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More and Less Effective Updating: The Role of Trajectory Management in Making Sense Again

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Abstract
This study examines how updating—the process of revising provisional sensemaking to incorporate new cues—occurs within teams during unexpected events. I compare how 19 teams of emergency department staff managed the same unexpected event (a broken piece of equipment) in a medical simulation scenario. Using a microethnographic approach to analyze video recordings of these teams, I conduct a fine-grained examination of how updating takes place and find considerable variation in its effectiveness across teams. I show that the effectiveness of updating depends not only on how teams remake sense but also on how they engage in trajectory management, balancing the work of updating with their ongoing work (in this case, patient care). Trajectory management practices related to monitoring cues and managing engaging tasks facilitated effective updating and allowed teams to detect and identify the problem caused by the broken piece of equipment and correct it before it led to serious consequences. More-effective teams monitor and rapidly interpret cues, confirming them with others and evaluating changes over time; they then investigate cues, develop plausible explanations, and quickly test them, monitoring cues for feedback. Less-effective teams fail to monitor and confirm cues with others, overlook or misinterpret cues, and delay investigating cues and developing plausible explanations; they also delay testing explanations, often being sidetracked by patient care tasks.

Keywords: cognition, team performance, sensemaking, updating, microethnography, team adaptation, coordination

In organizations, teams frequently encounter unexpected events that evolve and change over time, requiring members to collectively make and remake sense as they take actions and acquire new information (Weick and Sutcliffe, 2015). Updating—the process of revising provisional sensemaking to incorporate new cues—is critically important for continuing to make sense of an

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unexpected event. If the essence of sensemaking is captured in the questions ''What's the story?'' and ''Now what?'' (Weick, Sutcliffe, and Obstfeld, 2005: 413), then updating also raises the question of whether the sense that has been made still makes sense.

Updating is essential for developing a more comprehensive understanding of the situation, for noticing and solving emergent problems, and for correcting failing courses of action (Weick, Sutcliffe, and Obstfeld, 1999, 2005; Rudolph, Morrison, and Carroll, 2009). Maitlis and Sonenshein (2010: 565) suggested that updating during crisis or change ''allows individuals to revise interpretations based on new information.'' When effective updating does not take place, disastrous consequences can occur. Weick (2010: 537) highlighted ''infrequent updating of both mental models and current hunches'' as one of the key breakdowns that led to the Bhopal gas explosion. The sensemaking and crisis literatures are full of examples of updating failures in which initial sensemaking remained unchanged despite mounting evidence that the sense that was created was categorically wrong or vastly underestimated the severity of the situation that a team faced (Weick, 1993; Snook, 2000). Likewise, there are examples of teams that persevered along a course of action long after they should have quit, without paying attention to cues that suggested they should turn back (Kayes, 2004). Even when some team members do have concerns, they may not be willing to speak up about those concerns (Mills and O'Connell, 2003) or to intervene to correct a potentially fatal course of action (Weick, 1990; Starbuck and Farjoun, 2005).

Despite the importance of updating, when and how updating occurs within teams during unexpected events remains largely unexplored. In part this is because unexpected events by definition are difficult to anticipate and study. Much of what we know about sensemaking during unexpected events comes from case studies of disasters, including the Bhopal toxic gas release (Shrivastava, 1987; Weick, 1988, 2010), the Tenerife airport disaster (Weick, 1990), the Western Pipe Lines accident (Gephart, 1993), the Mann Gulch wildland fire (Weick, 1993), the space shuttle *Challenger* and *Columbia* explosions (Vaughan, 1996; Starbuck and Farjoun, 2005), the U.S. Black Hawk shootdown incident (Snook, 2000), the *USS Greeneville* submarine collision (Roberts and Tadmor, 2002), and the Stockwell shooting in the London underground (Cornelissen, Mantere, and Vaara, 2014). There are rare mentions of effective updating in these studies. For example, Weick (1993) analyzed the Mann Gulch fire and described how Wagner Dodge revised the sense he had made that the fire could be outrun when he saw how rapidly the fire was advancing; as a consequence, he stopped running, lit an escape fire, and tried to convince other team members to stop running and join him. But most studies of disasters focus on moments when updating failed and, consequently, provide more insight into obstacles to updating than into how updating actually takes place. As a result, we know little about when and how updating occurs during unexpected events.

We know even less about what patterns of interactions differentiate between more and less effective updating. Single case studies describe a situation that arises from a unique constellation of circumstances, which makes it difficult to compare updating from case to case and to identify patterns of interactions that characterize more and less effective updating. This gap in our understanding about when and how updating occurs during unexpected events leaves important questions unanswered: how do teams, once engaged in a course of action, continue to incorporate new cues and revise their sensemaking trajectory? If teams become stuck or fixated on an ineffective course of action, can they become unstuck and begin to update? If so, how? The ability of teams to adjust the sense that they have already made is a cornerstone of effectively managing unexpected events (Weick and Sutcliffe, 2015), yet the sensemaking literature lacks a fine-grained description of the moment-to-moment moves that actors make as they engage in updating. In addition, examining how updating takes place has practical consequences for a deeper understanding of the real-time adjustment of sensemaking necessary to mitigate or prevent error.

Understanding how updating takes place can also illuminate the microdynamics of how teams adapt to unexpected events. Burke and colleagues (2006) highlighted that while much is known about the antecedents and consequences of adaptive team performance, relatively little is known about the process through which adaptation takes place. Past research has linked the similarity and accuracy of the shared cognitive frames that team members draw upon with more effective team performance (Mathieu et al., 2000; DeChurch and Mesmer-Magnus, 2010). But there has been very limited research on how teams update their mental models and existing practices when encountering unexpected events (cf. Marks, Zaccaro, and Mathieu, 2000; LePine, 2003; Uitdewilligen, Waller, and Pitariu, 2013). Although initial evidence shows that accurately updating cognitive frames is associated with improved team performance (Uitdewilligen, Waller, and Pitariu, 2013), many questions remain about when and how updating is actually accomplished.

Gaining insight into updating is also important for understanding coordinated action. Research on coordination is beginning to explore some of the mechanisms that underlie updating. For example, Faraj and Xiao (2006) illustrated how trauma teams that treat badly injured patients used different types of coordination practices when a patient was following a habitual (or standard) trajectory of care versus when a patient was on a problematic trajectory. But the ability to determine which patients were on problematic trajectories was taken for granted, and the process through which these trajectories became identified as problematic in the first place was not specified. Bechky and Okhuysen (2011) described how SWAT teams and film crews developed and engaged resources that enabled organizational bricolage around unexpected events: in keeping with other research on coordination, they considered the ability to notice cues, interpret cues as surprising, and revise a trajectory of cognition and action to be part of the everyday work of these teams. But in explicating how bricolage occurred, they focused more on structural practices—such as drafting agreement on work or developing cross-member expertise—rather than on the ongoing actions and interactions that rendered cues salient, created collective sense around emergent surprise, and negotiated a revised course of action to cope with that surprise.

A rich description of updating will also help us better understand high reliability organizations, which are characterized by frontline personnel who are able to quickly notice and respond to weak cues from the environment that indicate impending problems (e.g., Roberts, 1990; Weick and Roberts, 1993; Weick, Sutcliffe, and Obstfeld, 1999; Wreathall, 2006). Once weak cues are detected, team members direct the necessary attention and resources to prevent small problems from escalating into larger problems. Although we understand some of the principles that underpin highly reliable organizing—for instance, preoccupation with failure or reluctance to simplify interpretations (Weick, Sutcliffe, and Obstfeld, 1999)—we lack a detailed understanding of how and when front-line personnel detect cues in the first place, how they determine that cues are problematic, how they communicate their concerns to other team members, and how exactly they reallocate attention and resources to address emergent problems.

UPDATING AND UNEXPECTED EVENTS

Updating is rarely problematized. The ability to make sense again—to revise provisional sensemaking to incorporate new cues—is largely taken for granted in the sensemaking literature. One of the key characteristics of sensemaking is that it is ongoing (Weick, 1995). Whether scholars conceive of sensemaking as taking place continuously or in an episodic fashion, the assumption is that once sensemaking is initiated, it is an ongoing process in which provisional understandings are constantly adjusted in response to new information or changing circumstances (Maitlis and Christianson, 2014).

Even during unexpected events, the presumption is that updating occurs except under the most extreme circumstances, when sensemaking collapses altogether or sensemakers are too overwhelmed to continue. Weick (1993: 633–634) described a cosmology episode—a moment so shattering that people feel that ''I've never been here before, I have no idea where I am, and I have no idea who can help me''—as one type of event that precipitates the collapse of sensemaking. In his reanalysis of the Mann Gulch disaster, he argued that the firefighters were slow to recognize that the small fire they expected to encounter (''10 o'clock fire'') was actually a lethal inferno because the magnitude of this event caused panic and negated their ability to continue to make sense of the situation and to organize effectively. Situations do not need to escalate to the point of panic to paralyze sensemaking. Rudolph and Repenning (2002) argued that sensemaking can also break down because of multiple small interruptions, rather than one overwhelming cosmology event.

Descriptions of how updating takes place are usually embedded in broader discussions of how sensemaking is accomplished. Weick, Sutcliffe, and Obstfeld (2005: 415) described sensemaking as a set of ''progressive approximations'' intended to create a better understanding of the situation through the ''redrafting of an emerging story so that it becomes more comprehensive, incorporates more of the observed data, and is more resilient in the face of criticism.'' Sensemaking is revised through repeated action–meaning cycles as people take actions, notice cues, create explanations to account for those cues, and act to test the explanations that they have developed (Thomas, Clark, and Gioia, 1993; Weick, 1995; Weick, Sutcliffe, and Obstfeld, 2005; Rudolph, Morrison, and Carroll, 2009; Strike and Rerup, 2016). Developing and testing various explanations is aimed at adapting the sense that has already been made so that increasingly plausible explanations are selected and retained (Weick, Sutcliffe, and Obstfeld, 2005; Rudolph, Morrison, and Carroll, 2009).

Because sensemaking involves action and cognition (Weick, 1995; Weick, Sutcliffe, and Obstfeld, 2005), some scholars measure updating as a change in cognitive frames or beliefs (Rudolph, Morrison, and Carroll, 2009; Cornelissen, Mantere, and Vaara, 2014; Strike and Rerup, 2016), and other scholars measure updating as a change in sensemaking trajectory or course of action (Faraj and Xiao, 2006; Barton and Sutcliffe, 2009; Bechky and Okhuysen, 2011; Kaplan and Orlikowski, 2013). Both approaches give insight into how updating occurs (or fails to occur), but these approaches vary in their ontological stance toward sensemaking (Maitlis and Christianson, 2014). The ''cognitive frames or beliefs'' approach focuses on sensemaking that occurs within individuals (even if they are embedded in collectives). The ''trajectory'' approach focuses on sensemaking that occurs between individuals, as people jointly construct meaning and engage in coordinated action. By considering action as well as cognition, the trajectory approach sheds light on the interplay between interpretation and enactment as people make sense together again. This is especially critical in unexpected events, in which failures of updating can be failures to adjust the team's trajectory of action, despite revised individual cognitive frames (Weick, 1990, 2010; Cornelissen, Mantere, and Vaara, 2014).

Research suggests that updating may differ from initial sensemaking in that it may be more constrained. Updating occurs after sensemaking has been initiated and is a refinement of sensemaking already underway. This distinction is important because as sense is made again, earlier sensemaking influences subsequent sensemaking (Weick, 1988; Orton, 2000; Kaplan and Orlikowski, 2013). Initial cognitive frames or beliefs can be surprisingly enduring. Rudolph and colleagues (2009) found that updating takes place as new cues become available, but only if the problem solvers engaged in updating are open to those cues and the plausibility of the explanation based on the new cues is favorably weighed against the plausibility of the current belief. Their research demonstrates that, without a change trigger, updating is a self-reinforcing feedback loop that lends increasing credence to the sense that has already been made. Once frames or beliefs are acted upon, it becomes even more challenging to alter prior sensemaking (Weick, 1988; Cornelissen, Mantere, and Vaara, 2014). Actions—particularly if visible to others, difficult to undo, and chosen freely—restrict future actions and beliefs by increasing commitment to a particular sensemaking trajectory (Salancik, 1977; Weick, 1988).

