

Navigating Chaos: A Critical Analysis Of Decision-Making In Emergency Medicine

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1. Introduction

In the emergency department (ED), chaos is the norm rather than the exception. Time is of the essence, staff exhibit the highest levels of clinical activity, critically ill and injured patients are cared for, and profound decisions about care and resources must be made. It is little wonder then that working in an emergency department has been ranked, according to a number of indices, as the highest-stress medical specialty. The manner in which medical management problems are solved and decisions made in such settings has rarely been explored at any level of detail important to clinicians working in that environment. Generally speaking, clinical

decision-making is a subject that features infrequently in either the medical or business disciplines. The area is largely categorized by investigative studies from psychology attempting to explain why professionals do not always evoke rational behavior.

In the high-stakes, time-sensitive environment of the Emergency Department, clinical decision-making involves negotiating a complex interplay between individual, ecological, and technological factors. In this paper, we take a critical approach to the analysis of clinical decision-making in emergency medicine to explore how sense-making and decisions shape, and are shaped by, the specific characteristics of this clinical environment. We present a qualitative study of extended physician-nurse interaction in an effort to explicate the interpretative processes and communicative strategies that underpin the complex work of clinical decision-making. Our in-depth, rigorous analysis demonstrates the sense-making differences between the two clinician types. This work contributes to a greater understanding of the complex cognitive processes of sense-making and communication by clinicians in pressured circumstances, in addition to contributing to the body of literature in a field where detailed reports of the nature of skill and expertise in clinical decision-making are rare.

1.1. Background and Significance

Emergency physicians encounter a large number of problems in a short time, necessitating the application of an ad-hoc knowledge of pharmacology and the consistent use of procedures and technology. The patients managed in an urban emergency department are often the sickest of the sick; those who will rapidly die without treatment. Management of these patients takes place in a very unobtrusive, almost clandestine manner. Death seems ordered and arbitrary, helpful on the one hand and often malevolent on the other. The emergency physician must first understand the complexity of individual life. Once able to do this, he/she must be both a great listener and an effective decision maker. When needed, the physician will have the wisdom to recognize the best and most accurate therapy. However, the critical nature of the patient care that takes place in the emergency department is difficult to learn, humiliating in practice, full of fallacies, and harmonious occurrences of being both harmed and being a hero. (Chavez et al.2)

There are some environments that demand adaptation more frequently and with less lead-time for preparation. Few are as intellectually demanding and exacting as the emergency department. The rhythm of emergency medicine has a staccato beat that pulsates to the quick intensity of crisis and lifethreatening illness. It can be a frightening, isolating, and frustrating experience. As the pace picks up and the ability to think logically diminishes, it becomes necessary to depend more and more on memory and habit. The major objective of this research was to discover the pattern of activities in the management of critically ill or injured patients by emergency physicians and to subsequently develop decision-making strategies, which could be utilized by emergency medical personnel.

1.2. Purpose and Scope of the Study

The extreme events related to major natural and manmade crises are not run-of-the-mill risks. They are transgressive as they embody levels of risk that concern individuals, organizations and the society as a whole. Insights into how emergency management can be made more effective is needed, but many of the existing relevant works are inspecific about the micro-level decisionmaking reasoning processes that occur during chaotic crises. This work can provide details about the hidden work that needs to be carried out by medical staff during emergency situations. At the very least, it could provide suggestions on how to improve medical staff training and other logistical aspects of emergency medicine. Finally, there is the wider significance of this work. By analyzing medical decisions in the dangerous and uncertain context of major emergencies, we can better understand collective decision-making under risk, uncertainty and extreme events. Such insights have potential implications for decision-making within the organization and beyond, within the domain of collaborative and networked decisions of a similar nature. (Raoust et al., 2019)

As a literature review, this research does not test any specific hypothesis or theory. The question is, therefore, why, in the absence of such empirical testing, is this work necessary and valuable. First, the issue of collective decision making under risk and uncertainty during a major emergency is, potentially, of global significance. This is because medical staff (including those in Spain who are the primary focus of this research) can be called on at

almost any time to deal with demanding and dangerous crises. A growing body of work from political science and sociology describes and explains the role played by all kinds of professions in dealing with disasters and emergencies. However, those medical workers who risk their lives to help society are, arguably, at particular risk of dying due to the uncertainties and dangers associated with the events that they must deal with.

1.3. Methodology

Interactions were guided but not led by our interview questions, the wording and structure of which have previously been discussed. Each interviewer was also issued the same brief, additional probing questions. These probes were designed to illuminate the meaning, force, direction, and perception of the emergent themes. Their inclusion assisted our quality control efforts in giving credit to the nuances and subtleties of the varying contextual situations in which the experts operated. Such focused matters shone light on the essential and requisite decision-making strategies implicit in each case. Allowances were of course made to tailor the interview topics to the emergency clinicians' narratives, such that emergent, unanticipated subject matter was not a cause for concern. Within these interviews, defined ethical considerations were also dutifully observed. Individuals were given time and space adjustments permitting them to shape their reflections and interactions, whereby engagement, disengagement, or clarification at any one time was equally permissible. (Roberts, 2019)

With exploration as our primary goal, and mindful not to compromise our aforementioned trustworthiness, in-depth, semistructured interviews with fourteen experienced emergency medicine consultants were chosen as the method of data collection. In assembling our sample, we were mindful of the three needs of representing an experienced group of clinicians, conducting more than five interviews per hospital, and unique patient populations. Specifically, four consultants each were interviewed from two separate large university teaching hospitals, and six hailed from a large regional hospital with no affiliation to a university. The nature of the hectic schedules of our targeted participant group necessitated conducting these interviews outside of regular working hours, so to respect participants' limited free

time, it was explained to them that all interview topics would be limited to either personal or group experiences relating to disaster priorities.

