

ORIGINAL ARTICLE

Dispatched nurses' experience of wearing full gear personal protective equipment to care for COVID-19 patients in China—A descriptive qualitative study

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Abstract

Aims and objectives: We explored dispatched nurses' experiences of wearing full gear personal protective equipment to care for patients with coronavirus disease-2019 (COVID-19) in Wuhan, China.

Background: Full gear personal protective equipment is the primary and foremost measure to prevent the contact and transmission of severe acute respiratory syndrome-coronavirus 2 (SARS-CoV2); however, working in full gear personal protective equipment may hinder nursing care activities and thus negatively affect patients' and nurses' health.

Design: This descriptive qualitative inquiry followed the COREQ guidelines.

Methods: Individual semi-structured telephone interviews were conducted in a purposive sample of 15 frontline nurses who were dispatched to the outbreak epicentre from March to April 2020. Verbatim transcripts were content analysed.

Results: Four themes emerged from the data: inadequate preparedness for working with full gear personal protective equipment, full gear personal protective equipment stimulated stress responses, coping strategies and professional growth. Participants learned a great deal from problem-focussed and emotion-focussed strategies to tackle challenges related to the prolonged wearing of full gear personal protective equipment for quality nursing care and reduced risk of exposure. They became more vigilant to the adherence to evolving protocols and appropriate training concerning full gear personal protective equipment use.

Conclusions: Frontline nurses confronted various but diminishing challenges related to the use of full gear personal protective equipment when caring for patients with COVID-19 across the approximate 40-day period. Consistent use of coverall personal protective equipment to protect from SARS-CoV-2 in high exposure settings would be feasible if nurses were better prepared; therefore, scenario-based skill training

concerning the prolonged use of full gear personal protective equipment should be offered regularly and intensively.

Relevance to clinical practice: This study informs future decisions concerning improved full gear personal protective equipment-related psychomotor training and promoting ways for nurses to cope with the stress that comes from working in highly contiguous environments.

KEYWORDS

clinical nursing research, coronavirus, experiential learning, infection control, nurses, occupational health, patient safety, personal protective equipment, qualitative study, severe acute respiratory syndrome-related coronavirus

What is already known about the topic?

- Continuous wearing of full gear personal protective equipment (PPE) is essential for direct patient care in isolation wards that may cause inconvenience and various discomforts.
- Nursing care for COVID-19 patients indicates the high risk of SARS-CoV-2 exposure and coronavirus disease-2019.
- Specific training for the use of full gear PPE is beneficial to the protection of nurses and patients in face of infectious diseases.

What this paper adds?

- The prolonged wearing of full gear PPE for direct nursing care for COVID-19 patients in isolation settings entailed negative and positive influences over health and professional practice.
- The major threat to nurses' competence at taking care of COVID-19 patients in isolation settings was the subjective unfamiliarity with working in fully geared PPE.
- Nurses could be better prepared for immediate care for COVID-19 patients if scenario based skill training on fully geared PPE was offered.

1 | INTRODUCTION

The coronavirus disease-2019 (COVID-19) outbreak is a global public health emergency. Since the beginning of the pandemic, the world has witnessed an astonishing increase in COVID-19 cases and related casualties in several countries and regions. Consequently, greater stress has been placed on the need to appropriately use of full gear personal protective equipment (PPE), primarily among frontline healthcare providers.

Awareness regarding the appropriate wearing of full gear PPE is key to controlling the contamination and transmission of severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2; the pathogen responsible for COVID-19) when treating infected patients in contagious settings. Continuous wearing of full gear PPE (i.e. being fully covered and not exposing any body part, through the use of goggles or face shield, coveralls and boot cover) poses great challenges to the supply of medical resources and undertaking of duties surrounding direct patient care, including administrative and treatment preparatory work in clean areas. Standard procedures for donning and doffing full gear PPE remain the same as those reported by Liu, Cheng, et al., (2020).

Previous outbreaks of highly infectious diseases such as Ebola virus disease and severe acute respiratory syndrome have informed

the effective use of full gear PPE for patient safety and infection control so far. However, little is known about the use of full gear PPE for a prolonged period, such as during this global outbreak of a highly contiguous disease, given the lack of effective vaccine and antiviral solutions.

