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Rapid Remote Care Work: How Emergency Medical Call Takers Use Relational and Situational Practices to Maintain Safety and Reliability in the 911 System

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Abstract

911 call takers are the foundation of emergency medical response in the United States. Through ethnographic observations in three emergency dispatch sites, we examine the formal and informal practices that make this work reliable and effective. We find that call takers practice a form of *rapid remote care work* in order to consistently assess and respond to chaotic and emergent situations and coach anxious callers into performing life saving medical interventions. We find that technologies and organizational process that enforce prescriptive adherence to procedure make call-taking less reliable by constraining this care work. Cost constraints and technical innovations increase the likelihood that such real time, life-critical work and care work will be handled remotely (e.g. air traffic control, telehealth). Thus, this work has implications for designers of high reliablility systems and scholars of care work.

Keywords: dispatch, care work, high reliability organizations, telehealth

1 Introduction

Example Call 1: Febrile Seizure Call

In the dispatch center of a large fire department in West County, United States, an emergency medical call-taker named Carlos sits in an air-locked room in front of seven monitors taking emergency medical and fire (911) calls.

> The caller, a woman, says through tears, "my son is four months old and is not responding to me." Carlos types "`M 4 months not responding`" into his command line dispatch interface. The address pre-populates into the window, but Carlos asks to confirm her address. The caller is so choked up that she is difficult to understand. Carlos looks at the map where the address is plotting and gently prompts her until she can repeat the cross streets.[1] Carlos says, "help is on the way", and presses enter, which sends out an Advanced Life Support (ALS) response. The caller then explains that her son was having a seizure before.
>
> Carlos says, "Take off all of his clothes including his diaper." The woman continues to cry. Carlos says, "It's going to be okay. Take a slow deep breath." As the woman breathes, Carlos exhales with her. He says, "You are going to keep him on his side, it's going to be okay ... we have police and fire department lights and sirens on the way ... keep him cool, on his side ... You are doing good mom ... take another slow deep breath." As he hears confusion on the line, Carlos adds, "There is nothing you could have done to prevent this ... nothing we can do to slow it down." The woman indicates that she has complied with the instructions. Carlos tells her that when the baby wakes up he won't be fully alert, but it will be okay.
>
> Carlos stays on the line until we hear sirens and the door opening. He explains to the ethnographer that it's scary for parents, but febrile seizures are common. Carlos says his primary goal is to make sure the parent doesn't panic and inadvertently hurt their unresponsive child. "You have to calm the parents down because the one thing you don't want to do is have them shake the kid or try to get a response out of them ... because it takes them a while to wake up."

Some of the earliest and most important study sites in HCI and CSCW involve technically mediated, real-time, and high-reliability work like emergency medicine (Schaefer et al. 1994), ambulance dispatch (Bowers and Martin 1999; Martin et al. 1997; Beynon-Davies 1999; Whalen et al. 2002), air traffic control (Suchman 1993, 2002, 1997), and nuclear power (Perrow 1999). A key topic in these early studies of control rooms, and in HCI more broadly, are the promises and perils of technical systems and organizational processes that force rigid adherence to procedure (which we call "prescriptive procedures"). However, since these initial studies, the nature of this work has changed dramatically. Technical advances and the desire to reduce costs have led to efforts to automate and streamline high-reliability work; increasing time pressure and distance between those doing the work and the site of the action. Control rooms and dispatch centers are increasingly pressured to automate tasks, and coordinate resources across multiple organizations and locations (Normark et al. 2024). For example, some airports have moved activities from traditional towers on site to remote locations that rely on cameras and sensors (Young 2021). Emergency response centers once defined

[1] The county is so large that cross streets are required because addresses are duplicated and the GPS location provided when a call comes from a cell phone is often inaccurate.

by collaborative work to locate and deploy resources now often involve employees monitoring many streams of information and independently reviewing recommendations provided by computer aided dispatch (CAD) systems (Normark et al. 2024). Similar trends toward automation and remote work can be observed in high-reliability work focused on providing services to people. Numerous aspects of healthcare including primary care (Han et al. 2020), radiology (Belfi et al. 2025; Garg et al. 2017), mental health care (Dalton-Locke et al. 2021; Olawade et al. 2024; Pro et al. 2023), and emergency stroke response in rural areas (Mohr et al. 2019) are now performed remotely, either fully or partially. At the same time, technical advances enable greater worker surveillance and workflow systems that potentially increase the ability for organizations to enforce "prescriptive procedures" in the performance of high reliability work. To understand the stakes of this trend towards proceduralization and remote work in high reliability settings, we turn to a well-established example of remote, high-speed, proceduralized work: emergency medical call-taking.

Emergency medical (EM) call-takers[2] responding to callers facing medical emergencies present an established and extreme example of high-stakes, temporally pressing, remote service. In EM call-taking, 911 call-takers like Carlos answer emergency calls from the public and determine—ideally within 30 seconds—what medical resources should be sent and where. As evidenced in the opening vignette, EM call-takers are also responsible for providing emergency medical advice and safety instructions (called Emergency Medical Dispatch or EMD) to help the caller stabilize the patient and stay safe until help arrives on scene. Thus, the EM call-taker's ability to manage the caller, understand the broader scene, and appropriately direct action from a distance is critical to keeping callers and patients safe and getting them the help they need. Thus, studying the interaction between EM call-takers and callers provides a way to study how reliability in life critical interactions is achieved in a time pressured and remote context that likely represents a future of other types of life-critical work.

In this study, we investigated these EM call-taking interactions through in-depth observation. Specifically, we spent over 140 hours observing EM call-taking across three sites in the US. In these sites, call-takers were provided different amounts of autonomy in relation to organizational procedure and follow EMD call-taking protocol and enter information using different technologies. Witnessing these differences allowed us to explore the oft-hidden aspects of emergency call-taking that we find to be critical for this work. Specifically, we ask:

- What formal and informal practices do call-takers use to achieve reliability in this unique remote context?
- What is the effect of *prescriptive procedure* on the quality and reliability of call-taking interactions and call-takers themselves?

Based on our observations, the formal work of EM call-taking involves three activities: deploying the correct resources to the site quickly; managing the scene until help

[2]In the US, emergency medical response is generally provided by fire departments. We refer to people like Carlos, who answer medical calls routed to the fire department for fire and decide what response they get (fire truck with paramedics, ambulance, etc,), as "emergency medical call-takers", and the places where this work happens as "dispatch centers". All the call centers involved in this study dispatch both fire response and emergency medical response, so Carlos also takes calls for fires and rescues.

arrives (including giving medical advice and keeping callers physically secure); and documenting the call. EM call-taking organizations and medical call-takers are worried about four kinds of failure: lack of speed (not sending a resource fast enough), sending too little help (under-triage) or too much help (over-triage), and failing to provide the correct medical advice to keep a patient stable.

We find that reliability in each of the objectives outlined above is achieved through a combination of formal protocols and informal relational work. Specifically, in order to get accurate information for callers to calm them down and and keep them safe, call-takers must empathize with callers' emotional and physical realities. Further, they must coach callers to perform unfamiliar medical interventions. We characterize these activities as a unique form of *rapid remote care work* that is critical to enabling EM call-takers to consistently assess and respond to chaotic and emergent situations.

We further observed that rigid dispatch procedures often make it more difficult for call-takers to reliably send correct resources and manage the scene because such procedures can undermine the calltaker's ability to deploy the informal relational practices involved in *rapid remote care work*. Technologies enforcing compliance with dispatch procedures are intended to increase speed and reduce errors related to medical triage and giving appropriate advice. However, in line with prior work on procedure in emergency medicine, we find that dispatch procedures that require following a script or collecting information in a particular order generally make it more difficult to extract the right information efficiently (slowing down call-taking). Scripting also make calming and coaching callers—a necessary component of remotely assessing the scene and preparing it for the arrival of emergency responders (what we call "managing the scene")—more difficult.

We theorize that this rapid remote care work is related to other forms of care work identified in the literature such as emotional labor and repair work, but both the stakes of the work and the techniques required are unique to affordances available in remote, high-reliability contexts. Rapid remote care work represent a future of both high-reliability work and care work. In particular, as cost saving and technology advances lead to deskilling of onsite operators, repairing breakdowns in high-reliability systems often involves a remote call for help. Many areas of healthcare increasingly resemble aspects of medical call-taking: a provider has a brief, technologically-mediated interaction with a patient during which they give instructions and triage the patient for more specialized care downstream. Thus, determining how to design organizational processes and technologies that enable rapid remote care work should be a key concern for scholars of high-reliability systems and care work. We find that both the remote and high-reliability context increase the ability and incentive for organizations to implement technologies and processes that force workers to comply with tightly-scripted procedure. Our findings suggest that software and procedures that script the flow of these interactions and automate triage decisions are likely to make workers across these contexts more error-prone, stressed, and unable to respond to situated contingencies effectively.

2 Related Work

2.1 High-reliability Work

2.1.1 High-reliability work and procedure.

A longstanding concern in HCI has been the consequences of organizational protocols and the limitations of standardization, process, and design at ensuring safety and reliability (Berg 1997; Bowker and Star 1999; Manning 2003; Suchman 1987). Much of this literature on standardization is in so called High Reliability Organizations (HROs), such as nuclear power and emergency medicine, where the high cost of failure motivates an intense organizational focus on adhering to safety protocols (Weick and Sutcliffe 2001; Schaefer et al. 1994; LaPorte and Consolini 1991).

An important observation in this literature is that technical systems may enforce adherence to procedure either through surveillance - by making workers actions visible to other actors who can enforce compliance via organizational process (Berg 1999; Manning 1992) or automation – by limiting the actions that can be performed in a system (Bainbridge 1983). For example, in medicine, Electronic Health Record (EHR) systems may enforce particular medical practices either through visibility or automation and technical affordances. Bossen (2011) describe how electronic health record (EHR) systems were intended to make clinical practice visible to administrators through billing codes and standardized metrics, often with the goal of enforcing particular medical practices. More technically sophisticated EHR such as those described in Pine and Mazmanian (2017, 2014) may connect to workflow functions to enforce particular documentation practices and clinical actions (like ordering medications or procedures) by only allowing procedures or medication orders to be placed if documentation is filled out correctly and the correct authorization is provided. As we will discuss, in systems where the user needs a computer to do something—send an ambulance, put in a medicine order (Pine and Mazmanian 2017; Christensen 2016), start a truck (Levy 2015)—the system itself (rather than organizational process enabled by worker surveillance) is able to exert strong influence on compliance when workflows become technically-mediated. Despite varying mechanics and sophistication, these systems—which we refer to collectively as "prescriptive procedures"—are designed to promote certain sequences of work practices and prevent others using a combination of technology and organizational process.

2.1.2 Known problems of prescriptive procedures.

Numerous studies of systems that enforce prescriptive procedures find that while proceduralization can be useful for organizations to track and regulate work processes, it can also lead to negative consequences for work practices and workers. An over emphasis on process has been shown to limit flexible situated work, coordination, and the ability of workers in dangerous jobs to care for themselves.

A critique common in HCI and organizational scholarship is that rigid work flow systems—often introduced to limit legal liability or provide visibility to managers or auditors (Bossen 2011; Pine and Mazmanian 2014)—can also limit dynamic action and

situated flexibility that is necessary for certain kinds of work. Dourish (2001) essentially argues that no software can be both rigid enough to offer accountability and plastic enough to effectively enable coordination and collaboration. Many scholars of life critical systems in health care in particular have found that systems that attempt to ensure safety and accountability through strict enforcement of pre-established protocols (e.g. who has the authority to perform certain actions and the order that those actions are performed) can lead to unsafe situations by "contorting" actions that would best be performed dynamically and in response to situated contingencies (Pine and Mazmanian 2017; Zhang et al. 2017). Further, such systems often make information exchange and documentation more challenging, since real time documentation is enhanced by simple yet flexible artifacts to aid communication (Kristensen et al. 2006). Many studies, particularly in health care, find that when documentation systems are overly rigid, people are forced into a proliferation of work-arounds (Zhang et al. 2021), that can lead to inaccurate (Pine and Mazmanian 2014), and retroactive (Jagannath et al. 2019) record keeping.

In emergency medicine specifically, scholars have repeatedly found that prescriptive documentation systems(characterized by both a high liability consequences and demands of emergent real time communication) lead to substantial issues in coordination. One problem is that communication, even in somewhat formalized scenarios like emergency department check ins, is often iterative. Thus, effective interfaces to support these exchanges need to enable back and forth exchanges and informal task delegation and arrangement (Ambe et al. 2025; Zhang et al. 2017). Another problem with prescriptive documentation interfaces is that they often inhibit information exchange by forcing professionals to match complex, emergent information with a prescribed set of fields or artifacts. For example, several studies of EMS workers in the field and in hospital resuscitation situations find that the rapid coordination associated with emergency response makes real-time documentation using a form fill interface essentially impossible and providers have to use a free text field to record information and then go through a form fill after the fact (Jagannath et al. 2019; Zhang et al. 2022; Sarcevic and Ferraro 2017).

Finally, an important theme in research on proceduralization across sites and disciplines is that such systems often worsen the day-to-day of front-line operators. Automated systems almost always require additional data collection and record keeping labor that often falls to low status members of the organization (Sun et al. 2023; Chen et al. 2014; Pine et al. 2018). These systems also introduce opportunities for workplace surveillance that encourages ranking and comparing of workers - adding to workplace stress and economic pressures (Brayne and Christin 2021; Levy 2015). Such systems have also been found to undermine palliative labor practices to resist economic insecurity and overwork such as informal rests and peer support and organizing (Lee et al. 2015; Mateescu 2021) and reduce workers' sense of autonomy (Levy 2015).

