

Masked and Distanced: A Qualitative Study of How Personal Protective Equipment and Distancing Affect Teamwork in Emergency Care

Tuna C. Hayirli, BA^{1,2}
Nicholas Stark, MD, MBA^{3,4}
Aditi Bhanja, MPH⁵
James Hardy, MD³
Christopher R. Peabody, MD, MPH^{3,4}
Michaela J. Kerrissey, PhD, MS⁵

Institutional affiliations:

- 1- Harvard Medical School, Boston MA
- 2- Harvard Business School, Boston MA
- 3- Department of Emergency Medicine, University of California, San Francisco CA
- 4- Department of Emergency Medicine, Zuckerberg San Francisco General Hospital and Trauma Center, CA
- 5- Department of Health Policy and Management, Harvard T.H. Chan School of Public Health, MA

Manuscript word count: 2142

Abstract word count: 203

Corresponding author:

Michaela J. Kerrissey, PhD, MS
Assistant Professor of Management
Harvard School of Public Health
677 Huntington Avenue, Boston
e-mail: mkerrissey@hsph.harvard.edu
phone: 617.432.7139

Masked and Distanced: A Qualitative Study of How Personal Protective Equipment and Distancing Affect Teamwork in Emergency Care

Abstract

Background: Newly intensified use of personal protective equipment (PPE) in emergency departments presents teamwork challenges affecting the quality and safety of care at the

© The Author(s) 2021. Published by Oxford University Press on behalf of International Society for Quality in Health Care. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com

frontlines. We conducted a qualitative study to categorize and describe barriers to teamwork posed by PPE and distancing in the emergency setting.

Methods: We conducted 55 semi-structured interviews between June-August, 2020 with personnel from two emergency departments serving in a variety of roles. We then performed a thematic analysis to identify and construct patterns of teamwork challenges into themes.

Results: We discovered two types of challenges to teamwork: material barriers related to wearing masks, gowns, and powered air purifying respirators, and spatial barriers implemented to conserve PPE and limit coronavirus exposure. Both material and spatial barriers resulted in disrupted communication, roles, and interpersonal relationships, but did so in unique ways. Material barriers muffled information flow, impeded team member recognition and role/task division, and reduced belonging and cohesion while increasing interpersonal strain. Spatial barriers resulted in mediated communication, and added physical and emotional distance between teammates and patients.

Conclusion: Our findings identify specific aspects of how intensified PPE use disrupts teamwork, and can inform efforts to ensure care quality and safety in emergency settings as PPE use continues during and, potentially beyond, the COVID-19 pandemic.

Key words: COVID-19; Communication; Teamwork; Emergency Service, Hospital; Quality of Health Care

Introduction

Personal protective equipment (PPE) offers a critical barrier for preventing disease transmission in healthcare settings,¹ but its widespread use during the COVID-19 pandemic has changed the experience of care delivery. Even in emergency departments (ED), where PPE use was common prior to COVID-19, approaches to PPE have changed considerably during the pandemic. Universal masking mandates and related hospital policies²⁻⁴ have intensified PPE

usage - gowns, gloves, masks, respirators and face shields have gone from being used only when necessary to a constant fixture of the ED environment. These policies have been complemented by measures to conserve and preserve PPE to meet the demands of constant use.⁵⁻⁷ Together, such policies protect patients and ED personnel, but they also create new challenges to teamwork in the ED. Teamwork is important for delivering high quality and safe care,⁸ and research is needed to identify how PPE-related changes have affected ED teamwork during COVID-19.

