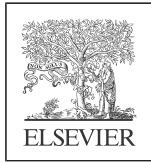




Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



## A study of Indiana University Health's spirit of inquiry and innovation during COVID

Janet S. Carpenter, PhD, RN, FAAN<sup>a,\*</sup>, Claire B. Draucker, PhD, RN, FAAN<sup>a</sup>,  
Rebecca J. Bartlett Ellis, PhD, RN, ACNS-BC<sup>a</sup>, Melora D. Ferren, MSN, RN, NPD-BC<sup>a,b</sup>,  
Jason H. Gilbert, PhD, RN, NEA-BC<sup>b</sup>, Robin P. Newhouse, PhD, RN, FAAN<sup>a,b</sup>,  
Diane Von Ah, PhD, RN, FAAN<sup>a</sup>

<sup>a</sup>Indiana University School of Nursing, 600 Barnhill Drive, Indianapolis, IN, 46202

<sup>b</sup>Indiana University Health, Fairbanks Hall, 340 W. 10th Street, Indianapolis, IN 46202

### ARTICLE INFO

#### Article history:

Received 29 January 2021

Received in revised form

23 June 2021

Accepted 28 June 2021

Available online July 8, 2021.

#### Abbreviations:

COVID-19: novel coronavirus disease 2019

PPE: personal protective equipment

#### Keywords:

Pandemic

Nursing innovation

Nursing leadership

Clinical care

Qualitative

research

### ABSTRACT

**Background:** COVID-19 has required nursing innovations to meet patient care needs not previously encountered.

**Purpose:** The purpose of this study was to describe nursing innovations conceived, implemented, and desired during the first COVID-19 surge.

**Methods:** The investigators invited registered nurses employed across 16 Midwest hospitals (6,207) to complete the survey. Respondents provided demographics and written descriptions of innovations they conceived, witnessed, and desired. Investigators analyzed text responses using standard content analytic procedures and summarized quantitative demographics using percentages.

**Findings:** Nurses reported seven types of innovations that would (a) improve personal protective equipment (PPE), (b) limit the need to repeatedly don and doff PPE, (c) ensure safer practice, (d) conserve and access supplies, (e) provide patient and family education and support, (f) make team member communication more efficient, and (g) improve peer support.

**Discussion:** Nurses are in a unique position to generate innovative solutions to meet patient care needs under adverse and rapidly changing situations.

**Cite this article:** Carpenter, J.S., Draucker, C.B., Ellis, R.J.B., Ferren, M.D., Gilbert, J.H., Newhouse, R.P., & Von Ah, D. (2022, January/February). A study of Indiana University Health's spirit of inquiry and innovation during COVID. *Nurs Outlook*, 70(1), 137–144. <https://doi.org/10.1016/j.outlook.2021.06.019>.

### Introduction

The novel COVID-19 pandemic has created unprecedented clinical demands on nurses in acute care

settings. Rising cases during the first wave of the pandemic in the United States (March–August 2020) resulted in a sudden influx of hospitalized patients. Nurses managed patients with sparse evidence to guide care for people with a never-before-seen

Conflict of interest: Dr. Carpenter reports: personal fees from RoundGlass Inc, Astellas Pharma Inc, Kappa Santé, Sojournix, Mapi/ICON, and University of Wisconsin Milwaukee; and research grants to her institution from QUE oncology. Dr. Ellis reports research grants to her institution from Beckton Dickinson. Ms. Ferren and Drs. Draucker, Ellis, Gilbert, Newhouse, and Von Ah have nothing to disclose.

\*Corresponding author: Janet S. Carpenter, Indiana University School of Nursing, 600 Barnhill Drive, NU338, Indianapolis, IN, 46202

E-mail address: [carpentj@iu.edu](mailto:carpentj@iu.edu) (J.S. Carpenter).

0029-6554/\$ - see front matter © 2021 Elsevier Inc. All rights reserved.

<https://doi.org/10.1016/j.outlook.2021.06.019>

critical illness under conditions of rapidly changing information.