2.1.3 Remote High Reliability Work and Centers of Coordination

While issues with formalized organizational protocols and procedural documentation in high reliability contexts have been well established in HCI, few studies consider how a remote context might specifically change how prescriptive procedures impact work

practices. However, we can turn to HCI and CSCW work on remote coordination and cooperation to better understand the role that remoteness might play in maintaining reliability at a distance. Early work on the limits of proceduralization focuses on what Suchman (1997) helpfully names "centers of coordination"— sites where workers are responding to time-critical situations to coordinate people and objects across space and time (i.e. remotely)—such as call centers and control rooms. Most early studies of control rooms (Heath and Luff 1992; Whalen et al. 2002; Suchman 1997; Normark and Randall 2005; Martin et al. 1997; Luff et al. 2000; Lutters and Ackerman 2002) focus on how large numbers of people working in the same location collaborate with each other to manage the work of others who are geographically distant. With modern computer aided dispatch systems (CADs) emergency medical call-takers, interact very sparsely with each other. However Schuman highlights that, by definition, work in centers of control is intended to align events to a time table or procedure; these sites are defined by a desire to standardize work and keep practices aligned to protocol (Suchman 1997, 2002). Thus, the control room literature does surface important insights about how the emergent and remote context of dispatch complicates the work of applying procedure since procedure is so integral to that work.

A key observations in the control room literature is that this work of aligning events with procedure is much more improvisational and situated than it might initially seem. Numerous studies of emergency call centers and control rooms find that the knowledge required to respond to emergencies requires situated knowledge of the local landscape that can be deployed to supplement the distanced, and thus inherently limited, information coming into the control room (Normark and Randall 2005; Procter et al. 2016; Farshchian et al. 2017). Martin et al. (2007); Paoletti (2009) argue that the classification work that goes into responding to emergencies in call centers relies on intuition, tacit knowledge, and improvisation which is usually rendered invisible by the process of proceduralization. In sum this literature suggests that remote, emergent, and limited context of the work makes improvisation and situated knowledge (both likely to be impeded by prescriptive procedure) as critical as in other high reliability contexts even though it is potentially less visible.

2.2 Care Work

EM call-taking is not only life critical work, it is also a deeply human interaction. Thus, we build on insights established in scholarship of high reliability and coordination work, while also situating our study within the HCI tradition of examining how technical conditions complicate relational, body, and maintenance labor, often called "care work".

2.2.1 Defining Care Work

Care work has been broadly defined as the formal and informal labor of sustaining people, bodies, relationships, and communities (England 2005; Wu et al. 2024). Care work is associated with formal, material labor like that done by medical professionals (particularly nurses and home healthcare workers), educators, social workers, and childcare providers (England 2005). It is also used to refer to emotional and relational

work. This latter capacity is also associated with the service industry (Hochschild 2012; Raval and Dourish 2016), caregiving relationships like parenthood (Kaziunas et al. 2019), and movement building (Calacci and Pentland 2022). A consistent theme in the research across care work and care workers are the ways that care work is rendered invisible (Hatton 2017), undervalued, and often performed by, and associated with, women and people of other marginalized identities (Karusala et al. 2021). Some scholars articulate care work as separate from so called "productive labor" (Wu et al. 2024). Significant scholarship examines how commodification of care work impacts care work and those who perform it (Hochschild 2012; Raval and Dourish 2016).

Implicitly, care work is often articulated as in opposition to efficiency and scale and as an inherent good, but increasingly anthropologists and others argue that care, and more broadly "caring" (Toombs et al. 2018) should be seen as the relational work needed to sustain systems and organizations (Adams et al. 2015; Puig de La Bellacasa 2017). In this way, care can be seen as a form of bureaucratic and maintenance labor that is required for speed and scale (Stevenson 2014; Seaver 2021). Importantly for our analysis, Puig de la Bellacasa encourages scholars to look for care work in uncaring places and to focus on how maintenance work and relational labor can occur outside of traditional care contexts (Puig de La Bellacasa 2017).

2.2.2 Invisible Labor, care work and call centers

Although they do not use the term "care work", scholarship on call-taking identifies informal, emotional and relational work between caller and call taker as a key component of the job. For example, in observations of Italian Emergency Medical call-takers, Dovigo and Redaelli (2010) find that even establishing the relatively simple fact of a patient's location requires collaborative negotiation. These scholars argue that the most effective call takers work to elevate new callers from laymen to expert coworkers in their brief interactions. In a post-mortum analysis of calls to emergency services after a factory accident in Italy, Paoletti (2009) find that call-takers' ability to determine what was happening and dispatch the correct resources was hindered by their inability to calm callers enough to get them to answer diagnostic questions. More broadly, the invisible classification work in emergency call-taking described by Martin et al. (2007) and others (discussed above) could be characterized as care work in the expanded definition used by or bureaucratic or maintenance labor Puig de La Bellacasa (2017). In an ethnographic account of Police call-takers in the US, Wang (2022) bridges these two ideas. He shows how the emotional labor of getting information from callers is a critical piece of undergoing the bureaucratic maintenance labor of matching emergency calls with rigid categories. Wang argues the call-takers use a regulated emotional state of call-takers is used as a critical link between rigid bureaucratic categories and emergent situations.

2.2.3 Impact of prescriptive proceduralization on care work

HCI has been particularly concerned with understanding how technologies impact care work and how to design to support care workers. Care work professions including nurses (Bowker and Star 1999), elder care workers (Sun et al. 2023), home health aids (Poon et al. 2021; Lazar et al. 2018; Ming et al. 2023; Mateescu 2021), and social

workers (Saxena et al. 2020; Eubanks and Mateescu 2021) have all been targets for technologies that enforce procedure. However, previous work shows that a care work setting may actually exacerbate the problems associated with proceduralization in general – failing to account for informal work constraining work practices, and creating more work, more stress, and more surveillance for workers.

In particular, the difficulty measuring and accounting for care work means that models of work embedded in documentation systems and prescriptive proceduralization often fail to account for informal and relational elements of care professions (Bowker and Star 1999; Hatton 2017). As a result, such systems may inadvertently constrain people's ability to perform their core care work functions because these functions are not supported by systems of accountability (Pillai et al. 2025; Pine 2012). Furthermore, studies find that because care work is often performed by workers with less organizational status, documentation systems tend to put the burden of documentation and data work on the same people who perform critical, but often unseen and undervalued, care work. (Sun et al. 2023). Ming et al. (2023) describes this as overlapping invisibility, in which the invisible systems work of navigating uncertainty and imperfect systems intersects and magnifies emotional invisible labor associated with care work.

When systems of record keeping do account for care practices, scholars find that in making care work visible, such work can also becomes subject to commodification, control and surveilance (Bowker and Star 1999; Karusala et al. 2021; Toombs et al. 2018). Further, the lack of workplace protections and autonomy common in care work contexts is particularly harmful for people who perform emotionally taxing and physically dangerous work (Mateescu 2021).

2.3 Telehealth

Care work is further affected by technological mediation. A substantial amount of scholarship in HCI focuses on the challenges of performing care work in remote contexts (i.e. via phone or video) (Bhat et al. 2023). Telehealth is a particularly important site of study for HCI. Scholars of long term telehealth solutions in medicine suggest that while clinical outcomes may be largely the same with remote delivery, (Greenhalgh et al. 2016), building long term trust in patient relationships is more difficult over the phone (Bhat et al. 2021). Further, telehealth facilitates various forms of workplace surveillance for care providers that may negatively impact care givers (Bhat et al. 2023). Other scholars focus on ways to design telehealth solutions that better facilitate care work - with some research indicating that video in addition to the phone may ameliorate these challenges and lead to better clinical outcomes in diagnostics and long term care (Caffery et al. 2025).

Bringing together the scholarship on high reliable systems, centers of coordination, and care work suggests that the conditions of emergency dispatch (i.e. time pressure, critical situations, and phone-only communication) provide a difficult environment in which call takers must perform care work. Further, this legacy of scholarship sheds light on why rigid proceduralization might negatively impact care work. What remains understudied is how care work is actually performed by emergency medical call-takers, how the life critical context of dispatch might complicate this work, and how rigid

proceduraliztion might affect the both the quality of the job and efficacy and reliability of dispatching work.

3 Methods

To study how emergency medical dispatchers use technology, we conduct a long term ethnographic study in which we observe this work in action over an extended period of time. The field sites and interviews selected for this study of technology in emergency medical call taking follow a process of inductive ethnographic sampling, in which we select observation sites iteratively based on emerging themes and theoretical insights from the data (Lofland et al. 2006; Emerson et al. 2011; Charmaz 2006).

3.1 Study Context

The research for this paper was conducted as part of a larger community-engaged (Stoecker 2009) research collaboration between university researchers and four fire departments across the United States.[3] The project began in 2022 and is ongoing through 2026 and is primarily focused on understanding how a rise in medical call volume is impacting fire-based EMS in the United States. For this paper we draw primarily on observations conducted in three fire dispatching centers by the first author (herein, "the ethnographer"), in a large urban fire department in the western US (West County), a large suburban east coast county fire department (East County), and a medium size midwestern city (Midwest City). However we contextualize our findings based on ethnographer observations of firefighter emergency medical technicians (EMTs) and paramedics in West County and Midwest City conducted by the first and last authors as well as design workshops attended by the first, second, and last authors.

3.2 Field Sites

We selected sites for the participatory research project based on the geographic distribution of the departments, varying EMS response models, and self-reported concern about increased 911 call volume. All are large, busy departments with diverse populations and areas that are both urban and semi-urban in their jurisdictions.

The three departments selected for observations in dispatch centers represent three common approaches to EM call-taking in the US. West County employs civilian dispatchers (people who are not firefighters)[4] working within the fire department, and is completely separate from law enforcement dispatch. East County operates a combined 911 center with civilian dispatchers handling calls for law enforcement, fire, and emergency medical response. Midwest City police department uses civilian dispatchers. Midwest City Fire Department still employs union firefighters for medical call-taking and fire dispatching.

The civilian dispatching arrangements in East and West County are certainly the most common approaches to dispatch, as most departments across the US have moved

[3] University ethics review board approves human-subjects research and they approved this project.

[4] civilian in this case means not uniformed members of the fire service, which operates as a paramilitary organization in the US (Brunacini 1985).

to less skilled and less expensive employees for dispatch (Zachariah and Pepe 1995). We provide a more extensive discussion of the differences between civilian and non civilian dispatchers in Section 4. There is a general trend towards combined emergency dispatching centers, as in East County to reduce labor costs and call transfers. Though less common, we wanted to observe call-taking when it is done by uniformed fire fighters (as in Midwest City) for two reasons. First, much of the literature about emergency dispatching has focused on the extreme power dynamic between call-takers and the uniformed fire fighter and police officers who oversee dispatch and respond to dispatching calls (Karunakaran 2022, 2019; Wang 2022) and we were curious to understand the work of EM call-taking isolated from this power dynamic. Second, one justification for prescriptive procedure is that civilian dispatchers lack sufficient medical knowledge since they are not EMTs. We are interested to see how both the practices and call-taking and consequences procedure are complicated by these different power dynamics and expertise at the different field site.

These departments represent the three most common options for EMD technology: software that presents screen by screen flow for triage questions and medical advice (as in Midwest City), cards developed by a third party (such as in East Coast County), and in-house procedures (West County). More detail about the technologies and procedures used in each department can be found in the appendix (Section A.2). This variation allowed us to examine how different organizational structures and personnel models shape the intersection of proceduralization and care work practices. The three field sites are summarized in Table 4.4.

3.3 Data Collection

The first author conducted 140 hours of observation across the three dispatch sites. We conducted in situ observations of call-taking operations in which we listened in on 911 calls, observing dispatcher-caller interactions during multiple shifts including day, evening, and overnight periods to capture variation in call volume and types.

Observations focused on call-taker and caller interactions, use of technological systems, coordination between call-takers and field units, and informal workplace practices. The ethnographer took detailed field notes documenting the sequence of actions, technology use, verbal interactions, and contextual factors surrounding emergency calls. The desk-job nature of dispatch allowed the ethnographer to take detailed notes on a laptop and to conduct "ethnographic interviews" with call-takers about their background, experience with call-taking, and EMD technology between calls or on breaks (Lofland et al. 2006).

The ethnographer also conducted ethnographic interviews with fire officers working in dispatch, dispatch supervisors, and dispatch trainers to understand organizational perspectives on technology implementation and training and workplace stress. Most interviews were not recorded and instead instead we rely on notes typed on a laptop during these interview. We collected artifacts including protocol documents, training materials, and system interfaces where permitted. More detail about these observations and ethnographic interviews collected can be found in the appendix (Section A.1.)

3.4 Data Analysis

We based our analytic work on Charmaz's constructivist grounded theory method (Charmaz 2006). All the data was coded an analyzed by the first author, using Atlas TI qualitative coding software. She used initial house keeping coding to identify data about training, technology, quality assurance practices, workplace stress and wrote a short memo and created a comparative table for each category. She also identified every observed interaction of a medical call taking and completed a round of line-by-line open coding of these interactions (Corbin and Strauss 2008). After the open coding she developed "axial codes" (Charmaz 2006) that represented the different activities of dispatch – locating callers, medical triaging, giving medical advice, reassuring, and managing the scene and completed a final round of open coding within these categories focusing on techniques of reassuring and scene management and when and how call-takers applied and deviated from dispatching protocol. She then completed a second round of memos about each of these activities surfacing themes about the formal and informal activities of dispatch as well as identifying calls that provided clear examples of common phenomena. The memos were circulated through the team for feedback on emerging themes. In addition to circulating the memos the research team met once a week during the data collection and analyzing process to discuss comparisons with their field work and discussion of theoretical insights.