2. Theoretical Framework

The Agility paradigm uses Shared Decision Making to refer to a team state that typically involves solving a specific decision problem. This means to generate, evaluate, and select a set of potential outcomes. The decision-making process is driven during Information Sharing through a proposal and consensus-based process. A team is in a Decision Making state after a decision is proposed, but before it is taken. Symbol: Team leaders usually contribute to this state by seeking consensus. This approach emphasizes objective models, while normative models focus on subjective decision making. In the prognosis and diagnosis of the environment are based on weather maps, statistics and historical data comparisons, i.e. on the assessment of Objective Situation Awareness. Various studies have related Objective Situation Awareness to the success of team decision making across multiple contexts prompting decisions. (Blasch et al.2018)

In a seminal book, Simon brought the discussion on decisionmaking to the attention of behavioral scholars. However, he also cautioned against the deterministic use of the 'decision-making' term, reminding us of the essential concerns that led us to the exploration of the concept. This research presents a behavior analysis of the shared-making process for context-aware capabilities in emergency response teams. This was implemented by following an agile development process. Participants in the forthcoming experiment re-enacted an event report where it was emphasized how team activities were aimed at achieving shared intentions and cognitive work dealing with the situation. They did a two-stage tacit and then explicit decision-making process.

2.1. Complexity Theory

Decisions in the health care arena have been seen as linear aimed at an ordered state. The new sciences such as Complexity, with particular reference to Complex Adaptive Systems, challenge these theories and present fundamental implications for the practice of management and organizations. Indeed, the new adaptation of health services as Complex Adaptive Systems is perhaps not core

science to many emergency physicians, but there are interesting arguments that can be drawn to help inform and give insights into the emerging chaos that is presented to them within their professional practice. (Begun & Jiang, 2018)

At the start of the twentieth century, linear management theories were developed to impose order and control in environments where there was much chaos. As we witness the unfolding of the twenty-first century and the increased complexity associated with emergency medicine, these management theories cannot cope with the level of chaos and decisions that arise in emergency medicine. A new science has emerged that challenges such traditional linear theories. This new science is Complexity Theory. Scientists from different disciplines such as business, psychology, economics, physics, and epidemiology have been informing management and social science.

2.2. Sensemaking and Decision-Making Theories Faced with the complexity and time pressure of their work, clinicians must use cognitive strategies to allocate their attention efficiently to the important information around them. Many researchers, including mostly those in the field of Human Factors, use the term sensemaking to describe these processes. Sensemaking applies a systems approach to this aspect of decision making rather than a psychological one; it is about understanding the big picture of how decision making at work unfolds and developing interventions that improve that. A classic model of sensemaking identifies a cycle of behaviors including: initial disorientation in the immediate aftermath of an event; stocktaking and mapping the issues at play; identification and utilization of resources; analysis to sharpen understanding and prioritize; deliberation to form plans; and action. Sensemaking theory is being used to research decision-making in emergency medicine and provide practical advice to emergency medicine professionals. Sensemaking theory helps to explain these findings; it posits that people respond to the stimuli they receive and do so in a way that does their best to keep their goals in mind. People therefore adapt their response in the light of new information that becomes significant as their understanding of the situation develops. (Cunningham et al., 2018)

3. Decision-Making in Emergency Medicine

Emergency medicine is a uniquely chaotic environment. Like complexity, to which it is intimately connected, chaos is formed by an interdependent whole. The emergency room (ER) might be considered a small, contained expression of this greater chaotic whole due to the high density of interactions between patients, among physicians, between patients and physicians, and among physicians and allied healthcare workers. These intradiscipline and patient/physician connections were described by Christakis, who noted that both groups shared in a symmetrical manner nearly identical relationships proscribed by *patenté*: They both came exposed and hidden diagnosis, seeking relief from their suffering and confusion. These back-and-forth relationships confer on the ER a unique position, worthy of special study. Markedly less heavily studied within the ER is the emergency physician's relationship with her own internal definition of self and work. She is singular in the ability to function at the nexus of patient, disease, and advanced technology while hiding her uncertainty behind a facade that appears confident and in control. (Al-Azri, 2018)

An inherent aspiration of emergency medicine is the competent resolution of uncertainty, often in the form of rapid, impactful, and sometimes life-altering decisions on the part of the emergency physician. Emergency medicine relies on a shared decision-making model in an environment characterized as much by ambiguity and irrationality as by the potential (and often very real) risk of harm if the wrong decision is made. Growing interest in non-rational or intuitive decision-making processes has occurred in parallel with the medical literature on emergency medicine due to the unsettling similarities between the work of emergency medicine physicians and that described by the authors in a variety of nonmedical disciplines. Emergency medicine has, therefore, become a rich environment for the study of intuitive decision-making processes as has been explored by Stolper et al., Croskerry et al., and others.

3.1. Characteristics of Emergency Medicine Decision-Making

Multifactorial and multidimensional decision-making: The daily task of weighing up multiple co-morbidities, individualizing treatment, introducing medications for "off-label" indications, differing from "standard practice," and making decisions with regards to end-of-life choices are just some of the challenging

issues that these decisions cover. Much of the pharmaceutical decision-making in the prehospital arena is guided by the personal prescription of the attending physician's local policies, or a nonvalidated protocol. The success of poorly evidenced-based medications is based on context as well, for example, the delay time in instituting a particular intervention, or if an intervention is not completely initiated. Any new evidence that is developed in order to evaluate the prehospital environment needs to take into account the unique challenges this setting presents. (Ortmann et al.2018)

The complex, chaotic, and time-sensitive nature of EMS decisionmaking: Emergency medical services (EMS) physicians must make quick decisions regarding the care of time-sensitive or acutely deteriorating patients, often based on an incomplete clinical picture. Inherent within emergency medicine is the unpredictable nature of cases: no two patients, even with the same presenting complaints, are the same. This leads to critical decision-making, where results can have nationwide implications in the event of local, regional, or national disasters. Despite having only limited information, not making decisions is not an option. Furthermore, these time-sensitive high-risk decisions are often made under conditions of uncertainty, in the absence of full patient details and results of potentially significant investigations.

