Effects of Safety Zone Implementation on Perceptions of Safety and Well-being When Caring for COVID-19 Patients

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Background In March 2020, the caseload of patients positive for COVID-19 in hospitals began increasing rapidly, creating fear and anxiety among health care workers and concern about supplies of personal protective equipment.

Objectives To determine if implementing safety zones improves the perceptions of safety, well-being, workflow, and teamwork among hospital staff caring for patients during a pandemic.

Methods A safety zone process was implemented to designate levels of contamination risk and appropriate activities for certain areas. Zones were designated as hot (highest risk), warm (moderate risk), or cold (lowest risk). Caregivers working in the safety zones were invited to complete a survey regarding their perceptions of safety, caregiver well-being, workflow, and teamwork. Each question was asked twice to obtain caregiver opinions for the periods before and after implementation of the zones.

Results Significant improvements were seen in perceptions of caregiver safety ($P<.001$) and collaboration within a multidisciplinary staff ($P<.001$). Significant reductions in perceived staff fatigue ($P=.03$), perceived cross contamination ($P<.001$), anxiety ($P<.001$), and fear of exposure ($P<.001$) were also seen. Teamwork ($P=.23$) and workflow ($P=.69$) were not significantly affected.

Conclusions Safety zone implementation improved caregivers' perceptions of their safety, their well-being, and collaboration within the multidisciplinary staff but did not improve their perceptions of teamwork or workflow.

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SARS-CoV-2 is a single-stranded RNA virus that can spread quickly.[1] Despite growing awareness of the risk of COVID-19 infection to health care workers (HCWs), conflicting evidence and conflicting expert opinions from policy makers on this risk persist.[2] Health care workers are at risk for exposure to many infectious diseases, particularly when caring for patients undergoing aerosol-generating procedures (AGPs).

Aerosol-generating procedures include handheld nebulizer treatments, oral/tracheal suction, intubation, and mechanical ventilation. However, the risk of transmission to HCWs through AGPs has not been well studied.[3] Indirect evidence suggests that noninvasive ventilation and invasive mechanical ventilation may increase the risk of COVID-19 transmission.[4] Aerosol-generating procedures and noninvasive ventilation quickly became part of the standard of care for patients hospitalized for COVID-19 infections, increasing the fear of viral spread to the frontline HCWs.

The first case of COVID-19 at the study facility was confirmed on March 9, 2020. Before the pandemic, approximately 360 isolation gowns and fewer than 100 N95 masks were used per month. By the middle of June 2020, more than 1900 gowns and 150 N95 masks were being used each day. Similar increases in the use of gloves, face shields, and surgical masks were identified. Supplies of alcohol-based hand sanitizer and disinfectant wipes were at a critical shortage by the middle of June 2020. Concern over the shortage grew as the number of positive cases rapidly increased. Caregivers expressed concerns over their safety.

Within months, the study hospital had a critical shortage of supplies of PPE, disinfectants, and hand sanitizer.

Surge planning became a priority, as did strategies for personal protective equipment (PPE) conservation. The situation was changing daily, requiring close tracking of PPE resources and increased efforts to obtain PPE through unfamiliar suppliers. Staff were required to use unfamiliar PPE and other supplies. Anxiety among HCWs increased as the standard protocols to minimize risk were modified.[5]

As in many medical centers throughout the country, exposure to and transmission of COVID-19 to caregivers began to increase in the study facility. At that time, compared with workers in other professions, HCWs were more likely to become infected with COVID-19.[6] By June 2020, the Centers for Disease Control and Prevention reported that 19% of patients with confirmed COVID-19 in the United States were HCWs.[7] (The figure was based on patients with confirmed COVID-19 whose occupations were on record.) At that time, hundreds of HCWs had been exposed to patients with COVID-19 at the study facility. Several HCWs had tested positive, creating additional fear and stress. As the acuity level of patients increased, so did the use of AGPs and other supportive respiratory therapies. The magnitude of the risk of acquiring an infectious disease through patient care and procedures is not clearly understood.[8] The scarcity of information regarding protection provided by PPE remained a concern.[9]

As case counts began to climb, we began grouping patients into cohorts. This gave us an opportunity to develop a team of caregivers with additional training and competency in safely caring for patients with COVID-19. With the rapid decline of the PPE supply, we focused on slowing the rate of PPE use, protecting caregivers, reducing fatigue from donning and doffing PPE, and providing the best possible care for our patients.