The state of working “on the edge of evidence” (Weberg & Davidson, 2020) is known to fuel innovations in health care. However, little is known about nursing innovations implemented in response to the COVID-19 pandemic. Published articles have focused on single innovations (Kettle, 2020; Roberts, 2020) or multiple innovations used within a single setting (Loewenstein et al., 2020). For example, Kettle et al. (2020) described using video chats for communication between the healthcare team and families during patients’ intensive care unit stays, and Loewenstein et al. (2020) described the use of virtual town hall meetings, a care algorithm, and use of telehealth on a mental health unit. However, no published reports have delineated and described a range of innovations conceived, implemented, and desired by acute care nurses in a large healthcare system during the pandemic.

Nurses throughout history have innovated their practices to improve patient outcomes and save lives. Nursing innovations have been especially evident when nurses practice in remote areas, developing countries, and combat settings or when they care for persons affected by natural disasters, epidemics, or pandemics (Sarnecky, 2007). Florence Nightingale innovated handwashing and basic sanitary processes during the Crimean War. Nurses practicing during the Spanish Flu pandemic of 1918 innovated nursing care practices to reduce transmission of the virus. During these and other historical events, the innovations nurses implemented demonstrate nurses’ abilities to adapt their practice under adverse and rapidly changing conditions (Newby et al., 2020).

## Conceptual Model

---

Healthcare systems globally will need to identify and support the diffusion of nursing innovations driven by the evolving COVID-19 pandemic. An understanding of what innovations are present in a healthcare system is the basis of the Conceptual Model for Considering the Determinants of Diffusion, Dissemination, and Implementation of Innovations in Health Services Delivery and Organization. This framework describes new processes or products and how they become applied in clinical settings (Greenhalgh et al., 2004). However, before applying the framework to support the diffusion of innovations in the care setting, we first need to know more about what innovations nurses had conceived, implemented, and desired during the COVID-19 pandemic.

## Purpose

---

The purpose of this article is to report descriptive qualitative findings on nursing innovations driven by the

first surge of the COVID-19 pandemic. Consistent with the guiding conceptual model, we sought to understand new processes and products conceived, witnessed, or desired by acute care nurses in our state’s largest healthcare system. The findings will allow us to describe a variety of innovative practices from the nurses’ perspectives and create a historical record of nursing innovations in our healthcare setting. This information will help nursing administrators and clinical nurses implement innovations during the remaining months of the pandemic or in future pandemic or disaster situations. The findings will also provide foundational knowledge for teams of nurses, engineers, industry partners, and others who seek to develop nursing innovations to improve patient care delivery.

## Methods

---

### Design and Sample

We conducted a cross-sectional, descriptive, electronic study of nurses employed by a major healthcare system in a midwestern state in August of 2020. Of the 16 acute care facilities in the healthcare system, seven have achieved Magnet® designation and 8 Pathway to Excellence® designation from the American Nurses Credentialing Center. All Registered Nurses employed on acute care units in these hospitals received an invitation to participate ( $n = 6,207$ ).

### Data Collection

We created an investigator-designed, electronic data collection tool to elicit quantitative demographic data about the nurse participants and qualitative descriptive data about innovations. Authors iteratively created the tool and then submitted it to the nursing shared leadership committee of the healthcare system for additional feedback. The authors used feedback received from 5 leaders to finalize the tool. The tool began with two short paragraphs that defined innovation and described the purpose of the study, the research partnership between the school and healthcare system, and participant rights, including a statement that completion indicated willingness to participate in the study. Nurses answered demographic questions and three open-ended questions: “During the past four months in relation to COVID-19, did you... (1) think of any innovations, (2) witness any innovations, and (3) wish for any innovations?” Nurses marked yes or no to each question. If they marked yes to a question, the tool prompted them to describe the innovations in a text box that would accept up to 1,000 words. The team obtained institutional review board approval.

Healthcare system leaders distributed the data collection tool through electronic assignment within a shared learning platform in mid-August 2020. The tool

was visible to each nurse for 14 days within their learning plans allowing nurses to ignore or complete the questions. After 14 days, the tool disappeared from the nurses' learning plans regardless of whether they completed it.