2 | BACKGROUND

Wearing quality PPE is the primary and foremost strategy to reduce the exposure to the vector (e.g. patients with COVID-19) and the contamination of environments. PPE acts as a physical barrier to protect the wearer from contamination through respiratory droplets, body fluids or other contact routes (Beam et al., 2011; WHO, 2020a). To enhance the protection of healthcare workers, many experimental studies have determined the type and wearing methods of full gear PPE as well as the effects of specific training on full gear PPE use (Park, 2020; Verbeek et al., 2020; Williams et al., 2019). A recent literature review concluded that more body parts being covered by full gear PPE provided better protection, which was often associated with increased difficulty in donning and doffing PPE and reduced satisfaction among healthcare workers (Verbeek et al., 2020). An online survey and serological tests of 420 participants

(116 doctors and 304 nurses) showed that strict full gear PPE use provided adequate protection in settings with a high exposure to SARS-CoV-2 (Liu, Cheng, et al., 2020).

Self-contamination during the removal of contaminated PPE is known to be common among healthcare workers (Okamoto et al., 2019; Tomas et al., 2015), which increases the risk of transmission and threatens the safety of healthcare workers and other patients. Some evidence showed that healthcare workers' use of full gear PPE might be below the expectation for direct care of COVID-19 cases (Barratt et al., 2020), suggesting the need for more in-depth investigation concerning those who provide direct patient care.

Nonetheless, the protective efficacy of full gear PPE could be compromised by the adverse effects associated with the prolonged wearing of full gear PPE for patient care. Shaukat et al., (2020) and Tabah et al., (2020) found that majority of healthcare workers who were treating patients with COVID-19 experienced these adverse effects after wearing full gear PPE (e.g. excess heat, skin injuries, headaches, extreme exhaustion, thirst and minimal use of the bathroom). Yuan et al., (2020) further revealed that 83.72% of the studied nurses (108/129) had a higher incidences of rashes ($\chi^2 = 4.519$, $p < .05$) and dizziness ($\chi^2 = 4.213$, $p < .05$) compared with doctors, while those with fewer (<8.5) years of clinical experience had a higher rate of heat stress ($\chi^2 = 5.228$, $p < .05$) compared with their more experienced counterparts.

A qualitative study was conducted among dispatched physicians ($n = 4$) and nurses ($n = 9$) in the early rescue period (January–February 2020), focussing on their short experience (4–22 days) in isolated intensive care units (ICUs) caring for patients with COVID-19 using the phenomenological approach. Thematic findings centred on the professional obligation for patient care in high-risk conditions, physical and mental challenges and resilience in the face of viral pandemic challenges (Liu, Luo, et al., 2020). This study did not compare physicians' and nurses' experiences owing to their different roles in direct patient care. It was also difficult to determine whether these findings were associated with the use of full gear PPE as the inquiry employed open-ended questions instead of those focussed on different aspects of full gear PPE use.

Reflective practice has been a long-established mechanism that allows nurses to continuously learn from what occurred in the past and then generates new insights to inspire solutions for problems faced in the current practices for better patient outcomes (Asselin & Fain, 2013; Goulet et al., 2016). Currently, reflective practice is advocated as being 'more key than ever' for nurses to adapt and grow from their experiences with COVID-19 care (Dean, 2020). As stressed in Kolb's experiential learning cycle/spiral, the recursive process of experience, reflection, thinking/abstraction and action led to human growth or development (Kolb & Kolb, 2012). Gibbs' reflective cycle (Gibbs, 1988) grew out of the experiential learning cycle by structuring the reflection for action into six stages: describe (concrete experience), think (feelings and thoughts), evaluate (positive and negative aspects), analyse (make sense), conclude (what was learned and could be changed for better outcomes) and action plan (transform what was learned

into practice for positive change). This reflective cycle became the most well-known model for its clear-cut way of guiding reflective practice in nursing.

The dispatched nurses were assumed to bring more diversified perspectives to the use of full gear PPE compared with the local nurses who were overwhelmed at the beginning but adjusted eventually after the national rescue. This study thereby aimed to identify the strengths and weaknesses of the use of full gear PPE based on the responses of nurses dispatched during the initial outbreak of COVID-19 in Wuhan—the epicenter and the capital city of Hubei Province, Central China.

The National Health Commission coordinated the emergency response dispatching when local workforces and other resources were exhausted. Healthcare workers, mostly doctors and nurses, were selected from the most competent volunteers nationwide. The stronger the health facilities, the more likely that more healthcare providers were dispatched. Four batches of healthcare providers from January to March 2020 were sent to Wuhan from the target province. These providers had prestige and many experiences in disaster and emergency events as demonstrated in their achievements, peer assessments and personal narratives.

