentive to adopt another view of decision-making informed by enhanced SA. Not only does it represent a significant change, it also requires that the meaning of the proposed model rather than the text of the model be understood.

For the deep learner, the meaning of the approach may be clearer. The inclusion of reflection in understanding and reviewing experience is not a major change. It is to this group that the approach presented in the SAFER course can be seen as relevant to their safe practice, as well as having application to the adoption of treatment guidelines for patient treatment. The premise of moving to treatment guidelines from protocols is that the paramedic at the patient side is in a better position to make the best treatment decision for that patient, rather than a group of physicians gathered at a table considering how to prescribe treatment that will apply in most cases, will have minimal harm potential, and will fit within the various scope-of-practice definitions for different license levels. Those who adopt treatment guidelines are treating the patient, rather than trying to make the patient fit a protocol.

Similarly, for a safe practice involving decision-making, the deep learner can recognize that the changing nature of situations means that it is impossible to define a "protocol of practice" for every situation. What is needed is adoption of an approach that will enable safe decisions to be made in a wide variety of situations—identify cues, mentally simulate results to a course of action, and adjust the actions accordingly.

It is only recently that the surface/deep distinction has appeared as a factor for consideration in EMS education (Heijne-Penninga et al., 2010). The authors structure their argument in terms of "need for cognition" related to an individual predilection to engage in effortful thinking. While students with a higher need for cognition performed better on both open- and closed-book tests, there was no influence of deep learning on performance. A potential extension of this finding would be to the nature of problems that paramedics face and how they are assessed. That is, do the assessments relate to the core knowledge of paramedic practice referred to by Heijne-Penninga et al. (2010) or the "nice-to-know" knowledge? As the role and scope of practice are expanding, the influence of deep or surface learning will become a more important aspect to consider in evaluation.

UPDATE ON DECISION-MAKING CONSIDERATIONS

Effective decision-making in the chaotic field of EMS practice can benefit from an understanding of the nature of decision-making and the specific aspects that are relevant to healthcare. Much of the work that has been done in this area focused on decision-making by physicians. In particular, the work of Croskerry (2002, 2006, 2007) is appropriate to guide applications in EMS. Klein's work (Ross, Klein et al., 2004; Klein, 2008, 2009) in establishing an understanding of the factors to be considered in NDM and the development of the RPD model provides a mechanism to assist practitioners. The important elements are that the model is descriptive rather than prescriptive, and creating the environment to acquire an understanding of the significant elements is the first step to making progress in this area.

The description of system I and system II as espoused by Kahneman (2011) is not in opposition to the RPD model (Kahneman and Klein, 2009), and both can be informative. The work of Croskerry (2007, 2009b,c) has investigated both the practice of decision-making in emergency medicine and the potential impact in education. The work of Norman and Eva (2010), in particular, points out the need to consider the ways of embedding these skills in the courses for medical students as well as how faculty can structure programs to give students the needed practice and opportunity of self-reflection in this regard. In particular, the use of simulation with well-structured debriefing sessions affords participants the experiences that will enable them to hone their insights.

It is perhaps useful to consider the realm of decision-making that has been reasonable for EMS practitioners as the field emerged. Rule-of-thumb decision approaches, based on informed medical considerations, provided an appropriate guideline for paramedics and often were the basis for the standardized protocols to be followed. The problem of clear thinking in an emergency (Schull et al., 2001) supports the benefit of heuristics to make the knowing of what is right to do translated more quickly into the doing. Mencl et al. (2013) raise some concerns regarding the ability of paramedics to correctly identify the ST elevation myocardial infarction (STEMI) presentations in their study. However, the limitations of evaluating the training programs including the assessment and reinforcement leave the question of suitability of the application of STEMI recognition by paramedics somewhat open.

A specific application for paramedics, START (Simple Triage and Rapid Treatment, Cook, 2001), was refined post-9/11 to improve the triaging of adult patients. And, perhaps, the exploration of a heuristic for detection of strokes, indicated as being more accurate than magnetic resonance imaging exams (Gigerenzer and Gaissmaier, 2011), suggests that specifically created heuristics appropriate to paramedic practice may represent an approach to enabling them to develop expertise relevant to their expanding practice. However, the insights of Feltovich et al. (2004) indicate caution.