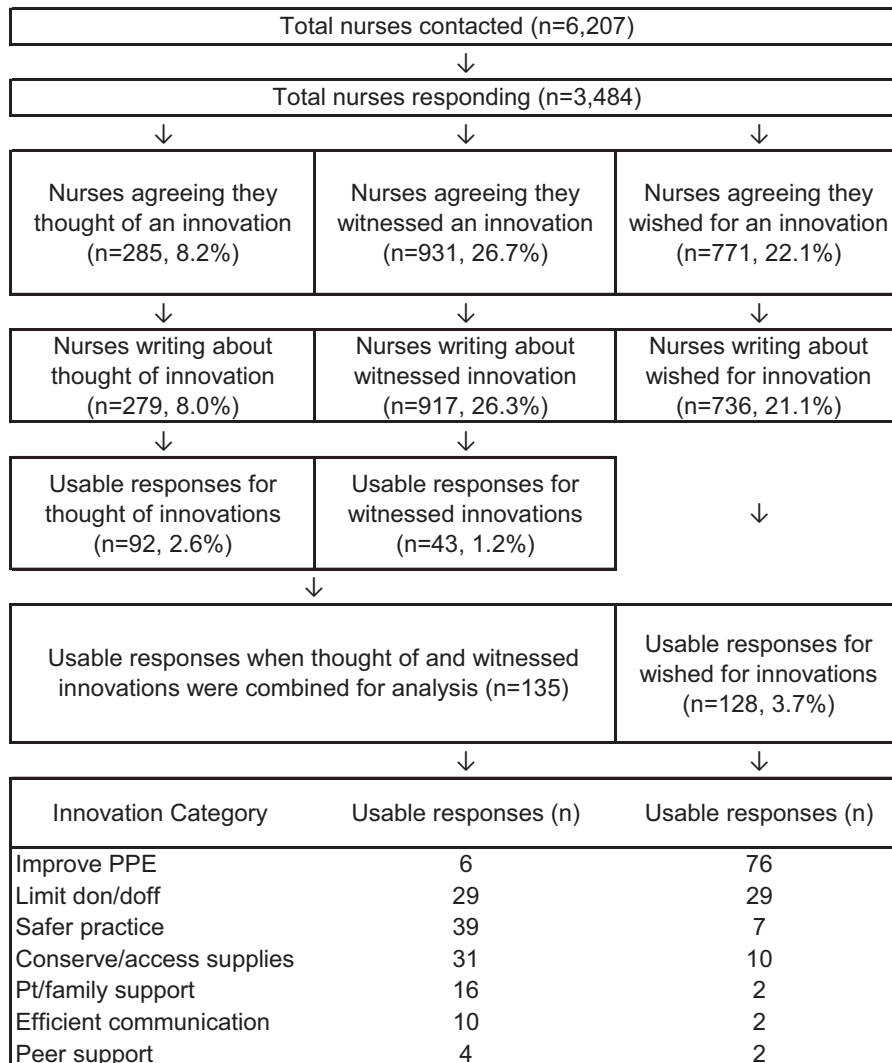
**Data Analysis**

Two team members analyzed qualitative data using standard content analytic procedures as described by Miles, Huberman, and Saldaña (Miles et al., 2014). Both authors read all text provided in response to the three questions. One author then coded each relevant segment of text with a label to capture the essential meaning. Authors grouped similar codes and organized them into categories. Another author reviewed the codes and categories with a reexamination of the data. The two team members reached consensus on the final categories through electronic discussion. Investigators analyzed quantitative demographics using percentages.

**Findings**

As shown in Figure 1, 3,484 out of 6,207 nurses across 16 facilities and a float pool completed the data collection tool for a 56% response rate. Most nurses reported they had cared for patients with COVID-19 (72%, n = 2,502). The mean number of years in nursing was 10.67 (SD = 11.15), and 23% of nurses held specialty certification (n = 791). Thirty-eight percent were 20-29 years old (n = 1,332), 26% were 30-39 years (n = 919), 16% were 40-49 years (n = 572), 13% were 50-59 years (n = 461), 6% were 60-69 years (n = 220), and 0.5% were 70+ (n = 17).