4 Background

4.1 The Context of Emergency Medicine and 911 System in the U.S

In the US anyone can dial 911 for a police, fire, or medical emergency. 911 call-taking assumes different forms in different jurisdictions. In most jurisdictions, 911 calls are routed first to local law enforcement. If the call is medical, it will be routed from law enforcement to a local emergency medical services (EMS) organization who coordinates sending a response and in most jurisdictions gives EM advice. In most urban areas in the US, including all of our field sites, these EMS organizations are publicly funded "all hazards" fire departments that are responsible for EMS along with traditional fire department activities [5] Since the eighties, many large urban areas use civilians (who are not part of the fire department or paramedics) with specific medical dispatch training and no required additional medical expertise (Zachariah and Pepe 1995). We call these workers "civilian call-takers". These civilian dispatchers are public employees and are often unionized but, being outside of the powerful fire department labor unions and having less specific training, and thus often much lower wages. In some places including West County, these civilians sit within the fire department and handle only medical and fire calls. In other places including East County, these civilians handle police, fire, and 911 calls from a combined 911 operations center. That is, the same person will take calls about a heart attack, break in, or house fire and recommend the appropriate emergency response from the police or fire department.

[5] Half of EMS departments in the US are in fire departments (Institute of Medicine (U.S.) 2007).

4.2 Time Pressure and Non Emergency Calls

Emergency medical dispatchers, especially in civilian call centers, are under extreme time pressure. Speed dominates evaluation metrics of call-taking and is easy to compare across departments using public records[6]. Most departments (including all of our field sites) expect call-takers to get an address and begin a response within 30 seconds. Departments are also flooded with non emergency calls(NFPA Research 2022), and it is common for call-takers to rotate through other positions and take on other administrative tasks for the department.[7] As a result, Call-takers often have to switch between mundane tasks like looking up a fire hydrant for public works with high stakes tasks like talking through giving CPR on a child.

4.3 Legal Liability

Like most forms of medical work, medical dispatching carries with it regulation and legal dangers. This liability concern has its own organizational logic and is often conflated with concerns about public accountability and bad publicity, as all 911 calls are recorded and accessible via public records requests. EMD scripts and technologies are posited as a way to manage this threat of liability. In departments using off-the-shelf EMD scripts and technologies, the logic is that by using the technology, the liability for EM call-taking is being passed from the medical director to the companies who develop these scripts.

4.4 Stress and Call Volume

911 call volume is increasing in most areas of the US.[8]. This increase is attributable to a rise in serious medical emergencies (due to lack of access to primary care and public health crises like opiate use disorder (Christopher Karl Hoffman et al. 2025)) and to a rise in low acuity (less serious) medical calls (Cannuscio et al. 2016). As fire departments struggle to handle increasing call volume, civilian call-takers have been particularly hard hit. Burnout and challenges retaining civilian 911 call-takers has now become a nationwide crisis, with one survey suggesting that more than 80% of American dispatch centers are operating below desired staffing levels (International Academies of Emergency Dispatch (IAED) 2023; Chris Nussman 2024; Carbyne and National Emergency Number Association (NENA) 2024). The staffing crisis has exacerbated time pressure on call-takers. For example, some in West County felt pressure to finish calls in less than 90 seconds when more calls were waiting, so they could get onto the next. They were always aware when calls were waiting and felt an extreme sense of urgency in those situations.

[6]For example, an analysis in the Oregon Free Press about how the ProQA dispatch system slowed down 911 responses was conducted using public records requests (Jonathan Levinson 2022).

[7]In particular, West County call-takers handle the accounting effort associated with wild-land fire fighting; East County call-takers handle parking infractions and other database lookup and management tasks for the police department; in all departments a significant portion of call-takers' time is spent responding to commercial fire alarms and medical alarms.

[8]Due to a lack of federal infrastructure around the US these trends are difficult to measure. Participation in the National EMS Information System is supported by the National Highway Traffic Safety Administration. However they find a dramatic year over year increase in calls at least since 2018, and many departments also report expanding call volume(Hoang et al. 2022).

	West County	Midwest City	East County
Fieldwork completed	73 hours over 9 days with FF call-takers	31 hours over 4 Days with FF 10 hours over two days with PD call-takers*	26 hours over 3 Days with 911 call-takers
Call Taker Background	Civilian: Employed by FD but were not ever uniformed, not in union. Overseen by civilian supervisor and UFO	Fire Fighter: All are current FF in the same union	Civilian: Call-takers are county employees. fire dispatching done UFO
PSAP Arrangement	Completely Separate: PSAP is separate building, organization, CAD	Mostly Separate: PSAP dispatchers under different org, but the same building and CAD is connected.	Combined: take both police and fire calls
EMD Technology	Department created PDFs	ProQA Software	Physical APCO Cards
General Perscriptiveness	Medium: Consistent but flexible QA process	Low: Mostly do not use ProQA, minimal QA process	Extremely high: Rigid QA Process

5 Findings

In 140 hours of observing medical call-taking we find that job is much more difficult and requires much more emotional and relational work than was assumed by the authors, fire fighters in the field describing dispatch, or than seems to be embedded in technical products aimed at dispatchers. As we will discuss, the technical interventions and formal procedure of dispatch focus mostly on determining the level of triage and giving medical advice although our observations reveal that much of the difficulty and complexity in dispatch is in more broadly managing the scene and the emotional and relational work required to get information from callers and get them to perform medical interventions.

5.1 Formal Functions of Emergency Medical Call-Taking

EM call-takers have three core formal, recognized functions within the fire department: 1) locating callers and determining the medical level of triage, 2) giving medical advice (EMD) and managing the scene until help arrives, and 3) documenting calls for the organization.

5.1.1 Formal functions: Sending the correct resources.

The primary function of EM call-takers is assessing what resources should be sent to a caller. This involves first locating the caller and/or patient (it's not always the same place). Although GPS location is available, departments often need more detail and want callers to provide an address and a cross street to help first responders locate them.[9] Sending the correct resources also requires determining what level of

[9]Calling 911 on a GPS-equipped cell phone automatically transfers coordinates to the Police Service Access Point (PSAP) that first recieves the 911 call. However, this information is missing any time someone calls from an area where GPS is unavailable (common in hilly West County) and when a call is incorrectly transferred from the police access point, which happens regularly when the PSAP is separate from the fire department or medical response agency.

medical response should be required, and determining if the scene poses a threat to first responders, which would require law enforcement escort.

Medical triage is relatively straightforward and highly delineated. Most agencies' policy is to send callers a response articulating any medical need, and the triage options are relatively limited, with essentially two levels—ALS (Advanced Life Support) and BLS (Basic Life Support)—and a few specialized resources like a rescue unit, stroke unit, or surgical team. Call-takers have a flowchart of questions they are supposed to ask to determine the level of response. In many if not most cases, the ALS and BLS distinction is dictated by the first sentence explanation from the caller. For example, if a caller says "I have an 83-year-old man at a nursing home", that is ALS without further questions. As one call-taker summarized, "If it's a real emergency, that is the first thing people say".

5.1.2 Failure to send the correct resources.

Dispatchers and dispatch supervisors worry about three kinds of failures associated with sending the correct resources: lack of speed, under-triage, and over-triage.

1. **Lack of speed:** Reliability in assessing the correct resource involves making this determination according to protocol quickly (usually within 30 seconds). The primary objective of QA protocols in the organizations we observed is to review any call where a response was not started quickly enough. Departments and call-takers work incredibly hard to avoid a scenario in which a hypothetical call-taker fails to determine quickly enough the type and location of the resources needed and a patient might die waiting for help to be sent. The concern with speed also motivates call-takers to try to end calls quickly when other calls are waiting, as they worry that other callers could die while waiting to talk to a 911 operator. On busy days, in particularly busy urban centers like West County, dispatch centers often have many callers waiting on hold to talk to a 911 operator.
2. **Under-triage:** Fire officers, and dispatch supervisors are terrified of "under-triage", e.g., not sending enough resources to a serious call. Most processes focus on identifying signs of a potentially serious emergency, making dispatch more conservative. Fear of under-triage is usually expressed as concern that the organization will be sued for deaths or injuries attributable to under-triage, although it seems to often be conflated with political backlash for failing to respond sufficiently or quickly enough to an emergency.
3. **Over-triage:** Inversely, firefighters in the field are exasperated by over-triage, in particular, seeing relatively scarce paramedic resources sent to medical calls that do not warrant them. This is amplified by real difficulties in the fire service with escalating call volume. However, this frustration tends to focus on the idea that the call-takers were asking for medical symptoms in the wrong way and lacked sufficient medical knowledge to apply triaging guidelines even though call-takers have little discretion in these decisions.

5.1.3 Formal functions: Managing the scene.

Managing the scene is formally required, but not well-delineated. The formal responsibility of managing the scene focuses on medical advice (EMD), which is limited to a relatively few tightly scripted options. However, call-takers interpret "managing the scene" as keeping callers and patients safe until help arrives. Call-takers see their duty as performing medical interventions like CPR on patients by both spatially navigating how these interventions can reasonably be performed and by persuading callers that they can and should perform these interventions.

5.1.4 Failure to manage the scene and give correct medical advice.

Formally, the primary concern in managing the scene is that a call-taker could fail to recognize that medical intervention is required and not deliver the correct EMD, resulting in injury or preventable death. In practice, the types of life critical medical advice that callers can give is quite limited—CPR, applying tourniquets, resting seizure patient's head down, handling choking—and most call-takers seemed to know these interventions by heart. The more difficult component was getting call-takers to actually perform these interventions. Participants understood the legal standard to be a "reasonable attempt" to give EMD. Still, organizations and call-takers held themselves accountable not just for giving medical advice, but for the outcomes of implementing that medical advice, e.g., getting callers to successfully perform medical interventions. [10]

5.1.5 Formal functions: Documenting the call.

Documenting a call is a tertiary goal for call-takers and involves providing the field with information and documenting the call for the organization. Documentation plays a small role in accountability for individual call-taker performance because calls are entirely recorded. However, it is a key motivator for use of software-based systems like ProQA because information about patients and the dispatch flow might be used to statistically analyze the efficacy of particular scripts and triaging protocols.

5.2 Informal Strategies for Achieving High Reliability

Within the context of emergency response, call-takers are understood to be technicians applying medical procedures. However, as evidenced by the febrile seizure vignette (example call 1), call-takers deploy a variety of informal strategies to triage calls and keep callers safe until help arrives. We find that the success of EM call-taking interactions is largely reliant on these informal strategies. Call-takers cannot touch callers or see their faces, and any relationship that they develop with them usually ends within a few minutes. However, we found that triaging medical calls and providing EMD on the phone requires a unique form of care work that we have come to call *rapid remote care work*—in which call-takers build brief but personal connections with callers and, in so doing, care for both their emotions and their bodies.

[10] Much of the conversation about EMD is dominated by concern about call-takers failing to get a bystander to start CPR (Kashani et al. 2018).

To illustrate the importance of rapid remote care work, we introduce another example of EM call-taking. In contrast to the first example (example 1), this is an example of a call-taker, by his own account, falling short in the formal expectations of EM call-taking.

Example Call 2: Drug Overdose

Call-taker Joe was working his 16th hour at dispatch, having been asked to extend his shift in order to complete an administrative task related to wildland fire dispatching. Seeing that there were many calls waiting, Joe decided to log on and answer some 911 calls as he continued his data entry task.

> A panicked voice says something about how "we don't know her" but they think she "took something" and is "not waking up". It takes Joe several questions to establish the location of the callers, who sound like a group of teenagers. Joe sends a response to this location. In the meantime, Joe tries to get the teenagers to start CPR, and asks if one of them can look for Narcan[11], but they are passing the phone amongst them and there is lots of confusion. Someone says something about a parking lot. Joe now realizes that the group is in a moving car, and he has to convince them to try and pull over. The teenagers are hesitant to start CPR and are yelling over each other. Frustrated Joe yells, "Do you want to save her life? Pull over and lay her down in the car." To which one of the teenagers says in a panicked voice, "I can't do nothing if she is going to die". Joe counts off compressions for CPR over the confusion, but it is not clear that anyone is performing them. Eventually someone says something about finding Narcan and Joe recites from memory the instructions for administering it. But again it is not clear if these instructions are being followed. The call is disconnected.
>
> Joe is frustrated and concerned. Engines have been dispatched to the GPS location of the original call, coded as an overdose. However, Joe is not sure whether the teenagers are still in that location or what state the patient will be in when the engines arrive.

5.2.1 Informal strategies: calming and coaching

Joe—who had been a firefighter in a nearby city for more than fifteen years before taking a higher paying job with the county as a call-taker—was able to identify the correct procedure to follow and medical interventions to suggest. He even had the script and sequence of steps for performing CPR and administering Narcan memorized. Where this scene breaks down is in Joe's ability to coach a car of teenagers through performing a simple, but scary set of tasks and help them physically navigate a chaotic scene over the phone and under pressure. Our core insight is that reliably getting callers to give information and follow medical instructions requires callers to leverage significant relational work to calm callers enough to provide critical information like their address and to coach them in managing the scene.

