Situational Awareness in Emergency Medical Dispatch: An Observation Study and Proposed Model

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ABSTRACT

Introduction: Situational awareness (SA, also called situation awareness) is the ability to take in relevant information about an event in order to understand it and take effective action. Maintaining effective SA as an emergency medical dispatcher (EMD) may be more difficult than in other, similarly complex roles because of the remote nature of an emergency call for help. This study attempts to provide insight on one remote SA situation by reporting on a simulation study in which cardiopulmonary resuscitation (CPR) instructions were provided over the phone to laypeople, whose behavior was observed by researchers as they performed the instructed actions (or didn't).

Objective: The primary objectives of this study were to identify (a) whether callers were performing the actions instructed by the EMDs, (b) whether EMDs took any specific actions to ensure that they were aware of the actual situation on scene and the caller's actions, and (c) whether there were any common or predictable types of disconnect between the instructed and performed actions.

Methods: This study comprised the qualitative, observational portion of a previously published prospective, randomized, controlled study that was conducted by simulating cardiac arrest calls to 911 using layperson-caller participants at four locations in Salt Lake City, Utah, USA.

Results: Eleven common behaviors were observed that indicated disconnects between the instructions provided by the EMD and the actions performed by the participant callers. In general, the common elements that led to poor (or even non-performed) CPR involved the speed at which instructions were provided back-to-back, missed or misunderstood information, "gaps" or periods of EMD silence, and uncertainty about how to physically manage the phone (and the interaction with the EMD) while providing CPR.

Conclusion: The results of the metronome case study suggest a model of SA for EMDs as they gather, interpret, and transmit information for the caller, the team, and the entire profession. Future studies will evaluate the best ways to integrate SA into protocol development and how best to measure and assess it through quality assurance.

INTRODUCTION

Situational awareness (SA, also called situation awareness) is the ability to take in relevant information about an event in order to understand it and take effective action. Originally applied to pilots in World War I, the concept quickly expanded to be applied in many high-risk, high-stress, high-information environments, including healthcare.[1] The most widely-used definition of SA is "the perception of elements in the environment in a volume of time and space, the comprehension of their meaning and the projection of their status in the near future."[2] Another commonly-cited definition refers to SA as "the up-to-the minute comprehension of task relevant information that enables appropriate decision making under stress."[3] In simpler terms, SA has been called "a person's knowledge of the environment at a given point in time," or even just "knowing what is going on."[2]

No matter which specific definition is used, SA is always assumed to include three elements: perceiving or observing what is happening, interpreting the meaning of that perception, and projecting or predicting what will happen next.[2,4-5] In other words, true SA depends on the ability to accurately gather information or data, interpret its meaning in the situation, and predict what will happen as a result. Moreover, high-quality SA does not gather and interpret all information, but only that information relevant to one's specific, immediate goal.[2,6] To further complicate matters, SA is not static but "dynamic and iterative,"[7] meaning that an individual must regularly check in and update perceptions and interpretations to ensure that they have an "up-to-date understanding" of the situation.[6] In other words, maintaining effective SA is complex and requires significant cognitive effort.

Emergency dispatching is precisely the type of high-risk, time-constrained, high-stress situation in which SA is particularly important, and particularly difficult to maintain. In fact, maintaining effective SA as an emergency medical dispatcher (EMD) may be more difficult than in other, similarly complex roles because of the remote nature of an emergency call for help, with its very limited direct sensory input (visual, tactile, etc.). Visual input, for example, factors heavily in SA for pilots and clinical professionals such as nurses and physicians, but EMDs often receive limited input from the one person in a position to actually know what is happening on the scene of the incident: the caller. Moreover, the caller is generally a layperson with no training in medicine or emergency response, meaning that EMDs must maintain situational awareness on the basis of limited, inexpert descriptions of an event they cannot experience or sense first-hand.