We determined the number and percentages of participants (a) who said yes to each question, (b) who wrote a response in the text boxes, and (c) whose responses provided usable data. Usable data were responses that clearly described an innovation. Examples of data that were not usable included generic responses (e.g., "see previous response"), vague



**Figure 1 – Flow of Data.**

responses (e.g., “multiple”), or responses not describing an innovation (e.g., “the [unit name] at [location]”). As seen in [Figure 1](#), 8.2% of the nurses indicated they had thought of an innovation ( $n = 285$ ), 26.7% indicated they had witnessed an innovation ( $n = 931$ ), and 22.1% indicated they wished for an innovation ( $n = 771$ ). Of these, 2.6% provided usable textual data related to innovations they thought of ( $n = 92$ ), 1.2% for innovations they witnessed ( $n = 43$ ), and 3.7% for innovations they wished for ( $n = 128$ ).

Textual responses to the first two questions (i.e., innovations thought of and innovations witnessed) overlapped a great deal. Many nurses wrote the same answers to both questions and/or wrote about innovations that others had implemented or that they had personally incorporated into their everyday practices. For these reasons, we pooled responses to the first two questions for the qualitative analysis. We report responses to the third question (i.e., innovations wished for) separately as these responses were generally about innovations the nurses believed were needed but had not yet been implemented or were not available to them.

We identified seven categories of innovations described by the participants. The categories included innovations to (a) improve personal protective equipment (PPE), (b) limit the need to repeatedly don and doff PPE, (c) ensure safer practice, (d) conserve and access supplies, (e) provide patient and family education and support, (f) make team member communication more efficient, and (g) improve peer support. [Figure 1](#) shows the flow of data that supported these seven categories. Below we provide descriptions of each category with examples of specific innovations identified by the nurses.

### **Innovations to Improve PPE**

Eighty two responses were about innovations to improve PPE. Six responses in this category were about innovations the nurses had thought of or had witnessed in their practice. For example, some nurses reported using new cleaning methods to sanitize N95 masks and three dimensional printed ear savers to use with masks to improve comfort. Others used tape or tissues over their masks to prevent their glasses from fogging up. One nurse observed the use of transparent face masks with patients who were deaf so they could lip-read what the nurses said.

Seventy-six of the responses in this category, however, were about innovations nurses desired. Many nurses simply indicated they desired better PPE. Others wanted better ways to clean, sanitize, and re-use masks, face shields, and other PPE. Many wished for more comfortable PPE. They wanted more breathable and cooler gowns, more breathable and less suffocating masks, PPE that did not hurt the bridge of the nose or ears, headbands with ear protectors, masks that were less scratchy, and masks that caused less acne. One nurse wanted a

better way or better machine to conduct fit testing for masks.

Some nurses desired changes in PPE designs. They wanted PPE designed for R naught conditions (i.e., extremely contagious or infectious diseases), in the form of safety isolation suits, or anti-bacterial or silver infused for better protection. Some nurses wanted masks that came in different varieties, masks that would stay on, and goggles and masks integrated into one-piece. Others desired PPE that came in different sizes and was longer for taller or larger framed bodies. One nurse wanted the hospital to provide hats to cover hair. Nurses also wanted improvements so that PPE did not hinder care delivery. One nurse wanted a better way to communicate with patients while wearing a power air purifying respirator hood. Some nurses desired PPE that allowed for easier donning and doffing.

Many nurses wished for PPE with improved visibility for providing care. They wanted PPE that would prevent fogging or streaking of glasses, goggles, and face shields. Others wanted PPE that allowed patients to see their faces and mouths for better communication and/or lip-reading.

### **Innovations to Limit Need to Repeatedly Don and Doff PPE**

Fifty eight responses were about innovations to limit the need to repeatedly don and doff PPE. Twenty-nine responses in this category were about innovations the nurses had thought of or witnessed in their practice. These nurses made changes to care delivery, including “batching pharmaceuticals,” creating a turning schedule that minimized the number of times two people had to enter COVID-19 rooms, and verifying medications through glass windows to allow one nurse to remain outside the patient room. Other nurses turned off or remotely silenced alarms or moved intravenous poles and/or ventilators outside of patient rooms so they would not have to don and doff PPE to adjust.