Teamwork is vital in emergency medicine because interdisciplinary team members must coordinate their efforts and skills in unpredictable, stressful, and time-pressured situations to provide safe and high-quality care.⁹ Research in healthcare has shown that poor teamwork is associated with lower quality and safety, worse patient outcomes and experiences, and decreased healthcare worker engagement and satisfaction.¹⁰ In the emergency context in particular, research has documented a clear link between teamwork and errors; for example, one study found an average of 8.8 teamwork failures per reported incident.¹¹ This awareness of the importance of teamwork has led to many efforts for improvement in communication and coordination in ED teams,¹² with recommendations to train personnel in teamwork behaviors and implement effective team design.¹³

The potential unintended consequences of PPE on teamwork have not been examined in depth, despite widespread attention to the individual and human factors challenges posed by PPE. Foundational work in team science has long established that team performance depends on the formation of a 'real' team in which it is clear who is on the team, and the team is a relatively stable unit over time.¹⁴ Such teams both satisfy individuals' desire to belong in social groups and facilitate the achievement of common goals through role differentiation and coordinating processes.¹⁵ To coordinate their reciprocal task interdependence,¹⁶ team members must be able to

share information by communicating effectively while minimizing interpersonal conflicts.¹⁷ Early in the pandemic, team scholars noted the potential for PPE use to disrupt teamwork by separating team members, decreasing familiarity among them, and introducing lack of clarity about team membership and structure that harm teamwork and patient safety.^{18,19} PPE may also disrupt the team climates and relationships that enable teams to effectively draw on individual expertise and knowledge.^{20,21} Yet the presence and extent of these disruptions and their implications for care quality and safety in emergency settings has remained unclear.

In this study, we qualitatively examine perceptions of challenges to teamwork during COVID-19, and explore implications for patient care quality resulting from intensified PPE usage and distancing.

Methods

We conducted 55 semi-structured interviews between June-August, 2020 in two EDs affiliated with an academic medical center in San Francisco, USA. These sites were pragmatically selected to represent similar organizational responses to the pandemic, as both hospitals faced similar PPE shortages and developed similar PPE usage and conservation policies following the Centers for Disease Control and Prevention's guidance. The participant sample was drawn purposively to achieve similar proportions of respondents by department and role. Participants were engaged for recruitment either face-to-face or by email, and were divided about evenly across the two hospitals, with approximately 44% from Hospital A, 40% from Hospital B, and 16% working across both hospitals. Interviews suggested that both EDs had similar experiences with PPE; we thus present findings across the whole sample rather than by hospital. The investigators' two institutional review boards each determined the study to be exempt

because the interview procedures limited participant identification and any potential disclosure would not place the participants at significant risk.

All interviewers used a semi-structured interview guide focusing on participants' role and background, their experiences with teamwork and communication before and during the COVID-19 pandemic, and how the pandemic affected their work. We asked probing questions encouraging participants to share examples of challenges with teamwork when participants mentioned PPE as a barrier. The interview guide was drafted through iterative discussions among the investigator team, consisting of three management researchers with qualitative research experience and three emergency medicine physicians. Prior to each interview, participants were made aware of the study goals and procedures. Author1 conducted 29, Author2 conducted 2, Author3 conducted 17, Author4 conducted 1, and Author6 conducted 6 interviews. Most of the interviews were conducted by three 'outsider' investigators (Author1, Author3, Author6) who were more physically and psychologically distant from the research setting than the three 'insider' investigators (Author2, Author4, Author5). The few interviews conducted by 'insider' investigators were carefully selected to ensure that participants did not work with or report to the investigators, and were used predominately to ensure that 'insider' investigators understood the data collection process and the type of data it would generate. Interviewers wrote memos after each interview and held weekly debriefs to enhance comparison and reflexivity, allowing for deliberate integration of inquisitive perspectives from 'inside' and 'outside' of the research setting.²² Recruitment of participants continued until we reached theoretical saturation (i.e., until no new information was gathered during interviews).²³ Participants received a USD \$20 gift card in appreciation for their time.