[11] Narcan is a drug that reduces the effects of opioid overdose

Calming callers down is required in every part of medical dispatching, from getting the right address, to assessing the level of medical triage, to effectively communicating EMD. When callers are particularly anxious, they often want to begin the call by explaining the medical problem and how severe it is. Unfortunately what call-takers most need is a way to locate the caller, which can require several questions.Calming techniques are extensive but informal. Reassuring callers is somewhat codified in call-taking procedures. Some organizations had a simple checkbox in the QA process to verify that the call-taker had said *"help is on the way"*, and this phrase is included in the ProQA script. Still, call-takers deployed a much broader array of techniques for calming. Both West County and East County call-takers were explicitly taught to ask people's names and continue repeating their names. They also developed their own phrases. When people were rushed or wanted help faster, call-takers often used the phrase *"help is on the way; we are coming to you with lights and sirens"* as a way to indicate speed without giving an ETA. The most skillful call-takers would not just say the "help is on the way" phrase once, but keep repeating it gently as they asked questions. Call-takers would also say "let's take slow deep breaths" and actually count and breathe with the caller over the phone. Breathing with caller doesn't only calm them, but seems to help the caller enter a shared emotional space with call-takers so they can follow instructions.

When managing the scene, calming provides a foundation for a more proactive form of relational work best described as coaching. This coaching work goes beyond just providing information and reassuring, it requires bringing callers into a state where they are calm enough and confident enough to perform unfamiliar and uncomfortable tasks: interrupting a high school graduation to lay a seizure patient down in the aisle, performing CPR on a loved one who is possibly dead, or even just finding a place to pull over in an unknown part of town.

These calming and coaching techniques require pausing and deviating from the medical call-taking script. In the febrile seizure call (example 1), Carlos followed the febrile seizure procedure closely, reading out the exact text for the instructions. However, he made several deviations and additions in the script. In particular, he paused to breathe with the caller, to remind her that help is on the way, and made reference to her role as a mom. These moment-by-moment adjustments help him establish the credibility he needs to get her to do something that is difficult—not touch her unresponsive son.

5.2.2 Informal strategies: Developing disembodied spatial awareness.

Managing the scene and keeping callers safe often required call-takers to remotely move people and objects in space, requiring them to create a mental map of the scene of the call. In some particularly complicated situations, even understanding the basic facts of a call hinges on developing a shared understanding of a caller's physical space and a patient's body. For example, a completely panicked woman describing a nonsensical list of injuries after an accident turned out to be talking about injuries to two different people in a car. This fact only became clear when a call-taker asked the caller to hand the phone to a less panicked person on scene. Building this awareness and building

it quickly is instrumental to determine the triage level and location of a response out reliably within 30 seconds.

There is no way to formalize or proceduralize this disembodied scene management because the layout and complexity of emergencies differ widely and are extremely difficult to assess over the phone. Experienced call-takers build a set of assumptions about relationships and situations that make them faster at assessing context clues and building this mental picture. We saw call-takers quickly determine that a case was likely heat stroke because it was hot outside and a caller was standing outside of a store; that a home health aide was describing a vascular stroke based on a veiled description of a client's change in behavior over time; or that someone suffered cardiac arrest by the tone and identity of the nursing home staff member on the line. Eliciting these context clues depends on call-takers and callers alike staying open-minded and flexible.

5.2.3 Informal strategies in call-taking vs. the field

The relational techniques of calming, coaching, and disembodied spatial awareness in order to build brief but personal connections with callers are unique to the remote context of dispatching. Greater medical knowledge did sometimes help call-takers understand a scene and callers' language, especially when it included translation information from doctors. However, techniques of reassuring and scene management did not seem easier for call-takers who had previously worked as EMTs or paramedics.

Some call-takers would adopt a firm, authoritative (and often loud) voice to give instructions—as is common of firefighters in the field—rather than a gentle reassuring tone. Generalizing broadly, such authoritative tactics are likely more effective coming from a man in uniform who is on scene than coming over the phone. Sometimes, as in the drug overdose call (Example 5.2), it seemed to lead to yelling, further disregulation, and chaos. Other techniques for reassurance and scene management used in the field, like a comforting hand on the shoulder of a loved one (a fire captain staple) or physically separating bystanders, are obviously impossible in the remote context of call-taking.

Instead, techniques of reassurance and disembodied spatial awareness seem to be learned over time within the setting of EM call-taking. Many call-takers who had been firefighters and EMTs were clear that call-taking required fundamentally different skills and was stressful in a different way than working in the field. One East County call-taker, Fred, who had been an intercity EMT for a decade, described how scene management in a pediatric choking call would be different in the field.

> *"The dynamic is different. [If it's] a choking kid and I have to figure out what to do, I wonder, 'is it me not getting across' [or are you just not capable]. [In contrast] when you show up on the [ambulance] I can just take the baby from you and say [internally] 'you are an idiot' and fix the problem.*

Fred could not use authority, action, or even knowledge to get a bystander to perform an intervention. Instead, he has to work to communicate, reassure, and ultimately persuade.

5.3 Consequences of Procedures Aimed at Achieving High Reliability

Call-takers we interacted with uniformly resented rigid dispatching procedures. We find that rigid dispatch technologies both in the form of workflow software solutions, like the ProQA software used in Midwest City, and organizational processes that require conforming with step-by-step procedure, such as following the APCO guide cards in Midwest City, are universally disliked by call-takers who feel that they constrain their ability to accurately and efficiently do the job of medical call-taking. One way of articulating the problem with these procedures is that they constrain the opportunity of call-takers to perform the informal, care-work components of call-taking.

5.3.1 Why prescriptive medical call-taking procedure slows down calls.

As we have discussed, speed is a primary objective of emergency call-takers. Their number-one complaint is that following a step-by-step script enforced by software or organizational process in asking questions slows them down. Many departments have reported that using ProQA dramatically slows down calls and external analysis find this to be the case in quantitative terms. For example, both Portland(Jonathan Levinson 2022) and Minneapolis(Matt Belanger 2019) abandoned the software after public investigations uncovered increased call wait times. ProQA was abandoned by Midwest City after an initial trial period because it slowed dispatch times. It was only reinstated after almost ten years when the department worked with ProQA to customize the software to allow call-takers to bypass initial demographic and intake questions. However, most call-takers still thought this option was insufficient and cited this as a key reason for not using the software. We lack access to dispatch data to quantify response times, however our observations provide important insight into *how and why* the technology might slow down call-taking.

Example Call 3: Pro QA for Difficulty Breathing

Consider the following example, in which one call-taker, Bob, a firefighter in Midwest City, agreed to use ProQA solely for the ethnographer's benefit.

> *Dispatch Bob receives a call. He cheerfully asks "what is going on?" The caller responds that her mom is "having a hard time breathing". ProQA brings up a screen with a series of form fills and Bob asks the questions to fill them. He fills in the gender and asks a series of questions prompted by the software: "How old is mom? Is she conscious? Does she have difficulty speaking between breaths?" A different colored text appears on the screen with a list of rules for sending an ALS response (the most serious level). He enters the response but continues to ask the ProQA questions: "Did she use an inhaler today? Is she on an oxygen machine? Does she have COPD [chronic obstructive pulmonary disease]? Has she tested positive for Covid?"*

Finally, after getting answers to all these questions, Bob says "They are on their way" and hangs up.

Bob insisted that if he hadn't used ProQA, when the mom said she was having a hard time breathing, he would have input the call as a difficulty breathing call, asked about COPD, and been done, which would have gotten the response out much quicker (he estimated 45 seconds). Obviously we cannot verify Bob's claim. However, examining this call reveals a few mechanisms by which the more scripted interaction proscribed by workflow software *might* slow down calls.

First, as illustrated by the the previous section about managing the scene, call-takers use context clues (weather, caller location, tone of voice) to infer important information about a scene. For example, knowing the temperature was over 100 degrees might lead one to jump straight to questions about heat stroke, while responding to a panicked voice in the tone of the caller might further speed up the call-taker's response time and decision making. All the examples presented in the section about using context clues (see section 5.2.2) are pulled from instances witnessed in Midwest City and West County when dispatchers were able to complete a call without following a script. Thus, it is reasonable to assume that such inferences could not be used to speed up a call if call-takers had to use a screen-by-screen ProQA-like software or repeat a script exactly as in East County.

Second, prescriptive software systems also involve a slower interface for data entry. Both Midwest City and East County software systems required call-takers to enter information into a form-fill interface, while West County's archaic system has a command line interface. The command line interface is more difficult to learn, but is faster to use since everything can be typed and is mostly an open text field. In Midwest City, which incidentally has no typing speed requirement, call-takers (who were trained as fire fighters) sometimes had to pause in the screen-by-screen ProQA questions to enter information and would often have to enter information about a call after it had ended.

5.3.2 Prescriptive medical call-taking procedure impedes rapid remote care work.

Pressure to stick to a script made it difficult to communicate with callers in language that they can understand. Call-takers described how the ability to speak with callers in language that was tailored to them was critical for interpreting symptoms and communicating instructions. One Midwest City call-taker explained blithely that he didn't use ProQA because *"you have to use your hillbilly logic" [when working with people on the outskirts of town].* This call-taker felt that the script of ProQA prevented him from adapting his vernacular to particular communities as he asked the questions.

East County callers tended to stick to the language of the questions even when that was difficult to understand and in a few cases this seemed to cause symptoms to be misinterpreted and dangerous communication breakdowns. In one particularly unfortunate incident a call-taker in East County interpreted "shaking" to mean seizure and, determined to stick to the seizure script, did not seem able to elicit more specific symptoms of adjusting the call type and response even as details continued to emerge suggesting the call was not a seizure.

Despite the emphasis on speed, experienced call-takers would often let a patient ramble for a calculated 5-10 seconds with their medical problem so the rest of the call would be calmer. In contrast, when pressure to move faster was high, some call-takers felt compelled to interrupt callers' initial descriptions of what was wrong. This often led the caller to be anxious and combative, making it more difficult to solicit basic information like an address. Part of calming callers is gathering information in the order callers naturally present it. For example, we observed a call-taker in Midwest City let a patient ramble about how she had a dialysis patient who couldn't get up for perhaps 20 seconds, before proceeding to the formal breathing and consciousness assessment. In the rambling, the call-taker was able to infer that there had been changes in the patient's behavior that warranted a stroke assessment. This might not have been possible if the call-taker had bulldozed the woman with specific questions. Soliciting these context clues while simultaneously calming call-takers is much easier when documentation requirements are short and when call-takers can use a free form text box. Call-takers in Midwest City often had to pause or ask patients to repeat things in order to fill in the specific ProQA data field: A practice which often seemed to both slow down calls and create additional stress for panicked callers.

5.3.3 Overtriage

We observe that call-takers perceived that call-taking procedure and technology consistently pushed them to send a response they thought was overkill and that they knew would frustrate emergency personnel in the field. While the triage procedure is intended to reduce liability, call-takers did not perceive that the procedure helped them catch things that they would have missed. Instead, they felt that it often pushed them to make a judgment that they felt they knew was wrong and which would lead to resentment in other parts of the organization. One call-taker in East County, after ineffectively urging a woman in a nursing home to start CPR, commented *"Sometimes, when the field [crews] show up they say if he is breathing you don't need to do CPR, which makes us look bad ... but you have your way of thinking and we have ours."* Some incidents like this are inevitable, but the volume of them exasperates the field and dispatchers alike.

In addition to slowing calls down, Midwest City call-takers explained that part of their frustration with the ProQA software was that the system would automatically upgrade calls that they did not believe should be upgraded. This is partly by design and is not necessarily bad. A dispatch supervisor cited recognizing that seizures were cardiac arrests as a key motivation for wanting call-takers to use the software. However, is not clear that the more conservative dispatch is acuate and it often seems to go against call-takers judgment. For example, the ethnographer observed an incident in Midwest city where a call-taker had to work with a college to correct the call type of a response that the call-taker was sure was a seizure that had been automatically changed to a cardiac arrest based on the answer to some questions in a way that the call-taker didn't understand and thought was incorrect. Such a correction is not possible for civilian call-takers. In fact, in East County the policy was that call takers could upgrade a call type to a more serious one during a call but could not down-grade a call even if new information clearly showed that the initial triage level was wrong

(such as that someone is actually conscious). While an analysis of the accuracy of triage decisions is beyond the scope of this analysis, these policies certainty contribute to a strong feeling in the field that dispatch is too conservative and contribute to call-takers overall sense of frustration.

5.3.4 Restrictive dispatch procedure increases workplace stress and time pressure.

Finally, prescriptive proceduralization not only increased stress on call-takers by increasing call time, it also contributed to call-takers' sense of powerlessness and experience of vicarious trauma. Call-takers in East County uniformly loathed the prescriptive organizational procedure that made them "stick to the cards" and to "harass people with these questions" (e.g. follow a script past when call-takers wanted to hear it). They described how making decisions that went against their judgment and expertise was a contributing factor to feeling powerless and overwhelmed. One who had been an EMT said that being a call-taker was more stressful than being an EMT because he felt like he couldn't use his judgment and could "only do what the cards tell me". Call-takers sighed, put their face in their hands, and winced when they had to upgrade calls that they knew shouldn't be upgraded, had to ask patients questions they perceived were unnecessary, or had to give advice that was not only unwelcome but (they perceived) unnecessary.