Thus a growing body of research suggests that it may be more difficult to remake sense than is usually portrayed in the sensemaking literature. For example, in their study of wildland fire crews, Barton and Sutcliffe (2009) showed that sensemaking can take on a dysfunctional momentum, preventing teams from redirecting ongoing action if sensemaking is not periodically interrupted and reevaluated. They highlighted the importance of giving voice to concerns within teams and seeking alternative perspectives to overcome dysfunctional momentum. Similarly, in their study of family business entrepreneurs, Strike and Rerup (2016) found that entrepreneurs can develop an ''entrapped frame,'' and updating that frame can be facilitated when trusted advisors interrupt the momentum of an entrepreneur's sensemaking and raise questions about the previous sense that has been made. Even when sensemaking is reevaluated and a concerted effort is made to shift an established sensemaking trajectory, earlier sensemaking can still persist. Mantere, Schildt, and Sillince (2012) showed that managers of a Nordic public sector organization faced such a moment when organizational priorities changed and a planned merger was canceled, but despite considerable effort on the part of the managers, sensemaking related to the importance of the change persisted (''sensemaking residuals'') and employees were unwilling to return to the status quo.

Despite the importance of updating during unexpected events, paradoxically, the threat-rigidity literature suggests that the moment when updating is most necessary may also be when it is the most difficult to accomplish (Staw, Sandelands, and Dutton, 1981). Threat can constrain the cognitive and behavioral resources within a team, causing individuals to limit what kinds of cues they notice (focusing more on obvious or dominant cues) and to construct explanations that favor earlier hypotheses or well-learned responses; threat may even inhibit action if team members freeze up in response to the threat (Staw, Sandelands, and Dutton, 1981). Threat may also influence the social dynamics of teams, increasing the pressure for consensus within the group, which makes voicing differing or minority opinions less likely (Staw, Sandelands, and Dutton, 1981). Actions are more consequential during unexpected events: the public and often irrevocable nature of actions during crises increases commitment, making it even more difficult to alter sensemaking. Understanding when and how updating occurs during unexpected events will help create a richer portrait of how sensemaking is made and remade at precisely the moment when it is most needed. To gain insight into updating, I examine how teams make and remake sense during an unexpected event to answer two research questions: When and how does updating occur, and what patterns of interaction characterize more and less effective updating?

METHOD

Investigating when and how updating occurs and what characterizes more and less effective updating requires a methodological approach that enables the researcher to (1) gather rich real-time process data, (2) evaluate the effectiveness of updating, and (3) compare and contrast how different teams update around the same unexpected event. The simulation lab fulfills these criteria: it affords the opportunity to video-record the performance of teams in a realistic setting while standardizing the unexpected event that they encounter. I used a microethnographic approach to analyze video recordings of 19 emergency department health care teams from a single organization (''Children's Hospital'') that participated in the same scenario in a medical simulation lab.

Though microethnography shares many of the same concerns as ethnography—particularly a focus on the emic experience of participants—it differs in that it does not require the researcher to be immersed in the research setting that the video recordings were collected from. Earlier research with microethnography often combined the analysis of video with interviews or field observations, but according to Streeck and Mehus (2005: 381), ''Contemporary microethnography, in contrast, largely shares its methods with interactionist modes of analysis, notably conversation analysis, which concentrate on the analysis of recorded specimens of interaction, usually without consulting participants' judgments.''

Using Microethnography to Study Unfolding Interactions

Video recordings are sources of fine-grained process data that give insight into unfolding social interactions that are impossible to capture any other way.

Microethnography involves moment-to-moment analysis of video data ''with attention to the sequential progression of interactional processes within which they take place'' (Streeck and Mehus, 2005: 388). In this way, microethnography is a study of practices (Streeck and Mehus, 2005) that examines how people ''organize their conduct and make sense of each other's actions for the practical purposes at hand. This includes how verbal, bodily, and material resources are deployed in the coordination of work and organizational practice'' (Llewellyn and Hindmarsh, 2013: 1403). Although microethnographic analyses of video recordings have long been used in anthropology, education, and communication studies to study social interactions (Streeck and Mehus, 2005; Goldman et al., 2006; Erickson, 2011), their use in organization studies is relatively new. Organizational scholars have found this technique to be useful for studying issues such as embodiment and situated work practices (Hindmarsh and Pilnick, 2007; Liu and Maitlis, 2014; Balogun, Best, and Lê, 2015; Jarzabkowski, Burke, and Spee, 2015).

Microethnography is a useful approach for studying how people make and remake sense together (Pomerantz and Fehr, 1997; Gylfe et al., 2016; LeBaron et al., 2016). Sensemaking is an inherently social process and ''can be studied in the discourses of social members—the intersubjective social world—rather than simply occurring in their minds'' (Gephart, 1993: 1470). Thus to study how updating is accomplished, it is important to examine the visible and audible behaviors that people make available to each other as they interact. These are the same behaviors that participants themselves rely on to make sense of the situation—they do not have access to what other team members are thinking, only what they are saying or doing.

Microethnography offers a methodological toolkit for analyzing these visible and audible behaviors. To do so, it draws on many research traditions, including ethnomethodology and conversation analysis, and is centrally concerned with understanding the social and sequential organization of talk-in-interaction (Drew and Heritage, 1992; Sacks, 1992; Schegloff, 2007). The fine-grained analysis of video recordings does not depend on what participants notice or can recall. Analyzing what people are saying and doing, instead of asking them to recount their behaviors, is useful because much of what people do is taken for granted and occurs outside of the scope of their awareness (Garfinkel, 1967). In fact, much of the time, expert practitioners find it difficult to articulate what they are doing or why they are doing it that way (Dreyfus and Dreyfus, 1986; Leonard and Swap, 2005). Video recordings also facilitate a fine-grained examination of interactions to a degree not possible using other methods such as observations. The ability to pause and rewind video makes it possible to identify instances of updating and then analyze what was happening in the moments right before or right after updating occurred. Video can be watched and rewatched, which facilitates inductive theory development. Video can also be slowed down, allowing for a frame-by-frame analysis of activity, which is particularly useful in fast-paced and dynamic settings.

Research Context: Simulation Lab

Simulation has long been used in high-risk industries such as aviation, nuclear power, and medicine to train teams and evaluate how they manage unexpected events. Simulation allows the researcher to standardize the unexpected event, evaluate the effectiveness of updating, and compare and contrast how different teams manage the same unexpected event, a feat that is impossible to accomplish in the field. Simulation is intended to provide a safe environment in which learning can take place. As such, team members sometimes engage in more ''backstage'' behaviors (Goffman, 1959) than might be seen in the actual work environment. For instance, in this study, there are a few moments in the simulations when staff joked with each other or made a joke about the patient. Humor may be more likely to be used in the simulation lab, but it also occurs as part of regular patient care (Watson, 2011).

Although simulation cannot fully replicate what happens in real-world settings, there is evidence from many different industries that simulation approximates a real-world experience. Physiological measures show that fighter pilots exhibit similar physiological responses (increased heart rate) to the same scenario in both real and simulated flight (Ylonen et al., 1997). Self-report survey measures show that anesthesiologists participating in simulations perceive them to be realistic (Devitt et al., 2001; Hotchkiss, Biddle, and Fallacaro, 2002). Furthermore, there is growing evidence that skills learned in the simulation lab can translate into improved performance of those skills in clinical settings (Draycott et al., 2006; Wayne et al., 2006; Sturm et al., 2008; Wayne et al., 2008; Barsuk et al., 2009).

In this study, there were a number of reasons for participants to take the simulation seriously. The setting was realistic: (1) the lab itself was a high-fidelity simulation lab, with the lab space being an identical physical replica of Children's Hospital's emergency department trauma bay, (2) teams in the simulations were multidisciplinary, including participants from a range of professional roles, and (3) team members participated in their usual professional role (i.e., doctors were doctors in the simulation, nurses were nurses). Furthermore, all emergency department clinical personnel participated in this training, the simulation took place during regular working hours, and participants received paid time off work to attend the training. Last, the simulation staff conducting the training was very experienced in creating and running simulations: Children's Hospital has one of the top simulation labs in the U.S. In these ways, the simulation lab replicated the setting in which participants accomplished their everyday work as faithfully as possible, which facilitated the analysis of social interactions (Bavelas, 1999, cited in LeBaron, Mandelbaum, and Glenn, 2003; Speer, 2002) while still permitting the unexpected event to be standardized.

Research Design

Unit of analysis. I studied the updating of health care teams from the perspective of a change in the patient's trajectory of care. Strauss et al. (1985: 8) defined trajectory of care as ''not only the physiological unfolding of a patient's disease but the total organization of work done over that course.'' As such, the concept of trajectory of care encompasses the unfolding understanding and action involved in patient care and provides a theoretical framework within which to analyze where, when, and how updating is occurring. The trajectory of care, whether influenced by one team member or the team as a whole, is ultimately the unit of analysis that is most clinically relevant for the patient and has been used in other organizational research to study how health care teams manage high-hazard situations (e.g., Faraj and Xiao, 2006; Klein et al., 2006). A trajectory focus includes considering both action and cognition, but measuring whether updating has occurred or not involves noting exactly when the team modifies the trajectory of care for the patient. From a trajectory perspective, changing a cognitive frame alone is insufficient; updating must involve altering the course of action the team is engaged in.

Data collection and sample. I used an archival video dataset from a simulation conducted at Children's Hospital (pseudonym), a research and teaching hospital that is routinely ranked among the top 10 pediatric hospitals in the U.S. The video for this study came from simulation training that emergency department health care providers at Children's Hospital participated in as part of ongoing training and evaluation (July 2005–March 2008). From this dataset, I analyzed video recordings of 19 emergency department health care teams that participated in the same simulation scenario.

The simulation scenario. In this scenario, a small boy with a past history of asthma was brought to the emergency department because he was having trouble breathing. As the simulation progressed, his breathing got worse, and he eventually stopped breathing. The unexpected event in this scenario was that the piece of equipment that the team used to ventilate or breathe for the patient—the bag-valve-mask (''bag'')—was broken. In addition to providing appropriate treatment for the patient's asthma, the team needed to figure out that the bag was broken and replace it. If they continued to use the bag, the patient was not receiving supplementary oxygen and eventually went into cardiac arrest. Even though this simulation scenario was standardized, the actions that team members took during the simulation—for instance, the medications they administered and the order in which they administered them—influenced how the simulation unfolded. Thus there was variation in how teams managed the same unexpected event, which allowed for comparison of more and less effective updating.

Team members could interact with the simulation staff. For example, they could order tests such as blood work or a chest x-ray or they could request an expert consultation. If the team called for a consult, a simulation staff member would arrive and play the role of the consultant. Simulation staff sometimes participated in the simulations, usually playing the role of the babysitter or parent of the child with asthma. Occasionally, they would also participate as a member of the health care team. Likewise, the simulation staff could offer assistance. If teams reached a diagnostic standstill, simulation staff would give teams a clue: ''DOPE,'' a mnemonic device that all emergency department staff learn during mandatory Pediatric Advanced Life Support (PALS) training. ''DOPE'' lists all the causes of failure to ventilate: ''D'' stands for displacement or dislodgement of the endotracheal tube (aka, ''tube'' or ''ET tube''); ''O'' stands for obstruction of the tube or airway; ''P'' stands for pneumothorax; and ''E'' stands for equipment failure (the unexpected event in this simulation). Staff would say, ''I'm trying to remember that [PALS] mnemonic for when you can't ventilate. . . .'' If no one on the team responded, they would add, ''I think it was DOPE. . . . What does D stand for?'' After several attempts, if team members were still not able to update, the simulation staff would reveal the underlying challenge in the simulation—the broken bag—and end the simulation. Simulations lasted at most 20 minutes.