One-on-one interviews lasted about 30 minutes on the Zoom platform. Audio recordings were downloaded and transcribed verbatim. We addressed the shortcomings of virtual interviews with respect to audio quality and building rapport with participants in the following ways: we offered flexibility in timing and re-scheduled interviews when necessary, asked participants to find a quiet place where they could be alone for the duration of the interview, and requested that the interview be conducted through videoconferencing rather than audio-only.²⁴⁻²⁶

After all of the interviews were completed, we conducted a thematic analysis, taking an inductive and constructivist approach to understanding participants' lived experiences and the teamwork challenges they faced.²⁷ Following the constant comparison approach, the first author reviewed and open coded half of the memos and transcripts using NVivo (version-12.6.0), inductively searching for patterns of teamwork challenges identified across roles and sites. The last author independently reviewed the codes and the data, and met with the first author to construct codes into higher-order themes. The first author then applied this coding framework to all memos and transcripts. The investigator team met multiple times throughout the coding process to review the codes in detail, discuss patterns apparent in the data, and resolve any discrepancies. Through iterative rounds of discussions, we derived themes categorizing participants' experience with teamwork in the ED, and present these themes below.

Results

Our sample included registered nurses (n=18), physicians (n=17), nurse practitioners and physician assistants (n=7), pharmacists (n=5), social workers (n=3), and medical assistants and technologists (n=5). Participants' tenure at the EDs varied, ranging from two or less years (n=15), three to five years (n=11), six to fifteen years (n=18), to greater than fifteen years (n=11). Analysis revealed two distinct barriers to teamwork: material barriers related to wearing

masks, gowns, and powered air purifying respirators (PAPRs) and spatial barriers implemented to conserve PPE and limit coronavirus exposure.

Material barriers muffled face-to-face information exchange, increased interpersonal strain, created confusion about roles and task division, and decreased teammates' sense of belonging and cohesion (Table 1). Impeding ability to see, hear, and speak, material barriers disrupted information flow, especially amid the pressure and background noise of resuscitations. Teammates' inability to hear - or tendency to mishear - one another during critical events often resulted in repetition and redundancies in task completion. Beyond slowing care down, muffled communication presented concerning opportunities for error. Attempts to facilitate communication by adjusting intonation and projecting voice loudly were misinterpreted as negative emotions which strained relationships. PPE itself served as a source of frustration because of how it felt to wear all day, and because it changed how communication happened and was interpreted. PPE also made it difficult to recognize team members. This sense of anonymity created confusion about who was responsible for occupying which roles and completing which tasks. Since all staff looked similar behind the veil of PPE, it became difficult to rely on the simple visual cues they had used in the past to identify roles. Difficulty recognizing teammates through PPE also reduced the sense of belonging and cohesion among team members. Teammates felt like they were stripped of both their sense of individuality and togetherness. Feeling lonely at work, they lamented not being able to recognize – and not being recognized by – their teammates whose faces, hair, and name tags were covered.

Beyond the material barriers posed by PPE, policies regarding PPE use and conservation led to spatial barriers. Staff were encouraged to preserve PPE for those frequently interacting with patients (e.g., limiting who could enter a resuscitation room enclosed with sliding glass

doors), to ration PAPRs for those performing aerosolizing procedures such as intubations, and to maintain social distance.

Team members who would have normally practiced side-by-side were unable to co-locate due to spatial barriers, leading to mediated communication, disrupted interprofessional care, and impeded ability to respond empathetically to suffering (Table 2). Teammates found their communication blocked by physical barriers such as walls, windows, and doors. Rather than being shared directly among teammates at the bedside, information now flowed through technologies (e.g., using phones, whiteboards, and baby monitors) or simple work-arounds (e.g., shouting from a doorway) that enabled exchange across physical barriers. Especially for pharmacists and social workers, conserving PPE often meant practicing from outside of patient rooms or the hospital. This posed difficulties to teams in making use of their teammates' expertise when it was most needed, and eliminated informal opportunities to share information from teams' routines. Further, the imposition of spatial barriers disrupted relationships among teammates and with patients. Standing six feet away from others while covered in PPE, not socializing with teammates at work, and losing the ability to provide a comforting touch made it difficult for staff to respond empathetically to suffering.