The view embedded in dispatch software and procedures seems to be that the primary work of emergency medical call-taking is deploying medical advice and triage and — especially in the case of civilian call-takers — that medical interventions and protocols are too complex to be executed without a prescriptive reference card or software. Our observations reveal, however, that the medical triage and advice component of emergency medical dispatch is actually relatively straightforward and easily learned by call-takers, compared to the complexity of managing the infinite possible emotions and configurations of emergency situations. Failures in medical call-taking are less likely to arise from misapplication of medical advice or procedure than from call-takers struggling to sufficiently reassure callers to obtain accurate information, manage a complex scene from afar, and coach callers in performing medical interventions. Rigid scripting makes this relational and improvisational work more difficult.

6 Discussion

Returning to our initial research question about the formal and informal practices that call-takers employ toward achieving reliability in a remote context, we find that when they are able to engage in *rapid remote care work*, emergency medical call-takers are able to reliably and quickly determine what level of medical response to send and keep callers safe before help arrives.

Formally, emergency medical call taking is highly procedural. However, executing triage protocol and managing the scene requires call-takers to leverage emotional and relational techniques. These relational strategies are distinct from those cultivated both formally and informally by firefighters in the field. Specifically, call-takers manage the pacing of a call, mimic the language of the caller, find ways to map the scene

through a disembodied spatial awareness, and display empathy in order to calm callers, comprehend what is going on, and coach them into action. We find that effective call-taking is hampered by prescriptive proceduralization that constrains call-takers' ability to act improvisationally and relationally, leading to slower calls and increased stress in call-takers.

6.1 Theorizing rapid remote care work as the intersection of care work and high-reliability work

Call-takers are never in the same space with callers, and their interactions with them last only a few minutes. Nonetheless, emergency medical call-takers care for callers, firefighters in the field, and the fire service organization. Their care work practices are both similar to practices of relational labor and repair labor described by other scholars of care work, but are also unique to remote, time pressured,life-critical contexts.

6.1.1 Repair: caring as system repair in high-reliability systems

Broadly, rapid remote care work is care work in the sense of repair work and maintenance labor described by Puig de La Bellacasa (2017) and others since it involves matching emergent situations with procedure, and involves relational work required to overcome breakdowns or exceptions. Rapid remote care work is how call-takers overcome the limitations of a scripted triaging flow to match the messy human and natural world of emergencies. Still, the pace and stakes of the repair work we witnessed in 911 call taking are specific to the high-reliability context. Just as Seaver (2021) describes how repair work and data work can be seen as a component of scaling technical systems, rapid remote care work is how workers, who are just one part of larger high-reliability system, adjust their tightly prescribed protocol to an onslaught of inevitably nonstandard cases. We should see emergency medical call-takers as engaging in continuous acts of organizationally invisible but life critical acts of organizational system repair.

6.1.2 Epistemic: caring as knowing.

An important part of the repair work involved in emergency call-taking is using relational, emotional, and—in the case of disembodied spatial awareness—bodily techniques to understand a caller's emotional and physical reality. Building on Perrow's "Normal Accidents" (Perrow 1999), Downer (2023) argues that the limitations of knowledge lead to a category of impossible-to-eliminate accidents called "rational accidents", which are essentially driven by epistemic failure. Though Downer is concerned with the mismatch between the natural world and scientific theory, a similar argument could be made about a system like emergency medical call-taking that relies on call-takers quickly developing a "theory" of a remote scene. This understanding of the scene is developed through emotional and relational work when the scene is composed of or narrated by people.

Studying how police dispatchers learn to match 911 calls with a limited set of dispatch codes, Wang (2022) argues that dispatchers must use not just cognitive discretion as described by Lipsky (2010), but also use "managed emotions" to ensure

cooperation from callers and empathize with them to understand what is happening. Our study and Wang's find that dispatchers do feel pressure (enforced by QA systems and supervisors) to provide clients with good, polite customer service, and this can be a difficult and taxing part of the job. However, dispatchers' informal work goes beyond the "emotional labor" described by studies of those in the service industry (Hochschild 2012), since it includes relating and managing callers' physical situations and is essential to maintaining a life-critical system.

We find that in the absence of being able to see a situation, call-takers must engage in two forms of empathy: they relate to callers emotionally to get their trust, and they relate to their physical situation in order to assess the scene and get accurate information.

6.1.3 Proactive: caring as coaching.

Rapid remote care work goes beyond just relational work as it involves physically (through intermediaries) caring for bodies, spaces, and systems. Both the remote and emergent aspects of rapid remote care work mean that the care work involves proactive instructions (coaching) oriented around getting another human to act in a particular way. Rapid remote care work goes beyond just relational work as it involves physically (through intermediaries) caring for bodies, spaces, and systems. Our findings thus suggest that this proactive coaching requires deeper, and potentially more taxing, relational work than just reassuring and calming callers. Furthermore, the emergent, time-pressured context of this work also makes this care work unique. We find that absent the more traditional ways of establishing credibility and relating to people—such as the in-person projection of authority available to firefighters in the field or the long-term relationship building that a primary care provider or remote therapist might use over multiple interactions—call takers are forced to develop new forms of relating to callers. Better understanding this coaching element of EM dispatch and the relational techniques required to manage intermediaries is a promising future direction suggested by this work.

6.2 Technology and Rapid Remote Care Work In High-Reliability Settings

6.2.1 Generalizing rapid remote care work in other high-reliability settings.

Our findings have significant implications for studies of high-reliability work beyond the context of 911 dispatch. Not all high-reliability work involves rapid remote care work. However, many elements translate to organizations outside of healthcare. In many high-reliability systems, breakdowns are addressed by a call for help, often from someone who is not physically present at the location of the emergency.

This dynamic of on-location operator vs. remote expert already exists when life-critical operations take place in locations that are physically dangerous or inaccessible, such as in space exploration (Platt and Boy 2014), off-shore oil drilling (Ponsonby et al. 2009; Nathanael et al. 2024), or wildfire and disaster response (Gupta and Roy 2024) (which we witnessed in West County Fire Dispatch). As automation becomes

more sophisticated, many high-risk industries, like the chemical industry (Zwetsloot et al. 2007), have pursued both technology-enabled deskilling (Katz 2024) and what might be called "geographic deskilling" where a more skilled operator is moved off site (such as in remote surgery (Mohr et al. 2018), air traffic control (Young 2021), or radiology (Cai et al. 2019; Garg et al. 2017)). Both of these trends potentially increase the frequency and stakes of calls for remote help and necessitate the presence of workers with particular skills in communicating to others off site. Care work provides a useful lens for scholars of high-reliability systems to study the relational dynamics of these critical moments of addressing breakdown from afar.

6.2.2 Designing to support rapid remote care work.

Drawing on Dourish (2006) critique that ethnographic research should not be evaluated primarily on its ability to generate direct design prescriptions, we avoid concrete design recommendations for EM dispatchers. However, our close observation of emergency call-takers does surface conceptual resources for thinking differently about the design space for emergency medical call-taking and rapid remote care work more generally.

Rapid remote care work is constrained when systems are designed to reduce worker discretion and standardize how workers apply protocol in the name of promoting safety (Pine and Mazmanian 2017; Schön 2017; Manning 1992, 2003; Freidson 1988). Call-takers seem to perform best when they have a set of information points to gather, but also are provided flexibility in the exact order in which they solicit those points, how they phrase specific questions, and when they provide warmth and reassurance. Such discretion can thus enhance a call-taker's ability to assess a scene, connect with the caller, and quickly gather information. As a consequence, these rigid procedural efforts seem to consistently slow down call-takers.

We further find that rigid procedures have the side effect of negatively impacting call-takers' experience and increasing stress. This concern should not be taken lightly. Surveys of call-takers themselves (International Academies of Emergency Dispatch (IAED) 2023; Carbyne and National Emergency Number Association (NENA) 2024) and scholars (Linos et al. 2022) all suggest that stress, overwork, and staffing concerns that force call-takers to work under unnecessary added stress and time pressure are perhaps the biggest threat to consistent and efficient call-taking. Instead of focusing on procedure, to improve reliability, we argue that taking into account the benefits of long-term, apprenticeship-style training that allows call-takers to learn the informal practices of call-taking with experienced personnel, would enhance the long term success of both individual call takers and departments as a whole. Further, we urge departments to consider the power of surfacing and cataloging the specific care work techniques used in call-taking in order to better preserve and train these critical skills in call takers.

There are also opportunities to design systems and processes that more creatively support these informal aspects of call-taking, which may translate to other types of rapid remote care work. The first is to to make visible the informal work required for reliability visible in training and quality assurance (QA). This involves seeing difficult

calls not just as calls that are medically severe, but where the relational and situational dynamics of the caller are complicated. Certain kinds of calls, like CPR and childbirth, are celebrated internally in dispatch. However, the QA process does not focus specifically on calls with more complicated relational dynamics (language barriers, multiple intermediaries, informants who are children). Giving these calls special recognition may help emphasize relational work.

Second, we identify room to explore more flexible interfaces for EM call-taking. Currently, the only ways of presenting triaging and EMD procedure to call-takers are either a single PDF or card of instructions or a screen-by-screen workflow. Recognizing that call-takers need some information to refer to, but must navigate the flowchart on their own, there is likely opportunity to design references for protocol more creatively. Similarly, although calls, are recorded, documentation is a key motivator for software solutions since they force call-takers to extract particular data points that can be used in future statistical analysis. There are potentially opportunities to design systems that do this extraction automatically from a call transcript rather than requiring a call-taker to do it while responding to an emergency.

Finally, a design caveat; some scholars have proposed systems that allow EM call-takers to turn on callers' video (Singhal and Neustaedter 2018). Our participants were consistent in their concern that video in 911 call-taking would increase their experience of vicarious trauma, and were worried callers would abuse this function. Video might be useful in more advanced medical triaging situations like stroke assessments (Mohr et al. 2019; Zachrison et al. 2022). However, video is unlikely to improve the disembodied spatial awareness component of call-taking since an individual person's cell phone usually does not provide a good overview of a chaotic situation, especially if the phone operator is panicked—and as Singhal and Neustaedter (2018) find, people's ability to navigate basic video features on their phone is surprisingly low.

In sum, these findings suggest several broader design principles for supporting rapid remote care work. First, when protocol must be closely followed, systems should prioritize worker discretion over rigid proceduralization, recognizing that the repair work required to match emergent situations with procedure necessitates flexibility in how workers gather information, communicate with remote parties, and provide guidance. Second, organizations should invest in training and quality assurance processes that make visible the informal relational and epistemic work required for reliability—including the management of emotional dynamics, the development of disembodied spatial awareness, and the techniques of remote coaching—rather than evaluating performance solely on adherence to protocol or technical outcomes. In line with other scholars of documentation of emergency medicine (Jagannath et al. 2019; Sarcevic and Ferraro 2017), we also find that complex form fill interfaces are simply not possible to complete while doing real-time emergency work. There are opportunities to design more creatively to enable data extraction from recorded interactions or free form notes, freeing workers to focus on real-time care work rather than data entry.

6.3 Implications for Study of Care Work and Telehealth

6.3.1 Applying rapid remote care work to telehealth.

Many areas of tele-medicine have some, if not all, of the elements of rapid remote care work. The clearest example is remote consultation for rural health care providers, which has becoming increasingly important in the Global South (Kim 2010) and rural areas in the US (Tsou et al. 2021; Chen et al. 2021). In these cases, on-site providers have to assess and communicate complex, emergent medical situations with providers off-site.[12] Outside of emergency telehealth, most telehealth situations do not require a patient or intermediary to perform medical interventions, and thus do not have the proactive element of rapid remote care work. However, both the repair element and epistemic element of rapid remote care work are present in these situations when caller and provider interactions are shorter and part of larger complex systems of care. For example, digital-first primary care models now offer patients their first contact through digital channels rather than face-to-face consultations (Greenhalgh et al. 2016), and many health care settings now screen patients virtually to determine appropriate care settings (Kobeissi and Ruppert 2021). Both these cases involve an increasingly short interaction (Shaver 2022) where the primary responsibility of the provider is to gather accurate information about bodies and space (epistemic care work) and match this information to a necessarily limited triage protocol (repair care work).

6.3.2 New techniques of remote care work

A key implication of our findings is how much care work is possible even in a time pressured and remote consequence. We find that communicating with patients over the phone and even having an interaction be entirely recorded on its own does not prevent care work, it just requires different techniques of care work such as relating to callers and breathing with them rather than projecting authority. What is detrimental to care work is when the recording facilitates technology or process that orders how patients interact with providers and how they collect information about them. Thus, while much of the literature in telehealth discusses how remote care work is inferior to in-person care work, we argue, like Bhat et al. (2023), that better questions might be: how are techniques of care work fundamentally different in remote contexts? And how might organizational and technical processes best support this work and those who perform it?

Our findings suggest that specific skills of remote care work can develop through hands-on training and mentorship, but require unique forms of support and flexibility to execute. How these skills develop and in what environments they flourish is worth further scholarly attention. For example, triangulating between callers, patients, and bystanders is key to the success of emergency medical call-taking. This use of intermediaries (Bhat et al. 2021)—people who are neither patient nor provider—is likely to be important in many other areas of remote care work and interpersonal techniques to manage the use of intermediaries requires further study.