Team composition. In this simulation, health care providers were randomly assigned to multidisciplinary teams, which consisted of physicians (medical residents, fellows, attending physicians, or clinical staff), nurses, personal care assistants, paramedics, respiratory therapists, and nurse practitioners. See table A1 in the Online Appendix (http://journals.sagepub.com/doi/suppl/10.1177/0001839217750856) for the composition of each team. Although all emergency department health care providers in this organization participated in simulation training, only a subset of health care providers participated in each scenario, resulting in slight variation in terms of team size, the gender and role composition of the team, and the number of experienced team members.

Data Analysis

To examine how updating was accomplished, I analyzed the video recordings of 19 teams participating in the same asthma simulation, in four phases: (1) identifying and coding instances of updating, (2) examining instances of updating as part of a larger trajectory of action, (3) comparing instances of more and less effective updating, and (4) studying patterns of more and less effective updating over time. I distinguish these phases to highlight important dimensions of the analysis. Like many other qualitative methods, however, microethnographic analysis is an inductive and recursive process, so I revisited earlier phases as I deepened and elaborated the theory that I was developing. Phases 1 and 2 helped me explore when and how updating occurs, and phases 3 and 4 helped me investigate what patterns of interaction characterize more and less effective updating.

Traditionally, scholars examining video to gain insight into social interactions have either explored a single episode of unfolding behavior in great detail or assembled a collection of instances to compare multiple occurrences of a particular action (Heath, Hindmarsh, and Luff, 2010). Recently, management scholars have started to use microethnography to look at a wider scope of activity by comparing multiple episodes of unfolding behavior over longer periods of time (Liu and Maitlis, 2014; Balogun, Best, and Lê, 2015). One challenge associated with using a microethnographic approach to study behaviors over a longer period of time is integrating data analysis, which involves a fine-grained examination occurring at the level of individual instances, with a way of presenting the data that makes trajectories visible and illustrates changes in behavior over time. My study takes on this challenge. In the last phase of my analysis, I drew on other techniques used by process scholars (Langley, 1999), such as narrative summaries and visual maps, to supplement my microethnographic analysis so that I could compare instances of updating across time and between teams.

Phase 1: Identifying and coding instances of updating. My analysis started with watching and re-watching the video to find moments in which updating took place. I created detailed transcripts of the simulation for each team, which included both audible and visible behaviors. I used these transcripts in conjunction with the video during my analysis. Once I had identified these moments and created a detailed log of events, I engaged in a close analysis of the video to learn more about what actions characterized updating. I looked for recurring patterns of action (Drew and Heritage, 1992; Gylfe et al., 2016). Across my data set, I found that updating consisted of a common sequence of moves: noticing cues, searching for explanations, and testing those explanations.[1] By moves, I refer to the unitary acts that are the building blocks of situated interaction (Goffman, 1981; Schegloff, 1982; Pentland, 1992). For instance, a team might identify that the patient's chest was not moving with bagging (noticing cues), wonder if the tube was displaced (searching for explanations), and re-intubate the patient (testing explanations). Because teams were managing a standardized unexpected event, I was able to assess the effectiveness of updating. In this study, effective updating occurred when teams detected and replaced the broken bag. Next, I examined the video to learn more about how participants produced and sequenced these actions (Pomerantz and Fehr, 1997). For example, I looked at when team members noticed cues, what cues they noticed, what they did and said after they noticed cues, what other explanations (i.e., non-asthma diagnoses) were discussed, and what actions were taken to test those explanations. My focus here was on examining the interactional and sequential organization of updating—specifically, how team members jointly accomplished each of the updating moves and how they navigated from one move to the next, orienting toward prior actions or projecting future actions (Sacks, 1992; Schegloff, 2007).

Phase 2: Examining instances of updating as part of a larger trajectory of action. Studying when and how updating occurred required understanding how instances of updating fit into the broader work of the team. To examine updating in the context of the trajectory of care, I constructed narrative summaries and detailed timelines for each team. Narrative summaries provide a thick description and are useful for capturing contextual details and the chronological unfolding of events (Langley, 1999). The detailed timelines augmented the narrative summaries and noted when various updating moves took place (noticing cues, developing explanations, and testing explanations) as well as when the team engaged in other actions essential to the care of the patient—for example, when intubations or extubations took place, when medications were administered, etc. Taken together, the narrative summaries and detailed timelines showed how updating related to the larger arc of work of each team. During this phase of the analysis, it became apparent that updating was not occurring just within the trajectory of care, it was inextricably interwoven with and often interrupted by tasks of patient care. In addition, by mapping out the activities of

[1] This study evaluates the visible and audible behaviors that participants make available to each other during interaction. Thus "noticing cues" does not refer to an interior cognitive activity but rather to what can be seen and heard on the video when the participants "do" noticing cues—that is, the actions they took (for instance, checking pieces of equipment, tracing the oxygen tubing back to the wall to make sure that it was connected) or the things that they said, for example, reading aloud the O_2 level shown on the patient monitor or saying, "I'm not getting any air movement," etc.

the team over time, I also identified which teams were able to update effectively (replace the broken bag) and which teams were not.

Phase 3: Comparing instances of more and less effective updating. To learn more about what patterns of interaction characterized more and less effective updating, I compared and contrasted instances of updating within teams and between teams. As in phase 1, I looked for recurring patterns of action. The most marked variation in terms of effectiveness of updating occurred between teams, but my analysis also revealed within-team variation. For instance, I found important similarities and differences related to how effectively teams accomplished and navigated each of the updating moves as well as how they balanced the work of updating with the tasks of patient care. In this phase, notions of trajectory management emerged as salient. For example, I noticed that how teams organized around monitoring cues and managing engaging tasks such as CPR differed significantly in instances of effective vs. ineffective updating. While Strauss (2011: 56) broadly defined trajectory management as ''the entire process by which the course of the phenomenon is shaped by the actors,'' I define trajectory management more narrowly and focus on how it is concretely accomplished.

Phase 4: Studying patterns of more and less effective updating over time. The last phase of data analysis required that I ''zoom out'' (Nicolini, 2009) so that I could study overarching patterns of more and less effective updating. I engaged in fine-grained coding of the transcripts to create utterance maps, which visually depicted the sequential unfolding of talk-in-interaction. Langley (1999: 700) wrote that visual mapping strategies are ''particularly attractive for the analysis of process data because they allow for the simultaneous representation of a large number of dimensions, and they can easily be used to show precedence, parallel processes, and the passage of time.'' Utterance maps were a methodological innovation for this paper and provided a way of displaying the utterance-by-utterance unfolding of talk over time, while also showing the overall trajectory of care for each team. Coding to enable comparison of patterns across cases is compatible with a conversation analytic approach, as long as the coding preserves the interactional quality of the data (Hindmarsh and Llewellyn, 2016).

There was frequent turn-taking in the simulations (i.e., speakers changed often), so I coded the transcripts for each team utterance by utterance, defining utterance as a segment of ''continuous talk by one person, preceded by and followed by talk by someone else'' (Hatfield and Weider-Hatfield, 1978: 47). The coding categories used in the utterance maps were based on the earlier phases of analysis, which showed that tasks of patient care were interwoven with updating, specifically monitoring the patient for cues and developing and testing other possible explanations for the patient's symptoms. Therefore each utterance was coded into one of three mutually exclusive categories related to the content of the talk: task, monitoring, or diagnosis; see table 1 for examples. On the rare occasion when a turn-at-talk was extended and the speaker's utterance included more than one coding category, I further divided this utterance and coded each segment (analogous to a thought unit) separately.

Once the transcripts were coded, I created utterance maps to visually display the utterance-by-utterance sequential unfolding of talk for the entire

Table 1. Examples of Coding for Utterance Maps

Description	Examples
Task talk: Utterances related to accomplishing the work of patient care	E: And our bolus is going in. Is our bolus on rapid infuser? D: Yes. B: It is. H: 1:1,000 [epinephrine] in. D: Can you bring that stool over here?
Monitoring talk: Utterances related to evaluating patient status, including how tasks are affecting the patient and general patient trajectory	H: His O_2 sats are dropping. C: Yeah, I don't hear anything. H: Pulse is uh, bradying down. A: It's okay. H: 63. E: Are you able to move air at all? C: Yeah, he's movin' air.
Diagnostic talk: Utterances related to developing explanations for the patient's symptoms (i.e., the underlying cause or diagnoses)	F: Do we have a cord blockage in there? D: So is, is this a thing for the cords? Yeah. Let's . . . should we get that x-ray? What I'm worried about is an obstruction or some reason that an asthmatic is wheezing, and he's got something there. H: Is our mask not working? G: Well, it's too small.

simulation, illustrating whether a given utterance related to tasks of patient care, monitoring the patient, or discussing possible diagnoses.[2] I annotated maps with key actions, such as when intubations took place or CPR was performed. The utterance maps provide an overview of the sequential organization of talk and a context for locating specific excerpts that are discussed in more detail.

Taken together, this four-phase process of data analysis enabled a close examination and comparison of how teams remade sense around an unexpected event. In what follows, consistent with a microethnographic approach, I use a small set of detailed examples from the video recordings to illustrate how and when updating was accomplished. I chose these excerpts because they clearly demonstrate important patterns of interaction, but they were not unique. To substantiate these patterns of interaction, I provide additional evidence in supplementary figures and tables.

FINDINGS

The findings detail how teams engaged in more and less effective updating around the same unexpected event. Part of the variation in updating could be

[2] I coded all transcripts. Because the utterance maps were a methodological innovation, to confirm that coding related to tasks, monitoring, and diagnostic talk was robust, I hired and trained two independent coders (blind to the theory being developed). The first coder, who had no medical training, coded all transcripts. Compared with the author's coding, our percentage agreements averaged 86 percent, with a Cohen's kappa (which corrects for the amount of agreement that might occur by chance) averaging 75 percent. Next, I hired a second coder with medical training, who also coded all transcripts and, compared with the author's coding, our percentage agreements averaged 89 percent with a Cohen's kappa averaging 81 percent. Given my expertise with the context and these data, and the high level of agreement in coding, the utterance maps were based on my coding.

explained by how teams noticed cues, searched for explanations, and acted to test those explanations.[3] But my findings also revealed that the work of updating was interwoven with the work of ongoing patient care. Thus trajectory management—how teams balanced the work of making sense again with the work of patient care—emerged as a key factor that contributed to effective updating, particularly when updating took place over an extended period of time.

More and Less Effective Updating

All teams made the same initial sense of the patient's symptoms and began by treating the patient for a severe asthma attack, giving him extra oxygen and medications to help with breathing. When the patient was no longer able to breathe on his own, teams began to assist the patient by using the bag to breathe for him. But because the bag was broken, the patient was not receiving supplementary oxygen. The longer the teams used the bag, the more the patient's condition deteriorated. Effective updating in this simulation occurred when teams replaced the broken bag.

Across the teams, I found considerable variation in terms of when and how updating occurred. Table 2 provides an overview of the updating of all teams in the simulation. It illustrates similarities and differences in terms of the types of cues that teams noticed, the number and type of plausible explanations that teams developed to account for those cues, and the challenges that teams encountered related to searching for or testing those explanations. Eight teams (Teams Alpha–Hotel) were able to quickly make sense of the situation and replace the broken bag. These teams noticed cues related to the broken bag itself, homed in on the problem with the bag as the first or second explanation developed, and immediately tested the explanations they developed. This process took place in a short period of time—within the first few minutes of the simulation (five minutes or less), these teams were able to effectively update the patient's trajectory of care. For the remaining 11 teams, updating took place over a more extended period of time (5 to 20 minutes), as teams ran into problems with updating, including missing cues, misinterpreting cues, incomplete or delayed search for explanations, and incomplete or delayed testing of explanations. Despite these challenges, six of the eleven teams (Teams India–November) were eventually able to make sense of the situation and replace the broken bag. In contrast, the other five teams (Teams Oscar–Sierra) were never able to update effectively.

I found that all teams engaged in three updating moves: noticing cues, searching for explanations, and acting to test those explanations. While these updating moves were the same for all teams, more and less effective updating depended on how teams accomplished these moves and how they navigated from one move to the next. One possible explanation for this variation is that teams with effective updating were more expert. As table 3 shows, teams with effective updating had, on average, one more expert team member than teams with ineffective updating. But the individuals involved in detecting the broken

[3] In this setting, the explanations that the teams are developing and testing are medical diagnoses. Thus the terms "explanations" and "diagnoses" are used synonymously when discussing the findings.