Discussion

Statement of principal findings

Intensified use of PPE in emergency medicine presents material and spatial barriers to teamwork, disrupting team communication, roles, and relationships in distinct ways (Table 3). Material barriers hindered face-to-face information flow, obscured teammate identities, decreased the sense of belonging and cohesion, and increased interpersonal friction among teammates. Mediated communication occurred as a result of spatial barriers, which disrupted

coordinated interprofessional care, and made it difficult for ED clinicians to respond empathetically to their patients' and each other's suffering. These findings identify specific aspects of how PPE and distancing affect the experience of team-based care, and can inform efforts to ensure quality and safety in emergency settings as intensified PPE use continues during and, potentially beyond, this pandemic.

Strengths and limitations

Our study had several limitations. Following regulations and rules of ethical research conduct for the COVID-19 pandemic, we conducted interviews virtually in two EDs. Our findings may be less generalizable to other setting where PPE is often used, such as operating theatres. Our study's cross-sectional nature limited our ability to compare pre-pandemic perceptions of teamwork with ones during the pandemic, placing an increased reliance on participant recall. Lastly, we could not interview any patients, who could have potentially helped triangulate our findings.

Our study is strengthened by our relatively large sample size, inclusive of a diversity of roles. Conducting interviews with 55 physicians, trainees, nurses, social workers, pharmacists, and other health professionals allowed us to explore how PPE and distancing affected the experience of teamwork from a variety of perspectives. Further, to our knowledge, there have been no other empirical studies on how PPE and distancing affect teamwork in emergency care, allowing us to pursue exploratory and phenomenon-driven research.

Interpretation within the context of the wider literature

The impact of material and spatial barriers on teamwork discovered in our study presents evidence that intensified PPE use has implications beyond the common ergonomic challenges faced by individuals.²⁸ PPE use is known to be associated with difficulties in auditory and visual

perception, dexterity, situational awareness, cognition, and decision-making.^{29,30} Wearing PPE for long periods of time is also uncomfortable for health care workers, and can lead to both physical and cognitive stress.^{31,32} Recognizing these challenges, clinicians have noted that communication and teamwork have suffered in emergency settings during the COVID-19 pandemic. In response, practical proposals in the literature have included the use of name and role stickers,³³ and the re-design of resuscitation teams aided by technologies.³⁴ Our study captures the use of both of these proposals within the material and spatial barriers scheme, and provides a framework that can help guide practical and research efforts moving forward.

Our findings also contribute to the wider literature on communication during emergency situations. Poor communication and teamwork are associated with poor clinical outcomes in a variety of care settings.³⁵ Principals for effective teamwork to avoid errors in emergency care include voicing findings out loud, reviewing information as a team, and thinking aloud as a team.³⁶ Nonetheless, these principals assume that teammates are co-located, have recognizable roles and task differentiation, and can exchange information accurately. Our study demonstrates the difficulty of enacting these principals when teamwork and communication are stymied, and clarifies areas of improvement for communication challenges experienced during a crisis at the frontlines of care delivery.

Implications for policy, practice and research

By distinguishing between material and spatial barriers, our findings highlight how PPE usage creates challenges in two distinct aspects of care delivery and illustrate how addressing these unique challenges may take unique solutions. For example, the problem of muffled sound when speaking through a mask side-by-side with a teammate is distinct from the problem of speaking through a phone or writing on a whiteboard instead of being at the bedside. While

material barriers hindering face-to-face communication and information exchange could be overcome through process innovations and behavioral interventions,³⁷⁻³⁹ spatial barriers that block tacit information uptake and fracture teams into virtual or dispersed units may call for more process-oriented interventions.⁴⁰⁻⁴²

Our findings also uncover how teamwork challenges arising from PPE use are not experienced equally across roles – particularly, pharmacists’ and social workers’ roles were dramatically altered by spatial barriers, disrupting coordination in team-based care. Pharmacists and social workers play a critical role in delivering safe and high-quality care to patients in the emergency setting.^{43,44} These findings suggest that efforts to improve teams’ ability to deliver high quality care amid heightened PPE may require specific attention to the impact on these roles. For instance, committees established to guide organizational responses to the pandemic may wish to include representatives from these highly affected professions and/or ensure there are ways of incorporating their experiences and views directly in response planning.