3.2. Factors Influencing Decision-Making in Emergencies There are many personal factors which the individual possesses that can influence the manner in which they react to an emergency situation. These factors consist of not only personal characteristics such as sex, ethnicity, language capabilities, and expertise, but also prior experiences, including entire call volumes, automatic reactions, and coping mechanisms. Additionally, variations in attitudes, specifically those pertaining to stress and attitudes developing during medical education or training. Likewise, a clinician's state of mind can flow into their medical decisionmaking process, guiding on how decisions are actually designed. Researchers have also extended the decision-making model to include varieties in affect: certain kinds of personnel employ affective decision-making, which depends on the fast and programmed emotional response. (Beldhuis et al.2017)

Emergency situations are often characterized by uncertainty, complexity, and disorder. Decision-making under these conditions can be extremely challenging as individuals may find it difficult to stay focused and make appropriate decisions based on the available information. One can, however, simplify the cognitive processes that influence decision-making by explaining the various factors involved. These factors can be divided into individual factors, interaction factors between the individual and the emergency medical services (EMS) context, and the factors influenced by the EMS context itself. The next section will thus provide an overview of the various individual factors that have been found to influence decision-making in an emergency situation. This will be followed by an explanation of how such decisions are influenced by interaction factors and the EMS context.

4. Cognitive Biases and Heuristics

Overconfidence is a bias that predisposes emergency physicians to hold unrealistic beliefs about the certainty associated with their diagnoses and therapeutic plans. Confidence is thought to be a measure of the validity of judgments. Since confidence is not strictly predictive, it is not unusual for decisions to be both overconfident and biased. The medical literature has documented consistent levels of diagnosis overconfidence among emergency physicians, typically finding that diagnostic accuracy is therefore inversely related to confidence. Confidence can also spur physicians to prefer more evasive or aggressive treatments compared to those who have lower confidence.

Cognitive biases and heuristics are important contributing factors to errors in reasoning that can occur in the process of clinical decision-making. A heuristic is a mental shortcut, which doesn't require attention, planning, effort, or conscious awareness, thus allowing us to make quick and sometimes efficient judgments. In judgment under uncertainty, decision-making relies on heuristics due to the cognitive limits of the human brain to store and process information. This applies particularly to emergency cases when time to make life-saving decisions might be very limited. Certain biases may reinforce the use of heuristics in emergency medicine, such as overconfidence, confirmatory bias, recent-event bias, and the availability heuristic. Inadequately applied, heuristics can cause

clinicians to make systematically different or faulty decisions. (Whelehan et al.2019)

4.1. Overview of Cognitive Biases

Models of decision-making purporting to describe intuitive, cluebased judgments contrast with similar models meant to describe analytic, rule-based ones. Each type is associated to a greater or lesser extent with certain cognitive biases and errors. Most heuristics, error or biases research seeks to explain how specific heuristics and control can lead to biases and errors, rather than when. In this part of the chapter, the descripto-normative research program will also provide a brief overview of some of the more well-known cognitive biases and errors. Work has been done in models of analytical decision-making in certain disciplines in which emergency workers operate. The mechanics are the subject of the following section. (Hartigan et al.2019)

4.1. Overview of Cognitive Biases

Emergency workers frequently wonder why patients call an ambulance for obviously minor conditions or might abuse the system by calling repeatedly. Ambulance staff are usually trained to deal with life-threatening emergencies and deal with 999 calls proportionately. However, not only are we skilled at providing reassurance when the situation really is non-emergent, but the ambulance is a mobile platform staffed by professionals with considerable expertise in dealing with undifferentiated, unscheduled care.

4.2. Common Heuristics in Emergency Medicine

The use of heuristics, especially in high acuity, demanding contexts, is therefore indispensable. Unnecessary complexity of simple tasks can be reduced by identifying the key features and regularly referring to them in sick patients. In managing multiple trauma casualties in a mass disaster setting, heuristics such as examining each of a number of simple RSI components, timely thoracostomy, use of clinical signs to determine pharmacotherapy to establish airway, and to ensure preparedness ensure timely, organized care to prolong life. High-fidelity simulation training for emergency doctors may promote recognition, application, and ease of use for challenging high acuity heuristics. While examination of heuristics used in providing high-quality, efficient emergency care assists in

improving safety and quality of patient care and safety, ongoing patient involvement in research, service design, service by other health disciplines, and delivery will continue to reveal valuable information and multiple benefits for all stakeholders, including patients.

Critical decisions are continually made by emergency physicians under varying degrees of certainty, urgency, and resource availability. This process is affected by a number of personal characteristics as well as the demands of the environment in which the decision is being made. Heuristics help guide our thinking during the decision-making process and simplify complex and ambiguous reality. They are, however, valuable tools, helping physicians to make rapid decisions and prioritize patient care needs. Common examples of heuristics, such as recognition of the importance of rapid defibrillation and time-dependent treatment options, and a sense of reassurance with the presence of organized thinking aids and tools can assist in the taking of life-saving decisions where cognitive load is high and rapid, accurate judgments are needed.