Table 2. Overview of Updating in the Simulation

Team	Effective?	Cues Noticed: Problem with bag	Cues Noticed: Chest rise / breath sounds	Cues Noticed: Low O_2	Cues Noticed: Arrhythmia	Explanations Developed: Total #	Explanations Developed: Alternate explanations developed	Explanations Tested
Alpha	Yes	√	√			1	Broken bag	√
Bravo	Yes	√	√	√		2	Bag too small; possible pneumo	√
Charlie	Yes	√	√	√		1	Bag wrong size	√
Delta	Yes	√	√	√		2	Mask too small; bag not working	√
Echo	Yes	√	√	√		2	O_2 not working; bag not working	√
Foxtrot	Yes	√	√	√		2	Tube placement; something wrong with bag	√
Golf	Yes	√	√	√		2	Tube too deep; bag not working	√
Hotel	Yes		√ (misinterpret initially)	√		1	Mask broken	√
India	Yes		√		√†	6	Displaced tube; foreign body; pneumo; obstructed tube; faulty tube; equipment (O_2, bag)	Incomplete
Juliet	Yes		√	√	√	5	Displaced tube; obstruction; displaced tube again; broken mask; pneumo; displaced tube again; insufficient PEEP	√
Kilo	Yes		√	√	√	4	Pneumo; foreign body; inadequate perfusion pressure; pneumo again; needs different bag	Delayed
Lima	Yes		√		√†	4	Aspiration of a foreign body; pneumo; displaced tube; foreign body again; pneumo again; equipment (O_2 and bag)	Delayed
Mike*	Yes		√	√	√†	3	Airway obstruction; displaced tube; DOPE clue → reservoir bag not filling	√
November*	Yes		√	√	√†	5	Blocked airway; displaced tube; mask wrong size; lower airway obstruction; DOPE clue → check equipment (O_2 tubing, change bag, suction tube)	Incomplete
Oscar*	No		√ (misinterpret initially)	√	√†	4	Pneumo; displaced tube; foreign body; obstructed tube	√
Papa*	No				√†	3	Pulmonary edema; myocarditis; possible displaced tube	√
Quebec*	No		√	√	√†	4	Foreign body; equipment/ oxygen; pneumo; displaced tube	Delayed
Romeo*	No		√	√	√†	3	Mask too small; hypoxia; tube placement (displaced vs. too deep)	Incomplete, failure to test
Sierra*	No	√	√	√		3	Problem with bag; displaced tube; foreign body	Failure to test

* Simulation staff gave the ''DOPE'' clue.
† Patient also goes into cardiac arrest.

Table 3. Descriptive Statistics on Teams with Effective and Ineffective Updating

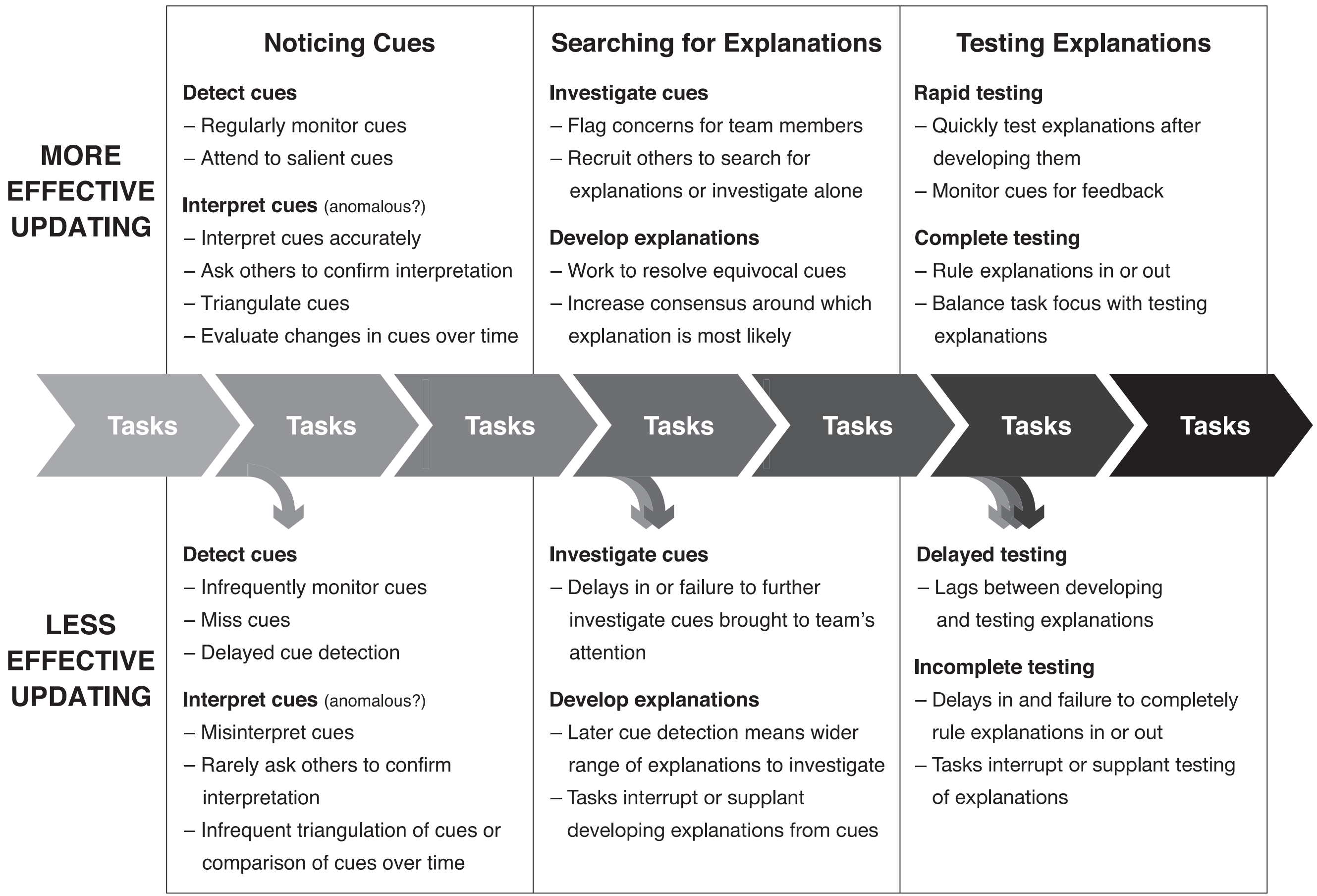
	Effective Updating			Ineffective Updating		
Variable	Min.	Max.	Mean (S.D.)	Min.	Max.	Mean (S.D.)
Team size	4	8	6.29 (1.44)	3	7	6 (1.73)
Males on team	0	3	1.14 (0.95)	0	2	0.8 (0.84)
Females on team	3	7	5.14 (1.41)	2	7	5.2 (1.92)
Physicians on team	1	5	2.29 (1.27)	1	3	2.4 (0.89)
Nurses on team	2	6	3.29 (1.27)	1	4	3 (1.41)
Other professionals on team	0	3	0.71 (0.91)	0	2	0.6 (0.89)
Experienced team members (> 3 years experience in ED)	0	5	2.43 (1.5)	0	2	1.2 (0.84)

bag came from a number of professional roles and were more often novices than experts, suggesting that more complicated factors were in play. Furthermore, updating was accomplished through interactions between team members. If expertise played a role, it seems to be related to how teams organized to remake sense.

The finding that some teams were better at noticing cues and searching for and testing plausible explanations helps to explain why effective updating unfolded quickly in some teams (Teams Alpha–Hotel) but does not fully account for the variation in the remaining teams. As table 2 shows, with few exceptions (cf. Team Papa), the 11 teams (Team India–Sierra) that encountered problems with updating noticed the same kinds of cues and developed and tested roughly the same set of plausible explanations, particularly displaced tube, foreign body, obstructed tube, and pneumothorax. My findings demonstrate that trajectory management was a key factor that differentiated teams that were able to update effectively and teams that were not. I found that updating did not occur separate from the work of patient care; instead, it was embedded within it. As teams noticed cues, searched for explanations, and tested explanations, they also had to carry out tasks of patient care. Some of those tasks required significant attention—for example, intubating the patient or performing CPR—and focusing the attention of the team on those tasks could interrupt and delay updating. Figure 1 is the process model induced from my data, which summarizes what characterized more and less effective updating.

Figure 1 shows that noticing cues, searching for explanations, and testing explanations occurred sequentially and could be performed more and less effectively. Updating moves were intertwined with tasks, and as teams navigated from one move to the next, they could become distracted by tasks, which could delay or impede the updating process. Separating updating into moves also highlights that teams could be more effective with one of the moves in the sequence and less effective with other moves in any given iteration of this process. Teams could also be more effective in one iteration of the updating process than in another. Last, the model includes movement between the more and less effective accomplishment of each move to illustrate that when teams ran into difficulty, such as a delay in developing explanations due to a focus on tasks, they could recover and begin to update more effectively. Alternately, teams could also become stuck at any move in the process and no

Figure 1. Process model of updating sensemaking while managing the trajectory of patient care.



longer be able to update effectively. Figure 1 also shows that the work of patient care (tasks) becomes more demanding over time. If teams were not able to engage in trajectory management, accumulating tasks could tip the balance toward ineffective updating.

To illustrate the patterns of more and less effective updating depicted in figure 1, I draw on the fine-grained process data captured by the video recordings of the 19 teams that participated in the same asthma simulation. I analyze excerpts from these recordings to show how updating unfolded over time—that is, how teams accomplished each of the updating moves and navigated from one move to the next. When updating took place over an extended period of time, I augment the presentation of excerpts with narrative summaries as well as visual maps to show when and how updating occurred. I show how trajectory management, particularly monitoring cues and managing engaging tasks, facilitated effective updating even when a team encountered delays.

Updating and Trajectory Management

Updating involves revising an established trajectory of cognition and action. When teams began using the broken bag, they were already treating the patient for a severe asthma attack. Caring for the patient involved tasks that were effortful and often required coordination between team members. In this simulation, some of the tasks that team members performed as part of patient care included gaining intravenous (IV) access so that the patient could receive fluids and medications, calculating what dosage of medications to order for the patient, preparing and administering medications (often multiple medications, which needed to be given in a certain order), drawing blood for lab tests, bagging the patient to support his breathing, intubating the patient to secure airway access, and performing CPR and sometimes even shocking the patient if he went into cardiac arrest. These tasks of patient care, especially intubation and performing CPR, were demanding, and it was often difficult for teams to balance the work of updating with the tasks of patient care.

Trajectory management involved monitoring the patient for cues to determine whether the tasks that the team was performing were having the intended consequences (Did bagging cause chest rise? Was there a pulse with cardiac compressions?), as well as evaluating the patient's condition more generally (Was he getting better? Getting worse?). If the patient wasn't responding as expected or his condition was worsening, teams needed to reconsider their initial diagnosis (asthma) and search for other plausible explanations. The degree to which trajectory management was required depended in part on how long it took teams to update. For longer periods of time, more trajectory management was required. As teams continued to use the broken bag and the patient's condition deteriorated, the work of patient care and the work of updating intensified.

I found that effective updating was facilitated by trajectory management practices, including rapid cycling through the sequence of updating moves, monitoring cues, and managing engaging tasks. To illustrate the relationship between updating and trajectory management, I begin with an excerpt showing how Team Bravo rapidly cycled from one updating move to the next and homed in on the diagnosis of the broken bag as the first plausible explanation they developed.[4] This excerpt illustrates how this team navigated from noticing cues to searching for explanations to testing explanations. As well, this excerpt shows how monitoring cues—in this case, related to oxygen (O_2) saturations (‘‘sats’’)—helped Team Bravo update the patient’s trajectory of care:

1 0:00 *G starts bagging patient.*
2 *A assists G by adjusting patient’s head.*

3 *A few seconds of silence as B monitors breathing with stethoscope, G starts to get*
4 *ready to intubate, A checks readings on monitor.*

5 0:08 C: Wait just for a minute for the succ.