Doffing an isolation gown that has been worn in a room with aerosolized respiratory secretions is considered a high-risk procedure.[10] The doffing process may aerosolize contamination on the gown; the HCW, no longer protected by the gown, would then be at risk for direct contamination of the skin. The potential for inhaling aerosolized particles exists; however, continued use of N95 masks protected caregivers from this risk.

Through our search, we discovered a process that would meet our needs to conserve PPE, conserve staff energy during donning and doffing, and reduce HCWs' risk of exposure to COVID-19. In the Environmental

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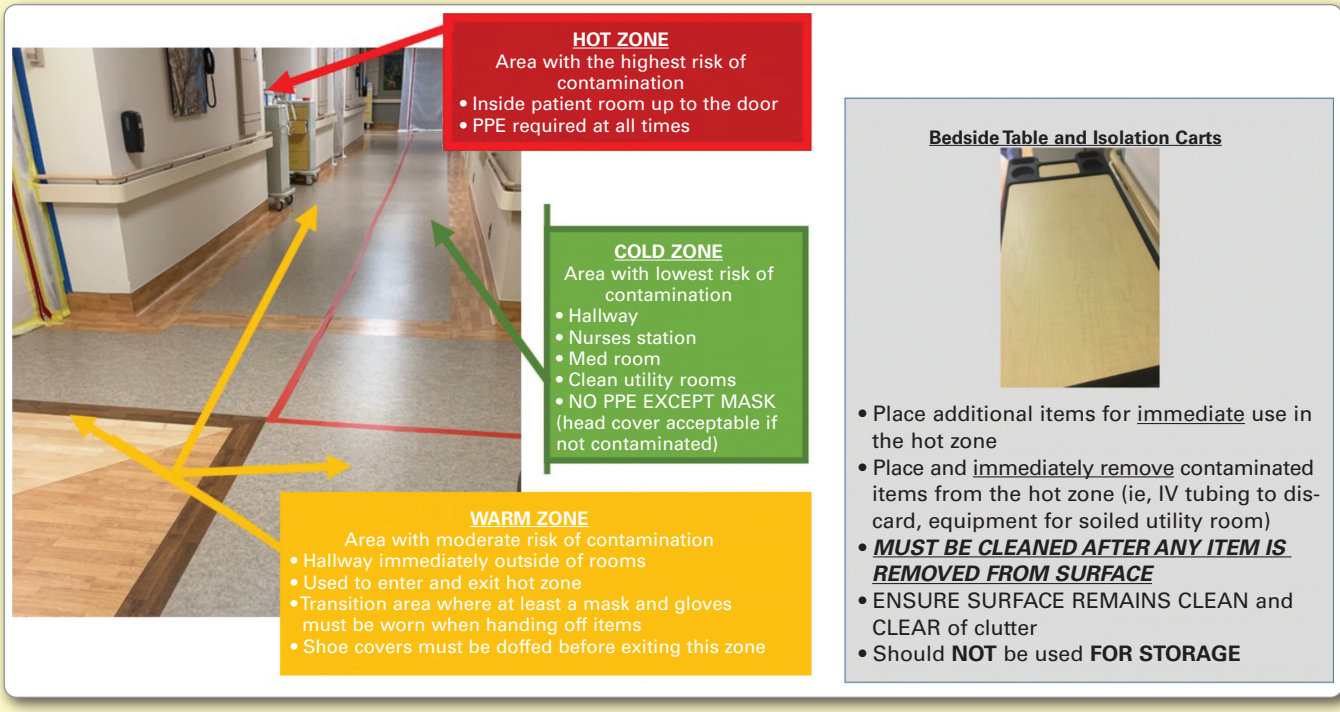

Figure Example of setup of COVID unit with hot, warm, and cold zones to keep staff safe and reduce workflow burden.
Abbreviations: IV, intravenous; PPE, personal protective equipment.

Protection Agency's (EPA) emergency response plan, a safety zone process is described.[11] This process had been used successfully in other health care organizations to care for patients with highly infectious, highly virulent diseases.[12] After a thorough review of the safety zone process, we decided to implement it in the step-down/critical care unit and medical/surgical units which were providing care only for patients with COVID-19.

Methods

Three safety zones were designated: hot, warm, and cold. Designations were based on levels of expected viral contamination. Patient rooms, declared hot zones, were considered to have the highest level of contamination. In these areas, direct patient care activities occurred. Aerosol-generating procedures would be performed in this area, so droplet and aerosolized contamination would be expected. Personal protective equipment is always required in a hot zone. Transition areas, such as the hallways in front of patient care rooms, were declared warm zones because the risk for contamination in these areas was moderate (see Figure). These zones were used for donning and doffing and to clean contaminated equipment such as powered air-purifying respirator hoods. Staff were required to perform hand hygiene before leaving the warm zone. This allows the HCWs to step outside the hot zone, to prevent contamination from aerosolized and droplet particles while doffing gowns, reducing the risk of contamination. Cold zones were the hallways outside the warm zones and the areas inside the nurses' station, supply room, and medication rooms. These areas were expected to have the lowest risk of viral contamination, as all PPE would have been removed, all equipment would have been cleaned, and hand hygiene would have been performed.