5. Ethical Considerations

It has been shown that after the decision of surrogates to provide or withhold information from the patient changes, the substituted judgment for the patient's most probable wishes, showing the correctness and integrity of surrogates' behavior according to the patient's will. Lasting power of attorney LPS76305 enquire of this. Foster surrogate autonomy also means expressing the will to decide or not the convenience of the disclosure to the in-charge physician of decisions made on their behalf by the patient. This will prevent any moral conditioning of their affirmation to steer the physician in the desired direction. At the same time, silencing oneself, accepting the opinion of and deferring to other members of the family, such as that of brothers, the children of the patient if he is old enough, without confronting themselves with the doctor, is not a good way of being a substitute decision-maker. (Spalding & Edelstein, 2019)

The requirement of informed consent is augmented by the presence of a surrogate decision-maker who can be called on to exercise an incapacitated patient's right to self-determination.

Decisions made by the surrogate should be based on the patient's expressed values and beliefs. The principle of substituted judgment should guide the surrogate, along with patient autonomy, beneficence, and non-maleficence. The Emergency Medical Treatment and Labor Act (EMTALA) complements this principle by protecting patients from actions based on financial status. Emergency physicians frequently navigate around these standards. The difficulties of informed consent are exacerbated by the fact that informed consent often only includes disease, risk and benefit discussion and rarely involves the more complicated discussions of value, quality of life, and the potential impact on patients, caregivers, and society.

5.1. Ethical Principles in Emergency Medicine Decision-Making

The essence of emergency medicine, and clinical decision-making in particular, generates a number of ethical conflicts. Clinical decisions and considerations made through the patient's eyes can result in conflicts with justice from a distributive resource allocation standpoint. Consent may similarly demand a compromise, with the patient requiring expedient treatment versus the doctor feeling that the true authenticity of the consent itself has been compromised. Physicians may also feel trapped into making decisions that they are not entirely comfortable making. These conflicts can only be resolved by examining the fundamental ethical framework that underlies professional judgment. By developing an enhanced understanding of the ethical issues involved in emergency care, emergency medicine physicians and educators may better fulfill their complementary missions of individual patient care and service to society.

In the emergency room, decisions may have to be made quickly and under extremely difficult circumstances. There is little time to consider a decision's impact, formulate alternative courses of action, or objectively consider the choices available. The environment also places physicians under enormous stress, and they are sometimes forced to act despite incomplete information. Despite the complexity of the discipline and the fact that it is based on a range of different ethical and decision-making issues, the two areas are not usually associated with each other. An understanding of the area's ethical issues is fundamental to an overall understanding of emergency medicine, setting it in the context of

other disciplines and thus influencing its content and direction. Because of this elemental relationship between emergency medicine and medical ethics, the two topics warrant exploration and comparison.

5.2. Challenges and Dilemmas in Ethical Decision-Making The role of bioethical decision-making in emergency medicine practice is most pertinently described as simultaneously recognizing the 'almost certain' and the 'inevitably uncertain'. We do so within the context of each moment when we must practice triage, work in disaster medicine and in all the uniquely unpredictable and critical arising events. Making the least bad decision that balances the focus on individual patients within the wider expectations of emergency care and public wellbeing is challenging. Placeholder decisions are multifaceted and demand both ongoing reflection and a focused chemistry of individual strength, determination, and bravery. In doing so, we reflect the most human aspect of medical compassion and patient advocacy. (Ekmekci & Folayan, 2018)

The provision of sound ethical guidance in the ED is essential but challenging. Many ethical issues faced relate to process and have a significant impact on the delivery of care. The confidentiality of text messaging (SMS, WhatsApp, Messenger) groups has been of particular concern. Legal and ethical dilemmas typically arise when premature or presumptuous questioning of an issue is made. Multiple conflicting factors require consideration, and most emergent medical events are multifaceted. Time and emotional pressure affect judgment, and they are considered to drive many decisions which conflict with the 'ideal' guidance. Overriding a patient's wishes is a recognized issue, especially in trauma contexts. Ethical challenges within the resuscitation room bear characteristics unique to this particular environment. Religion and death can also pose particular difficulties, with requests for medical futility and prolongation of life based predominantly on cultural factors arising at certain times.

6. Team Dynamics and Communication

Successful delivery consists of taking a global view of the patient to identify any immediately reversible causes, distinguishing reversible and non-reversible causes, and having a clear, structured approach to prioritize care around commonly modeled critical

incidents. Trauma and surgical leadership roles in crisis resource management are, relative to medicine, more clearly defined and have a longer history of practice. Key components of this leadership, inclusive of advanced leadership training curricula and advanced simulation faculty development programs, focus on flexibility, self-identification of situational awareness and preventing the persistence of loss of leader control, as well as preventing and managing acute stress and arousal.

Good communication is critical to clinician teamwork and patient safety. As such, the concept of closed-loop communication is well described in the teamwork training literature. This entails the team leader issuing clear and direct commands in an appropriate tone and volume, subordinates responding promptly, and both the team leader and team members confirming understanding of the delegation and execution respectively. This construct, more than any individual directive or management intervention, ties with effective and efficient treatment of the critically ill patient. A recent mixed-methods review in other critical care and trauma disciplines found that communication challenges were complex and pervasive. These included operationalizing communication protocols and teamwork strategies, unconscious hierarchy, language, structure and the tone of clinical conversation, handover procedures and resultant gaps in continuity and multiple competing tasks. Across the emergency and critical care domains, the lack of standardized, easy-to-use and effective communication tools was highlighted.

6.1. Importance of Teamwork in Emergency Medicine Team leadership has repeatedly been recognized for its importance in team performance, medical error reduction, and the enhancement of patient outcomes, and team leadership skills can be developed by means of simulation-based training. Effective decisions in situations characterized by a high degree of complexity and high time pressure, such as EDs, can lead to the expression and implementation of the best solutions found, regardless of who initially discovers or recognizes them. Both the quantity and description of the interactions between healthcare professionals in an ED setting can heavily influence the application of teamwork to clinical decisions. Examples include interdisciplinary teamwork or peer collaboration, the relationships between physicians as

collaborators versus conflicts, the attention paid to and reporting of FEWs, and the dynamic application of standard operating procedures. The presence of a sufficient number of trained healthcare staff to support decision making and perform tasks needed in life-threatening clinical presentations in ED settings can have an effect on the quality of healthcare services. For this purpose, an effective ED should aim to avoid task overload or staff shortages either in terms of staffing levels or the skills and competences of the ED team.