Other nurses described new ways to communicate so that only one nurse wearing PPE could remain inside the patient room. They used both high-tech and low-tech methods for more efficient team member-to-patient and team member-to-team member communication. These methods included using the call light system, room phones, baby monitors, walkie-talkies, earpieces, and writing on whiteboards, doors, and windows. The team used these ways of communicating to assess patient needs before nurses entered patient rooms, make lists of needed items for the next time nurses were to enter patient rooms and make lists for runners or others to bring needed supplies to the room.

Twenty nine of the responses in this category were about innovations nurses desired. Some nurses identified tasks that required frequent donning and doffing, including monitoring patient status and tending to intravenous pumps. Many indicated that the solution to frequent donning and doffing entailed new ways to provide care remotely. Several nurses indicated they

wished for means to titrate intravenous meds, adjust intravenous drip rates, and reach and control intravenous tubing and pumps from outside the room. Others wanted the ability to turn off bed alarms or other nuisance alarms without having to reapply PPE and re-enter patient rooms. Some nurses wanted ways to monitor blood glucose levels, blood pressures, or electrocardiograms from outside the room. One nurse desired a ventilator that would automatically activate suctioning. Some nurses wished for heads-up displays or other monitors to have remote access to visualize and assess patients. Others wanted better ways of answering the phone to speak with physicians or others without leaving the patient's room.

### ***Innovations for Safer Practice***

Forty six responses were about innovations for making practice safer. Thirty nine responses in the category were about innovations the nurses had thought of or had witnessed in their practice. For example, some nurses rearranged the physical layout of patient rooms to allow safer workflow. Others used supplies in new ways to enhance patient safety. Several repurposed waffle mattresses to hold patients during manual proning and wrist restraint straps to assist with this. Other nurses used device stabilization locks, foley holders, and homemade wooden holders to keep lines off the floor; taped biohazard bags to the outside of patient doors so they could drop in laboratory tubes without contamination; created red boxes of supplies for high acuity patients; placed buckets or baskets outside patient rooms to retrieve supplies brought by runners, and added armbands to intravenous poles placed outside of patient rooms. To prevent exposure, other nurses covered toilets with plastic-backed disposable bed pads when flushing and covered patients with clear plastic boxes, ponchos, or shower curtains during invasive procedures. One nurse observed the use of a self-containment liner for a transport plane to help decontamination between patients.

Several of the nurses described innovations for safer practice that required new roles. One nurse mentioned a donning and doffing champion who taught others proper procedures to use, and a couple of nurses mentioned utilizing a manual prone team that could intubate, line, and lead the proning of a patient. Other nurses used runners to obtain needed supplies so nurses could remain inside COVID-19 rooms to monitor patients.

The nurses also revealed new practices to enhance patient safety. Several nurses observed changes to care delivery protocols, including testing all patients at high risk for COVID-19 exposure, creating new care planning protocols, and implementing enhanced PPE requirements for code blue protocols for patients with COVID-19. Nurses also made donning and doffing protocols visible to ensure safety.

Seven responses in this category were about innovations nurses desired. They wanted pockets or bags to

store charts when transporting patients, specific types of intravenous cannulas, and walk-through decontamination stations. One nurse wished for automated methods to track patients during transport through the hospital, and others wanted better ways to transfer supplies into and out of patients' rooms.

### ***Innovations to Conserve and Access Supplies***

Forty one responses were about innovations for conserving and accessing supplies. Thirty one responses in this category were about innovations nurses had thought of or witnessed in their practice. Many moved supplies to make them more accessible and ready to use. They posted measuring tapes inside patients' doorways for height measurements and taped plastic bags containing cleaning wipes inside patient rooms. Some placed PPE just outside patient rooms, attached PPE to the doors of patient rooms, or carried PPE in containers around their waists. To increase accessibility of supplies, some nurses reorganized supply carts, created special carts and grab-and-go packets, and bundled supplies. For example, they made a special surgical cart for obstetrical patients with COVID-19, prepped bags for intubation and fluid boluses, and kept carts with airway and oxygen devices in one place.

Some nurses used innovations to conserve supplies. They moved supplies away from patients to prevent contamination. One advocated for a change in the unit's intravenous line change policy so that nurses would not change lines more quickly than hospital policy required. Other nurses kept masks that were part of central line or dressing kits. One nurse saved individual blood pressure cuffs in labeled zip lock bags for patients who frequently returned to the unit for care. Others repurposed supplies by using plastic sandwich containers for PPE mask storage devices, substituting radiation gowns for PPE, and using surgical drapes and sterile packaging for masks. Although never used on patients, new ventilator connectors were three dimensional printed so the team could use one ventilator for multiple patients. Other nurses placed cameras and televisions in some rooms to communicate during patient rounding.

