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Sensemaking Approaches to Improving Processes of Emergency Medical Trauma Centers

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Abstract

Trauma Center (TC) operations at hospitals are conducted as part of very complex environments. TCs, which are focused on life-saving and resuscitative actions in the treatment of trauma patients, engage many individuals in the solving of multifaceted and on-going ill-structured problems. The solutions to these problems are comprised of multiple human experts' resources that must collaborate to be effective in reducing complexity and providing information for systemic approaches to acute injury care. Understanding an emergency situation requires interdisciplinary and collaborative judgments, surgical decision–making in complex scenarios, hands on practical experience, and insight into difficult trauma situations. This paper addressed the application of collaborative sensemaking (CS) techniques to improve the decision making processes in TCs complex environments.

Keywords
Collaborative sensemaking, trauma centers, healthcare, decision-making, complexity

1. Introduction
The healthcare industry has affected much of the social, economical, and political aspects of everyone's lives. In the United States alone, the appropriate administration of healthcare has become a question commanding a price tag of more than two-trillion dollars [1]. More than ever, healthcare decision makers need to advance their understanding of human performance by exploring the sensemaking processes experienced daily by healthcare professionals around patient care that determine successful service delivery outcomes. Making sense of situations and events has become vital to coordinate and induce cooperative work among all healthcare entities. Essentially, healthcare decision makers are addressing complex, uncertain, and ambiguous issues that not only involve large financial resource commitments but they are also routinely addressing issues involving decisions of patient's life and death.

This paper examines the concept of CS and its applications to emergency medicine. CS has the potential to increase the quality of trauma centers' care through improving communications and effectiveness among the complex array of conditions of the patient, physical environment, and human factors. Sensemaking (SM) is an extensive anthology of ongoing interpretive actions, central to the conduct of everyday organizational life. As such, the individual SM guides the behavior of individuals by informing the construction of knowledge based on individual's schema (mental model), some set of existing information, and external cues in the task environment (i.e., a trauma center). Therefore, it is a process of understanding a novel situation, where previous knowledge and experience meet the intake of novel information that is unstructured, partial, and rapid. In order to act effectively, individuals must be able to create structured information that is accurate and relevant to the novel task within a complex information environment. However, individuals do not act alone in the TC environment and the effectiveness of treating trauma patients depends on a collection of individuals constructing information to create a socially constructed understanding of novel information, often within a context of a very complex task environment. CS is a construct that speaks directly to the social phenomena of sensemaking. It becomes exponentially complex as the number of individuals increases, the diversity of those individuals' experience, the consistency of among individuals' schemas, and the familiarity of the individuals' understanding of their colleagues ways of constructing information and translating those behaviors into individual and social behavior (i.e., decision-making, information sharing, etc.).

Additionally, TCs engage many individuals working toward solutions of multifaceted and on-going ill-structured problems with multiple human experts' resources that must collaborate. CS can be seen in the context of people

arriving at an understanding (explicit or not) or it might expose the different characteristics of others, in which a leader or individual is lone wolf and will act to "get out of the way" or marginalize an actor in the task environment. "People are helped by others who see the situation as they do, but also by those who see the situation differently," with the focus being on how people socially connect with each other, how they construct bridges, and what accounts for differences in their observations [2]. "Sensemaking demands intense, deep collaboration with participating agents" [3]. We not only learn from our past experiences but we also learn from one another. A collaborative sensemaking system is a framework that provides useful construct for exploring the social aspects of collective analysis of information in a problem context [4]. Understanding an emergency situation requires interdisciplinary and collaborative judgments of these skilled workers.

The application of CS technique to improve decision making processes in trauma centers environments has the core objective of identifying the developmental pathways and social circumstances that lead to an evolutionary process. It targets wicked problem domains that are recognized in the literature of sensemaking as constraints in planning of complex situations. A wicked problem is one that involves multiple stakeholders working together to solve an ill-structured problem [5]. A vignette is used to elucidate the advantages of sensemaking in TCs. Today's TCs operate with speed and urgency and a business model completely unlike the traditional "emergency room" model of the past. Intrinsically, a TC is a hospital that has additional resources to help care for severely injured patients. Additional challenges faced by TCs include declining incomes, high patient volume, and rising expenses.