Gigerenzer and Gaissmaier (2011) summarize the review of heuristics with indicators that can be applied to EMS activities. Heuristics are presented as potentially more accurate than complex strategies, as having a context dependency for accuracy and being suitable to function as one of an available array of choices for decision-making. These aspects support the use of heuristics in EMS practice thus far.

Decision-making in EMS practice has not received the study that decision-making by physicians has. The exploration of decision-making in emergency medicine, for example by Croskerry (2002, 2008, 2009a,b,c) can be placed into three large areas—first, the inherent factors which interfere with decision-making; second, the consideration of a theory to better understand the decision-making process and its relationship to expertise; and, third, what aspects of decision-making can be taught.

Croskerry (2002) explores the reasons that understanding how physicians think in the ED setting is a significant research area. The use of heuristics is acknowledged, and the benefit of being more aware of cognitive processes is seen as informing the quality of decisions (e.g., Flavell, 1976), improving instruction in the teaching of cognitive strategies, and, most importantly, improving patient safety. The discussion of the types of biases that influence decision-making has relevance to the EMS setting.

A full discussion of bias and its influence on clinical decision-making was reported by Croskerry (2002). The use of specific cognitive strategies to mitigate the identified biases can be applied to both medical education and professional development. Croskerry (2002) refers to the importance of understanding the role of metacognitive strategies as a characteristic of experts who have been successful in "overcoming weak cognitive tendencies, biases, and flawed heuristics." His work was focused on decision-making within the ED and thus seems of relevance to EMS situations. In particular, there may be associations that are more prevalent for low-volume EMS stations where particular patient presentations are seen so infrequently that incorrect application of heuristic thinking would be understandable. However, it should be noted that a number of decision researchers have been critical of this bias and flawed heuristic view (see Klein, 2009, for a summary). Biases can be demonstrated in laboratory settings but miss the value of heuristics for operating in complex environments.

Other works based on physician decision-making explored which theoretical model best matched decisions made under diagnostic uncertainty. The dual-processing model was most closely aligned with the physician decision-making studied, in particular, a threshold approach in which the decision to treat was applied when the probability of disease was above a predetermined threshold and the decision not to

treat when the presentation was below the threshold. Developing such an approach may be of benefit to paramedic practice (Djulbegovic et al., 2014).

The analysis of decision-making also introduces the concept of errors in decision-making, in the realm of clinical decision-making by physicians (Shaban, 2005; Croskerry, 2006). Again, the identification of the cognitive basis for the errors raises the prospect that there can also be approaches to minimizing or mitigating the cognitive biases. Another view of error in clinical decision-making is presented by Thompson and Dowding (2004), who identify several sources of error. Strict adherence to rules categorized as "bad," false, or inadvisable is one source. The inappropriate application of heuristics is seen as another bias-laden issue. The authors present approaches to overcoming these error sources, and the extension beyond the realm of nursing practice may be worth considering for other health practitioners.

A further category as a contributory source to error in clinical decision-making is overconfidence. This arena has been reviewed by several authors (Kruger and Dunning, 1999; Davis et al., 2006; Berner and Graber, 2008; Croskerry and Norman, 2008), and there are consistencies in the findings over the number of studies. Reliance on the initial consideration of the situation, application of inappropriate heuristics, and the inability to recognize one's own limitations are presented as the major sources of difficulty. There are varying degrees to which successful interventions may be applied in each instance. Understanding the role of cognitive strategies is presented as one way in which practitioners can reduce the errors to improve patient safety (Chapman and Aubin, 2002). The comment by Berner and Graber regarding physician error, "that they believe that their initial diagnoses are correct (even when they are not) and there is no reason for change," is reminiscent of the intervention previously described to improve paramedic SA. They perceived their practice to be safe and hence were not as receptive to education designed to improve that aspect of decision-making. The review by Davis et al. (2006) suggests that physicians are not proficient at accurate self-assessment. This inability resulted in those least skilled having the worst self-assessment and the greatest overconfidence.