Yet these difficulties do not make SA any less relevant or job-critical for EMDs. EMDs must gather information in order to determine the nature of the problem, as physicians do. They must determine the best resources for the situation and manage the allocation of those resources within a larger system, as nurses and other care coordinators do. They must identify and take the most appropriate immediate action to secure patient and bystander safety and, if possible, provide patient care, as emergency responders do. All of these tasks require high-quality SA.[4,8-9] EMDs must also manage relevant information coming in from multiple sources (the caller; ANI/ALI, GPS, and other systems; others in the emergency communication center and responders), a reality that can increase overall knowledge about the situation but also substantially increase the complexity of arriving at an effective single picture of the scene.[7]

Despite its complexity and difficulty, the development of SA is a critically important element of an EMD's job. SA has been consistently correlated with reduced error and risk and improved safety.[5,8,10] Intuitively, it makes sense that the ability to better understand and remotely visualize what is happening on the scene would make EMDs more effective. For example, Chief Complaint selection (the identification of the caller's primary problem) relies very heavily on the caller's description, but may be changed dramatically by small pieces of information or attention to details outside the caller's description—such as when a caller reports that she has fallen but is whispering and afraid (potentially a domestic violence situation) or when a caller states that her son has a broken arm, but the EMD hears traffic sounds and yelling in the background (the broken arm may be the result of a traffic collision). However, no research to date has evaluated the role of SA in emergency dispatching or attempted to identify the specific elements of SA that apply to the EMD.

Dispatcher-directed cardiopulmonary resuscitation (CPR)—when the EMD provides instruction over the phone to a caller or bystander, who then performs CPR on the patient—provides a particularly relevant opportunity to study SA in emergency dispatching (see endnote). Cardiac arrest, the primary condition for which CPR is provided, is relatively rare, making up between 1 and 2 percent of all EMD calls (and even then, not all cardiac arrest cases receive CPR, since they include obvious deaths, traumatic arrests, and other conditions not appropriate to CPR). However, despite its rarity, cardiac arrest is one of the most time-critical and stressful[11] events any EMD handles, and has been the subject of the majority of existing research on emergency dispatchers.[12] In cases requiring CPR instructions, delay or misidentification can make a real difference in patient outcomes.[13] Such cases also encapsulate the fundamental tension EMDs experience in their information-gathering and SA development: the tension between speed and accuracy.[14] Standards for emergency dispatchers tend to focus heavily, if not solely, on speed,[15,16] with time measures for problem identification, dispatch of responding units, and provision of pre-arrival instructions (PAIs). Such time pressures potentially pose a significant "threat" to effective SA,[10] meaning that in identifying a sudden cardiac arrest and providing CPR instructions, EMDs are caught between time guidelines and the need for complete and accurate situation information.

Because of the lack of direct sensory input, improving SA for EMDs may prove to be very difficult; unlike surgeons, nurses, pilots, and others in jobs requiring high-quality SA, EMDs cannot, for example, watch what callers are doing in response to their instructions and adjust accordingly. This study attempts to provide insight on one remote SA situation by reporting on a simulation study in which CPR instructions were provided over the phone to laypeople, whose behavior was observed by researchers as they attempted to perform the instructed actions (or didn't). Such a study provides a first look into the elements of SA in EMD and a possible model for integrating SA into EMD training and real-time workflow.

OBJECTIVES

The primary objectives of this study were to identify (a) whether callers were performing the actions instructed by the EMDs, (b) whether EMDs took any specific actions to ensure that they were aware of the actual situation on scene, including the caller's actions, and (c) whether there were any common or predictable[17] types of disconnect between the instructed and performed actions, for which SA-feedback elements could be built into EMD protocols as improved standard practice.

METHODS

This study comprised the qualitative, observational portion of a previously-published prospective, randomized, controlled study that was conducted by simulating cardiac arrest calls to 911 using layperson-caller participants at four locations in Salt Lake City, Utah, USA. In that study, participants were provided with CPR instructions over the phone, and an automated recording CPR mannikin recorded the depth and rate of the chest compressions provided. The instructions provided were from the Medical Priority Dispatch System (MPDS) version 13.0.