Ten responses in the category were about desired innovations, and most of these were related to improved PPE storage. Nurses wanted better systems to organize and store PPE, so it was ready for use and rapid deployment. In addition, one nurse wanted automated patient carts for moving supplies.

### ***Innovations for Patient and Family Education and Support***

Eighteen responses were about innovations to educate and support patients and families. Sixteen of the responses in the category were about innovations nurses had thought of or witnessed in practice. Several nurses used new types of electronic and paper educational materials. For example, one developed a COVID-



19 educational pamphlet and another a web-based instruction video for spirometer teaching. Nurses also altered their educational practices to incorporate remote or recorded teaching. For example, one nurse provided chemotherapy education virtually in advance of patient visits or in waiting rooms because families could not enter clinic rooms. Another nurse recorded discharge teaching so patients could share it with their families at home. In addition, nurses implemented a new family stressor assessment, created roles for family and patient liaisons, used technology such as electronic tablets to connect nurses and patients to families, and wore photos of themselves so patients could see them despite the PPE. One nurse provided coloring and activity pages to patients who could not have visitors.

Two responses in this category were about innovations the nurses desired to support patient and family education. Some wanted additional technology to make it easier to connect patients with families. One nurse acknowledged the current technology required a lot of nurse time to connect patients to their families virtually. Another nurse called for better virtual connection methods such as voice-enabled video dialing.

### ***Innovations for More Efficient Team Member Communication***

Twelve responses were about innovations for more efficient team member communication. Ten responses in this category were about innovations the nurses had thought of or witnessed in their practice. Some nurses used innovations to improve communications between shifts; they revamped report sheets, used pencils for shift report sheet updates, and created a group text thread to update evening nurses about changes in procedures that had occurred during the day. Several nurses used signage to communicate important information. They used color-coded cards and other signs to communicate COVID-19 testing status and test results. For example, one nurse reported seeing a red taped "X" on a patient's mask to indicate an oral airway was in place under the mask. Some nurses also put circles on laminated supply sheets to easily communicate to a runner to bring needed supplies, used a system of colored squares in patient areas to denote COVID-19 testing status, and developed a system of turning lights on or off to denote whether rooms were clean or dirty.

Two responses in this category were about desired innovations. Nurses wanted ways to chart more efficiently in general or specified wanting automated or transcription-type charting for easier documentation.

### ***Innovations for Peer Support***

Six responses were about innovations to support their peers. Four responses were about innovations that nurses had thought of or seen in their practice. These nurses described an oasis room for relaxation, an

evidence-informed peer support program with a repository of resources, and flexible staffing models, including the ability to work from home. Two responses were about innovations nurses desired. These nurses wanted innovations that might help with morale or provide better ways for nurses to feel supported and protected.

## **Discussion**

We identified seven categories of nursing innovations identified by nurses working in major healthcare system during the first surge of the COVID-19 pandemic. The categories included innovations to improve PPE, limit the need to repeatedly don and doff PPE, ensure safer practice, conserve and access supplies, provide patient and family education and support, make communication more efficient, and improve peer support.

Technology played a key role in many of the innovations discussed by the nurses, consistent with the acceleration of technologies seen during the pandemic (Harrington, 2020). They identified how technology could provide remote monitoring and care and improve communication between team members or between patients and team members. Other innovations involved small but astute practice changes that did not require technology, including rearranging the placement of supplies, re-purposing the use of equipment, and finding new ways to organize workflow.

Innovations identified in this study bear some similarities and differences to the eight types of innovations identified by 24 academic nursing faculty and staff and 33 nurses in an academic health center (Joseph et al., 2019). The innovations presented in the report were to "create care delivery models, transform processes to improve care, develop patient care interventions, advance research and translational methods, facilitate communication and collaborations, harness technology and data, enable role transitions, and develop teaching methods."<sup>6</sup> Two of the innovations identified in our study resonate with these innovations. Our category of innovations for patient and family education and support is similar to innovations to "develop teaching methods." Our category of innovations for more efficient team member communication is similar to innovations to "facilitate communication and collaborations." The remaining categories from our findings are difficult to place within the typology of Joseph et al. and may reflect the nature of nursing innovations developed in response to a pandemic or other natural disaster.