[12] For example, two-way remote video consultation is now used in many Emergency Rooms for trauma, cardiac, and stroke consultation (Mohr et al. 2018; Tsou et al. 2021) and 24/7 stroke consultation centers offer remote examination and diagnostics to EDs around the county (Mohr et al. 2019; Zachrison et al. 2022).

6.3.3 Compounding consequences of surveillance technology on remote care workers

A robust care work literature discusses the negative impact of surveillance and technological constraint on care work. Unfortunately, we find that both the remote and high-reliability context both increase organizational incentives to implement these technologies while also exacerbating their negative consequences. The fire service (and other EMS providers) are examples of fast paced high-reliability systems in which most people have clearly defined and largely procedural roles. EMTs and paramedics are considered to be technicians who perform medical interventions under the authority of a medical director. However, they are allowed significant flexibility in how they divide labor amongst themselves and perform emergency medical interventions (Zhang and Sarcevic 2018). There is a sense in emergency medicine that because of the embodied, tactile nature of emergency response, first responders require discretion and agency in how they handle emergent situations in new locations. In contrast, we observe an assumption in the fire service that because call-takers' work is always over the phone it can be fully scripted and proceduralized. This is simply not the case. Even though call-takers do their work from a single location, they are still first responders and have to be able to adapt to the functionally infinite configurations of bodies and spaces of the emergencies they address. Many scholars have shown that an emphasis on procedure, which is common and necessary to some extent in high-reliability work, is likely to be detrimental when it misses less visible care work elements. Unfortunately, this outcome is even more likely in the less visible context of remote care work (Ming et al. 2023). In civilian EM call-taking this invisibility is exacerbated by the training and gender dynamics of dispatch rooms, in which a gender balanced workforce of call-takers applies procedure defined and enforced by predominantly male fire officers with significantly more organizational status (Wang 2022; Karunakaran 2022).

Unfortunately, the technical properties of an already technically-mediated remote context may make it particularly easy for organizations to implement software solutions that prescribe, standardize, and record remote care work. Numerous studies of data systems in healthcare find that when data systems restrict how various workers coordinate and collaborate they develop a proliferation of in-person, often paper-based, workarounds (Jagannath et al. 2019; Chen et al. 2014) to support improvisational work. These workarounds are difficult or impossible in telemedicine where workers don't have alternative ways of communicating with patients or colleagues and where their entire interaction with patients is recorded an easily accessible to supervisors who can enforce adherence to procedure.

Furthermore, the remote context enables more workplace surveillance and, in so doing, fewer opportunities for self-paced breaks, camaraderie, and other palliative practices that are especially important for care workers physical and emotional health. For example, emergency response in the field includes some natural break between cases. We observed firefighters, particularly after disturbing cases, taking a few minutes to chat outside after checking a patient into the hospital or loading them into an

ambulance.[13] In contrast, in both East County and West County civilian call-takers have no discretion in when they answer calls. There is literally no button for them to press, the next 911 calls come into their head sets automatically as soon the previous one ends.

Perscriptive procedure also worsens the emotional impact on emergency call-takers by increasing their sense of powerlessness, which is an important driver of feelings of vicarious trauma (Adams et al. 2015). Call-takers in both East County and West County were unanimous in stating that feeling hamstrung by procedure increased stress and a sense of powerlessness in the job. Thus, We encourage scholars to support remote care worker organizations in developing systems that produce accountability and consistently while maintaining sane working conditions, flexibility, necessary discretion, and respect for professional judgment.

7 Conclusion

Through over 140 hours of observations in three emergency medical dispatch centers across the United States, we examined the formal and informal practices that call-takers leverage to achieve reliability. We find that experienced emergency medical call-takers engage in informal techniques of calming and coaching callers and tactics for creating disembodied spatial awareness in order to effectively and quickly gather needed information and manage a volatile scene from a distance. These techniques are the basis of what we have come to call *rapid remote care work*, in which call-takers build brief but personal connections with callers and, in so doing, care for both their emotions and their bodies.

By examining this remarkable work across three sites, with different technical and organizational requirements and varying degrees of proceduralization, we are further able to analyze the effects of prescriptive procedures – whether enforced by software or organizational process on rapid remote care work. We find that while general protocols enable call-takers to effectively gather needed information and triage appropriate resources, rigid procedures undermine rapid remote care work.

We are not the first to point out the limitations and potential adverse effects of prescriptive procedure in high-reliability contexts (Schön 2017; Manning 1992, 2003; Freidson 1988), However, our work contributes to this scholarship by showing how care work is a useful lens for understanding both how reliability is achieved in life critical work even as that work increasingly involves remote interactions and how particular technical interventions facilitate or inhibit relational work in these contexts.

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[13] Seim (2020) discusses how supervisors of private ambulance providers exert significant effort to curtail these breaks. However, some amount of transition time is still inevitable in the 911 model that relies on traveling between emergency locations.

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The authors have not conflicts of interest to declare.

Appendix A Field Work

A.1 Ethnographic Interviews at Field Sites

- **West County**: We conducted 73 hours of observation in West County over 9 days spanning a nine-month period, both in and out of the traditional fire season. During that time, we sat with civilian call-takers both while they were taking 911 calls and while they were in the dispatch and radio positions, communicating with firefighters in the field and dispatching structure fire and wildland response. Over the nine days, we sat with 15 different call-takers. We also conducted ethnographic interviews with 2 additional call-takers during their lunch breaks. In addition to call-takers, we interviewed two dispatch supervisors, two dispatchers who now oversee training and technology, two full-time technology specialists who work on the CAD, and three fire officers who oversee dispatching operations. Five of the 15 call-takers are women ranging from their twenties to forties. This is a lower proportion of women than most studies find in surveys of 911 dispatchers Franco (2022). A very high proportion of call-takers (four of fifteen) had experience working as EMTs or firefighters in other areas. This may be somewhat unique to West County, whose pay is high enough that it is more lucrative to work as a dispatcher for the county than as an EMT or firefighter in a smaller city. All the supervisors and technology specialists are men in their forties and fifties. All fire officers are men in their fifties and sixties.
- **Midwest City**: We observed call-taking in Midwest City 911 dispatch headquarters for 41 hours over five days. Thirty-one hours over four days were spent with fire dispatch. There we sat with and conducted ethnographic interviews with ten call-takers. In addition, we interviewed two fire lieutenants who oversee dispatch, one fire officer who manages dispatch, and a fire captain who is in charge of dispatch training and technology. We also sat with police dispatch (3 hours) and a crisis counseling hotline (7 hours). One firefighter call-taker is female. All other fire department personnel were men, and most call-takers were at the end of their careers (in their forties or fifties). In contrast, a supervisor on the police side of dispatch reported that half of civilian police dispatchers are female, and many are younger than thirty.
- **East County**: We observed call-taking in East County's combined 911 dispatch center for 26 hours over 3 days. During that time, we sat with 5 different call-takers and one fire captain who dispatches fire response. We also interviewed 2 other call-takers about their experience with technology in dispatch. Separate from these observations, we conducted formal interviews with two data analysts who work at the department who had built data artifacts for dispatch and two fire officers who could speak to how data is used to set dispatch procedures and training. Like

everywhere else, civilian call-takers are gender balanced and skew young, while fire officers are all men over forty.

A.2 Technology at Each of the Field Sites

Rigid dispatch systems are an outcome of both technology and organizational power dynamics in each of our three field sites. Our field sites represent three different technological strategies for determining the level of medical triage and giving out medical advice. In terms of technology, West County call-takers use department-created PDFs, East County uses laminated triage cards (called "guidecards") created by a company called APCO International,[14] and in Midwest City, prescriptive workflow software created by Priority Dispatch Corp., referred to by our participants as ProQA.[15] However, the experience of emergency medical call-takers using these systems and the triaging decisions generated by these systems have very little to do with the systems themselves, and instead are the result of the technical system in tandem with the organizational process surrounding the technology and the labor politics of the organization. The prescriptiveness of medical advice and triage practice in each department can be characterized as follows:

- **East County** has the most rigid medical call-taking process of our three field sites because they have a rigorous QA process in which civilian call-takers face material consequences for deviating from organizational policy and the script given by the workflow cards. In particular, call-takers in East County feel tremendous pressure to elicit symptoms from callers in the language and order that they appear on the cards, to triage exactly according to the flow in the most conservative way possible, and to complete the medical advice script in all cases. All 7 call-takers the ethnographer spoke with in East County expressed frustration with the APCO cards and the rigidity of the process.
- **West County** is the next most rigid system. There, call-takers refer to PDFs created with the dispatching flow and advice. West County FD has a robust QA system, but call-takers are encouraged to use their own language to elicit symptoms and give advice, and there is no organizational requirement that call-takers complete all the medical advice. Instead, the QA process simply records whether they come to the correct triaging decisions according to the judgment of a dispatch supervisor and make a "reasonable attempt" to give medical advice. Call-takers also have the most training on medical call-taking, in part because their outdated computer-aided dispatch system lacks a graphical user interface and call-takers have to memorize all the medical call types and responses.
- **Midwest City**: Finally, despite the use of the ProQA software system, Midwest City call-takers' EMD process is comparatively flexible. Uniformed firefighters who work as call-takers refuse to use the software system in most cases, mostly because they found it to be too slow, apparently without any consequence. Beyond refusing the ProQA system, call-takers in Midwest City felt empowered to provide advice that went beyond that scripted in the ProQA system, stop giving advice and end a

[14] https://www.apcointl.org/services/guidecards/
[15] https://www.prioritydispatch.net/en/proqa

call if it was not well received, and downgrade the level of triage according to their own (very reasonable and well-informed) judgment even when the most conservative criteria for a more serious response might be met. Midwest City call-takers would also go off script to offer additional support, such as suggesting to callers that they could talk to people in the hospital about supportive services.

References

Adams, K., J. Shakespeare-Finch, and D. Armstrong. 2015, September. An Interpretative Phenomenological Analysis of Stress and Well-Being in Emergency Medical Dispatchers. *Journal of Loss and Trauma 20*(5): 430–448. https://doi.org/10.1080/15325024.2014.949141 .

Ambe, A.H., I. Salisbury, T. Grundgeiger, D. Bodnar, S. Rothwell, N. Brown, P. Sanderson, and B. Matthews 2025, April. Patient Handover in the Emergency Department Is Not Just a Point Event: Insights for Designing Information Support Tools. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems*, CHI '25, New York, NY, USA, pp. 1–16. Association for Computing Machinery.

Bainbridge, L. 1983, November. Ironies of automation. *Automatica 19*(6): 775–779. https://doi.org/10.1016/0005-1098(83)90046-8 .

Belfi, L.M., M. Retrouvey, L. Alexandre Frigini, S. Harrington, Z. Verzani, R. Woods, and S.L. Averill. 2025, March. Current Trends in Remote and Flexible Work Options in Radiology and Perception of Impact on Radiologist Well-being. *Academic Radiology 32*(3): 1661–1670. https://doi.org/10.1016/j.acra.2024.11.071 .

Berg, M. 1997. *Rationalizing Medical Work: Decision Support Techniques and Medical Practices*. Cambridge, MA: MIT Press.

Berg, M. 1999. Accumulating and coordinating: Occasions for information technologies in medical work. *Computer Supported Cooperative Work (CSCW)* 8: 373–401 .

Beynon-Davies, P. 1999, June. Human error and information systems failure: the case of the London ambulance service computer-aided despatch system project. *Interacting with Computers 11*(6): 699–720. https://doi.org/10.1016/S0953-5438(98)00050-2 .

Bhat, K.S., A. Ismail, A.K. Hall, N. Karusala, H.M. Mentis, J. Vines, and N. Kumar 2023. The future of hybrid care and wellbeing in hci. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI EA '23, New York, NY, USA. Association for Computing Machinery.

Bhat, K.S., M. Jain, and N. Kumar. 2021, October. Infrastructuring Telehealth in (In)Formal Patient-Doctor Contexts. *Proc. ACM Hum.-Comput. Interact. 5*(CSCW2): 323:1–323:28. https://doi.org/10.1145/3476064 .

Bhat, K.S., N. Kumar, K. Shamanna, N. Kwatra, and M. Jain 2023, April. Towards Intermediated Workflows for Hybrid Telemedicine. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI '23, New York, NY, USA, pp. 1–17. Association for Computing Machinery.

Bossen, C. 2011. Accounting and co-constructing: The development of a standard for electronic health records. *Computer Supported Cooperative Work (CSCW) 20*(6): 473–495 .

Bowers, J. and D. Martin 1999, September. Informing collaborative information visualisation through an ethnography of ambulance control. In *Proceedings of the sixth conference on European Conference on Computer Supported Cooperative Work*, ECSCW'99, USA, pp. 311–330. Kluwer Academic Publishers.

Bowker, G.C. and S.L. Star. 1999, September. *Sorting Things Out: Classification and Its Consequences*. Cambridge, MA, USA: MIT Press.

Brayne, S. and A. Christin. 2021, August. Technologies of Crime Prediction: The Reception of Algorithms in Policing and Criminal Courts. *Social Problems 68*(3): 608–624. https://doi.org/10.1093/socpro/spaa004 .

Brunacini, A.V. 1985. *Fire Command*. Quincy, MA: National Fire Protection Association.

Caffery, L.J., S.D.C. Catapan, M.L. Taylor, J.T. Kelly, H.M. Haydon, A.C. Smith, and C.L. Snoswell. 2025, September. Telephone versus video consultations: A systematic review of comparative effectiveness studies and guidance for choosing the most appropriate modality. *Journal of Telemedicine and Telecare 31*(7): 909–918. https://doi.org/10.1177/1357633X241232464 .