Because this was a simulation study and not a study of on-line MPDS use, protocol compliance was not measured; however, all EMDs followed the protocol as scripted and were observed throughout the study.

Simultaneously—and not reported in the previous study—participants were observed as they listened to, interpreted, and acted upon the instructions provided by the EMDs. Currently-certified, working EMDs provided the instructions in order to provide a realistic scenario, and the EMDs providing the instructions were in a separate room so that they could not see the participants.

RESULTS

A total of 148 layperson-callers were included in the study. Of these, 57.4% (n=85) were assigned to the experimental group. Overall, the population studied was predominantly female (56.8%). In the control group, 65.1% were female, while the experimental group was equivalently distributed by gender (50.6% female and 49.4% male) (Table 1). The median age was 19 years, with the population evenly distributed on the median. Of the four recruitment locations, the highest percentage of participants (36.5%) came from the state university, and the smallest percentage (10.1%) from the assisted-living facility. A majority (56.1%) of the participants reported as having prior CPR training: 63.5% in the control group and 50.6% in the experimental group.

Eleven common behaviors were observed that indicated disconnects between the instructions provided by the EMD and the actions performed by the participant callers (Table 2). Each of these behaviors had a significant effect on the ability of the caller to perform the

Measure		Overall (N=148) n (%)	Study group: n (%)	
			Control 63 (42.6)	Metronome 85 (57.4)
Gender	Female	84 (56.8)	41 (65.1)	43 (50.6)
	Male	64 (43.2)	22 (34.9)	42 (49.4)
Age (years)	<=19	82 (55.0)	36 (57.1)	46 (54.1)
	>19	66 (45.0)	27 (42.9)	39 (45.9)
Location	Assisted-living residential	15 (10.1)	8 (12.7)	7 (8.2)
	High School	46 (31.1)	20 (31.7)	26 (30.6)
	Community College	33 (22.3)	10 (15.9)	23 (22.3)
	State University	54 (36.5)	25 (39.7)	29 (19.6)
CPR Training	No	65 (43.9)	23 (36.5)	42 (49.4)
	Yes	83 (56.1)	41 (63.5)	44 (50.6)

Table 1. Baseline demographics

Observed Behaviors	Specific Effects on CPR Performance
EMD Behaviors	
EMDs moved through instructions too quickly	Callers lost, not able to keep up with instructions, had to ask for repetitions and clarifications, often ended up with poor rate, depth, and/or position because of missed information
EMDs experienced fatigue from counting out loud	EMDs stopped counting out loud in some cases; in every one of these cases, the caller immediately stopped performing CPR
Caller Behaviors	
Caller waited until instructions complete before starting any action	Listening to complete instruction set (hand placement, depth and rate instructions, etc.) before starting any action meant they had to memorize it all rather than doing one action at a time
Caller failed to use speaker phone function	Phone held against the ear or placed on the ground (which kept them from hearing the instructions); caller attempted CPR one-handed while holding phone or had trouble hearing instructions and performing actions simultaneously
Caller unclear when to start counting and what number sequence to use	Caller attempted to count with unlimited number sequence (1-2-3-4-5-6 etc.) instead of 1-2-3-4 repetition, which led to attempt to keep count (and sometimes stopping to check the count)
Caller counted to him/herself instead of out loud	EMD unable to follow the count and did not know whether the rate was correct; could not provide speed-up or slow-down instructions
Caller unclear whether the EMD was still there	Caller stopped to ask, "Are you still there," or simply stopped performing CPR as soon as the EMD completed instructions
Caller lacked understanding of certain terms	Caller got left behind in instruction sequence because of unfamiliar words (e.g., "breastbone" was unclear to many)
Caller bent his/her arms or pressed on the side of the chest	Callers sometimes performed a "push-up" motion, lowering themselves to the patient rather than compressing the chest; some pressed from the side of the chest
Caller unclear about "twice per second"	Callers were confused about how fast "twice per second" is
Caller unclear about what counted as one chest compression	Some callers thought that "twice per second" meant pressing down and then up in one second ("down" and "up" as separate actions)