The specific elements of disrupted teamwork that we identified in this study present an initial set of insights to support efforts to intervene. We were inspired by the resiliency and adaptation demonstrated by ED staff in our study. Whiteboards, baby monitors, stickers, and loud introductions were some of the organic solutions teams generated when facing material and spatial barriers. Leaders could encourage teams with situated knowledge to deliberately experiment and propose solutions⁴⁵ for each challenge. As vaccines become available, it is likely that some aspects of heightened PPE use will change, and others will remain. Without PPE shortages and exposure concerns, teams could return to their pre-pandemic structures and processes more quickly. Still, many participants in our study felt baffled that PPE use was not as common prior to the pandemic and expressed that masks in the ED are here to stay. Our findings

suggest that for future crises with PPE shortages, potential trade-offs between personal safety and teamwork, and how such trade-offs affect care quality and patient safety, should be explicitly discussed among decision-makers.

Conclusions

Both material and spatial barriers undermine facilitators to teamwork. As masking and social distancing in the healthcare setting are likely to continue even when vaccines become widely available, team leaders should be mindful of these material and spatial barriers as they engage all team members in continuing to care for patients both during and after this pandemic.

End-Matter

Contributorship: All authors contributed to study conception, data collection, and writing of the manuscript. The first and last authors are responsible for data analysis.

Ethics and other permissions: This study was deemed exempt by the authors' two institutional review boards in accordance with regulations found at 45 CFR 46.104(d)(2).

Funding: None.

Conflict of interests: No known conflict of interests.

Acknowledgements: None.

Data availability statement: Requests for data can be made to the corresponding author.

References

- 1- Livingston E, Desai A, Berkwits M. Sourcing personal protective equipment during the COVID-19 pandemic. *JAMA* 2020;323(19):1912-1914.
- 2- Brooks JT, Butler JC, Redfield RR. Universal masking to prevent SARS-CoV-2 transmission—the time is now. *JAMA* 2020;324(7):635–637.
- 3- Klompas M, Morris CA, Sinclair J, Pearson M, Shenoy ES. Universal masking in hospitals in the Covid-19 era. *New England Journal of Medicine* 2020;382(21):e63.
- 4- Centers for Disease Control and Prevention. Interim infection prevention and control recommendations for healthcare personnel during the coronavirus disease 2019 (COVID-19) pandemic. Updated November 4, 2020.
- 5- Bauchner H, Fontanarosa PB, Livingston EH. Conserving supply of personal protective equipment—a call for ideas. *JAMA* 2020;323(19):1911-1911.;
- 6- Livingston E, Desai A, Berkwits M. Sourcing personal protective equipment during the COVID-19 pandemic. *JAMA* 2020;323(19):1912-4.;
- 7- Benjamin EM, Brindle M, Gullo S, Loehrer S. COVID Pandemic: Conserving Personal Protective Equipment. *Ariadne Labs* Accessed on Nov 12, 2020.
- 8- Baker DP, Gustafson S, Beaubien J, Salas E, Barach P. Medical teamwork and patient safety: the evidence-based relation. *AHRQ* 2005;5(53):1-64.
- 9- Kilner E, Sheppard LA. The role of teamwork and communication in the emergency department: a systematic review. *International emergency nursing* 2010;18(3):127-137.
- 10- Rosen MA, DiazGranados D, Dietz AS, *et al.* Teamwork in healthcare: Key discoveries enabling safer, high-quality care. *American Psychologist* 2018;73(4):433.
- 11- Risser DT, Rice MM, Salisbury ML, *et al.* The potential for improved teamwork to reduce medical errors in the emergency department. *Annals of Emergency Medicine* 1999;34:373-383.
- 12- Fernandez R, Kozlowski SW, Shapiro MJ, Salas E. Toward a definition of teamwork in emergency medicine. *Academic Emergency Medicine* 2008;15(11):1104-12.
- 13- Boet S, Etherington N, Larrigan S, *et al.* Measuring the teamwork performance of teams in crisis situations: a systematic review of assessment tools and their measurement properties. *BMJ Quality & Safety* 2019;28:327-337.
- 14- Hackman JR. A normative model of work team effectiveness. *Office of Naval Research* 1983.
- 15- Pearce III JA, Ravlin EC. The design and activation of self-regulating work groups. *Human relations* 1987;40(11):751-82.
- 16- Thompson JD. Organizations in Action: Social Science Bases of Administrative Theory 1967.
- 17- Mickan S, Rodger S. Characteristics of effective teams: a literature review. *Australian Health Review* 2000;23(3):201-8.
- 18- Tannenbaum SI, Traylor AM, Thomas EJ, *et al.* Managing teamwork in the face of pandemic: evidence-based tips. *BMJ Quality & Safety* Published Online First: 29 May 2020.
- 19- Kerrissey MJ, Singer SJ. Leading Frontline Covid-19 Teams: Research-Informed Strategies. *NEJM Catalyst Innovations in Care Delivery* 2020.
- 20- Huckman RS, Staats BR. Fluid Tasks and Fluid Teams: The Impact of Diversity in Experience and Team Familiarity on Team Performance. *Manufacturing & Service Operations Management* 2011;13(33): 310–328.