6 0:15 B: Yeah, do we have another 1:1000?
7 C: Yeah, just in case, yep.
8 B: We’ll go ahead after . . .

9 0:23 G (*gives three squeezes of the bag; keeps glancing at monitor; refits mask on*
10 *face*): Okay, sats are still pretty low. Not very good.

11 0:26 F (*addressing C*): How long do you wait between the succ and the etomidate?
12 C: Give it a good 30 seconds.
13 F: Okay.
14 C: 30 seconds to a minute.

15 0:36 A: Sats are still low . . .
16 A to G: . . . We need a bigger bag . . .
17 G (*nods*): Please.
18 *A goes to get the bigger bag from the wall.*

19 0:37 B: So we could think about possibly even, even needling his chest maybe and
20 think about chest tubes. . . . His chest could be . . .

21 0:42 G (*addressing B, who is listening to patient’s chest*): How does he sound?
22 B: He’s very decreased. He’s very . . . (*B glances at monitor behind him, and A*
23 *places the new bag on bed on the right side of the patient’s head.*) He’s very
24 decreased, he’s not movin’ a lot of air.
25 G: On uh, on both sides?
26 B: Both sides. Everywhere. He’s not movin’ a lot of air.
27 0:51 *F and G replace bag and G starts bagging again.*

Monitoring cues about the patient, especially the oxygen saturations, helped G and A to update the trajectory of care for the patient. G began to adjust the mask shortly after beginning bagging the patient (lines 9 and 10). Despite these

[4] Excerpts were transcribed verbatim from the video recordings, and the transcripts were annotated with actions (indicated by italicized text). Each line of the transcript was numbered. These numbers facilitated discussion of the data (specific utterances could be referred to by their line number). Spaces between sets of utterances increased readability of long excerpts and showed which utterances were grouped together. Explanatory notes are marked off by square brackets. To facilitate comparison of transcripts across teams, all transcript timestamps start at zero at the moment the team starts using the broken bag.

adjustments, G did not voice a concern about the bag itself. Instead G and A talked about cues related to the patient's oxygen saturation level.

Shortly after she started using the bag, G remarked, ''Okay, sats are still pretty low. Not very good'' (line 10), and A replied, ''Sats are still low'' (line 15). G's initial statement flagged the low sats as problematic. Notice the use of the word ''still'' by both G and A to emphasize the persistence of the low oxygen sats over time. The continually low oxygen saturations provided the prompt for changing the bag. A's comment, ''Sats are still low,'' was immediately followed by her statement, ''We need a bigger bag'' (line 16), which G agreed with (line 17). Implicit in these two back-to-back statements was the claim that the low oxygen saturations were related to using a bag that was too small to provide sufficient pressure for ventilation. Though the issue was that the bag was broken (not too small), G and A's assessment of the situation was correct, insomuch as a broken bag provides no pressure at all.

While waiting for the bag to be replaced, another team member (B) suggested a second plausible explanation: a pneumothorax. G and B worked together to monitor the patient and gathered additional information to rule this explanation in or out. B listened to the chest to determine whether there was air movement on both sides (lines 21–26). If there had been a difference in air movement from one side to the other, this finding would have been suggestive of a pneumothorax. But the findings that breath sounds were ''very decreased'' and the patient was ''not movin' a lot of air'' (lines 22–26) were in keeping with the earlier explanation that the bag was not providing sufficient pressure to ventilate (line 16).

This example highlights the social and discursive nature of updating. A, G, and B made noticing cues, searching for explanations, and testing explanations visible to other team members by narrating what they were thinking and doing. By closely monitoring cues related to the effect their actions were having on the patient, they were able to quickly make sense again and change the broken bag. In addition, discussions related to monitoring and revising the trajectory of care were intertwined with discussions about the ongoing care of the patient, including how long to wait before medications took effect (line 5), how long to wait between administering the first and second medication in the intubation induction sequence (lines 11–14), what other medications were on hand just in case (lines 6–7), and what next steps to consider if the intubation didn't work (lines 19–20). This excerpt from Team Bravo shows how updating, even when it occurred quickly and without difficulty, was interwoven with tasks of patient care.

Monitoring the effectiveness of those patient care tasks also provided an occasion for updating. For instance, intubating the patient was always followed by an examination to see whether the ET tube was in the right place, which could include listening for breath sounds with bagging, watching for chest rise with bagging, visually confirming tube placement (by seeing the tube pass through the vocal cords during intubation or by getting a chest x-ray to check the position of the tube), looking for condensation in the tube, or using a carbon dioxide (CO_2) monitor. The following example from Team Golf shows how monitoring the patient after intubation provided cues that triggered updating. This excerpt begins two and a half minutes after the team started bagging the patient. Team members had just finished intubating the patient and were trying to determine whether the intubation had been successful:

2:22 A: Sats are still droppin'. 65. Heart rate's 72 now.
E: I have no breath sounds.
F: No breath sounds.
E: I don't have any breath sounds. Are we not in far enough?
B: We're in too deep.
A: How far are we down?
F and A lean forward to look at where the ET tube crosses lip line.
F: We're at . . .
E: Sats are droppin'.
F: Lip at 20. . . . Lip at 19, excuse me. [Numbers indicate depth of placement of the ET tube in centimeters.]

A: Alright, to 65. [Number refers to level of oxygen saturation]

2:48 F: Should I pull this [ET tube] back?
C: Pull it back to 16 or 15.
F: 'Kay I'm pulling it back. (*H bent over looking at markers on lip*)
A: Keep listening for breath sounds. Keep listening for breath sounds.
F: At 16.
B: I got it. I got it. (*Takes stethoscope off neck and begins to listen to patient's chest*)
F: We still have no chest rise.
B (*Shaking head*): I don't think anything is moving through the bag.
E: I know. It doesn't feel like that either. It sounds like there's a leak.
E: Here can you do that (*E moves toward wall while handing bag to F, who is at the head of bed*) and I'll switch bags? (*E switches tubing on wall to hook up new bag)*

B: No breath sounds.
3:17 A: Make a call to anesthesia. Anesthesiologist.
SS (*jokingly*): They're in the middle of a heart case, they'll be down as soon as they can.
A: Nice! (*Laughs*)

3:32 E (*asks F*): Ready?
F: Ready.
F takes bag off mask and switches out bag
A: Can we make the call for an attending? (*Laughs; others laugh as well.*) . . . Alright 65, heart rate's at 58.

3:34 E: Alright.
B: (*Listening to chest, nodding)* There we go. (*Nodding*)
F: It was the bag (*points at the old bag*).
E: OK, we got breath sounds bilaterally.
B: Breath sounds bilaterally.

For Team Golf, monitoring the effectiveness of tasks of patient care, specifically intubation, prompted updating. Prior to intubation, the team had been treating the patient for asthma. In this short excerpt, team members developed and tested two other plausible explanations to account for the cues they detected: whether the tube was in the right place and whether the bag was working properly. After the patient had been intubated, multiple team members (A, B, E, and F) sought out cues to evaluate whether the intubation had been successful. In line 1, A gave information about two separate types of cues about the patient—oxygen saturation and heart rate—as well as how those cues were changing over time. E built on A's statement and added, ''I have no breath sounds'' (line 2), which was immediately confirmed by F (line 3). E restated, ''I don't have any breath sounds'' (line 4) and then went further and suggested a plausible explanation: ''Are we not in far enough?'' (line 4). B immediately suggested the opposite, ''We're in too deep'' (line 5). Within the first five lines, four team members discussed three different types of cues (oxygen saturations, heart rate, and breath sounds) and developed a plausible explanation to account for those cues (tube placement).

The statements that follow showed team members checking on depth of tube placement (line 10), discussing how far to pull the tube back (lines 13–15, 17), and continuing to monitor the patient for cues throughout this process for feedback on whether changing tube placement resolved the problem of no breath sounds (line 16). Once the tube had been pulled back to 16 cm at the lip, B listened again and F watched the patient's chest, saying, ''We still have no chest rise'' (line 20). B then suggested a second plausible explanation, ''I don't think anything is moving through the bag'' (line 21). E immediately said, ''I know. It doesn't feel like that either. It sounds like there's a leak'' (line 22). Note that E did more than agree with B; she went further and added two complementary statements about how the bag felt and how it sounded. After a brief pause, E asked F to hold the old bag while she got a new one (lines 23–24). Team members hooked up the new bag to the oxygen tubing and began to use the new bag (line 32). After switching the bag, B and E listened again and confirmed that they could hear breath sounds now (lines 36, 38, 39), while F said, ''It was the bag'' (line 37).

Like Team Bravo, Team Golf rapidly cycled from one updating move to the next. Within a short period of time, Team Golf noticed anomalous cues and developed and tested two plausible explanations—tube too deep and bag not working—to account for those cues. Cue monitoring practices also played an important role in updating for this team. Monitoring cues involved immediately evaluating patient cues after changes were made, having team members work together to double-check and confirm interpretations of cues, and triangulating multiple related cues at the same time (evaluating oxygen saturations, heart rate, breath sounds, or how the bag felt and how the bag sounded).

Taken together, the excerpts from Teams Bravo and Golf showed how team members made noticing cues, searching for explanations, and testing explanations visible to each other. The updated sensemaking that teams developed was provisional and continued to be monitored and tested. Regular monitoring of the patient helped teams to detect anomalous cues, which prompted the development of explanations, and monitoring the patient also helped teams rule explanations in or out by using cues as feedback to see whether the changes they were making were effective.

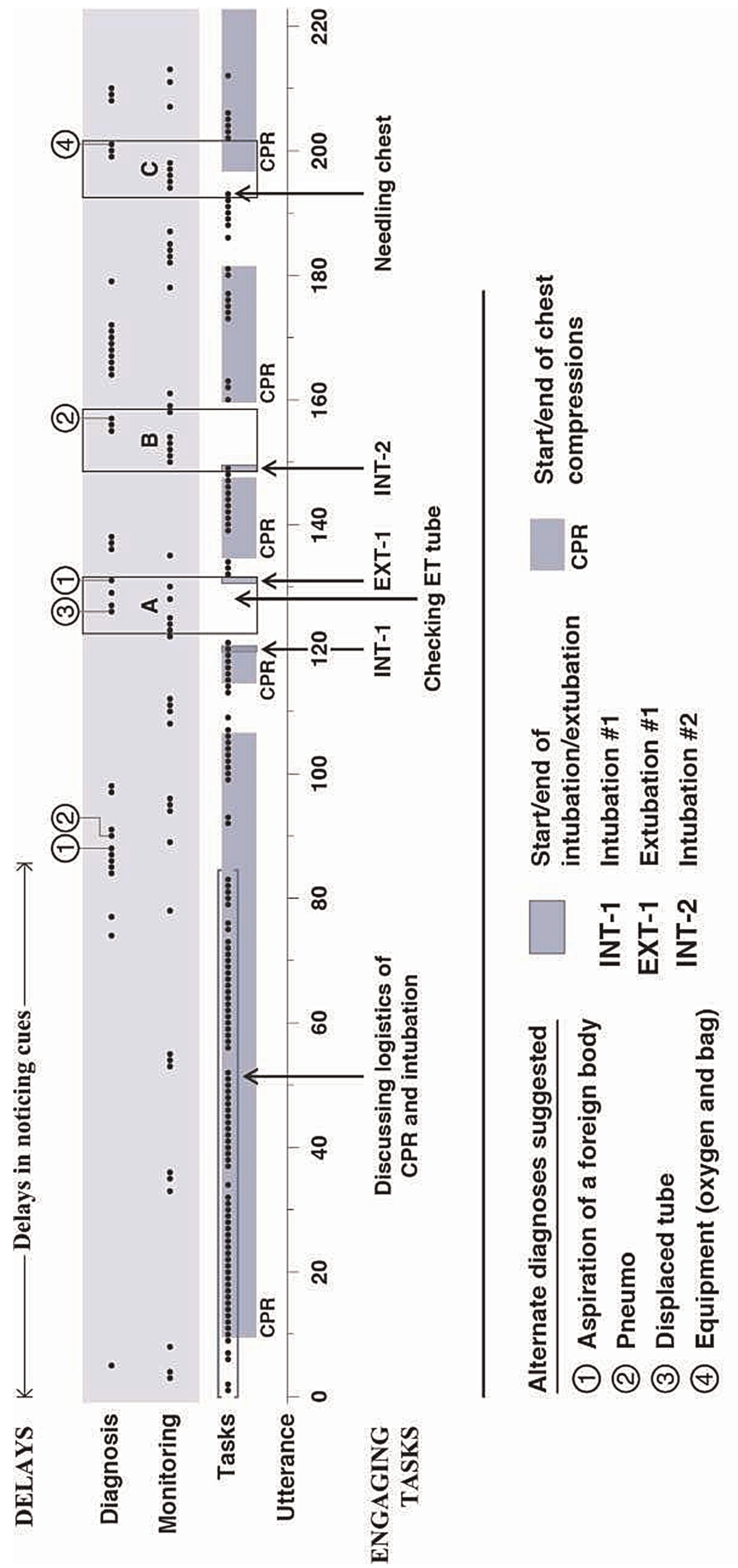
Extended updating and trajectory management. What happened when teams weren't able to quickly make sense of the situation and replace the broken bag? Of the remaining 11 teams in which updating took place over a longer period of time (5–20 minutes), six of the teams (Teams India–November) were eventually able to update effectively, and the other five (Teams Oscar–Sierra) were never able to do so. When updating took place over a longer period of time, trajectory management became even more critical because the work of updating and patient care both increased as the patient's condition worsened. As a result, tasks of patient care frequently interrupted updating.