Table 2. Observed EMD and caller behaviors and effects on CPR performance

CPR instructions as provided. In most cases, these were caller behaviors—actions taken or not taken by the caller in response to the instructions provided. However, two very common EMD behaviors also affected CPR performance: moving through instructions too quickly and experiencing "counting out loud" fatigue near the end of the two minutes of continuous CPR instructions (for those cases in which the EMD did count out loud).

In general, the common elements that led to poor (or even non-performed) CPR involved the speed at which instructions were provided back-to-back, missed or misunderstood information, "gaps" or periods of EMD silence, and uncertainty about how to manage the phone (and the interaction with the EMD) while providing CPR. Some other types of disconnecting behaviors also occurred, but only in single or rare instances—such as a caller with very long hair who kept pausing CPR to push it out of the way, while the EMD continued to provide instructions that were then missed.

For each of the eleven common behaviors, corrective actions were identified that would help re-align the EMD instructions with the actual actions being performed on scene. In several cases, at least one EMD (out of four total) spontaneously used an SA-generating compensating behavior during the study. In other cases, SA-generating actions were embedded in the protocol or the protocol development process. Both the spontaneous EMD corrective actions and the protocol-embedded actions were also recorded, with their effects (or likely effects) on performance. (Table 3).

DISCUSSION

In the case of CPR instructions, callers often were not performing the behaviors instructed by the EMDs. In some cases, they performed no actions at all, waiting until the EMD finished providing all the instructions before starting the first, and then being unable to remember all the instructions. In other cases, the caller was simply left behind or performed actions incorrectly compared to the instructed actions.

In general, the most significant disconnects between EMD-instructed behaviors and actual caller behaviors appeared to be the result of time pressure, single-task focus, and assumptions by the EMD about the caller's activities and understanding. In aviation—another time-constrained and high-consequence environment—"mental load, task load, time pressure, distractions, fatigue, and automation" have all been identified as "threats" to SA.[10] In this study, similarly, callers often got left behind in instruction sequences because EMDs were moving through instructions quickly without pausing to check comprehension and completion.

This is no surprise, given the almost obsessive focus on time in emergency dispatch oversight, and particularly in evaluating

Observed Behaviors	Corrective Actions to Reestablish SA
EMD Behaviors	
EMDs moved through instructions too quickly	• EMD clarification (e.g., "Have you done it?" or "Are your hands on the chest now?") after each instruction • One instruction presented at a time, with pausing
EMDs experienced fatigue from counting out loud	• Always instruct to "keep going" if the EMD is going to stop counting or if any other interruption (such as switching to radio) occurs • Instruct caller that "You must keep doing this until I tell you to stop"
Caller Behaviors	
Caller waited until instructions complete before starting any action	•EMD clarification (e.g., "Have you done it?" or "Are your hands on the chest now?")* after each instruction
Caller failed to use speaker phone function	• Instruct caller to put the phone on speaker and place it on the floor beside the patient • Instruct caller to call back if the call is lost (happened sometimes when caller attempted to switch to speaker)
Caller unclear when to start counting and what number sequence to use	• Instruct caller that the count will be "1-2-3-4, 1-2-3-4"
Caller counted to him/herself instead of out loud	• Instruct caller to "count out loud with me"
Caller unclear whether the EMD was still there	• Provide an audible metronome (whether spoken by EMD or as a sound/beep) • Reassure occasionally (e.g., "You're doing great, keep going!")
Caller lacked understanding of certain terms	• Test all instructions with laypeople to ensure nontechnical language and their understanding of instructions
Caller bent his/her arms or pressed on the side of the chest	• Include an instruction to "lock the elbows and press straight down, with your shoulders directly above the patient's chest"
Caller unclear about "twice per second"	• Instead of "twice per second," instruct callers to "pump the chest on my count of 1-2-3-4" (with correct rate used while giving this instruction)
Caller unclear about what counted as one chest compression	• Instructions should clearly indicate that the caller will compress the chest once for each counted number