3 | METHODS

3.1 | Study design

A descriptive qualitative study design was adopted by referring to the Consolidated Criteria for Reporting Qualitative Studies (COREQ; Tong et al., 2007; see File S1).

3.2 | Sample selection

Purposive sampling was used to recruit registered nurses (RNs) from the roster (eligible participants [N] = 100), who provided direct care for inpatients with confirmed COVID-19 in Wuhan. They were voluntary rescue team members from four batches of teams dispatched from January 26 to February 9, 2020 (Table 1). To reach a wide range of sociodemographic characteristics, we used years of work experience, sex, and marital status as reference variables to identify potential participants for initial email contact. We excluded those who refused to participate or had severe discomfort, suggesting post-traumatic stress disorder (PTSD) according to team reports. The recruitment was discontinued when no new information was elicited; that is, the achievement of data saturation (Speziale et al., 2011).

The sending hospitals were three university affiliated tertiary hospitals with an average of 2,980 open beds and 1,850 full-time RNs per hospital in Shandong Province, East China. The receiving hospitals were four of the most exhausted with an average of 942 open beds and 1,365 RNs per hospital. Each rescue team took over one isolation unit in the receiving hospital and acted according to

TABLE 1 Participants' sociodemographic and work-related characteristics (N = 15)

Nurse	Age (years)	Sex	Years of work	Education level	Marital status	Children (n)	Receiving place		Sending place	Dispatchment batch			Key dates in 2020			
							Patients (n)	Hospital		Hospital	Department	Hospital	No.	Healthcare workers (n)	Nurses (n)	Arrival
RN1	39	F	14	Master	Married	1	1,294	D	Infectious disease	A	1	4	2	Jan. 26	Mar. 21	Apr. 5
RN2	33	F	8	Bachelor	Married	1			Respiratory medicine	A						
RN3	38	F	12	Bachelor	Married	1	1,937	E	ICU	A	2	3	2	Jan. 28	Mar. 21	Apr. 5
RN4	37	F	16	Bachelor	Married	1			Thoracic surgery	A	3	7	5	Feb. 2	Mar. 30	Apr. 14
RN5	31	M	6	Bachelor	Married	1			Neurosurgery	A						
RN6	38	M	15	Associate	Married	1			EICU	A						
RN7	28	M	9	Bachelor	Married	1			Neurosurgery	A						
RN8	32	F	7	Associate	Married	1			Neurosurgery	B	3	5	5	Feb. 2	Mar. 30	Apr. 13
RN9	42	F	16	Bachelor	Married	1	1,462	F	EICU	A	4	131	100	Feb. 9	Mar. 31	Apr. 15
RN10	44	F	23	Bachelor	Married	1			ICU	A						
RN11	28	F	6	Bachelor	Married	1			NICU	A						
RN12	42	F	21	Bachelor	Married	1			Urology surgery	A						
RN13	24	F	3	Bachelor	Single	0			NICU	A						
RN14	38	F	13	Bachelor	Married	1			Haematology	A						
RN15	31	F	7	Master	Married	2	1,238	G	Neurosurgery	C	4	131	100	Feb. 7	Apr. 7	Apr. 21

Note: RN: registered nurse; F: female; M: male; D: Huanggang Central Hospital; E: Sino-French Branch of Tongji Hospital Affiliated to Tongji Medical College; F: Optical Valley Branch of Tongji Hospital Affiliated to Tongji Medical College; H: East Campus of Renmin Hospital of Wuhan University; Hubei General Hospital; ICU: intensive care unit; NICU/EICU: neonatal/emergency ICU.

updated guidelines for critical care for patients with COVID-19. Once all admitted patients in the ward had either been discharged or had died, the dispatched healthcare workers reassumed their job duties after their 14-day mandated quarantine.

3.3 | Data collection

Of all the eligible participants, fifteen nurses consented to be a part of the study. The principal investigator (RN, Master of Nursing Science, female) initiated a telephone appointment and then proceeded with the semi-structured interviews using the pre-designed interview guide (see Appendix 1) to capture different stages of reflective cycle during the agreed timeslot from March to April 2020.

The pilot interview was performed by two eligible RNs. No changes were made to the interview guide or to the data collection procedures. Considering the impact of the pilot inquiry on analytic outcomes, we integrated the pilot interviews with the subsequent interviews for further analysis. Field notes were taken when something came to mind, as inspired by what participants were talking about regarding the meaning or implications of their experiences. Each interview was conducted at a quiet place and lasted 15–45 min.