- 21- Sole D, Edmondson A. Situated Knowledge and Learning in Dispersed Teams. *British Journal of Management* 2002;13:17–34.
- 22- Louis MR, Bartunek JM. Insider/outsider research teams: Collaboration across diverse perspectives. *Journal of Management Inquiry*. 1992;1(2):101-10.
- 23- Glaser BG, Strauss AL. *Discovery of grounded theory: Strategies for qualitative research*. Routledge, 2017.
- 24- Sedgwick M, Spiers J. The use of videoconferencing as a medium for the qualitative interview. *International Journal of Qualitative Methods*. 2009;8(1):1-1.
- 25- Deakin H, Wakefield K. Skype interviewing: Reflections of two PhD researchers. *Qualitative research*. 2014;14(5):603-16.
- 26- Archibald MM, Ambagtsheer RC, Casey MG, Lawless M. Using zoom videoconferencing for qualitative data collection: perceptions and experiences of researchers and participants. *International Journal of Qualitative Methods*. 2019;18:1609406919874596.
- 27- Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative research in psychology* 2006;3(2):77-101.
- 28- Gurses AP, Tschudy MM, McGrath-Morrow S, Husain A, Solomon BS, Gerohristodoulos KA, Kim JM. Overcoming COVID-19: What can human factors and ergonomics offer? *Journal of Patient Safety and Risk Management* 2020;25(2):49-54.
- 29- Parush A, Wacht O, Gomes R, Frenkel A. Human Factor Considerations in Using Personal Protective Equipment in the COVID-19 Pandemic Context: Binational Survey Study. *Journal of Medical Internet Research* 2020;22(6):e19947.
- 30- Hignett S, Welsh R, Banerjee J. Human factors issues of working in personal protective equipment during the COVID-19 pandemic. *Anaesthesia* 2020;76:134-135.
- 31- Hancock PA. Specifying and Mitigating Thermal Stress Effects on Cognition During Personal Protective Equipment Use. *Human Factors* 2020;0018720820933794.
- 32- Davey SL, Lee BJ, Robbins T, Randeve H, Thake CD. Heat stress and PPE during COVID-19: impact on healthcare workers' performance, safety and well-being in NHS settings. *Journal of Hospital Infection*. 2021;108:185-8.
- 33- Smith N, Hughes R, Cushley C, Brain L, Galbreath J, Russell R, Jenkins M, Kelly FE. 'Who are you and what do you do?' Using name and role stickers to improve communication and teamwork in intensive care during the COVID-19 pandemic. *Journal of the Intensive Care Society*. 2020:1751143720959620.
- 34- Lin CH, Lin HY, Tseng WP, Ma MH, Tsai MS, Chen SY, Huang CH. Resuscitation teamwork during the COVID-19 pandemic in the emergency department: Challenges and solutions. *Resuscitation*. 2021;160:18.
- 35- Schenarts PJ, Cohen KC. The leadership vacuum in resuscitative medicine. *Critical care medicine*. 2010;38(4):1216-7.
- 36- Hunziker S, Johansson AC, Tschan F, et al. Teamwork and leadership in cardiopulmonary resuscitation. *Journal of the American College of Cardiology* 2011;57(24): 2381-2388.
- 37- Chodosh J, Weinstein BE, Blustein J. Face masks can be devastating for people with hearing loss. *BMJ* 2020;370:m2683
- 38- Cooley E. Training an interdisciplinary team in communication and decision-making skills. *Small group research* 1994;25(1):5-25.
- 39- Elfenbein HA, Polzer JT, Ambady N. Team Emotion Recognition Accuracy and Team Performance. *Research on emotion in organizations* 2007;3:87-119.