Because of the ongoing concerns about critical PPE shortages, a strategy for PPE conservation was implemented along with the safety zone process. Education was provided to all clinical staff who would be caring for patients with COVID-19, including nurses, doctors, respiratory therapists, dietary staff, radiology technicians, and physical therapists. The information was shared in face-to-face leadership huddles, unit-based huddles, and standard work documents. The standard work documents had step-by-step instructions and photographs of the zones.

> Safety zones including hot, warm, and cold zones were designated in the COVID-19 units.

The new protocols were first implemented in the step-down/critical care unit; within a week, they were also implemented in the medical/surgical unit. Staff participated in the development of the process, including deciding the delineation of the zones and preparing

Table 1
Description of study sample (N = 132) by role and unit worked

Characteristic	No. (%) of participants
Role	
Nurse	71 (54)
Other[a]	26 (20)
Patient care technician	19 (14)
Physician	16 (12)
Unit worked	
Medical/surgical	63 (48)
Step-down/critical care	40 (30)
Both	29 (22)

[a] Physical therapists, speech therapists, respiratory therapists, imaging technicians, laboratory staff, transportation staff, and environmental services staff.

the communication. No staff resistance was noted. Compliance with the new PPE protocols was very high. Potential staff resistance was mitigated by having the staff help develop the process. Staff feedback was essential to the initiative's success.

The PPE conservation process involved caregivers traveling between patients' rooms through the warm zone while keeping the same face shield, N95 mask, and isolation gown on. Between patients, caregivers performed hand hygiene, then donned new gloves. This conservation strategy was used only when 2 successive patients had COVID-19 and the first patient had no other known infection. If caring for a person under investigation (PUI) or a patient with other known sources of infection, complete PPE doffing, hand hygiene, and full PPE donning were required before entering the new room (see Figure).

Caregivers' perceptions of safety, well-being, and anxiety improved significantly after the safety zones were implemented.

Research Question

A multidisciplinary study was designed to evaluate the staff members' perceptions of safety, workflow, teamwork, and caregiver well-being for the periods before and after the safety zones were implemented. The goal was to determine whether these perceptions improved among members of an interdisciplinary team caring for patients with COVID-19 and PUIs in the step-down/critical care and medical/surgical units.

Setting

The study was conducted in a midsized, 330-bed, acute-care, faith-based community hospital. The hospital employs more than 3000 caregivers; it is part of a large health care system and is located in one of the largest counties in the United States.

The setting for the study comprised the step-down/critical care unit and the medical/surgical unit. Only patients with confirmed COVID-19 were admitted to these units; patients with confirmed COVID-19 were not admitted to other units. The medical/surgical unit had 30 beds, and the step-down/critical care unit had 20 beds. The nursing staff consisted of only registered nurses.

Study Design

We used a descriptive correlational design to retrospectively explore caregiver perceptions of patient safety, caregiver safety, workflow, teamwork, and caregiver well-being before and after the implementation of the safety zones in the COVID-19 units. Perception of patient safety was measured through caregiver responses to questions regarding staff fatigue, fatigue due to donning and doffing, and the risk of cross contamination. No patient data were collected during this study. Caregivers working on the 2 units were asked to take the survey but told that responding was optional. The respondents are a convenience sample. The health care system's institutional review board approved this study in June 2020.

Hospital Survey

Caregivers were asked to complete an anonymous survey with 15 questions. The survey questions were created by the Infection Prevention Team at the study site because a validated survey addressing the topics of interest was not available. The question responses were placed on a 5-point Likert scale (strongly disagree through strongly agree). Each question was asked twice. For the first response, caregivers were asked to recall how they felt before implementation and answer accordingly. For the second response, participants were asked for their postimplementation opinion. In addition, each participant was asked to provide their ethnicity, their gender, the unit on which they worked, and other demographic information (see Tables 1 and 2).

Caregivers were made aware of the study and the opportunity to participate via unit-based huddles and flyers placed within the patient care units and staff break areas. The survey was available via a quick response (QR) code on the flyer. The survey opened on June 10, 2020 and closed on June 21, 2020, with caregivers having access for 11 days. The survey was administered by using Survey Monkey.