The WHO and ERC guidelines detail that resuscitation teams in healthcare facilities, such as EDs, should be led by a designated team leader who can utilize other members as resources when they are needed. The anonymity of teams in an ED means that physicians and other healthcare workers on duty may change at short intervals, which itself necessitates excellent communication between all the team members. Team communication in EDs can become chaotic, with high volumes of information exchanged, short patient consultations, and continuous interruptions.

6.2. Effective Communication Strategies

Educational sessions can cover patient-centered communication strategies and bias reduction. Feedback can be reviewed and changes in practice and in interprofessional relations celebrated, together, as a group. Addressing the gendered impacts of profession, promotion, and patient care, paired mentorship systems may be helpful, particularly mentorship pairs of all genders navigating emergency medicine as a system. Similarly, enticing and encouraging sexual and gender minority populations to have discussions openly and among them about the heterogeneity of their experiences and their unique needs. Small allyship educational sessions, and faculty role modeling, will promote high-quality, professional, and respectful patient-centered care.

Effective communication is the linchpin of high quality care in the emergency department. There are several evidence-based strategies to enhance communication among patients, families, providers, and the interprofessional team. First, direct verbal communication is favored over indirect communication. From a patient-centered perspective, patients who perceive that they are "seen" are less likely to file a malpractice lawsuit. Second,

closedloop communication is essential for patient safety. An example of closed-loop communication is a nurse reading back a verbal order to the prescribing clinician. Third, teams with healthy conflict resolution do better in patient safety. The TeamSTEPPS curriculum is a valuable tool in teaching trainees and new staff.

7. Training and Education

The College of Emergency Medicine embodies these sentiments in the curriculum for emergency medicine training, which states that candidates must demonstrate an understanding and application of holistic assessment, as well as recognize the extent of uncertainty in fast and high stakes situations. This does not necessarily lead to a need to postulate 'competency' when applied to the license to practice, but most recruits can at least accept the requirement for every emergency physician to undergo a process of evolution. A good starting point may be to highlight when and how individuals are using one or all three aspects of troubleshooting expertise rather than having to introduce teaching on (non-specific) problem-solving skills.

The aforementioned decision-making tools and techniques should not necessarily be expected to be present in emergency physicians as a result of standard training and specialty expertise, as they are not part of the standard curriculum. Rather, this is a critical skill which should be formally taught and learnt as part of the uniqueness of emergency work. This was the sentiment behind initiating the majority of work related to human engineering, which evolved, in part, around the need for trained observation and expertise, and in part from the belief that non-cognitive skills were being underemphasized in undergraduate and postgraduate medical curriculums. The need for traditional medical education to focus on the development of troubleshooting expertise as much as troubleshooting expertise itself has been recognized in other areas.

7.1. Simulation Training in Emergency Medicine

Using practical exposure such as teaching through clinical encounters, case-based discussions, role-plays, and communication skills training continue to have a place, but simulation training has the added advantage that it can be used to operationalize the teaching of illness scripts in complex cases. Symptoms can be made more vivid, more severe, or more

refractory than is possible in real life in order to inculcate the idea that critical assessment really applies to every case, and to every patient. At the very least, this helps to bring rules of thumb to one's consciousness before they are selected for use, and, ideally, trains the respondent to consider the possibility that the patient is sicker than he or she appears. Platforms include the use of living patients, cadavers, and actors having symptoms injected into them by faculty who are supervised but not directly involved in the training exercise. Computer-assisted techniques and virtual reality may also be used, but have their limitations. In virtually every case, the latent variables of cost must also be considered. In addition to initial equipment costs, simulation work requires practice, and an analysis of the length of time spent on various stages of this work before and after clinical shifts brings into sharp focus the considerable opportunity costs that are manifest in the practice of this form of teaching.

Simulation training has become a standard aspect of undergraduate and postgraduate medical education in the last twenty years. High-fidelity, interactive experiences can be used to expose physicians and trainees to a range of difficult clinical scenarios in which they have a rare opportunity to make practicechanging mistakes in a semi-protected environment. In theoretical terms, simulation training involves a cycle which begins with planning, closely followed by an orientation phase which invokes feelings of being safe and supported. This phase aims to create sufficient anxiety to trigger active responses in trainees, but not enough to make clear thought or action impossible. The coaching phase involves goal setting and target-directed improvement followed by an immediate debrief. Under the best circumstances, this debrief happens in person, using real-time video, and involves multiple perspectives in an analysis of what happened that can be brought to bear in case-based teaching.

7.2. Continuous Professional Development

The pressures of clinical practice on the front line are many. Nurses and medical practitioners are often not given the time to reflect on their practice and as a result may suffer from compassion fatigue. Research has demonstrated that reflection can lead to an improvement in the physical, psychological, social and spiritual well-being. Throughout North America, particularly in Canada,

there is a growing interest in the issue of mindfulness and how it can be brought into health profession education and practice. This scientific field is growing and is indeed producing startling results scientifically. It can make a significant impact on a person's personal and professional life. Many universities and medical schools are looking at various methods of teaching mindfulness to students, as methods of reducing stress and increasing learner self-awareness. The methodologies include agile reflection, being (B), skills practice (P) and sharing and reflecting (S). These periods of reflection allow time for students to individually process the workshop content. Kolb's reflective model is another example of how self-awareness, critical ways of thinking and discussing and analyzing elements of an experience can contribute positively to a person's learning. Providing opportunities for a critical incident review with a trained facilitator can greatly improve response factors for a healthcare worker for the next time (preparedness and confidence).