*Some corrective actions applied to more than one observed behavior

Table 3. Observed disconnecting behavior and EMD correcting actions

the handling of CPR. Numerous oversight and government agencies have published guidelines or standards for emergency dispatching that require calls to be dispatched within certain set times.[15,16] Although there is no evidence that general dispatch time requirements improve the quality of the service or patient outcomes, nonetheless many agencies use them as the basis of their quality assurance measures. As a result, emergency dispatchers are constantly pressured to increase the speed of their call handling—with the potential, as demonstrated here, for leaving the caller several steps behind. The problem is at its worst in out-of-hospital cardiac arrest (OHCA) cases, since the American Heart Association and others have brought significant publicity to the problem of bystander CPR and the need for faster times to hands-on-chest. The problem is evident in the findings presented here: an EMD might get "credit" for a fast hands-on-chest time by rushing through the instructions, but if the caller has not actually begun CPR or has not performed it effectively, the underlying public health need has not been met.

Such a problem exists in other healthcare settings as well. One study, for example, found that the "tempo" of surgery could have a profound impact on outcomes. The solution, in that case, was counterintuitive: when situations were critical, surgeons were encouraged to slow down, not move faster. As one interviewed surgeon put it, "I say publically [*sic*] to everyone, 'I am going to slow down because I am getting to the critical last little step.'"[8] Emergency dispatchers can also benefit, even in time-critical CPR situations, from the approach of this surgeon: slow down and check in verbally (as described in Table 3).

The findings of this study also highlight another complication of SA for EMDs, or "threat" to SA in the EMD environment: lack of direct information. The EMD has only one source of information, a caller who most likely has no specialized knowledge and no experience to guide them in providing the most relevant facts or providing them at the right time. In this world, the caller's understanding is the EMD's understanding. The results of this study indicate a need for more training for EMDs about on-scene realities, potentially using videos of on-scene actions alongside call audio to demonstrate common "disconnects" that can occur and how to manage them.

EMDs in this study did sometimes use clarifying and "checking-in" behaviors to improve their awareness of the situation on scene. These and other system changes—such as testing all proposed protocol instruction sequences with laypeople before implementation—are being tested for integration into protocol development.

A Proposed Model of EMD SA

Situational awareness is said to exist at three different levels: the individual, the team, and the organization.[18] For example, while a surgeon must constantly be gathering and using information about the patient's condition under anesthesia, she is not alone in the operating room. Breakdowns in patient safety and outcomes are often the result of information not being shared. The right information generally exists; it just isn't shared with those who need it.[19] At the same time, the organization as a whole—say, the hospital in which surgeries are performed—must be able to gather information about overall outcomes and remain aware of its safety situation in a broader sense. A surgeon plays a role in generating SA at all three levels in a hospital, and an EMD is similarly placed at the center of SA development in the emergency dispatch system (Fig. 1).