- 40- Furst SA, Reeves M, Rosen B, Blackburn RS. Managing the life cycle of virtual teams. *Academy of Management Perspectives* 2004;18(2):6-20.
- 41- Malhotra A, Majchrzak A, Rosen B. Leading virtual teams. *Academy of Management perspectives* 2007;21(1):60-70.
- 42- Lacerenza CN, Marlow SL, Tannenbaum SI, Salas E. Team development interventions: Evidence-based approaches for improving teamwork. *American Psychologist* 2018;73(4):517.
- 43- Auerbach C, Mason SE. The value of the presence of social work in emergency departments. *Social work in health care* 2010;49(4):314-26.
- 44- Ernst AA, Weiss SJ, Sullivan IV A, Sarangarm D, Rankin S, Fees M, Sarangarm P. On-site pharmacists in the ED improve medical errors. *The American journal of emergency medicine* 2012;30(5):717-25.
- 45- Edmondson AC. Strategies for learning from failure. *Harvard Business Review* 2011;89(4):48-55.

Tables

Table 1. Material barriers to teamwork

Themes	Illustrative quotes
Disrupted communication: Muffled face-to-face information flow	“The mask during a code, it's actually almost fairly impossible for everyone to hear you in the room. That has been the biggest problem” (Physician 12)
	“I feel like it's been a lot more challenging with the PAPRs to hear each other very well. [...] It's hard to tell if people got you. I'll say something [...] but I don't know that they heard me. I think that's the hardest thing. [...] So then, you're saying three or four times instead of moving on. Everything takes longer. (Registered Nurse 13)”
	“I observed nursing staff getting access [to the bloodstream] in a way that they would have been instructed to in the past, but because they can't hear the person that's telling them to do it, they put an IO [intraosseous] instead of searching for new IV [intravenous] access. So, there's little pieces like that, you know. A code starts and a nurse administers epinephrine without it fully being ordered by the resident. It's appropriate, and certainly within normal care, but the order hasn't actually been given. Or maybe it has, and nobody heard it.