Statistical Analysis

Descriptive statistics were used to summarize study results. Means and standard deviations were

used for continuous variables, whereas percentages were used for categorical variables. The difference between each respondent's preimplementation and postimplementation scores was calculated for each survey question. Because the survey responses were not normally distributed, a Wilcoxon signed rank test was used to assess the changes in participants' perceptions after the implementation of the safety zones. (The Wilcoxon signed rank test is a nonparametric alternative of the paired *t* test; it is also known as a "within-subject" test.) The significance level was set at a *P* value of .05. We used the SAS Enterprise Guide (SAS Institute) to complete all statistical analyses for this study.

The Kruskal-Wallis test was used to study the effects of the intervention on various categories of health care workers: nurses, physicians, patient care technicians, and others. The category of others included physical therapists, speech therapists, respiratory therapists, imaging technicians, laboratory staff, transportation staff, and environmental services staff.

Results

A total of 132 caregivers participated in the survey. Not all caregivers answered each question. The majority of participants were female (67%), nurses (54%), and age 50 or younger (72%); 72% of participants worked predominantly on day shifts, and 65% of participants had been employed between 2 and 15 years (Table 1, Table 2).

Survey results (Table 3) revealed that the intervention had statistically significant positive effects in areas related to safety. Caregivers felt that their own safety improved (mean difference = 0.43, $P < .001$). Participants also felt that there were reductions in unit contamination (mean difference = −0.27, $P = .002$), patient risk related to staff fatigue (mean difference = −0.23, $P = .03$), and patient risk related to cross contamination (mean difference = −0.38, $P < .001$). Among 2 groups, a statistically significant difference ($P = .03$) was seen in the perception of patient safety due to staff fatigue: physicians reported the highest level of reduction (mean difference = −0.64), and caregivers classified as others reported the lowest level of reduction (mean difference = −0.04). Although there was an overall reduction in perception of patient safety being at risk due to cross contamination, there were no statistically significant differences between disciplines ($P = .62$).

Staff perceptions of collaboration within the multidisciplinary team (mean difference = 0.22, $P < .001$) significantly improved. Significant improvements were also seen in staff perceptions of well-being: anxiety over the extended use of PPE reduced after the zones were implemented (mean difference = −0.61, $P < .001$), as did fear of exposure (mean difference = −0.66, $P < .001$). There was no notable impact on perceptions of teamwork ($P = .23$) or workflow ($P = .69$).

Table 2
Demographics of study participants (N = 132)[a]

Demographic characteristic	No. (%) of participants
Sex	
Female	89 (67)
Male	43 (33)
Age range, y	
20-30	24 (18)
31-40	41 (31)
41-50	30 (23)
51-60	24 (18)
≥ 61	13 (10)
Shift	
Day	95 (72)
Night	37 (28)
Years of employment	
<2	24 (18)
2-5	48 (36)
>5-15	38 (29)
>15-25	12 (9)
>25	10 (8)
Nursing unit	
5 North	64 (48)
Step-down	39 (30)
Both	29 (22)
Ethnicity	
African American	2 (2)
Asian/Pacific Islander	60 (45)
Hispanic	19 (14)
Middle Eastern	6 (5)
Multiracial	2 (2)
Prefer not to answer	12 (9)
White	31 (23)
Education	
Associate degree	16 (12)
Bachelor's degree	56 (42)
Graduate degree	46 (35)
High school degree or equivalent	3 (2)
Some college but no degree	11 (8)

[a] Because of rounding, the sum of percentages for a category may not total 100.

Discussion

This study aimed to assess whether caregivers' perceptions of safety, workflow, caregiver well-being, and teamwork improved after safety zones were implemented in our COVID-19 units. Innovative methods to safely care for patients and conserve PPE became critical as the world faced a massive PPE shortage during the pandemic.[13] Our results show that after implementation, caregivers had better perceptions

Table 3
Caregiver perceptions for the periods before and after zone implementation