The first two categories of innovations (i.e., innovations to improve PPE and innovations to limit the need to repeatedly don and doff PPE) provide rich data to guide specific PPE improvements and support the need for investing in such improvements. The nurses' responses substantiate that convenient, functional, and comfortable PPE is a top priority and currently

available PPE is far from ideal. PPE limitations forced the nurses to create workarounds that reflected their ingenuity but also created frustration and stress. This finding is substantiated in a survey of 153 American nurses, which revealed workarounds were highly correlated with nurse stress ( $r = 0.70, p < .001$ ) (Heron & Bruk-Lee, 2020). Identifying workarounds can help uncover limitations in available technologies, typical care delivery processes, and physical environments (Litwack, 2018; van der Veen et al., 2020; Yoder-Wise, 2015) but need to be replaced with viable and sustainable innovative solutions (Litwack, 2018). Leaders should view nurses' workarounds related to PPE as instances of innovative or creative practices (Nelson-Brantley et al., 2020) but also as a signal to the critical need to ensure that PPE in the long-term is widely available, safe, and effective, and acceptable to the nurses who require it.

### Strengths and Limitations

This study had strengths and limitations. The investigators designed the data collection tool using an iterative process of improvement to create clear and understandable items for respondents. Respondents utilized open text boxes appropriately to provide meaningful narrative data. Because only some participants who completed the survey reported innovations in response to the open-ended questions, we cannot conclude we have identified all the innovations this group of nurses considered. However, the nurses who did respond to the open-ended question provided ideas about a wide-range of innovations and indicated those which were particularly important to them.

In terms of limitations, all data were from one healthcare system in one midwestern state, and 95% of the facilities were American Nurses Credentialing Center designated. Thus, the system may not be representative of other healthcare systems throughout the country or world. Because of the hectic pace of clinical practice during the pandemic, not all nurses who wished to respond may have had time to do so. Another limitation is the overlap of the responses to question one and two, possibly due to participant interpretation. If we repeat this study, we will likely reword the questions to clarify our intent and ask about (a) innovations participants thought of and implemented in their practice, (b) innovations participants witnessed other team members implementing, and (c) innovations participants had thought of but not yet implemented or were unable to implement. We would have then likely asked about facilitators and barriers to implementing innovations and study the impact of these innovations on patient care. The latter was beyond the scope of this study but could reveal how innovations that are efficient and/or protect nurses may alter patient safety. Moreover, data collection occurred shortly after the initial surge of COVID-19 patients into the health system. During this time, rapid changes to information about care protocols, such as the Centers for Disease Control guidelines, and supply chain

disruption, might have contributed to the focus on PPE. Finally, it is not clear whether nurses will sustain these innovations in practice post-pandemic.

### Conclusions

The novel COVID-19 pandemic and the first surge in hospitalizations presented unique challenges for nurses providing patient care. Nurses in our study drew on their clinical experiences under pandemic conditions, considered multiple solutions to the conditions they experienced, and developed or imagined innovations to address unique critical patient care needs. Because many of these solutions call for technological advances, nurses can lead or serve on entrepreneurial and interdisciplinary product development teams that will design, build, and test novel healthcare technologies (Ulrich et al., 2020). Inventorying what innovations are present and/or desired in the healthcare system is the first step towards identifying and supporting their application in the clinical setting (Greenhalgh et al., 2004).

### Author Contribution

Carpenter, Janet S: Conceptualization, data analysis, writing, reviewing, editing. Draucker, Claire B: Data analysis, writing, reviewing, editing. Bartlett Ellis, Rebecca J: Conceptualization, survey design, writing, reviewing, editing. Ferren, Melora D: Conceptualization, survey design, survey distribution, writing, reviewing, editing. Gilbert, Jason H: Conceptualization, survey design, writing, reviewing, editing. Newhouse, Robin P: Conceptualization, writing, reviewing, editing. Von Ah, Diane: Survey design, writing, reviewing, editing.