2. Complexities and Challenges Facing Trauma Centers

Especially crucial in TCs is to maintain good patient care in the face of rapid advancements in healthcare technology and the constant need to validate and revalidate scientific knowledge. Not surprisingly, the challenges in TCs thrive. There are challenges of sensemaking and decision making during patient trauma care because neither are deliberate; there is no consistent pattern of patient injury [6]. Each trauma patient coming in to the TC may have different anatomic, laboratory, physiologic, and/or psychological needs of care, increasing the difficulty of immediately assessing the extent of all injuries within the "golden hour." However, injuries are only the tip of the iceberg regarding challenges in a TC. As noted above, TCs require a somewhat large number of members from different clinical specialties working as a team to save a patient's life, bringing about situations where diagnostic errors occur. "Diagnostic errors are associated with a proportionally higher morbidity than is the case with other types of medical errors. A critical subset of diagnostic errors arises through cognitive errors, especially those associated with failures in perception, failed heuristics, and biases," [7] creating memory limitations and excessive cognitive loading.

TC teams are constantly working with complex situations which are full of uncertainties. Specifically, uncertainties in TCs stem from the fact that each incoming patient has a unique set of problems. Promptly recognizing when a critically injured patient shows warning signs, which require a certain kind of care, is vital to the patient's survival and it cannot always be delegated to technologies. This is a somewhat easy task to well trained individual members of the rapid-response TC team and it shows that humans in complex systems are more than data processors. In fact, J. Reason noted in his writings that, "the main reason humans are retained in systems is to handle 'non-design' emergencies. In short, operators are there because system designers cannot foresee all possible scenarios of failure and hence are not able to provide automatic safety devices for every contingency." However, despite all the knowledge and experience accumulated by these medical teams, they still are faced with many challenging critical incidents. A "critical incident is any situation experienced by trauma team members causing them to feel unusually strong emotional reactions that have the potential to interfere with their ability to function" [8], such as death of a child abused by an adult, victims who are relatives, events that threaten the safety and life of TC team members, combative patients, mass casualties, and any other incidents that may overwhelm their usual coping mechanisms. It is suggested here that a human-centered approach, which factors complexity into the difficult task of understanding how capable of adaptive behavior these TC team members are, permits situational awareness. Critical incidents may cause a loss of this situational awareness, leading the medical team to lose sight of human capabilities and weaknesses. The potential is then created for the medical team to become desensitized to changes in context, which could cause a failure to adapt to the situation at hand and, eventually, human errors. Human factors engineering are observed by the breakdowns of the interactions among the TC team members and the systems with which they work.

3. Tending Wounds: Trauma Patients

"Injury is a disease" [9] and it is a major threat to the immediate and often long-term health of individuals. Trauma remains the leading cause of mortality for patients between 1 year and 40 years of age and eclipses cancer, heart

disease, and HIV/AIDS [10]. Patients arriving at trauma centers are placed on the hands of highly specialized teams comprising of 15 to 20 people, including physician surgeons, physician residents, nurses, medical students, and technicians. Most hospital providers of trauma centers have three separate teams to ensure 24-hour coverage. Trauma injury is serious and injury deaths worldwide place a significant burden in the world's work force as it impacts mostly the youngest and potentially most productive members of society [9]. The World Health Organization estimates trauma injury as 12% of the world's burden of disease. In the United States alone, more than 1.7 million individuals incurred intentional and unintentional TBI (traumatic brain injury) [9]. Research by the American College of Surgeons (ACS) concluded that global trauma related costs are estimated to exceed $500 billion annually, not including costs related to lost wages, medical expenses, property damages, fire loss, and employer costs, among others [9]. By 2020 it is estimated that more than 1 in 10 people will die from injuries [9]. The difficulties preventing improvements in trauma care can be directly traced to the lack of recognition of trauma as a serious disease by both the public and governments alike.