Continuous Professional Development: Professional development of any career may refer to any educational activity which helps to maintain, develop, increase or enhance the quality of care that health professionals provide. Continuous professional development is based on the assumption that health professionals derive personal and professional benefits by engaging in a wide range of learning activities that help them to deliver better quality patient care. In emergency care, there is a wide range of activities that will enable nurses and medical practitioners to continue their professional development. Critical reflection on a personal level or sharing of personal experience is one way to develop as a professional. Practice-based learning can enhance knowledge and skills in current practice. There are many professional development tools such as audits. Professional development is not always a formal process, and reflection on specific clinical encounters can contribute significantly to professional development. Other ways to reflect and contribute to professional development are through blogging, contributing to articles or commenting on articles about emergency care. Emergency care is a fast-paced, high-pressure environment that forces clinicians to gain knowledge about mixed varieties of medical, surgical, gynecological and traumatic conditions. Using online resources, for example during shift work in

order to aid learning on a particular topic can greatly enhance knowledge.

8. Technology and Decision Support Systems

Conclusion: The decision support literature suggests that we can do more to assist the emergency physician. We can develop new techniques. But all of our wisdom, courage, and judgment alone makes our information and technology usable, politically acceptable, practical, and valuable. Between finishing a conference on decision analysis and doing the grand rounds in the emergency department, we read an article based on Markov Decision Processes. Our hair stood on end because, as contentbased decision analysis, this paper focused on naive decisionmaking mechanisms. We have concentrated on highlighting the limitations and potential pitfalls of rational approach, but we are concerned that the readers do not throw the baby out with the bathwater.

Background: Implicit in many modern decision theories is the role of the computer as the perfect decision-support device. How often are any of us ever faced with raw, cold uncertainty? Only in the context of a facilitated frame of reference or a collective wisdom, have we come to realize that we will never have all of the information and we will never be able to agree on what we want. How we deal with complexity and uncertainty has nothing to do with computer technology and everything to do with our role in human groups. Perhaps the best that can be hoped for is some discussion of the quandaries, an examination of means of improving probabilities or integrating risky preferences, or a look at what is just feasible or politically possible.

8.1. Role of Technology in Decision-Making

The most common in use are decision-making tools, which are essentially computer algorithms that use a set of rules or criteria to predict the probability of a patient having a specific disease or condition based on patient information. In formal terms, decisionmaking tools are exclusively based on Bayes' theorem and conditional probabilities to predict the prevalence and incidence of disease in different patient populations and determine the potential effects of disease in patients with symptoms. The Bayes theorem states that the clinical likelihood ratio (amount by which the test result alters pretest probability) is the means through

which a specific diagnostic test result will alter a patient's pretest likelihood of having a specific condition.

Technology has the ability to provide a structured and systematic approach to the decision-making process, essentially reducing individual analytical and cognitive burdens by guiding the user through the clinical reasoning process. As decision-making becomes more complex, the consequences of failing to make correct decisions increasingly dire, and increasing financial incentives are provided, resources have been invested to develop an array of decision-making tools. It is perhaps because of the complexity associated with emergency medicine that it is not surprising to find the earliest computer applications for clinical medicine developed in emergency medicine.

8.2. Advancements in Decision Support Systems

Some practical issues and potential obstacles still exist related to the widespread use of these tools in the EM department. From a practical perspective, electronic health records (EHRs) are one of the most commonly used decision support tools in the USA. However, emergency departments face unique challenges relating to the design and application of clinical decision support tools in an EHR, especially due to the workflow and time-sensitive care requirements that present barriers to use. In order to realize the potential of computerized clinical decision support tools, efforts would be best utilized in building a more robust, adaptable knowledge exchange system, especially taking into account the time constraints in the real-time environment of emergency care. From a research and ethical perspective, more needs to be understood about incorporating computerized decision support tools into clinical care while maintaining appropriate control and oversight, especially taking into account the complex cognitive dynamics and ethical considerations involved in emergency care practice. In practice, the computerized clinical decision support systems will likely require updates based on accumulated usage and feedback as the situations change. The ability to use these tools to continue to evolve in practice in order to eventually have a significant impact on decision quality highlights the importance of an ANDS model for future works. The development of these systems holds the potential for improving both the speed and quality of the decision-making process in EM. (Tan et al.2019)

Decision-making in emergency medicine (EM) has the potential to be improved through the use of new tools, including automated decision support systems. While many advancements within the EM field have yet to utilize these technologies in practice, some early findings support the idea that automated decision support engines can help guide practitioners to better patient care outcomes. Keyword-based systems allow for quick detection of potentially fatal diseases that account for over half of all eventual hospitalizations. Real-time access to specialized expertise can also be made utilizing telemedicine applications. Smartphone usage is widespread, and a number of applications exist to assist in and support clinical workflows, including those that focus on improving the diagnostic and triage processes. Patients can also access health records through their phones and computers using secure software. At the research level, cognitive analytics can search and detect patterns in vast amounts of structured and unstructured textual data, allowing for greater ease in data mining and extraction to facilitate decision support system development.

9. Quality Improvement and Patient Safety

This tool may be simple or complex, high or low tech and automated or manual. An automated option may be feasible in the future given the resources and electronic medical record capabilities. Alternatively, in the near-term, use of a simple manual tool that all trauma team member clinicians have in their pocket and can rapidly bring to the patient floor to view in the event of a handoff communication transfer would be adaptable. The patient navigation tool goal is to speed up getting the patient from an urgent trauma assessment need to the assessment by utilizing communication. We want to reduce preventable trauma patient wait times regardless of the root cause. (Bogan et al.2018)

Patients at our institution can experience significant delays in care depending on a variety of factors. Patients who experience this delay are in greatest need of organized, structured, and clear communication from the ED to the patient, family, and also to the caregivers on the floors and in the operating room. This patient can benefit from our secondary team member or flight nurse collaboration with our front-line providers, ED, and emerge our trauma teams while also offering patient perspective feedback. Quality improvement through the development of a patient

navigation tool is a strategy to mitigate preventable patient wait times. We can prevent some delays due to communication breakdowns by developing and implementing a patient navigation tool with hierarchical ED alerting follow-up.