### Acknowledgments

The authors thank the nurses who were caring for COVID-19 patients and took the time to answer the questions and share their responses. Funding: none.

### REFERENCES

- Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of innovations in service organizations: Systematic review and recommendations. *Milbank Quarterly*, 82(4), 581-629. Doi: [10.1111/j.0887-378X.2004.00325.x](https://doi.org/10.1111/j.0887-378X.2004.00325.x).
- Harrington, L. (2020). COVID-19 and the silver lining in health care technology. *AACN Advanced Critical Care*, 31(3), 250-253, doi:[10.4037/aacnacc2020955](https://doi.org/10.4037/aacnacc2020955).



- Heron, L., & Bruk-Lee, V. (2020). When empowered nurses are under stress: Understanding the impact on attitudes and behaviors. *Stress Health*, 36(2), 147-159, doi:10.1002/smi.2905.
- Joseph, M. L., Huber, D. L., Bair, H., Moorhead, S., & Hanrahan, K. (2019). A typology of innovations in nursing. *JONA: The Journal of Nursing Administration*, 49(7-8), 389-395, doi:10.1097/NNA.0000000000000773.
- Kettle, M., Kester, K., Cadavero, A., Floyd, S., Ornell, A., Meyer, M. H., & Granger, B. B. (2020). COVID-19: Mobilizing quickly for a rapid response. *AACN Advanced Critical Care*, 31(3), 326-333, doi:10.4037/aacnacc2020366.
- Litwick, K. (2018). Workaround, improvement, or innovation. *J Perianesth Nurs*, 33(4), 575-576, doi:10.1016/j.jopan.2018.05.008.
- Loewenstein, K., Saito, E., & Linder, H. (2020). Lessons learned from a mental health hospital: Managing COVID-19. *JONA: The Journal of Nursing Administration*, 50(11), 598-604, doi:10.1097/NNA.0000000000000943.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook*. Sage Third ed.
- Nelson-Brantley, H. V., Bailey, D., Batcheller, J., Caramanica, L., Lyman, B., & Snow, F. (2020). Disruptive innovation: Impact for practice, policy, and academia. *JONA: Journal of Nursing Administration*, 50(2), 63-65, doi:10.1097/NNA.0000000000000843.
- Newby, J. C., Mabry, M. C., Carlisle, B. A., Olson, D. M., & Lane, B. E. (2020). Reflections on nursing ingenuity during the COVID-19 pandemic. *The Journal of neuroscience nursing: journal of the American Association of Neuroscience Nurses*, 52(5), E13-E16, doi:10.1097/JNN.0000000000000525.
- Roberts, B., Wright, S. M., Christmas, C., Robertson, M., & Wu, D. S. (2020). COVID-19 pandemic response: #Development of outpatient palliative care toolkit based on narrative communication. *Am J Hosp Palliat Care*, 37(11), 985-987, doi:10.1177/1049909120944868.
- Sarnecky, M. T. (2007). Field expediency: How army nurses in vietnam "made do" An ability to improvise is a valuable nursing skill, on and off the battlefield. *AJN The American Journal of Nursing*, 107(5), 52-59, doi:10.1097/01.Naj.0000268170.33359.82.
- Ulrich, C. M., Rushton, C. H., & Grady, C. (2020). Nurses confronting the coronavirus: Challenges met and lessons learned to date. *Nurs Outlook*, 68(6), 838-844, doi:10.1016/j.outlook.2020.08.018.
- van der Veen, W., Taxis, K., Wouters, H., Vermeulen, H., Bates, D. W., van den Bemt, P., & Group, B. S. (2020). Factors associated with workarounds in barcode-assisted medication administration in hospitals. *J Clin Nurs*, 29(13-14), 2239-2250, doi:10.1111/jocn.15217.
- Weberg, D. R., & Davidson, S. (2020). *Leadership for evidence-based innovation in nursing and health professions*. Jones & Bartlett Learning 2nd edition.
- Yoder-Wise, P. S. (2015). Rethinking Workarounds. *J Contin Educ Nurs*, 46(7), 291, doi:10.3928/00220124-20150619-10.