Cai, C.J., E. Reif, N. Hegde, J. Hipp, B. Kim, D. Smilkov, M. Wattenberg, F. Viegas, G.S. Corrado, M.C. Stumpe, and M. Terry 2019, May. Human-Centered Tools for Coping with Imperfect Algorithms During Medical Decision-Making. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, New York, NY, USA, pp. 1–14. Association for Computing Machinery.

Calacci, D. and A. Pentland. 2022, November. Bargaining with the Black-Box: Designing and Deploying Worker-Centric Tools to Audit Algorithmic Management. *Proc. ACM Hum.-Comput. Interact. 6*(CSCW2): 428:1–428:24. https://doi.org/10.1145/3570601 .

Cannuscio, C.C., A.L. Davis, A.D. Kermis, Y. Khan, R. Dupuis, and J.A. Taylor. 2016. A Strained 9-1-1 System and Threats to Public Health. *Journal of Community Health* 41: 658–666. https://doi.org/10.1007/s10900-015-0142-x .

Carbyne and National Emergency Number Association (NENA) 2024. The Pulse of 911 2024. Technical report.

Charmaz, K. 2006, January. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. SAGE. Google-Books-ID: 2ThdBAAAQBAJ.

Chen, J., A. Amaize, and D. Barath. 2021, September. Evaluating Telehealth Adoption and Related Barriers Among Hospitals Located in Rural and Urban Areas. *The Journal of Rural Health 37*(4): 801–811. https://doi.org/10.1111/jrh.12534 .

Chen, Y., K. Cheng, C. Tang, K.A. Siek, and J.E. Bardram. 2014, September. The invisible work of health providers. *interactions 21*(5): 74–77. https://doi.org/10.1145/2645645 .

Chris Nussman. 2024, April. Survey Reveals Urgent Challenges in 9-1-1 Centers Amid Staffing Shortages & Technological Gaps - National Emergency Number Association .

Christensen, B. 2016. Formalization and accountability in surgery planning. In *Proceedings of the 2016 ACM International Conference on Supporting Group Work*, GROUP '16, New York, NY, USA, pp. 293–302. Association for Computing Machinery.

Christopher Karl Hoffman, Skyler Peterson, Benjamin Fisher, and Julianne Ehlers 2025. NEMSIS 2021 Data Report. Technical report, National Emergency Medical Services Information System (NEMSIS), NHTSA Office of EMS, Department of Transportation.

Corbin, J. and A. Strauss. 2008. *Basics of Qualitative Research (3rd ed.): Techniques and Procedures for Developing Grounded Theory*. 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc.

Dalton-Locke, C., S. Johnson, J. Harju-Seppänen, N. Lyons, L. Sheridan Rains, R. Stuart, A. Campbell, J. Clark, A. Clifford, L. Courtney, C. Dare, K. Kelly, C. Lynch, P. McCrone, S. Nairi, K. Newbigging, P. Nyikavaranda, D. Osborn, K. Persaud, M. Stefan, and B. Lloyd-Evans. 2021, October. Emerging models and trends in mental health crisis care in England: a national investigation of crisis care systems. *BMC Health Services Research 21*(1): 1174. https://doi.org/10.1186/s12913-021-07181-x .

Dourish, P. 2001, September. Process descriptions as organisational accounting devices: the dual use of workflow technologies. In *Proceedings of the 2001 ACM International Conference on Supporting Group Work*, GROUP '01, New York, NY, USA, pp. 52–60. Association for Computing Machinery.

Dourish, P. 2006. Implications for design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '06, New York, NY, USA, pp. 541–550. Association for Computing Machinery.

Dovigo, F. and I. Redaelli. 2010, October. Knowledge management in locating the patient in an emergency medical service in italy. *Computer Supported Cooperative Work 19*(5): 457–481. https://doi.org/10.1007/s10606-010-9118-7 .

Downer, J. 2023. *Rational accidents: reckoning with catastrophic technologies*. Inside technology. Cambridge, Massachusetts: The MIT Press.

Emerson, R.M., R.I. Fretz, and L.L. Shaw. 2011. *Writing Ethnographic Fieldnotes* (2nd ed.). Chicago, IL: University of Chicago Press.

England, P. 2005. Emerging Theories of Care Work. *Annual Review of Sociology* 31: 381–399 .

Eubanks, V. and A. Mateescu. 2021, July. 'We don't deserve this': new app places US caregivers under digital surveillance. *The Guardian* .

Farshchian, B.A., T. Vilarinho, and M. Mikalsen. 2017. From episodes to continuity of care: A study of a call center for supporting independent living. *Computer Supported Cooperative Work* 26: 309–343. https://doi.org/10.1007/s10606-017-9262-4 .

Franco. 2022, 3. Women in public safety: In their own words. Mark43. Accessed: 2025-12-03.

Freidson, E. 1988. *Profession of medicine: a study of the sociology of applied knowledge* (University of Chicago Press ed ed.). Chicago: University of Chicago Press.

Garg, A., M.P. Rajkhowa, and S. Dawar 2017, March. Real Time Remote Diagnosis and Distant Education using CollabDDS. In *Proceedings of the Special Collection on eGovernment Innovations in India*, ICEGOV '17, New York, NY, USA, pp. 6–10. Association for Computing Machinery.

Greenhalgh, T., S. Vijayaraghavan, J. Wherton, S. Shaw, E. Byrne, D. Campbell-Richards, S. Bhattacharya, P. Hanson, S. Ramoutar, C. Gutteridge, I. Hodkinson, A. Collard, and J. Morris. 2016, January. Virtual online consultations: advantages and limitations (VOCAL) study. *BMJ Open 6*(1): e009388. https://doi.org/10.1136/bmjopen-2015-009388 .

Gupta, T. and S. Roy 2024. Applications of artificial intelligence in disaster management. In *Proceedings of the 2024 10th International Conference on Computing and Artificial Intelligence*, ICCAI '24, New York, NY, USA, pp. 313–318. Association for Computing Machinery.

Han, D., C. Neustaedter, and Z. Tan 2020, April. Concerns of Primary Care Physicians for Video-Based Visits. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*, CHI EA '20, New York, NY, USA, pp. 1–7. Association for Computing Machinery.

Hatton, E. 2017, April. Mechanisms of invisibility: rethinking the concept of invisible work. *Work, Employment and Society 31*(2): 336–351. https://doi.org/10.1177/0950017016674894 .

Heath, C. and P. Luff. 1992, March. Collaboration and controlCrisis management and multimedia technology in London Underground Line Control Rooms. *Computer Supported Cooperative Work (CSCW) 1*(1): 69–94. https://doi.org/10.1007/BF00752451 .

Hoang, M., E. Hillier, C. Conger, D.N. Gengler, C.W. Welty, C. Mayer, and P.L. Haynes. 2022, March. Evaluation of call volume and negative emotions in emergency response system telecommunicators: a prospective, intensive longitudinal investigation. *AIMS Public Health 9*(2): 403–414. https://doi.org/10.3934/publichealth.2022027 .

Hochschild, A.R. 2012. *The managed heart: commercialization of human feeling* (Updated ed ed.). Berkeley, Calif. London: University of California Press.

Institute of Medicine (U.S.) ed. 2007. *Emergency medical services at the crossroads*. Future of emergency care. Washington, D.C: National Academies Press.

International Academies of Emergency Dispatch (IAED) 2023. AMERICA'S 911 WORKFORCE IS IN CRISIS: RESULTS OF A NATIONWIDE 911 STAFFING SURVEY. Survey, National Association of State 911 Dispatchers.

Jagannath, S., A. Sarcevic, V. Young, and S. Myers 2019, May. Temporal Rhythms and Patterns of Electronic Documentation in Time-Critical Medical Work. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, New York, NY, USA, pp. 1–13. Association for Computing Machinery.

Jonathan Levinson. 2022, May. Dying on hold: How new software is creating a logjam at Portland's 911 - OPB. *Oregon Public Prodcast Network* .

Karunakaran, A. 2019, August. Front-Line Professionals in the Wake of Digital Scrutiny: The Paradox of Public Accountability. *Academy of Management Proceedings 2019*(1): 13114. https://doi.org/10.5465/AMBPP.2019.225 .

Karunakaran, A. 2022, June. Status–Authority Asymmetry between Professions: The Case of 911 Dispatchers and Police Officers. *Administrative Science Quarterly 67*(2): 423–468. https://doi.org/10.1177/00018392211059505 .

Karusala, N., A. Ismail, K.S. Bhat, A. Gautam, S.R. Pendse, N. Kumar, R. Anderson, M. Balaam, S. Bardzell, N.J. Bidwell, M. Densmore, E. Kaziunas, A.M. Piper, N. Raval, P. Singh, A. Toombs, N. Verdezoto, and D. Wang 2021, October. The Future of Care Work: Towards a Radical Politics of Care in CSCW Research and Practice. In *Companion Publication of the 2021 Conference on Computer Supported Cooperative Work and Social Computing*, Virtual Event USA, pp. 338–342. ACM.

Kashani, S., S. Sanko, and M. Eckstein. 2018, August. The Critical Role of Dispatch. *Cardiology Clinics 36*(3): 343–350. https://doi.org/10.1016/j.ccl.2018.03.001 .

Katz, J. 2024, August. Deconstructing the Chemical Industry's Skills Gap.

Kaziunas, E., M.S. Klinkman, and M.S. Ackerman. 2019, November. Precarious Interventions: Designing for Ecologies of Care. *Proc. ACM Hum.-Comput. Interact. 3*(CSCW): 113:1–113:27. https://doi.org/10.1145/3359215 .

Kim, J.A. 2010, June. Telehealth in the Developing World. *Healthc Inform Res 16*(2): 140–141. https://doi.org/10.4258/hir.2010.16.2.140 .

Kobeissi, M.M. and S.D. Ruppert. 2021, September. Remote patient triage: Shifting toward safer telehealth practice. *Journal of the American Association of Nurse Practitioners 34*(3): 444–451. https://doi.org/10.1097/JXX.0000000000000655 .

Kristensen, M., M. Kyng, and L. Palen 2006, April. Participatory design in emergency medical service: designing for future practice. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '06, New York, NY, USA, pp. 161–170. Association for Computing Machinery.

LaPorte, T.R. and P.M. Consolini. 1991. Working in practice but not in theory: Theoretical challenges of "high-reliability organizations". *Journal of Public Administration Research and Theory 1*(1): 19–48. https://doi.org/10.1093/oxfordjournals.jpart.a037070 .

Lazar, A., H.J. Thompson, S.Y. Lin, and G. Demiris. 2018, November. Negotiating Relation Work with Telehealth Home Care Companionship Technologies that Support Aging in Place. *Proc. ACM Hum.-Comput. Interact. 2*(CSCW): 103:1–103:19. https://doi.org/10.1145/3274372 .

Lee, M.K., D. Kusbit, E. Metsky, and L. Dabbish 2015, April. Working with Machines: The Impact of Algorithmic and Data-Driven Management on Human Workers. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, Seoul Republic of Korea, pp. 1603–1612. ACM.

Levy, K.E.C. 2015, March. The Contexts of Control: Information, Power, and Truck-Driving Work. *The Information Society 31*(2): 160–174. https://doi.org/10.1080/01972243.2015.998105 .

Linos, E., K. Ruffini, and S. Wilcoxen. 2022. Reducing burnout and resignations among frontline workers: A field experiment. *Journal of Public Administration Research and Theory 32*(3): 473–488 .

Lipsky, M. 2010. *Street-Level Bureaucracy, 30th Ann. Ed. Dilemmas of the Individual in Public Service*. Russel Sage Foundation.

Lofland, J., L.H. Lofland, D.A. Snow, and L. Anderson. 2006. *Analyzing Social Settings: A Guide to Qualitative Observation and Analysis* (4th ed.). Belmont, CA: Wadsworth/Thomson Learning.

Luff, P., C. Heath, and M. Jirotka. 2000, December. Surveying the scene: technologies for everyday awareness and monitoring in control rooms. *Interacting with Computers 13*(2): 193–228. https://doi.org/10.1016/S0953-5438(00)00038-2 .

Lutters, W.G. and M.S. Ackerman 2002, November. Achieving safety: a field study of boundary objects in aircraft technical support. In *Proceedings of the 2002 ACM conference on Computer supported cooperative work*, CSCW '02, New York, NY, USA, pp. 266–275. Association for Computing Machinery.

Manning, P.K. 1992, January. Information Technologies and the Police. *Crime and Justice* 15: 349–398. https://doi.org/10.1086/449197 .

Manning, P.K. 2003. *Policing contingencies*. Chicago: University of Chicago Press.

Martin, D., J. Bowers, and D. Wastell. 1997. The Interactional Affordances of Technology: An Ethnography of Human-Computer Interaction in an Ambulance Control Centre, In *People and Computers XII*, eds. Thimbleby, H., B. O'Conaill, and P.J. Thomas, 263–281. London: Springer London. https://doi.org/10.1007/978-1-4471-3601-9_16.

Martin, D., J. O'Neill, D. Randall, and M. Rouncefield. 2007. How can I help you? Call centres, classification work and coordination. *Computer Supported Cooperative Work 16*(3): 231–264. https://doi.org/10.1007/s10606-007-9045-4 .

Mateescu, A. 2021. Electronic Visit Verification: The Weight of Surveillance and the Fracturing of Care. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4181895 .