9.1. Quality Metrics in Emergency Medicine

It is perhaps a measure of the success of emergency medicine quality work to note that many more projects have been listed than can be summarized within this discussion. Hundreds of emergency medicine quality improvement programs have been reported, addressing topics as diverse as chest pain, human immunodeficiency virus counseling, septic shock, lumbar puncture after head trauma, respiratory viral testing, fractures, and other diagnoses. Rather than measuring time from initial presentation to critical interventions, such as time to reperfusion after myocardial infarction, researchers have examined door-to-electrocardiogram time and door-to-treatment time, reflecting the time it took for patients to reach initial contact with the appropriate clinician—first clinical quality markers in regard to care for chest pain or myocardial ischemia. In brief, most refer to the time when the physician first sees the patient. (Ortíz-Barrios and Alfaro-Saíz 2010)

Scores of quality metrics have been developed in emergency medicine that address common syndromes, such as myocardial ischemia or pneumonia. Emergency physicians have been at the forefront in developing these evidence-based tools, most of them designed to guide the initial period of care of the patient with these common presentations when they are first evaluated in the emergency department. Quality work in emergency medicine began with standard-setting guidelines for specific presenting syndromes. As the National Committee for Quality Assurance began to measure and report emergency and other hospital care quality using administrative and medical-record data.

9.2. Patient Safety Initiatives

The main characteristic of the ED environment is the frequently shifting patient load, which stems from considerable variability in patient arrival patterns and foci of demand of the hospital catchment area. This variability is constant and pronounced in size and timing. It contributes to a lack of predictability and diagnostic uncertainty and the need for critically ill patients who will need

immediate evaluation and intervention. This flurry of activity and the sheer number of recommendations given to a "typical ED shift" is one of the most impressive and unique hallmarks of the specialty and also one of the reasons for making the ED a vulnerable environment for errors developed by staff.

Patients who present to the ED in acute distress are a particularly vulnerable population. A difficult and complex decision-making environment in the ED can exacerbate the loss of patients' autonomy and capacity and expose the patient to the risk of harm from medical treatment. However, the philosophy of emergency medicine has always been heavily grounded in the concept of patients' welfare and beneficence, which make the ED environment an important and special interface for the ethical principle of respect for persons. Decision-making is often difficult due to the large number of patients, the acuity of illness, the multiple comorbid conditions, potentially underlying polypharmacy and the need to make immediate bedside decisions with limited evidence. In times of crisis, emergent interventions and decisions must be made in the absence of time for deliberation, often in the setting of incomplete information and under physically, emotionally, and intellectually stressful circumstances. The ensuing state of "urgent download thinking" aimed at meeting the standard of care frequently requires physicians to modify evidence-based best practices. Personality, cognitive biases, heuristic algorithms, and intuitive reasoning could influence the decision-making process in the ED more than data, facts, or evidence.

It has been said that the ED represents an increasingly "highstakes, high-stress, rapidly evolving and unpredictable situation." Researchers and patient safety advocates advocate for building a healthcare system that prevents, detects, and mitigates risks to patients. They stress that the complex process of caring for sick patients creates ample opportunities for unintended error. As a result, numerous patient safety initiatives have been proposed or implemented with the intent of reducing or eliminating adverse events. However, many of the recommendations for reducing ED errors have small-sized evidence and are based on expert opinion and studies outside the ED setting. Therefore, only small-sized

studies exist in the literature specifically investigating the impact of patient safety interventions in the ED setting.

10. Future Directions and Innovations

Expertise, although vital, is not a universal panacea. For example, understanding an individual's tendencies to rationalize a negative decision as having been of sound rationale ultimately ignores human behavior occurring in an external environment. Relating decision quality to good outcomes propagates the illusion of goodness in our mental models. The expectation that high-quality fast decision-making should always be correct in cases of high uncertainty is not only infeasible but also has been associated with heightened cases of psychological regret. Associating personal value with the experience of dealing with uncertain outcomes without the adherence to poor outcomes is associated with planners and scenario thinkers, be they in military strategy or in general high-stakes decision-making within medicine. Unlike this concept, some suggest that active planning for scenario outcomes, a behavior that may border on willful ignorance of clinical intuition, is made by individuals who had experienced and regretted plans for worst-case scenarios, even though the missed signals were present during the pre-event period. It highlights that even the best decision-making environment does not catch every possible outcome. In this case, obstinately insisting that a priori plans should have been able to be predicted and adhered to... the demand that foresight of the future is the only way to not only minimize but to define possible regret scenarios is an unrealistic expectation of the world. The notion of scenario planners seems pedestrian in the case of critical care medicine. Any medical student knows that a potentially bad outcome can occur. However, the ability to engage in scenario planning daily as a role component present in many fields used as analogues to the ED is challenged by the overweening presence of specialized medical knowledge. (Elliott et al.2019)

Another area that could benefit from external expertise is judgment of risk. While there is evidence to suggest that being in a flow state increases the ability to accurately assess situational risk, we remain limited largely to a naive understanding of individual risk-taking behaviors and the perhaps more subtle temporal relationship of intuition and reasoning to the overall risk-taking

process. It is mostly assumed by an existing literature in that area is focused on preference for domain-specific risk-taking versus general tendencies to risk-taking. Preference for domain-specific case types may affect both care and diagnostic preferences. General tendencies, such as loss aversion, have been theorized to cloud clinical decision-making, though that has not been adequately studied.