	(Pharmacist 4)”
Disrupted roles: Confusion about roles and task division	“I have a sticker that says pharmacist, the resident will have a sticker that says primary resident, and then airway attending. So that, actually, although not verbal communication, has been pretty helpful [...] On top of that, introducing yourself from the beginning. And we do that a lot more than we used to. I think we relied on our knowledge of the people we work with a little too much, and now because you can't see anybody that you know you can't rely on that as much. (Pharmacist 2)”
	“In stressful situations when everyone's got PPE on – you don't know who's who” (Physician 3)
Disrupted relationships: Interpersonal strain	“I have had to sit down a couple times and say, ‘I'm sick of my N95 right now. I feel edgy. I'm not edgy about you or what you have to say to me right now. I just want to rip this off my face and I can't.’ [...] I've been given feedback that I'm yelling and [...] I sound different, maybe because I'm trying to force my voice out more. The tone comes out different and that creates, I think, some hard stuff, too” (Registered Nurse 9)
	“You can't read facial expressions, so it's weird at an interpersonal level. You actually have to convey things differently, voice things more loudly, and then also maybe with more in intonation because you can't read people” (Physician 8)
Disrupted relationships: Sense of belonging and cohesion	“You're also taking away the aspect of being able to see each other because suddenly we're all behind masks [...] we can't see each other's faces anymore [...] And so, there was a sense of, like we're together, but we don't know really who's on the team.” (Registered Nurse 3)
	“You are much less visible, much less human really, because all you are is just like everybody else. They're in the same color scrubs, in a mask, and like something covering your hair” (Physician 11)

Table 2. Spatial barriers to teamwork

Themes	Illustrative quotes
<p>Disrupted communication: Mediated communication</p>	<p>“Typically, when a trauma patient comes in we're in the room first thing and we're sort of hearing the story. Oftentimes we're able to just talk to the patient and say, like, ‘Who should I call for you?’ [...] And now we're not in the room because of PPE. They're sort of trying to limit how many people go in. So, we're getting a lot of information from these very sick patients secondhand. (Social Worker 2)”</p> <p>“The pharmacists actually stand outside of the room and we use a baby monitor. (Physician 17)”</p> <p>“We were figuring out, can we do our job outside of the room when the door is completely closed? That did require adjustment, like how do we communicate with the provider? We have no idea what's happening, really have no idea what's being discussed. So, for a while we were using a whiteboard to communicate through a glass window. (Pharmacist 2)”</p>
<p>Disrupted roles: Inability to contribute in the moment</p>	<p>“From practicing outside the room, we can't really function in the capacity that pharmacists who went into emergency medicine do [...] I've seen more like dirty epis and rates of titration that I would not normally do. I've seen allergies verified more slowly. So just like things happening, and I'm like, ‘wait a minute, what are you doing in there!’” (Pharmacist 1)</p> <p>“We have like very tight space here in the ED and we aren't able to socially distance [...] so we started working remotely 50% of the time [...] And here I think it's hard to not have us like visibly here, where they can just come to our office and ask us questions” (Social Worker 3)</p>
<p>Disrupted relationships: Difficulty responding to suffering</p>	<p>“The other thing that I found really hard is domestic violence. Because that tends to be a longer interview, it's much, much more personal. And it's very hard to do from standing in the doorway or over a phone” (Social Worker 1)</p> <p>“Keeping six feet from these people going through this terrible experience and limiting one person or two people to see the dead body</p>

	because of new regulations, I would say that's the worst part” (Social Worker 2)
--	--

Table 3. How material and spatial barriers affect teamwork on the frontlines of care

	Disrupted teamwork elements		
	Communication	Roles	Relationships
Material barriers (e.g., wearing masks)	Muffled face-to-face information flow, leading to repetition and misses	Obscured identities make role and task division unclear	Sense of belonging and cohesion reduced; increased interpersonal strain
Spatial barriers (e.g., limiting room access)	Communication mediated through technologies or work-arounds (e.g., phones)	Team members struggle to contribute because no longer permitted at bedside	Difficulty responding empathetically to suffering

Semi- Structured Interview Questions

1. Please tell me a bit about your role and background here in the ED.
2. Can you tell me about your experience working here during COVID-19?
3. How has your daily work and responsibilities changed?
4. How, if at all, has your team changed?
 - a. New people or roles?
 - b. New structures or processes?
5. Overall, throughout the response to COVID-19, would you say it has gotten easier or harder to work with your team?
6. Overall, throughout the response to COVID-19, how have you felt about the quality of care your team was able to deliver?
7. Thinking about the past few weeks, are there any things from your experience over the past few months that you think will never go back to normal?