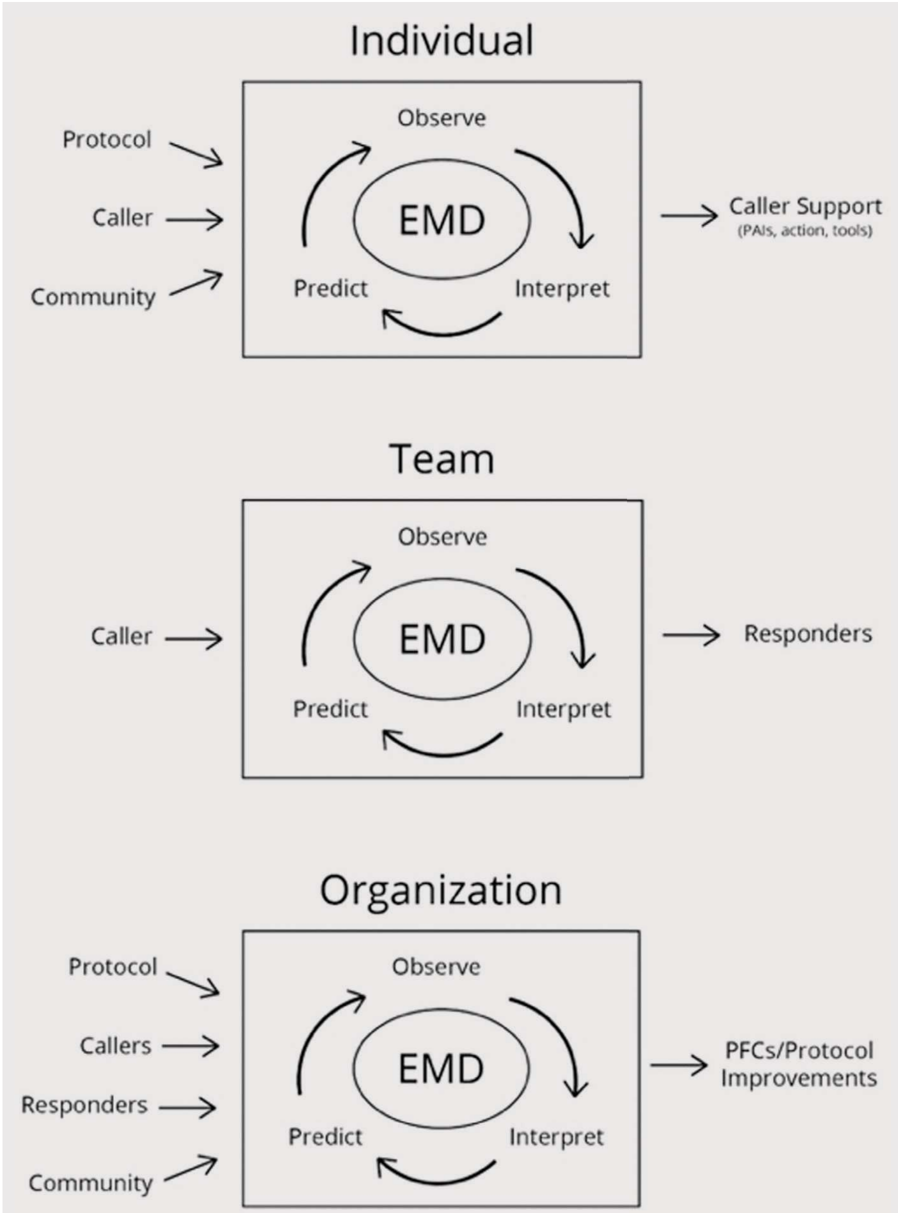

Figure 1. Three roles of the EMD in individual, team, and organization SA

At the individual level, the EMD interacts with incoming data, interprets that data, and takes action to help an individual caller or address an individual presenting situation. This first level of information collection involves a direct interaction between the EMD and the caller. This study suggests that a scripted protocol provides significant SA support to the EMD in collecting that information because the EMD does not need to "think up" what information to gather or what actions to take (such as specific instructions to provide). However, other sources of information—such as the sounds that can be heard over the phone, for example the counting of the person providing chest compressions—are also important. Without them, EMDs cannot perform their most vital role: interpretation. While a protocol creates a structured method of information-gathering, *only* the trained EMD can interpret the information being collected and combine it with the other inputs to determine exactly what is happening on scene. This model also suggests that caller management, including calming and emotion management, are critical elements in effective EMD SA because until the caller is calm enough to provide information, no SA can exist at all.[20,21] The SA-improvement strategies used by the EMDs in this study are being further evaluated for inclusion in future versions of the protocol.