To examine the role of trajectory management in extended updating, I compare and contrast how updating was accomplished in Team Lima, which was eventually able to update effectively, and Team Oscar, which was never able to do so. The patterns of interaction that characterized more and less effective updating in Team Lima and Team Oscar recurred throughout the data. Tables A2 and A3 in the Online Appendix provide synopses of the updating processes in Team Lima and Team Oscar, along with additional evidence from four other teams of the recurring patterns. Comparing Team Lima and Team Oscar revealed many similarities. Both teams experienced long initial delays in noticing cues, and they generated an almost identical set of alternate explanations for the patient's symptoms (Team Lima: foreign body, pneumo, displaced tube, equipment; Team Oscar: pneumo, displaced tube, foreign body, obstructed tube). As well, the patient went into cardiac arrest in both simulations, requiring teams to start CPR and give additional medications. Despite these similarities, however, a closer examination uncovered significant differences between these teams around trajectory management practices related to monitoring cues and managing engaging tasks.

Team Lima was eventually able to update effectively, even with delays caused by engaging tasks such as CPR. Figure 2 presents an utterance map, which helps visualize how updating unfolded for this team and shows the relationship between extended updating and trajectory management. The figure shows a long stretch of task talk (utterances 1–83, designated by black dots) associated with the initial delay in noticing cues, while the team discussed the logistics of CPR and intubation, such as where to find the equipment they needed and which team members would perform CPR. During this time, one of the team members asked if there was any reason to suspect the patient had another problem causing his difficulty breathing. Aspiration of a foreign body and pneumo were suggested as possibilities, but neither of these was investigated because the team wanted to first intubate the patient to see whether that improved the situation. After the intubation, the team monitored the patient to see whether the intubation had been effective. The following excerpt details the sequence of utterances in rectangle A in figure 2:

1A E: Someone listen please for breath sounds.
2A C: . . . 68 over 44. [Numbers refer to the patient's blood pressure]
3A I (*listening to patient's chest*): No.
4A B (*also listening to patient's chest, shaking head side to side*): You're not in.
5A I: I can't believe you're not in.
6A A (*uses the laryngoscope to look at the tube placement*): Guys, I'm in. Right
7A through the cords.
8A E: Sure there wasn't any trauma to the cords?
9A I (*listening to chest again*): I mean . . . I've got nothing for anything.
10A A: Okay, let's just go back and try to intubate, but I am through the cords guys.
11A So, is there a foreign body there or something? That we haven't seen? (*pulls the*
12A *tube out)* Gimme the mask.

Figure 2. Utterance map for Team Lima, effective updating around the unexpected event in the simulation.*



* Each dot indicates an individual utterance relating to tasks, monitoring, or diagnosis. The series of dots shows the sequential unfolding of talk over time.

The team leader, E, asked for someone to listen for breath sounds (line 1A). Two team members listened to the patient and stated there were no breath sounds. I, a physician, simply said, ''No'' (line 3A). B, a nurse, started by shaking her head from side to side to indicate no and then said, ''You're not in'' (line 4A), which confirmed I's previous comment and extended it to make a claim that the tube wasn't in the right place (i.e., trachea). The team then discussed the plausible explanation of a displaced tube. I expressed surprise (line 5A), and A, the physician who had performed the intubation, checked and verified the position of the tube again (lines 6A–7A). I listened again and reconfirmed the lack of breath sounds (line 9A). Despite having just visually confirmed tube placement, A treated I's assessment of cues from the patient as worthy of further investigation and responded by suggesting they take the tube out and reintubate the patient (line 10A). He also suggested a second plausible explanation to account for the lack of breath sounds: a foreign body (line 11A). At the same time he was making this suggestion, he was simultaneously removing the tube and switching back to bagging the patient (lines 11A–12A).

Updating for Team Lima in this excerpt involved not only noticing cues, developing plausible explanations, and acting to test those explanations, it also involved resolving multiple conflicting interpretations of the same situation. Team Lima identified an anomalous cue (lack of breath sounds with bagging), which suggested the tube might be displaced, but they also noticed a contradictory cue (tube was seen going through the cords), which suggested the tube was in the right place. To resolve this discrepancy, team members did two things: they acted as if the plausible explanation of tube displacement might be correct and removed the tube, and they also acted as if the plausible explanation of tube displacement might be wrong and developed a second plausible explanation (foreign body) to account for the discrepancy between cues.

The next excerpt details the sequence of utterances in rectangle B in figure 2. It shows how the team engaged in updating after they reintubated the patient, which served to test whether the tube had been initially displaced or whether there was a foreign body blocking the airway (which should be visible during intubation). A intubated the patient by pushing the tube as far as he could into the right mainstem bronchus to rule out a foreign body:

1B 7:40 A: Okay, I'm going through . . . (*A intubates for the second time*) . . . I'm going
2B all the way down. Love it. Here we go.
3B E: You can hear it on the right, guys.
4B A: You should hear on the right now.
5B I (*listening to the chest)*: That's where I'm listenin'.
6B A: Listen down here (*points lower down on the chest*).
7B I (*listening at a lower spot on the chest*): I don't hear anything, I don't see any
8B chest rise.
9B A: Well there's no foreign body there, it must be something . . .
10B E: So do you, let's . . .
11B E: Do you think we need to needle his chest? Is he, is he totally down on that side?
12B Hold it back a little bit.
13B I: Go back and see if I can hear anything on the left, slowly go back.

This excerpt is remarkable because E (the team leader) and A (the physician who performed the intubation) started to give I (another expert physician) instructions on how he should monitor the patient, specifically where he should listen to hear if there were breath sounds with bagging (lines 3B and 4B). When I confirmed he was already listening on the right side (line 5B), A became even more emphatic and pointed to the particular point where he wanted I to listen (line 6B). I moved his stethoscope, listened at the lower location, and reported on two types of cues: ''I don't hear anything, I don't see any chest rise'' (lines 7B and 8B).

In contrast to the last excerpt, team members did not suggest tube displacement as the explanation for lack of breath sounds. Instead, A confirmed that he didn't see any foreign body during intubation and suggested there must be another cause (line 9B). In response, E suggested a third plausible explanation—a pneumothorax—by asking a question: ''Do you think we need to needle his chest? Is he, is he totally down on that side?'' (line 11B). She followed this suggestion with a request for the team to pull back the tube, given that the initial intubation was unusually deep, which would facilitate comparison of breath sounds on both sides (line 12B). I built on her request and asked for the tube to be pulled back slowly, so he could listen on the left (line 13B). This excerpt again shows how Team Lima worked together to monitor the patient for cues and to rapidly cycle through the updating moves.

A last excerpt details the sequence of utterances in rectangle C in figure 2 and shows the resolution of updating for this team. Team Lima had already considered aspiration of a foreign body and a displaced tube and was in the midst of testing for a pneumothorax. The following excerpt shows the rapid transition from the third updating cycle (possible pneumothorax) to the fourth and last (problem with equipment):

1C 9:45 I: Uh, needle's in.
2C E: Yeah, we have no pulse, we can see that there's no pulse.
3C I: Can I have a whoosh of air?
4C E: Okay, there's a . . . .
5C G: No whoosh.
6C A: No whoosh of air.
7C I: Want me to stick the left while I'm here?
8C A: Yes.
9C E: Okay, is your equipment working?

When needling the chest did not produce a whoosh of air (lines 3C, 5C, and 6C), I asked whether he should needle the left side as well (line 7C). While he was preparing to do that, E suggested a fourth plausible explanation: equipment failure (line 9C). This suggestion followed immediately after the last explanation, pneumothorax, had been ruled out. The team checked the oxygen tubing and changed the broken bag, after which point they could hear breath sounds and see chest rise with bagging.

Team Lima again demonstrates the importance of cue monitoring practices in effective updating. Team members worked together to confirm interpretations, triangulate related cues, and track changes in cues over time. Team Lima faced the additional challenge of having to resolve equivocal cues. Monitoring cues provided feedback on how the patient was responding to care and whether the anomalous cues were resolved or persisted and required further sensemaking. In Team Lima, managing engaging tasks was also critical. Whereas updating was interwoven with tasks of patient care in Team Bravo and Team Golf, updating was interrupted by tasks of patient care in Team Lima. In spite of the initial delay in noticing cues while the team was focused on initiating CPR and giving medications to treat cardiac arrest, Team Lima was able to recover and resume updating.

Team Juliet and Team Kilo used the same cue monitoring practices Team Lima used to remake sense of the patient's symptoms as the situation unfolded over time; see tables A2 and A3 in the Online Appendix for summaries. Like the utterance map for Team Lima, the utterance maps for Team Juliet and Team Kilo—figures A2 and A3, respectively, in the Online Appendix—show that the work of updating was embedded in the overall work of patient care.[5] Team Juliet was able to transition between tasks of patient care and updating without difficulty using these cue monitoring practices, although it took some time to home in on the broken bag as the explanation for the patient's cues. Tasks of patient care were more disruptive for Team Kilo and caused a delay in testing explanations. In contrast to the cardiac arrest that delayed updating in Team Lima, the tasks that interrupted Team Kilo were relatively mundane: discussing how to administer medication and re-taping the ET tube. Team Kilo shows that even simple tasks could engage the team and delay updating.

Team Oscar encountered many of the same challenges that Team Lima did but was never able to update effectively, as summarized in table A3 in the Online Appendix. A detailed examination of this team reveals markedly different trajectory management practices. For Team Oscar, problems related to monitoring cues led to initial delays in updating and contributed to this team's inability to recover from interruptions due to engaging tasks. One of the main issues was that this team did not monitor the patient for cues very often. As the utterance map for Team Oscar shows in figure 3 (also reproduced as figure A4 in the Online Appendix), most of the talk in this team focused on tasks, with much less focus on monitoring the patient or discussing other explanations for the patient's symptoms.