While healthcare providers typically dispense high quality care, mistakes in judgment (i.e., diagnoses and treatments) occur and negatively impact quality of care. Addressing the dynamics of collaborative sensemaking and developing ways to enhance the efficiency and effectiveness (i.e., accuracy) may help to positively influence the quality of decision-making and outcomes of the trauma teams. This paper argues that CS is an appropriate area of human factors engineering that applies task design methodologies that focuses on changing human procedures in the complex environments of trauma centers. With the ongoing technological advances being made in every subspecialty of trauma medicine (i.e., orthopedics, surgery, tissue engineering, molecular medicine, diagnostics, etc.) as well as cost and quality imperatives, and ever-increasing expectations from consumers, CS might provide the practical framework for the practice of emergency medicine in trauma centers.

4. Collaborative Sensemaking as a Tool for Complex Environments

A definition for sensemaking might then read "a sprawling collection of ongoing interpretive actions, central to the conduct of everyday organizational life;" because it creates and discovers [11]. CS is then a system of actions, symbols, and processes that enables an organization to transform information into valued knowledge, turning decision makers into power centers, capable of structuring resources on a continual basis. Collaborative sensemaking has also been described as a theory, a process, or a paradigm, which recently has been used for organizational knowledge management, information fusion, and stimulating learning in organizations [12]. It is a theory and a process of how people reduce uncertainty or ambiguity as well as socially negotiate meaning during decision making events; a tool that attempts to bring uniformity into complex environments. Through the accurate construction of meaning, clarity increases and confusion decreases [12]. In essence, the collaborative sensemaking process, which is dynamically evolving in time and context, allows for the creation of cognitive maps that help with connecting the dots to bridge the gap between inaction and action and the human "ongoing efforts to articulate the underlying philosophical assumptions upon which our understandings of communication are built" [2].

CS and individual processes have always been interconnected, and an understanding of sensemaking is the initial step to fully value its application in healthcare decision-making, particularly within TCs. In every situation encountered by clinicians, decision making follows the CS process of finding the best set of perceptions that helps to understand the situation or event. Sensemaking processes are often described within varying fields of study (i.e., military, aerospace, nuclear power plants, business organizations) and using different constructs (i.e., situation awareness, shared understanding, knowledge creation, and knowledge management). However, intrinsically, the elements of the process are still the same.

The sensemaker creates representations to capture features that the individual judges have seeing salient in the task environment (i.e., trauma center). This form of communication is of the utmost importance in complex situations such as those of trauma centers because "communications remain problematic in this complex dynamic medical domain of trauma center" [6]. In a recent observational study of 205 trauma resuscitations at a level 1 trauma center, communication among clinicians was found to be sub-optimal and failing, where results showed that "during initial [patient] assessment, understandable communication ranged from 6% to 64% and understandable communication during secondary survey ranged from 21% to 74%" [13]. TC team members can quickly discover that making sense of a complex body of information requires systematic approaches and the development of a collaborative sensemaking trauma model to ameliorate communications. Sensemaking is a theory and a process of how people reduce uncertainty or ambiguity and socially negotiate meaning during decision-making events, and "through the accurate construction of meaning, clarity increases and confusion decreases" [14].

5. Moving Toward Multidisciplinary Teamwork with Sensemaking

For over three decades the American College of Surgeons has been teaching doctors in more than fifty countries a "common language and a common approach" for the care of injured patients, using an "international, multidisciplinary, and evidence-based approach" [9]. Even so, a trauma center team may have physicians with different specialties (i.e., orthopedics, neurologists, anesthesiologists, surgeons), as well as nurses, technicians, and others who may perceive the same clinical event differently, which raises the question, "does team structure affect collaborative sensemaking?" In the sensemaking process, collaboration is imperative when teams are involved. "Effective collaboration allows for better communication and achievement of the goals pursued by individuals, groups, or systems," [15] while complexity, ambiguity, and uncertainty are characteristics of the working conditions of TCs. This is supported by researchers in the area such as Bergs *et. al.* that indicate that, "communications is the utmost importance in complex situations like multidisciplinary trauma resuscitation" [13].