Improvements may be assisted by reviewing the aspects of critical thinking as outlined by Facione and Facione (2008). Their summary points to recent trends to improve clinical judgment training, as well as the apparent improvements in outcomes with an increased application of case-based and problem-based learning in educational programs in healthcare, for example Critical Care Paramedic education (BC Ambulance Service, 2013). This opens consideration of how decisions are being made in clinical settings (Sullivan and Chumbley, 2010). In general, the dual-processing model (system I/system II) as explored by Sanfey and Chang (2008) and Kahneman and Klein (2009) reinforces the complexity of decision-making in the NDM environment where reliance solely on System I (or the recognition-primed part of RPD) while efficient has potential risk for error. The more effortful system II reflection can be essential to achieving the status of expert in a particular field, as alluded to previously (Croskerry, 2002; Frederick, 2005; Croskerry and Norman, 2008). The importance of a full understanding of the context in which a decision is made must be emphasized, if there is to be learning from decision errors, whether system I or system II based (Croskerry, 2009c).

The broad area of education in decision-making, an approach to expertise acquisition, incorporates several strategies (e.g., Bowen, 2006; Milkman et al., 2008; Okoli et al., 2013). The general trend is to examine the approaches of experts and make them available to novices. The requirement is for the expert to assess both the nature of the problem presented and the developmental stage of the novice to ensure an appropriate level of feedback and probing questions. Concomitant considerations are of the roles of system I and system II thinking, the impact of prior experience as cues in RPD, and whether distinct approaches to unravel these two roles, the immediate and the reflective, in improving decision-making can be easily resolved (Milkman et al., 2008). Assistance in developing suitable approaches may be found in the work of Evans (2008), which takes a broad view of the available literature on dual processing in higher cognition. Further, there is an extension of these concepts to include categorization of decision-making processes, leading to the incorporation of intuitive judgment and intuition as a reflection of expertise (Glöckner and Witteman, 2010; Chu and MacGregor, 2011; Klein, 2013). Cunningham et al. (2009) in detailing a categorization of insights offer some potentially fruitful concepts for further consideration of the topic.

The approaches to improving clinical decision-making by use of cognitive strategies have been explored for emergency medicine and provide a guideline for improving the expertise in EMS (Chapman and Aubin, 2002). But as pointed out by Lajoie (2003), the approach to transition from novice to expert requires first that some form of assessment of what constitutes expertise for a particular domain is necessary. Novices can then benefit from awareness of the intended path to improve their expertise. Smith et al. (2013) engaged in such a cognitive task analysis to compare the performance of experienced and less experienced paramedics in their approach to complex patient presentations. While their findings demonstrated the greater expertise of more experienced practitioners and their greater gathering of cues, use of inferential reasoning, and strategic thinking, the shortage of research specific to EMS is alluded to in their proposals for future research in this area. The use of cognitive forcing strategies to reduce biases has been ineffective in at least one study (Sherbino et al., 2014) and thus reinforces the need for additional study in the area of increasing expertise. The poor track record of debiasing efforts calls into question the efficacy of the cognitive bias approach.

In a related healthcare field, nursing, other approaches have been introduced to promote critical thinking, a valuable line of inquiry to improve decision-making (Vacek, 2009). The relevance to EMS expertise is likely to be one of accepting relevant research from studies of other health professions. Indeed, the outlines of research on emergency physicians including their decision-making, cognitive strategies to mitigate bias, and ways of applying lessons learned to the education of medical students can be a guiding framework for acquisition of expertise in EMS practice. The available research on EMS paramedics is only recently concerned with these areas of inquiry.

Jensen et al. (2011) and Jensen (2011) present investigations of paramedic decision-making in high-acuity calls and outline the strategies employed for thinking about the patient presentation and the most appropriate treatment. The unique contexts in which paramedic practice occurs have features of high-density decision-making

during the initial on-scene phase, and expertise in that portion of patient treatment differs markedly from a potentially more controlled setting for other emergency health practitioners. The work of Ryan and Halliwell (2012) outlines two approaches that are deemed involved in paramedic decision-making and expertise and their relationship to deep and surface learning strategies. Earlier studies (Heijne-Penninga et al., 2010) explored the impact of deep learning on effective preparation for medical student assessments.

There appear to be several approaches that can have an impact on the improvement of clinical decision-making and expertise within the field of medicine. The adaptation of these specifically to paramedic expertise may seem beneficial to improving practice, but a cautionary view is presented by Graber (2009) with the question of whether educational strategies to reduce error can, in fact, be taught. Eva (2005) provides guidelines for clinical instructors regarding what they need to know about clinical reasoning, for effective teaching. Norman and Eva (2010) and Norman (2005, 2009) review research in the field of clinical reasoning and the relationship of dual processing in understanding diagnostic errors. Again, the research from the field of physician education and practice is viewed as a guideline for implementation in improving EMS expertise.