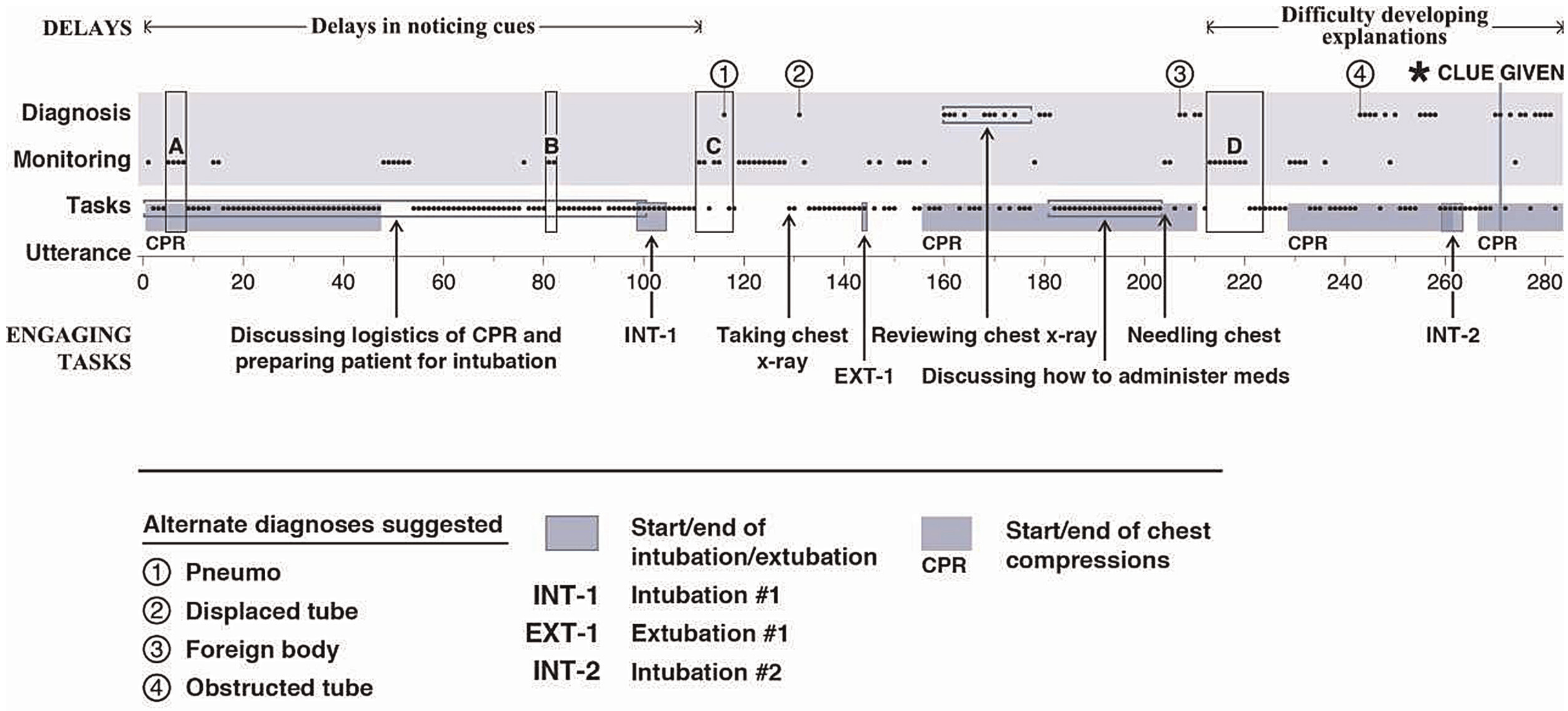
Figure 3 depicts long stretches of uninterrupted task talk. Problems with monitoring cues began early in the simulation when one of the team members—C, an expert physician—misinterpreted cues. In the excerpt marked by rectangle A in figure 3, when asked by another team member if bagging was working, he said,

1A C (*listening to the chest*): You're gettin' air, you're gettin' air.
2A A: Okay.
3A E: Our sats are 93.

Unfortunately, his interpretation was incorrect. There was no air movement being generated by the broken bag. His interpretation was not confirmed (or contradicted) because no one else was monitoring the patient's breath sounds

[5] To increase legibility for readers and preserve the detail and color of the utterance maps, they are presented in the Online Appendix. Figure 2, the utterance map for Team Lima, is reproduced again there (as figure A1), along with maps for five other teams, to allow comparisons among teams.

Figure 3. Utterance map for Team Oscar, ineffective updating around the unexpected event in the simulation.*



* Each dot indicates an individual utterance relating to tasks, monitoring, or diagnosis. The series of dots shows the sequential unfolding of talk over time.

or chest rise at this point in the simulation. The mistaken claim that air movement was occurring was compounded when E, the team leader, mentioned the oxygen saturations were 93 percent (line 3A). Although this level of oxygen saturation is not optimal, the level was still relatively high because the broken bag had only been in use for a few seconds. As the team busied itself with the logistics of performing CPR and preparing medications to sedate the patient before intubation, E, the team leader, asked C, ''Are you able to move air at all?'' (figure 3, rectangle B). C, without checking the patient again, repeated his incorrect assessment saying, ''Yeah he's movin' air'' (figure 3, rectangle B). With this reassuring but inaccurate information, no one else on the team checked on the patient's breathing again until after he was intubated.

Once again, intubation served as an occasion for remaking sense. After the patient had been intubated, team members reevaluated the patient to see if the intubation had been successful, as denoted in the utterances in rectangle C in figure 3:

1C C (*listening to chest*): I don't hear anything.
2C H: You don't hear any breath sounds?
3C E: We can put him on a vent. . . .
4C H: His O_2 sats are dropping.
5C C: Yeah, I don't hear anything.
6C E: Do we have a pneumo?

This excerpt shows that C was now correctly interpreting cues from the patient, indicating that he couldn't hear anything with bagging (lines 1C and 5C). H, a nurse, asked C to confirm his assessment, saying, ''You don't hear any breath sounds?'' (line 2C). This double-checking was in contrast to excerpt A, in which C's original statement that air movement was occurring went unchallenged. In addition to questioning C, H also added her own comment about a cue related to lack of air movement (dropping sats, line 4C). Following these comments about lack of breath sounds and dropping O_2 sats, the team leader, E, suggested the first alternate explanation for the patient's symptoms, ''Do we have a pneumo?'' (line 6C). To test this plausible explanation, the team ordered a chest x-ray to see if pneumo was present. They also extubated the patient in case the cues they noticed were due to a second plausible explanation, a displaced tube.

While they were testing these two explanations (pneumo and displaced tube), however, they were interrupted by tasks of patient care. Shortly after the team extubated the patient, the team restarted CPR because they noticed that the patient had developed a dangerously low heart rate. Figure 3 shows that, during this time, there was very little monitoring of the patient. Instead, the team discussed the diagnostic implications of the chest x-ray and then talked about the best way to administer medications. A team member mentioned another explanation for the patient's symptoms—a foreign body—but this was ruled out on the basis of nothing having been seen in the airway during intubation. Last, the team needled the patient's chest to see if there was any air return, which would have been diagnostic for a pneumo, but there was none.

When the team reevaluated the patient after needling the chest, they started by checking to see whether the patient had pulses, not whether breathing had improved. The following excerpt is from the utterances in rectangle D in figure 3:

1D D: You got pulses? (*H and D feel for pulses*)
2D E: He's still pretty flat (*looking at monitor*). Wait . . . wait . . . wait.
3D D: Yeah.
4D H: Very bradycardic.
5D D: Yeah.
6D C: He's very bradycardic.
7D D: I got a pulse.
8D E: Sats are 60. Alright, do you have another dose of epi?
9D H: Yep. 1:10,000.
10D C: Did you give magnesium?
11D E: Yeah, he got mag, he got solumedrol, he got sub q epi, he got the ketamine, he's
12D on continuous albuterol, we've given the epi a few times.

This excerpt marked a shift in focus for the team. Instead of monitoring chest rise, breath sounds, or other cues related to the patient's respiratory status, the team was now concerned with cues related to the patient's cardiac status. They monitored whether the patient had pulses without CPR (lines 1D, 2D, and 7D) and how fast the patient's pulse was going (lines 4D–6D). The only mention of oxygen saturations was brief—E: ''Sats are 60'' (line 8D)—with no comparison of saturations over time or triangulation with other respiratory cues. The statement about oxygen saturations was immediately followed by a question about what medications were available (line 8D). The team then transitioned to a discussion of which medications had already been given (lines 10D–12D).

The patient's condition continued to worsen. Several team members suggested an obstructed tube as a plausible explanation, forgetting that the patient had been extubated midway through the simulation and therefore had no tube in place to be obstructed. At this point, the team was no longer able to generate plausible explanations. They were given a clue by the simulation staff (''What's that mnemonic when you can't ventilate . . .'') as a prompt to help them develop plausible explanations, but despite this clue, the team remained stuck, unable to update effectively, and the simulation staff halted the simulation.

This example from Team Oscar illustrates a number of problems related to cue monitoring. Infrequent monitoring of the patient, failure to confirm cues, failure to triangulate cues, and failure to compare changes in cues over time meant that the team was not getting much feedback about how the patient was doing and that the feedback they were getting was incomplete. In addition to problems of monitoring, there were also problems related to what type of cues the team was monitoring.

Engaging tasks, particularly if they interrupted updating, could change what cues teams focused on. Just as Team Oscar started to develop and test plausible explanations, they were interrupted by tasks of patient care when they had to resume CPR due to a dangerously low heart rate. But instead of restarting chest compressions and then resuming their search for explanations for the original (and still unresolved) lack of breath sounds and chest rise with bagging, the team shifted focus to monitoring the patient's cardiac status. Though monitoring cardiac cues revealed that the patient's condition was worsening, these cues did not provide fodder for generating plausible explanations. The loss of diagnostic momentum for Team Oscar seemed to be related to a mismatch between the type of cues that teams ended up focusing on and the cues that were most useful for providing insight into the underlying problem (i.e., most closely linked to the unexpected event, not the downstream consequences of it). Team Oscar was never able to refocus its attention on the respiratory cues and update effectively.

Other teams with ineffective updating had similar problems with trajectory management. Team Romeo and Team Quebec provide additional evidence that engaging tasks could delay or derail updating. For example, Team Romeo (see table A3 and figure A5 in the Online Appendix) started in the right diagnostic area by noticing cues about lack of chest rise and breath sounds and questioning whether the patient's mask was broken. Before they tested this explanation, however, the team had to manage a complicated intubation, and just as they finished intubating the patient, he developed a lethal heart rhythm (V-fib or ventricular fibrillation) and went into cardiac arrest. The timing of this interruption was highly disruptive for updating. When the patient went into cardiac arrest, the team shifted focus to tasks of patient care (CPR and defibrillation). The team remained focused on the patient's cardiac status and had increasing difficulty developing explanations. Despite clues from the simulation staff, they were never able to detect and replace the broken bag.

Likewise, Team Quebec (see table A3 and figure A6 in the Online Appendix) also had difficulty balancing tasks of patient care and updating. Team Quebec initially was able to generate and test plausible explanations. As the simulation went on, the team experienced increasing difficulty with updating. Interruptions by tasks of patient care were exacerbated by how this team monitored cues. They were focused on monitoring the patient's cardiac status and frequently stopped CPR to check on the patient's pulse, which generated even more interruptions. Taken together, these interruptions delayed and then derailed updating: the team reached a point at which they had completely lost diagnostic momentum and recognized that they were having trouble but were no longer able to generate and test plausible explanations.

DISCUSSION

This study examines how updating occurs in teams during unexpected events. Using a microethnographic approach to analyze video recordings of multiple teams managing the same unexpected event, I found significant variation in the effectiveness of updating across the teams. The analyses highlight that updating is embedded in a larger arc of teams' work. The data and method made it possible for me to disentangle updating from the ongoing work of the team and demonstrate when and how they diverge and converge. I found that the effectiveness of updating depends not only on how teams notice cues, search for explanations, and test those explanations but also on how they balance the work of updating with the ongoing work of the team. I showed how trajectory management practices related to monitoring cues and managing engaging tasks facilitated effective updating. More broadly, my findings identify patterns of more and less effective updating and illustrate the role of trajectory management in revising an established trajectory of action.