Matt Belanger. 2019, August. Minneapolis to drop ProQA - wants 911 workers to talk & think for themselves - Statter911.

Ming, J., E. Kuo, K. Go, E. Tseng, J. Kallas, A. Vashistha, M. Sterling, and N. Dell. 2023, April. "I Go Beyond and Beyond" Examining the Invisible Work of Home Health Aides. *Proc. ACM Hum.-Comput. Interact. 7*(CSCW1): 59:1–59:21. https://doi.org/10.1145/3579492 .

Mohr, N.M., T. Young, K.K. Harland, B. Skow, A. Wittrock, A. Bell, and M.M. Ward. 2018, August. Emergency Department Telemedicine Shortens Rural Time-To-Provider and Emergency Department Transfer Times. *Telemedicine and e-Health 24*(8): 582–593. https://doi.org/10.1089/tmj.2017.0262 .

Mohr, N.M., T. Young, K.K. Harland, B. Skow, A. Wittrock, A. Bell, and M.M. Ward. 2019, February. Telemedicine Is Associated with Faster Diagnostic Imaging

in Stroke Patients: A Cohort Study. *Telemed J E Health 25*(2): 93–100. https://doi.org/10.1089/tmj.2018.0013 .

Nathanael, J., K. S, C. Samuel, N. Sansuddin, M.F. Hussin, M. Hapani, N.A. Musa, and K.A. Husna. 2024. Challenges in managing emergency offshore: A comparison of offshore and onshore perspectives. *Journal of Loss Prevention in the Process Industries* 88: 105275. https://doi.org/https://doi.org/10.1016/j.jlp.2024.105275 .

NFPA Research. 2022, 9. U.s. fire department profile report. https://www.nfpa.org/education-and-research/research/nfpa-research/fire-statistical-reports/us-fire-department-profile. Accessed: 2025-12-01.

Normark, M., P.G. Almklov, P. Luff, and I. Redaelli. 2024, March. Introducing Moving Back to the Control Room—Revisiting Centres of Coordination. *Computer Supported Cooperative Work (CSCW) 33*(1): 1–6. https://doi.org/10.1007/s10606-023-09477-4 .

Normark, M. and D. Randall 2005. Local expertise at an emergency call centre. In H. Gellersen, K. Schmidt, M. Beaudouin-Lafon, and W. Mackay (Eds.), *ECSCW 2005*, Berlin/Heidelberg, pp. 347–366. Springer-Verlag.

Olawade, D.B., O.Z. Wada, A. Odetayo, A.C. David-Olawade, F. Asaolu, and J. Eberhardt. 2024, August. Enhancing mental health with Artificial Intelligence: Current trends and future prospects. *Journal of Medicine, Surgery, and Public Health* 3: 100099. https://doi.org/10.1016/j.glmedi.2024.100099 .

Paoletti, I. 2009, June. Communication and diagnostic work in medical emergency calls in italy. *Computer Supported Cooperative Work 18*(2–3): 229–250. https://doi.org/10.1007/s10606-009-9091-1 .

Perrow, C. 1999. *Normal accidents: living with high-risk technologies*. Princeton paperbacks. Princeton, N.J: Princeton University Press.

Pillai, A.G., R. Liu, J.J. Lee, J. Cho, I. Baek, A. Choi, K. Doherty, C. Ferguson, R. Hu, S. Kettley, S. Kim, J. Liu, T.P. Ng, A. Petterson, M. Ratto, C. Seah, Y. Yao, and Y. Wu. 2025, July. Speculating and Disentangling the Relationship Between Technology and Care Work, *Companion Publication of the 2025 ACM Designing Interactive Systems Conference*, 433–439. New York, NY, USA: Association for Computing Machinery.

Pine, K. 2012, February. Fragmentation and choreography: caring for a patient and a chart during childbirth. In *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work*, CSCW '12, New York, NY, USA, pp. 887–896. Association for Computing Machinery.

Pine, K.H., C. Bossen, Y. Chen, G. Ellingsen, M. Grisot, M. Mazmanian, and N.H. Møller 2018, October. Data Work in Healthcare: Challenges for Patients, Clinicians

and Administrators. In *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing*, CSCW '18 Companion, New York, NY, USA, pp. 433–439. Association for Computing Machinery.

Pine, K.H. and M. Mazmanian 2014, February. Institutional logics of the EMR and the problem of 'perfect' but inaccurate accounts. In *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing*, CSCW '14, New York, NY, USA, pp. 283–294. Association for Computing Machinery.

Pine, K.H. and M. Mazmanian. 2017, April. Artful and Contorted Coordinating: The Ramifications of Imposing Formal Logics of Task Jurisdiction on Situated Practice. *Academy of Management Journal 60*(2): 720–742. https://doi.org/10.5465/amj.2014.0315 .

Platt, D. and G.A. Boy 2014. Participatory design of the virtual camera for deep space exploration. In *Proceedings of the International Conference on Human-Computer Interaction in Aerospace*, HCI-Aero '14, New York, NY, USA. Association for Computing Machinery.

Ponsonby, W., F. Mika, and G. Irons. 2009, August. Offshore industry: medical emergency response in the offshore oil and gas industry. *Occup Med (Lond) 59*(5): 298–303. https://doi.org/10.1093/occmed/kqp075 .

Poon, A., V. Hussain, J. Loughman, A.C. Avgar, M. Sterling, and N. Dell. 2021, October. Computer-Mediated Peer Support Needs of Home Care Workers: Emotional Labor & the Politics of Professionalism. *Proc. ACM Hum.-Comput. Interact. 5*(CSCW2): 336:1–336:32. https://doi.org/10.1145/3476077 .

Pro, G., B. Fairman, J. Baloh, D. Willis, and B.E.E. Montgomery. 2023, December. Temporal Trends in Telehealth Availability in Mental Health Treatment Settings: Differences in Growth by State Rurality, 2015–2020. *Journal of Urban Health 100*(6): 1149–1158. https://doi.org/10.1007/s11524-023-00795-y .

Procter, R., J. Wherton, T. Greenhalgh, P. Sugarhood, M. Rouncefield, and S. Hinder. 2016, February. Telecare call centre work and ageing in place. *Computer Supported Cooperative Work 25*(1): 79–105. https://doi.org/10.1007/s10606-015-9242-5 .

Puig de La Bellacasa, M. 2017. *Matters of care: speculative ethics in more than human worlds*. Number 41 in Posthumanities. Minneapolis (Minn.): University of Minnesota press.

Raval, N. and P. Dourish 2016, February. Standing Out from the Crowd: Emotional Labor, Body Labor, and Temporal Labor in Ridesharing. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, CSCW '16, New York, NY, USA, pp. 97–107. Association for Computing Machinery.

Sarcevic, A. and N. Ferraro. 2017, March. On the Use of Electronic Documentation Systems in Fast-Paced, Time-Critical Medical Settings. *Interacting with Computers 29*(2): 203–219. https://doi.org/10.1093/iwc/iww021 .

Saxena, D., K. Badillo-Urquiola, P.J. Wisniewski, and S. Guha 2020, April. A Human-Centered Review of Algorithms used within the U.S. Child Welfare System. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, CHI '20, New York, NY, USA, pp. 1–15. Association for Computing Machinery.

Schaefer, H.G., R.L. Helmreich, and D. Scheidegger. 1994, December. Human factors and safety in emergency medicine. *Resuscitation 28*(3): 221–225. https://doi.org/10.1016/0300-9572(94)90067-1 .

Schön, D.A. 2017, March. *The Reflective Practitioner* (0 ed.). Routledge.

Seaver, N. 2021. CARE AND SCALE: Decorrelative Ethics in Algorithmic Recommendation. *Cultural Anthropology 36*(3): 509–537. https://doi.org/10.14506/ca36.3.11 .

Seim, J.D. 2020. *Bandage, sort, and hustle: ambulance crews on the front lines of urban suffering*. Oakland, California: University of California Press.

Shaver, J. 2022, December. The State of Telehealth Before and After the COVID-19 Pandemic. *Primary Care 49*(4): 517–530. https://doi.org/10.1016/j.pop.2022.04.002 .

Singhal, S. and C. Neustaedter 2018, June. Caller Needs and Reactions to 9-1-1 Video Calling for Emergencies. In *Proceedings of the 2018 Designing Interactive Systems Conference*, DIS '18, New York, NY, USA, pp. 985–997. Association for Computing Machinery.

Stevenson, L. 2014. *Life beside itself: imagining care in the Canadian Arctic*. Oakland, California: University of California Press.

Stoecker, R. 2009, December. Are we talking the walk of community-based research? *Action Research 7*(4): 385–404. https://doi.org/10.1177/1476750309340944 .

Suchman, L. 1987. *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge University Press.

Suchman, L. 1993. Technologies of accountability: of lizards and airplanes, *Technology in Working Order: Studies of Work, Interaction and Technology*. Routledge.

Suchman, L. 1997. Centers of coordination: A case and some themes, In *Discourse, Tools and Reasoning*, eds. Resnick, L.B., R. Säljö, C. Pontecorvo, and B. Burge, 41–62. Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-03362-3_3.

Suchman, L. 2002, September. Located accountabilities in technology production. *Scand. J. Inf. Syst. 14*(2): 91–105 .

Sun, Y., X. Ma, S. Lindtner, and L. He. 2023, April. Data Work of Frontline Care Workers: Practices, Problems, and Opportunities in the Context of Data-Driven Long-Term Care. *Proc. ACM Hum.-Comput. Interact. 7*(CSCW1): 42:1–42:28. https://doi.org/10.1145/3579475 .

Toombs, A., L. Devendorf, P. Shih, E. Kaziunas, D. Nemer, H. Mentis, and L. Forlano 2018, October. Sociotechnical Systems of Care. In *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing*, Jersey City NJ USA, pp. 479–485. ACM.

Tsou, C., S. Robinson, J. Boyd, A. Jamieson, R. Blakeman, J. Yeung, J. McDonnell, S. Waters, K. Bosich, and D. Hendrie. 2021, November. Effectiveness of Telehealth in Rural and Remote Emergency Departments: Systematic Review. *Journal of Medical Internet Research 23*(11): e30632. https://doi.org/10.2196/30632 .

Wang, P.C. 2022. The 'desired state of mind': Emotional labor and the hidden cost of symbolic power in 911 emergency response in the u.s. *Ethnography*. https://doi.org/10.1177/14661381221145353 .

Weick, K.E. and K.M. Sutcliffe. 2001. *Managing the Unexpected: Assuring High Performance in an Age of Complexity*. San Francisco, CA: Jossey-Bass.

Whalen, J., M. Whalen, and K. Henderson. 2002, June. Improvisational choreography in teleservice work*. *The British Journal of Sociology 53*(2): 239–258. https://doi.org/10.1080/00071310220133322 .

Wu, Y., J.J. Lee, A.G. Pillai, J. Cho, N. Ahmadpour, V. Roto, T. Sachathep, J. Liu, M. Sawan, D. Song, M. Čaić, L. Cheng, R. Liu, S. Kettley, L. Soares, K. Grace, and T. Astell-Burt 2024, November. Collective Imaginaries for the Futures of Care Work. In *Companion Publication of the 2024 Conference on Computer-Supported Cooperative Work and Social Computing*, CSCW Companion '24, New York, NY, USA, pp. 732–735. Association for Computing Machinery.

Young, S. 2021, April. Ground control out, remote control in at London City Airport. *Reuters* .

Zachariah, B.S. and P.E. Pepe. 1995. The development of emergency medical dispatch in the USA: A historical perspective. *EUROPEAN JOURNAL OF EMERGENCY MEDICINE* .

Zachrison, K.S., R.E. Cash, O. Adeoye, K.M. Boggs, L.H. Schwamm, A. Mehrotra, and C.A. Camargo, Jr. 2022, February. Estimated Population Access to Acute Stroke and Telestroke Centers in the US, 2019. *JAMA Netw Open 5*(2): e2145824. https://doi.org/10.1001/jamanetworkopen.2021.45824 .

Zhang, Z., K. Joy, R. Harris, and S.Y. Park. 2022, November. Characteristics and Challenges of Clinical Documentation in Self-Organized Fast-Paced Medical Work. *Proc. ACM Hum.-Comput. Interact. 6*(CSCW2): 386:1–386:21. https://doi.org/10.1145/3555111 .

Zhang, Z., K. Joy, P. Upadhyayula, M. Ozkaynak, R. Harris, and K. Adelgais. 2021, October. Data Work and Decision Making in Emergency Medical Services: A Distributed Cognition Perspective. *Proc. ACM Hum.-Comput. Interact. 5*(CSCW2): 356:1–356:32. https://doi.org/10.1145/3479500 .

Zhang, Z. and A. Sarcevic. 2018, November. Coordination Mechanisms for Self-Organized Work in an Emergency Communication Center. *Proc. ACM Hum.-Comput. Interact. 2*(CSCW): 199:1–199:21. https://doi.org/10.1145/3274468 .

Zhang, Z., A. Sarcevic, and C. Bossen 2017, February. Constructing Common Information Spaces across Distributed Emergency Medical Teams. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*, CSCW '17, New York, NY, USA, pp. 934–947. Association for Computing Machinery.

Zwetsloot, G.I.J.M., J. Gort, N. Steijger, and C. Moonen. 2007, August. Management of change: Lessons learned from staff reductions in the chemical process industry. *Safety Science 45*(7): 769–789. https://doi.org/10.1016/j.ssci.2006.08.028 .