Emergency medicine is a strategy in the face of a complex system where unknown unknowns disrupt the most well-conceived decision-making models and routines. The nature of high-stakes decision-making under conditions of complex uncertainty will continue to be a primary research area in emergency medicine. Some specific areas of study are logical steps along a continuum of current research, whereas others represent nascent interest areas that are largely driven by expertise research outside of medicine. Our primary interest continues to be flow states in emergency medicine, which we suspect have applications throughout all of critical care, surgery, and even in routine decision-making. Expertise gained in the crucible of stress and temporal urgency can be leveraged to develop preclinical training routines that can be implemented outside of the very formal training environments.

10.1. Artificial Intelligence in Emergency Medicine

AI is increasingly filtering into healthcare, from basic storage of digital medical records, through the automation of repetitive diagnostic and surgical tasks, and the allocation of scarce medical resources to active roles in the development of new therapies and prognostication systems. In emergency medicine, clinicians face the double challenge of dealing with individuals at the point of greatest criticality and uncertainty. Patients present with serious conditions that require urgent and accurate diagnosis and treatment for favorable outcomes. Emergency physicians must make a wide range of often difficult and complex decisions under conditions of significant uncertainty and time pressure, in a particularly busy and difficult environment. Rapid, precise decision-making is of course crucial for all areas of medicine, but emergency physicians must often make decisions with almost no information, little time, or both. The involvement of the inexperienced clinician, the noise of distractions from the environment, and the need to address the often unconscious patient are also influences in the

management decisions taken in emergency medicine. (Fernandes et al.2016)

Artificial intelligence (AI) includes anything that enables computers to mimic behavioral tasks typical of humans. AI has been applied across many areas to automate repetitive tasks, improve efficiency, and provide novel insights. Machine learning is a subfield of AI that includes learning and predicting models with scores that determine the change in states of the surrounding environment and various other potential impacts. Deep learning is another subfield of AI that implements multiple layers of abstraction at the level of data representation. In a processing unit, deep learning is modeled after the central nervous system, forming complex systems with various functions.

10.2. Analytics and Decision-Making

Before comparing and contrasting forecasts, we need to understand what services the demand curve describes. An analysis of ED services would break down the types of requests, visit rates, and overall utilization confirmed by data. Descriptions of visits would break down types of patients, different types of illness episodes that people experience, and resource consumption (staff, supplies, etc.). They would also need a geographic assessment in order to understand what impact location produces endogenously (e.g., via SES, that does not depend on the attributes of a specific facility, but rather its relative position to other facilities).

Predictive analytics uses big data to anticipate future events, despite the uncertainty involved in identifying relationships within the data. The information used for forecasting is based on aggregates such as trends, patterns, state changes, and data derivatives. In attempting to understand patient volume at an ED, one can go through the steps required to understand the data. At the very least, an analysis could tell a hospital when people come in, how long they stay, what set of problems they have, etc. All of these findings directly relate to staffing decisions. Furthermore, inpatient occupancy and available room updates directly affect ED capacity, as well as overall hospital bed and staff demand. Anecdotal evidence released from developing, deploying, using, and sharing a common web application is based on demand and capacity information. ED leadership can use this information to

adjust staffing (i.e., flex up when full and down when not), and inform the hospital of its findings to help optimize the inpatient bed situation.

11. Conclusion and Implications for Practice

The advent of decision science within emergency medicine shows that the standard models are not directly applicable to the emergency room. There is now an imperative to make the next step, to complicate this picture with a greater understanding of the why and the how of these processes, and to draw on a wide and diverse body of scientific knowledge generated in many different settings. The challenge is to produce a model that is capable of being taught and transferred to the EM; if such a thing is possible then in so doing we will reaffirm the complexity and importance of this specialty, and indeed re-validate ourselves as individuals making such life and limb impacting decisions. Our new paradigm must be evidence-based, and we are determined in our efforts to elaborate the necessary models. We hope that discipline- and specialty-based research will follow, but in the meantime suggest that the next step, indeed the next several steps, can only be to thoughtfully and scrupulously observe ourselves in action. In doing so, we may begin to generate the basic elements of a new and more fitted paradigm.

Emergency medicine has long been described in terms of uncertainty, ambiguity, and chaos. Attitudes towards this reality have tended to reflect either blank acceptance and a dogged but perhaps irrational persistence, or active frustration and increased attempts to manage the unmanageable. The frustrations and breakdown, indeed the very fact that uncertainty is a problem, are largely related to our models of cognition and decision making, and understanding cognitive process is therefore of key importance. It might seem counterintuitive, in a specialty that deals largely with the unexpected, to suggest that much of that which is considered unique is actually the product of some very basic cognitive processes. Nevertheless, the simplified models that we currently use do not take into account the transaction between the individual and the task, and given the importance of the results, particularly in terms of patient outcomes, we feel it is of the utmost importance that a more sophisticated and complete model be promulgated.

11.1. Key Findings and Recommendations

(d) As there is little evidence of conscious breakout from the anticipatory existential delusion of emergency medicine's effectiveness, reflective techniques for eudaemonic learning are recommended.

(c) Commissioners of acute care services would benefit from considering the complex systems insights developed. They may need not only to work clinically but also to service provider various care pathways.

(b) There is a need for the Royal College of Accident and Emergency Medicine to revise its strategies for staff retention, related to job satisfaction, working conditions, and the influence of non-clinical factors. In particular, commercial orientation must now be factored into risk assessment, and hedonics considered as well as eudaemonics.

(a) Action is required concerning perceived issues of senior practitioners in relation to junior colleagues, nurse practitioners, and emergency care practitioners.

Ten key findings and recommendations are made concerning decision making in emergency medicine in the light of this five-year critical systems study. To summarize the recommendations:

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