More and Less Effective Updating

The ability to update the sense that has already been made is largely taken for granted in the sensemaking literature, but my findings show that updating is more problematic than often assumed. While past research has often investigated updating during disasters, where the disaster itself can be overwhelming, the simulation scenario that teams managed in this study was more consistent with the everyday unexpected events encountered in most organizations and was a conservative test of updating around an unexpected event. Teams took care of one patient in the simulation, compared with the multiple patients they would be responsible for during their work in the emergency department. The unexpected event—a broken piece of equipment—was not something unimaginable but instead was something that could realistically occur. Just like SWAT teams, film crews, wildland firefighters, and TV newsroom employees (Barton and Sutcliffe, 2009; Bechky and Okhuysen, 2011; Patriotta and Gruber, 2015), emergency department staff routinely manage unexpected events as part of their work. Teams were in a supportive learning environment and, if they got stuck and were not making progress toward detecting the broken bag, the simulation staff gave them clues to help prompt updating.

The findings exhibit significant variation in the effectiveness of updating across teams. Despite conditions that should facilitate updating, only eight teams were able to quickly make sense of the situation and effectively update the patient’s trajectory of care by replacing the broken bag. Another six teams were eventually able to update and replace the broken bag, but two of those teams required a clue before being able to do so. Most importantly, five teams were never able to update effectively, even when given clues. Whether people are able to revise an already established trajectory of action to incorporate new cues has implications beyond the sensemaking literature. Other literatures such as team adaptation, coordination, and high-reliability organizing also presume that, to a greater or lesser extent, people are able to update effectively in response to unplanned contingencies that occur during work (Weick, Sutcliffe, and Obstfeld, 1999; Burke et al., 2006; Okhuysen and Bechky, 2009).

My findings complement and extend research on adaptive sensemaking. Past research has provided insight into the interpretive aspects of updating by focusing on updating as a change in cognitive frames or beliefs (Rudolph, Morrison, and Carroll, 2009; Maitlis and Sonenshein, 2010; Cornelissen, Mantere, and Vaara, 2014; Strike and Rerup, 2016). By studying updating as a change in a trajectory of action, I was able to examine the interplay between interpretation and enactment. The findings highlight that effective updating depended on how teams connected plausible explanations with actions to test those explanations. More effective updating was characterized by teams acting quickly to test plausible explanations as they developed them. In contrast, less effective updating frequently involved delays in testing or failures to test explanations. For instance, in Team Romeo, which was never able to update effectively, the first plausible explanation that was suggested was changing the mask, but the team became distracted with a problem with intubating the patient and never returned to test that explanation. Maitlis and Sonenshein (2010) pointed out that for updating to be effective, revised interpretations need to be shared. My findings showed that even when revised interpretations are shared, however, updating can go awry if revised interpretations do not translate into a change in the course of action.

My research design makes it possible to consider the role of accuracy as well as plausibility in the effectiveness of updating. Sensemaking is generally concerned with plausibility over accuracy (Weick, 1995). The idea is that a plausible or "good enough" explanation helps get people moving and, once in motion, they generate increasingly plausible, though not necessarily accurate, explanations (Weick, Sutcliffe, and Obstfeld, 2005). In fact, studies of managerial sensemaking show that accuracy of perceptions may not matter (Mezias and Starbuck, 2003) or may even harm performance (Sutcliffe and Weber, 2003). For instance, in their study of senior managers' perceptions and interpretations, Sutcliffe and Weber (2003) found that accuracy and performance were negatively related—that is, organizational performance increased as the accuracy of managers' perceptions about the competitive environment decreased.

But in my study, accuracy also mattered. Plausible explanations, even ones that accounted for cues in a robust way, were insufficient for effective updating. For instance, displaced tube, obstructed tube, pneumothorax, and equipment failure were equally plausible explanations for a lack of chest rise and breath sounds with bagging, but only one of those explanations was accurate. If the team did not accurately make sense of the unexpected event and replace the broken bag, negative consequences ensued. Even when teams were testing other plausible explanations, if they continued to use the broken bag, the patient eventually developed a lethal heart rhythm and went into cardiac arrest.

Although my study took place in a simulation lab, where there was a "right" answer, accuracy is also salient in real-world unexpected events. Past research highlights that disaster can ensue when teams fail to accurately detect and correct emergent problems. For example, workers at the Bhopal Union Carbide plant failed to recognize that toxic methyl isocyanate gas was building up in the storage tank in time to prevent the tank from exploding (Shrivastava, 1987; Weick, 1988, 2010); the *USS Greeneville* personnel failed to detect a nearby ship and collided with a Japanese fishing trawler, killing nine passengers (Roberts and Tadmor, 2002); two U.S. Air Force F-15 fighter pilots misidentified two U.S. Black Hawk helicopters as hostile aircraft and fired on them, killing all 26 people on board (Snook, 2000); and London Metropolitan police officers mistook an innocent civilian for a suspected terrorist and shot and killed him (Cornelissen, Mantere, and Vaara, 2014). Weick (1995: 153) wrote that most of the time in organizational life, accuracy is a luxury. My findings and the examples above suggest that when ineffective updating around an emergent problem can lead to serious harm, plausible explanations need to become accurate explanations or negative consequences will continue to accumulate.

Updating and Trajectory Management

My study contributes to a growing body of research that draws on the notion of trajectories of action to examine sensemaking (Weick, 1988; Faraj and Xiao, 2006; Barton and Sutcliffe, 2009; Kaplan and Orlikowski, 2013; Patriotta and Gruber, 2015). My findings complicate Weick's (1988: 309) observation that early actions in unexpected events ''do more than set the tone; they determine the trajectory of the crisis.'' In my study, early actions mattered, but they were not deterministic. Instead, the findings show a more varied portrait of updating in which the effectiveness of updating could wax and wane over a given trajectory of care. Some teams, such as Team Quebec, were initially able to cycle through the updating moves but had increasing difficulty as the simulation progressed. Other teams, such as Team Lima, initially encountered problems with updating but were eventually able to make sense of the situation and replace the broken bag. The findings suggest a larger role for agency for teams in altering the trajectory of unexpected events and illustrate some of the trajectory management practices around monitoring cues and managing engaging tasks that facilitated effective updating.

Faraj and Xiao (2006) highlighted the importance of differentiating between habitual and problematic trajectories but did not specify how teams recognize problematic trajectories. My findings illustrate how teams monitored cues to identify when a trajectory of care became problematic and required further sensemaking. First, regular monitoring of the patient helped teams detect anomalous cues (such as lack of breath sounds with bagging), which usually prompted updating. Second, noticing changes in cues over time—especially a lack of improvement in or worsening of the patient's vital signs—was treated as a signal that the previous sense that had been made was insufficient, which triggered further investigation and developing and testing plausible explanations. Last, teams also tracked changes in cues over time to see whether the changes they were making to the patient's trajectory of care were effective.

Updating is usually studied as a separate activity from the work of teams. For instance, past research has examined updating that takes place during deliberate breaks from work (e.g., Waller, Gupta, and Giambatista, 2004; Goldenhar et al., 2013), following the completion of work (e.g., Ron, Lipshitz, and Popper, 2006; Schippers, Edmondson, and West, 2014), or when work ceases due to a disruptive event (Christianson et al., 2009). In my study, updating was embedded in the overall work of teams. As a result, teams had to balance updating with tasks of patient care. This balance was difficult to achieve. As the simulation progressed and the patient's care became more complicated, tasks began to pile up and could crowd out updating altogether.

My finding that teams had to balance updating with tasks broadens the scope of activity for scholars to consider as they examine how sense is made again during unexpected events. Much of the past research in high-hazard contexts has focused on how teams can enhance their capacity to manage the unexpected, such as by engaging in practices that enable errors to be detected and corrected earlier in their unfolding (Weick, Sutcliffe, and Obstfeld, 1999) or by developing skills for bricolage to handle surprises (Bechky and Okhuysen, 2011). My findings emphasize that teams must be able to manage tasks too, to free up attention for updating. Even routine tasks such as administering medications, intubating the patient, or performing CPR were complex enough that team members had to coordinate their actions to carry them out. Tasks were effortful accomplishments that engaged the attention of the team, and consequently teams often had difficulty transitioning between tasks and updating. But this transition was critically important. Findings revealed that teams with effective updating were able to manage tasks and then redirect their focus back to the original cues and resume updating; teams with ineffective updating were never able to do so. These findings complement past research that has identified other strategies for reducing the work of tasks—for example, pre-work briefings to identify potential challenges that teams may encounter (Roberts and Bea, 2001) or training to enrich the repertoire of routines that teams can draw upon (Weick, Sutcliffe, and Obstfeld, 1999)—or strategies to make it easier to balance updating and tasks, for example, by ensuring slack resources are available (Schulman, 1993; Sutcliffe and Vogus, 2003). My findings suggest that future research should take into account not only updating but also the ongoing work in which it is embedded.

My finding that interruptions can impede updating contrasts with Strike and Rerup (2016), who showed that interruptions can facilitate updating. In part, these contrasting findings can be explained by contextual differences between our studies. I studied updating during unexpected events, with a timeframe measured in minutes; Strike and Rerup (2016) examined updating during routine work, with a timeframe of days to weeks and in which delays may be less problematic. Nonetheless, our contrasting conclusions about the role of interruptions are echoed in the sensemaking literature, where some research has found that interruptions promote sensemaking (Louis, 1980; Meyer, 1982; Weick, 1995) and other research has found that interruptions hinder sensemaking (Weick, 1993; Rudolph and Repenning, 2002; Jett and George, 2003). Past studies have shown that magnitude (Weick, 1993), quantity (Rudolph and Repenning, 2002), and pacing (Strike and Rerup, 2016) are important considerations in terms of whether interruptions promote or hinder sensemaking. My study points out that the timing of interruptions is important as well.

In my study, not all interruptions were created equal. The effect of interruptions depended on when they occurred in the sequence of updating moves. Whereas Strike and Rerup (2016) and Barton and Sutcliffe (2009) showed that interruptions are useful for initiating updating, my findings showed that interruptions that occurred once updating was underway were problematic. Most disruptive were tasks of patient care that delayed developing explanations, followed by interruptions by tasks that occurred after plausible explanations were developed and delayed testing those explanations. Teams were better able to recover from interruptions that occurred between updating cycles (delaying noticing of cues). Furthermore, teams with effective updating tended to rapidly cycle from cues to explanations to action, which minimized interruptions by intervening tasks and enabled teams to quickly generate feedback about plausible explanations that they could, in turn, make sense of again. The finding that rapid cycling facilitates updating is in keeping with past research on managing unexpected events, which highlights that quick action enables an adaptive response (Waller, 1999; Rudolph, Morrison, and Carroll, 2009; Bechky and Okhuysen, 2011). My findings contribute to a growing body of work focused on understanding the temporality of updating (Rudolph, Morrison, and Carroll, 2009; Strike and Rerup, 2016). Future research is required to unpack the relationship of the magnitude, quantity, pacing, and timing of interruptions with the making and remaking of sense.

Boundary Conditions and Directions for Future Research

Although I found that updating was more problematic than often assumed, it may be even more difficult to accomplish in other settings. In contexts in which the consequences of ineffective updating are less severe or it is not as acceptable to question and revise a course of action, teams may be less likely to engage in updating. I studied updating during an unexpected event involving a single team and over a short period of time. Trajectory management may be even more critical and challenging in unexpected events that involve people from across an organization or take place over prolonged periods of time. Last, the unexpected event was within the response repertoire of the team—it was an everyday unexpected event. A less common type of unexpected event would likely increase the difficulty of updating. Future research could examine how features of the context, features of the team, and features of the unexpected event interact to shape the effectiveness of updating.

Conclusion

Much of the sensemaking literature takes for granted that people can update the sense they have already made, yet few studies have examined how updating takes place. By investigating how teams work together as they remake sense and coordinate their actions in response to an unexpected event, my study not only contributes to the sensemaking literature but also connects to a conversation in the organizational literature about trajectories. Using a trajectory approach facilitates the study of unfolding interactions over time and also reveals that updating is intertwined with the ongoing work of the team. My findings highlight that updating is often difficult to accomplish. I hope that this study serves to stimulate additional research on when and how updating occurs in other contexts and, more generally, how sensemaking trajectories evolve and change.

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Supplemental Material

Supplemental material for this article can be found in the Online Appendix at http://journals.sagepub.com/doi/suppl/10.1177/0001839217750856.

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