The EMD also acts as a creator of SA for the team—including the others in the communication center, the field responders (paramedics, firefighters, etc.), and final care providers such as hospital physicians. This is so much an expected part of their role that litigation has successfully been brought against EMDs who fail to transmit critical information to responders.[22] In a team setting, SA is considered "distributed," meaning that different members of the team gather, hold, interpret, and transmit pieces of the whole, with no single individual responsible for being aware of the entire situation. If the SA of any individual within the team is incomplete, the team's overall SA decreases, and the overall risk increases. In emergency dispatch, if the EMD does not gather, interpret, and transmit the information from the only person who is actually on the scene and in possession of SA information—the caller—the entire team's SA decreases, and risk goes up. This is true even when the caller and the responder are the same person, as in the case of CPR instructions. The caller may know information (that the patient is unconscious and not breathing, for example), but it is up to the EMD to gather the right information, interpret it correctly (such as by identifying an OHCA), and transmit the correct information back (whether that is information to responders to send an ambulance, or information to the caller to provide CPR).

Finally, the EMD acts as a gatherer and transmitter of information for the larger organization or system. This was clear in the study when the EMDs' evaluation of their own performance led to insights about how to change the protocol system. In this role, EMDs act as the "ears on the ground," the professionals in constant contact with callers who can provide information to the larger organization about the working of the system and its impact on callers. In this study, for example, it became clear that EMDs can gather information about what callers understand or don't understand, based on which instructions they ask for repeated clarifications about or don't seem able to answer. Organizational SA can be just as valuable as in-the-moment individual SA because it can lead to changes in the system itself, which then increase the information-gathering and action-taking potential of all system users around the world. Another study in this issue also demonstrates that value: EMDs provided feedback that the "not alert" question was difficult for callers to understand, and as a result, a new phrasing was tested.

An understanding of SA helps provide insight into the role of protocols in emergency dispatching. Many other high-consequence professions employ protocols and checklists to help practitioners manage incoming information. Surgeons, for example, use checklists to ensure that the correct procedures are being done. The same is true for pilots and astronauts, who maintain rigorous protocols in order to handle all the incoming information they must gather while simultaneously interpreting new data and taking action on existing data. EMDs fall into this same group, utilizing protocols to manage the amount and speed of information coming in, interpreting the information thus gathered, and applying instructions to ensure correct actions are taken.

Future studies should identify other common EMD situations in which breakdowns in SA occur and describe the predictable types of breakdowns (so that EMDs can be trained about them). In addition, future studies should identify behaviors EMDs are already using to overcome these breakdowns (like the check-in behaviors described here) to determine whether to incorporate these behaviors into instruction sequences or training. Finally, quality assurance and other forms of EMD review and evaluation should take into account the demonstrated effect of hurrying on SA and on caller ability to perform instructed actions, replacing the focus on how fast all the instructions are provided with a focus on actual completion of instructed actions. Future studies will evaluate the most effective means of doing this.

CONCLUSION

Providing scripted protocol instructions for activities such as CPR is vitally important for effective patient care. However, in some cases, callers and bystanders may not be completing instructions as provided, thus reducing the efficacy of the intervention for the patient. Situational awareness can help overcome this problem—as well as providing vital information for responders and for the broader organization. EMDs in the study demonstrated behaviors that can mitigate breakdowns in situational awareness; these should be further studied and integrated into protocol development, training, and quality assurance practices.

ENDNOTE

Previous literature has used the term Dispatcher-Assisted CPR. In this paper, we propose and use the term Dispatcher-Directed CPR to recognize the reality that, in most cases, CPR is not already ongoing and that the EMD actually initiates, instructs, and manages the CPR process.

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