Multidisciplinary context is the situational context in which sensemaking framework for identifying unique solutions for the TC team considers the trauma factors such as "a host" (patient), "a vector of transmission" (i.e., motor vehicle, firearm, etc) [9], and the environment in which the injury occurs. The injury environment cannot be ignored because it is part of the constructions that are necessarily fundamental to the sensemaking process. As Brenda Dervin put it, "human beings draw on their understandings of the world and make observations that they construct into ideas and then encode into messages that they then sent out where other human beings use their understandings of the world, and so on" [2]. The injury environment is as much a part of the trauma solution as the injury itself. As an illustration of a trauma event, following is a complex scenario quoted from the Advanced Trauma Life Support for Doctors (ATLS) manual. "A 43 year-old woman was ejected from a vehicle during an automobile collision. En route to the ED, pre-hospital personnel report that her heart rate is 110 beats/min, her blood pressure is 88/46 mm Hg, and her respiratory rate is 30 breaths/min. The patient is confused, and her peripheral capillary refill is reduced. (See Table 1) Her airway is patent. She is in respiratory distress with neck vein distention, absent breath sounds on the right and tracheal deviation on the left."

Table 1: Initial Assessment and Shock Management

Condition	Assessment (Physical Examination)	Management
Tension pneumothorax	• Tracheal deviation • Distended neck veins • Tympany • Absent breath sounds	• Needle decompression • Tube thoracostomy
Massive hemothorax	• Tracheal deviation • Flat neck veins • Percussion dullness • Absent breath sounds	• Venous access • Volume replacement • Surgical consultation • Tube thoracostomy
Cardiac tamponade	• Distended neck vein • Muffled heart tones • Ultrasound	• Venous access • Volume replacement • Pericardiotomy • Thoracotomy • Pericardiocentesis
Intraabdominal hemorrhage	• Distended abdomen • Uterine lift, if pregnant • DPL/ultrasonography • Vaginal examination	• Venous access • Volume replacement • Surgical consultation • Displace uterus from vena cava
Obvious external bleeding	• Identify source of obvious external bleeding	• Direct pressure • Splints • Closure bleeding scalp wounds

The initial assessment and shock management outlined in Table 1 demonstrates that in clinical situations, TC teams are faced with an emergent event similar to the scenario outlined in the previous paragraph, requiring cognitive

skills for decision making in these crucial areas for saving the patient's life. "Thoracic trauma is a significant cause of mortality" [9]. From Table 1, each outlined condition, its assessment, and management requires the TC team to interpret a massive amount of knowledge and requires previous experience in the case of pathophysiologic effects of chest injury. As the team identifies and initiates treatment of these conditions, multidisciplinary management involves the collaborative efforts of team members with different specialties (i.e., neurological, orthopedic, surgery, tissue engineering, etc.). For instance, if the team is alerted to the possible need for thoracotomy, due to "massive hemothorax", protocols require a qualified surgeon by training and experience to be present [9]. "The diagnosis of cardiac tamponade can be difficult" [9] and each of the other conditions in Table 1 face the same wicked decision problems. The ability of the TC team to accurately and collectively recognize these important life-threatening injuries, despite chaotic situations and time pressure in the complex environment of the TC, and the skill to perform the necessary procedures, can be life saving. As Pat Croskerry, MD, aptly described it, cognitive diagnostic failure is inevitable when exigencies of the clinical workplace do not allow such Olympian cerebral approaches. He further asserts that approximately half of the litigations brought against emergency physicians arise from delayed or missed diagnosis [7].