RECENT WORK ON THE EXPERIENTIAL/RATIONAL BASIS OF PARAMEDICS IN DECISION-MAKING

A further area of research has been the relationship between the experiential and rational bases for decision-making as it relates to tolerance for ambiguity. In this area, there appear to be strong correlations for cardiologists, emergency physicians, and paramedics (Calder et al., 2012; Jensen et al., 2014a,b). The demonstration of expertise in these contexts may be posited to reflect the ability to function effectively under the conditions of NDM, the frequent context for EMS practice (Furnham and Marks, 2013). This approach is based more on the individual capability rather than knowledge or skills resulting from education. For paramedics to benefit from the work on decision-making, the question is what approaches would benefit those who see their decision-making as having a rational basis rather than acknowledging the experiential basis. Individuals attracted to the profession may first benefit from an understanding of their decision-making (Klein, 1998, 2003, 2008) as well as becoming more self-reflective (Marton and Booth, 1997; Kruger and Dunning, 1998). Other work (Croskerry et al., 2010) introduces the element of emotional influences in clinical decision-making. For paramedics, this further understanding of aspects of their decision-making beyond the rational analysis can be a significant contribution to improved decisions. Williams et al. (2013) likewise point out that changing attitudes will be a necessary component if knowledge translation is to achieve a more influential position in adjusting paramedic practice to the new demands of the profession.

There may be value in approaching the educational components required for acquisition of expertise in the new environment by consideration of more fundamental aspects—the philosophical distinction of "knowing how" and "knowing that" (Quay, 2004), for example. Other potential sources for consideration would be earlier

discussions of cognitive study to the understanding of expertise (Schmidt et al., 1990) or exploration of applications of the reflection (system II) on initial decisions (system I) in terms of "slowing down," a counterintuitive notion for traditional paramedic reactive approaches to treatment (Moulton et al., 2007; Di Stefano et al., 2014).

FUTURE RESEARCH

At least 3 areas for future research seem relevant to the changing role of paramedics. The expanding scope of practice in terms of a larger response to nonurgent, nonemergent patient presentations will require an understanding and, perhaps, greater concentration on nontechnical skills. These attributes have been the subject of research and study in other medical areas, for example, surgery and anesthesiology (Flin and Maran, 2004; Flin et al., 2007), and attention to the needs for paramedics in this realm seems reasonable.

With paramedics taking a more proactive rather than reactive role, community paramedicine as an example, research on the effectiveness of such roles will be important to best tailor the role (Bigham et al., 2013) and the interprofessional relationships (Misasi et al., 2014) that are required to ensure the wise investment of healthcare resources. In this specific area, two approaches bear watching. The work of Morrison (Pers. Comm; Drennan et al., 2014) investigating, in a systematic fashion, the impact of community paramedicine practice on three chronic conditions, congestive heart failure (CHF), diabetes, and chronic obstructive pulmonary disease (COPD), will provide insights into anticipated effectiveness of this expanded role. Another view is taken by Craig (2015a,b), who suggests that confirmatory research is needed to make the ready acceptance of this trend valid.

A second broad area for future research would be on the role of technology, both in terms of paramedic practice and in regard to the educational approaches for the new roles, and the scope of current practice. Consider first the impact of technology in new roles. The impact of telehealth applications, for example, to enable more rapid and continuous contact with medical oversight may permit an increase in scope of practice to facilitate the realization of the intent to take the ED to the field. There have already been some approaches to facilitating such applications (EMS World, 2016). The confirmation of expenditures in technology as a means to provide more cost-effective healthcare seems reasonable as the direct costs of hospitalization are already identified (British Columbia Ministry of Health, 2014).

Further to the increasing use of technology are field applications for items such as intubation assists and cardiopulmonary resuscitation (CPR) assists. While the evidence is mixed for the use of intubation in the field (Wang et al., 2015), the role of CPR assists has some potential benefit (Krep et al., 2007). There is not a clear role for such assists in terms of patient benefit, but there may be in terms of paramedic safety to provide effective CPR while in transport.