Statement	No. of respondents[b]	Mean score[a]		Mean difference[c]	*P*[d]
		Before intervention	After intervention		
I felt safe while caring for a COVID-19 patient with the PPE provided.	119	3.42	3.85	0.43	<.001
I considered the entire unit as being highly contaminated.	121	3.34	3.07	–0.27	.002
Patient safety was at risk because of staff fatigue.	110	3.08	2.85	–0.23	.03
Patient safety was at risk because of cross contamination.	110	3.21	2.83	–0.38	<.001
The staff functioned as a team.	99	4.08	4.17	0.09	.23
I felt I could rely on my coworkers to help when I needed something.	102	4.13	4.19	0.06	.69
I felt responsible to colleagues in caring for COVID-19 patients.	99	4.07	4.29	0.22	.006
There was heavy multidisciplinary collaboration in caring for a COVID-19 patient.	103	3.91	4.13	0.22	<.001
There was no distinct area for donning and doffing.	92	3.17	2.21	–0.96	<.001
Donning and doffing created fatigue.	108	3.67	3.06	–0.61	<.001
I worried about forgetting supplies or equipment necessary when going into the patient care room.	97	3.93	3.26	–0.67	<.001
Donning and doffing took too much time away from patient care.	98	3.70	2.93	–0.77	<.001
I felt intense fear of exposure to COVID-19.	97	3.72	3.06	–0.66	<.001
I felt anxious about coming to work.	109	3.66	3.05	–0.61	<.001
I use healthy coping mechanisms at work.	83	3.04	3.55	0.51	<.001

Abbreviation: PPE, personal protective equipment.

[a] Scores were on a Likert scale from 1=strongly disagree to 5=strongly agree.
[b] Total number of survey participants was 132 caregivers; however, no participant answered all the questions. Missing responses for the questions ranged from 5 to 34. Only participants who provided their opinions both before and after the intervention were included in the review.
[c] A negative mean difference indicates a lower score after implementation.
[d] The *P* values (from Wilcoxon signed rank test) are for the mean differences from the period before to the period after the safety zones were implemented. A *P* value less than .05 indicates that the score for the postimplementation period differed significantly from the score for the preimplementation period.

of staff safety, patient safety, and staff collaboration while experiencing less fatigue, anxiety, and fear of cross contamination. These findings suggest that despite the global fear and uncertainty caused by the pandemic, an innovative safety zone process improved caregivers' perceptions of their ability to deliver care that was safe for both themselves and their patients.

Strategies to conserve PPE must address potential risk of spreading other infectious organisms among patients.

Teamwork and workflow were less affected by the implementation of the safety zones; this finding may be attributed to the increased workload associated with caring for critically ill patients with a novel disease. Future studies on the effects of an evolving global pandemic are needed to assess how caregiver perceptions change over time.

Unintended consequences of the PPE conservation strategies may lead to the spread of either SARS-CoV-2 or other infectious organisms among patients. Patients critically ill with COVID-19 tend to be at high risk for other infections as well; thus, the extended use of gowns could increase the risk of spreading multidrug-resistant organisms (MDROs). Therefore, to protect other patients, gowns should be changed before and after treating patients with known MDRO coinfections or colonization. Close attention to state and county department health reports of other harmful organisms should be a focus of the infection preventionists working within a facility to identify increased areas of risk. The potential spread of MDROs should be carefully examined when the extended use of isolation gowns and safety zones are implemented.

Limitations

The questionnaire used for measuring staff perceptions was not validated. Therefore, validated tools should be used in future research on this topic. The results related to teamwork and workflow warrant further review because statistically significant differences were not found. Furthermore, the use of a convenience sample in a single hospital may have introduced selection bias and limited the generalizability of the study results.

No survey participants answered all the questions. The number of unanswered survey questions ranged from 5 to 34. Only participants who provided answers for both the preintervention and postintervention periods were included. The reason for staff members skipping questions is unknown, although it may have been due to increased workload caused by the surge in and higher acuity of patients with COVID-19. All surveys were answered by participants while they were working on their shifts; participants may have been interrupted because patients needed care.

Additionally, participants were asked to complete the survey for both the preimplementation and postimplementation periods at the same time; hence, memory-related inaccuracies might have been introduced. An increase or decrease in the respondent's comfort level with caring for patients with COVID-19 or PUIs by the time the caregiver was responding to the survey questions may have affected the results. Last, survey fatigue may have contributed to the incomplete surveys submitted by caregivers.

Conclusion

Participants perceived that after the safety zones were implemented, caregiver safety was improved and patient risks related to staff fatigue and cross contamination were reduced. The safety zone process also reduced caregivers' perceived level of anxiety. Although the global pandemic caused fear, uncertainty, and weariness for caregivers, implementing innovative methods of delivering safe care while conserving PPE improved caregiver perceptions of safety, well-being, and collaboration within a multidisciplinary team. Further research and the validation of the tool are necessary to ensure that caregivers feel safe providing care during pandemics or outbreaks of infectious illnesses. In areas with a high risk of MDRO transmission, the safety zone process should be implemented without PPE conservation.

FINANCIAL DISCLOSURES
None reported.

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