The American surgeon Atul Gawande argues in his book, *Complications*, that patients are far more complicated and idiosyncratic than airplanes. Medicine isn't a matter of delivering a fixed product; and it may well be more complex than just about any field of human endeavor [16]. Many researchers have explored the similarities of stress related problems between healthcare and other industries such as aviation or nuclear power, focusing on the almost non-existent errors of these industries, insofar as to suggest that an introduction of an aviation-like communication feedback system can help to optimize trauma care [13]. The challenges a TC team faces are sometimes immeasurable and ubiquitous when often time there is not a readily accessible history of the patient, the extent of injuries are not clear, and the pattern of injuries are inconsistent. There also is the economic problem because many of the injured lack financial resources and medical insurance to cover medical expenses.

6. Discussion

Physicians often face wicked decision problems [17]. When TC members encounter wicked decision problems, involving "equivocality and ambiguity," CS may lead these people to reach beyond their capacity, turning them into more directionally focused decision makers for achieving the desired outcomes. In the context of TC, this is very complex and touchy on many basic issues. It requires cross-disciplinary analysis and human factors engineering design of complex systems. It seems essential in cross-disciplinary cooperation that all members of the team are mutually comparable in order to achieve team objectives and to avoid the gradual decoupling of a mental model of a process from its real steps. This argument is well exemplified by Helmerich and Davies' series of observations in operating rooms, where they noticed breakdowns in communication that resulted in loss of awareness of the patient's condition, distractions resulting in failure to note changes in patient status, dispute between members of anesthesia and surgical teams, failure to give feedback, and failures to use check lists [18]. It results in variation in the ability of the medical team to reason about the situation at hand and the ability to make the inference that these variables are inter-connected. Trauma centers challenges are not insurmountable, and with the right planning, problems can be overcome. It is crucial that a framework of approaches to improve effectiveness in TC be highlighted. The focus of such a framework should be key elements to help foster the promotion of collaborative cooperation, accomplishing the human factors goals through the TC members and the systems in which he or she is interacting.

In the case of the 43-year old woman who was ejected from the vehicle, the TC team had at least five possible conditions it had to manage to save that patient's life. Indeed, it seems like a monumental task to create truly high performing team to take a variety of actions in such short period of time to ensure survivability of the patient. At times such as this, there is no place for poor sensemaking processes. Instead, the design of CS should embody the basic requirements of cooperative work support that targets wicked problem domains and wicked decision problems. CS manifests itself in the format of the TC's information and expertise, tacit experience, individual member expertise, and communication through social knowledge. Coordinated team task performance relies primarily on effective communication and task distribution among team members. Complex work systems and discussions of their differences and similarities are often based on similar examples and the effective application of CS principles can help improve robust and effective team communication as well as coordination in complex task environments with multiple complementary goals and the requirements for adaptive planning.

7. Conclusion

"Dramatic failures of sensemaking are the basis for much of the research on sensemaking" [19]. CS approach has many valuable attributes to offer in the domain of planning and decision making and the development of a framework that can serve to characterize trauma center teams is needed to support results. Primarily social constructs of knowledge (informed by prior individual and collective presence, personal bias, access to quality (i.e., accurate information), quality of communication, and power relations), that has the potential to translate into collective/collaborative action, which in turn can enhance efficiency which cannot always translate into enhanced quality care. A major outcome of CS is the way it enhances the team's ability to maximize its sensemaking process effectiveness while fostering system thinking and facilitating team learning. Traumatic injury is a health problem worldwide and trauma centers can provide optimum care to the severely injured. The impact on trauma patient survivors needed to be researched, and the operating efficiency of pre-hospital interventions is a topic that needs to be covered in detail for its impact on mortality and morbidity. Additionally, quantitative metrics for measuring TCs high-leverage performance and for performing TC level diagnostics (not found in literature) need to be identified to address this gap.

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