For these and other potential interventions, large-scale randomized controlled trials, although expensive to conduct, are necessary to provide the evidence of evidence-based medicine. Paramedic involvement in research (Mencl et al., 2013; Mausz and Cheskes, 2015) is a two-edged sword. On one hand, the data collection from the field is essential. On the other, the potential impact in terms of self-initiated

practice without the clear evidence is consistent with the nature of paramedic practitioners (Tangherlini, 2000).

Technology can also play a role in the education of paramedics for their current or new roles. In the current scope of practice, simulations may be provided for initial acquisition of skills as well as the maintenance of competency in those skills. This area is one which, again, has roots in established medical interventions (Cheng et al., 2014; Halliwell et al., 2015) and is increasingly found in paramedic research. The use of simulation has been widely accepted in medical education and can be used to enhance new skill sets, to maintain existing skills, or to assess the effectiveness of such interventions in clinical practice (Tavares et al., 2013). Some aspects of the expanded role in terms of the nontechnical skill acquisition may be influenced by applications such as ShadowBox (Klein et al., 2015), which have already been demonstrated as effective in the realm of "Good Strangers," a program on cultural competency for the US Army. In this application, there was demonstrated success in providing individual learning through computer-based, virtual and simulation activities. These early demonstrations of improved educational outcomes suggest that further technology applications may be of benefit. However, there would appear to be a required understanding of decision-making and technology applications to ensure success (Patterson et al., 2013) as well as a thorough assessment of the knowledge of the "experts" in the domain (Hoffman et al., 1998).

Virtual reality applications such as TheraSim have been used in the provision of education for healthcare providers in a number of underserved areas, and similar approaches may be cost-effective methods for remote and rural areas where paramedic practice is provided frequently by individuals who have the least training and the least experience and, in low-call volume areas, the least opportunity to consolidate, improve, and maintain their skills. The need for research to provide evidence and direction for such applications is a ripe area for consideration.

The technology impact on practice can be determined only by costly large-scale, randomized controlled studies. But small-scale research will continue to provide guidance for adjusting and enhancing paramedic response to the new needs. Studies involving technology that can impact practice are suggested by an exploration of paramedic safe practice in a common area of service—cardiac arrest resuscitation (Ross et al., 2015). In this instance, eye-tracking technology revealed an inattention to individual and partner safety during defibrillation. The "presumed expertise" within even a frequently practiced intervention underlines the need for reinforcement of best practice for continued retention of expertise in a complex skill.

Overarching these potential research applications is the common issue of the demographics of the paramedic practitioners. Individuals with extensive experience will be taking the corporate memory of paramedic practice with them, and application of some methods to preserve the valuable insights gained over years seems indicated. Eliciting expertise is a resource-intensive field that can lead to an accelerated acquisition of expertise, as discussed thoroughly by Hoffman et al. (2014). Specific suggestions for accelerating expertise (Fadde and Klein, 2012; Fadde, 2013) offer some insights to achieve this desirable outcome. In light of the increasing complexity of patient treatments being offered in the field by paramedics, the ability to accelerate their path to expert is desirable. However, as O'Neil and Addrizzo-Harris (2009) point out, the effectiveness of

continuing education to improve skills and knowledge can be enhanced by multiple exposures and longer duration of education sessions. These recommended practices may be at odds with current approaches to continuing education for paramedics, either for license or certification retention or as provided by the employer.

CONCLUSION

The aspect of demonstrating expertise for paramedics is challenged in a number of ways. The research evidence specific to EMS that would assist in improving decision-making is scant. Only recently has there been attention to the notions of clinical decision-making in EMS practice, which is only recently being recognized as a distinct field of practice in healthcare.

The evolution of the role is expanding both in allowing treatment to more complex patients in the prehospital setting and in providing care in a community role as an adjunct to primary care providers. These two developments are almost in conflict—the former requiring more specialized skills and knowledge and the latter demanding more generalized knowledge with a greater emphasis perhaps on the nontechnical skills. And within each area, the role of technology places added assistance such as telehealth while simultaneously increasing demands for greater technical knowledge. The facility with technology may prove less of a barrier for more recent hires but can leave the experienced practitioner at a disadvantage.

Finally, achieving the path to professionalism has its own conflicts in terms of expertise in practice and expertise in theoretical knowledge. Working in the interprofessional setting, more likely with the expanded community role, will require changes to the education approach for the new generation of paramedics with expertise.

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