3.4 | Data analysis

Qualitative content analysis was employed following Krueger and Casey's (2000) method. Audio recordings were transcribed verbatim within 24 hr post-interview. The transcripts were read repeatedly to make sense of the whole, and then the meaningful units (i.e. a word, sentence or phrase) related to experience of wearing PPE were coded and marked in the transcript margins. All codes were collated and saved in the coding sheet. Codes with similar meanings were grouped to formulate categories (or themes) and then labelled according to the common meaningfulness. The categorisation and labelling continued until all categories did not overlap with each other, while the subcategories (or subthemes) were comprehensive enough to capture all critical aspects of corresponding categories and no more new categories/subcategories or better labelling was present; that is, the achievement of collective exhaustiveness and mutual exclusiveness. Themes and subthemes were the abstractive representation of the phenomenon under study.

Two researchers (RNs, Master of Nursing Science, females) with specific training and research experience in qualitative studies coded the data independently, and discrepancies were resolved through discussions involving two senior members (RNs, one with the Doctor of Philosophy, one with the Master of Nursing Science, females). Exemplar statements (i.e. quotations) were translated from Mandarin Chinese to English by the principal investigator,

cross-checked and then confirmed as well as polished by two senior members who are bilingual.

3.5 | Ethical considerations

This study was approved by an appropriate hospital research ethics committee (KYL 2020 [LW] 037). An information sheet about the study background, purpose and methods was emailed to potential eligible participants. E-signed consent forms were obtained before the telephone interviews; the interviews were also recorded with participants' permission. Participants were well-informed of the study details and ethical principles in compliance with the World Medical Association Declaration of Helsinki. They were informed about their right to withdraw anytime without reason or negative impact. All collected information was kept confidential and anonymous. No one other than the research team could access data, which will be destroyed after 5 years.

3.6 | Study rigour

Several strategies were used to establish the trustworthiness of this study following expert advice (Amankwaa, 2016; Speziale et al., 2011). The member-checking was applied for credibility by involving participants in the checking of the proximity of themes, subthemes and exemplar statements to their own experiences. Senior researchers with different education, working and research backgrounds played crucial roles in peer debriefing during group discussions to solve discrepancies that emerged from data analysis to improve the credibility and confirmability of this qualitative inquiry. Field notes about participants' responses to interview questions and written comments or the reflection over the transcripts served as audit trails and signs of long-engagement to substantiate the dependability of the findings. We also involved participants from hospital A and then moved to hospital B and C to attempt to enhance the transferability of our findings given organisational differences in history, overall competency, reputation, affiliation and engagement in rescue missions.

4 | RESULTS

4.1 | Participants' sociodemographic characteristics

One hundred eligible nurses were approached, and 15 agreed to participate. They were aged 24 to 44 (mean = 35.00, *SD* = 5.91) years, and three were men. Years of their RN work experience ranged from 3 to 23 (mean = 11.73, *SD* = 5.82), and they worked in diverse areas; for example, ICU, emergency ICU (EICU), neonatal ICU (NICU), neurosurgery, thoracic surgery, urology surgery, haematology, infectious

disease and respiratory medicine. Fourteen were married and parent of one or two children (Table 1).

5 | THEMATIC FINDINGS

Four themes emerged from the data: Inadequate preparedness for working with full gear PPE, full gear PPE stimulated stress responses, coping strategies and professional growth. These themes were further divided into subthemes, as shown in Table 2.

5.1 | Theme 1. Inadequate preparedness for working with full gear PPE

None of the participants had any experience of wearing full gear PPE continuously to care for patients with highly contagious diseases like COVID-19. The inadequate preparedness for such a situation including, both the training and supply of full gear PPE, hindered their professional ability.

5.1.1 | Inadequate training preparedness for working with full gear PPE

Putting on/taking off disinfected or disposable gowns, gloves and cap following the sterile protocol was an essential form of training for nursing students and clinical nurses. Nevertheless, all participants received intensive training focussing on hand hygiene and the use of full gear PPE for the health care of patients with COVID-19 at the sending hospital. The training at the sending hospital comprised 4 hr of theoretical lectures and eight hours of self-study concerning audio-visual teaching materials about donning and doffing PPE, nasopharyngeal and oropharyngeal swabs and infection prevention/control strategies. An additional 1 hour of field training was provided in the isolation ward at the receiving hospital related to the wearing of full gear PPE. Other materials (e.g. national guidelines of relevancy,

and nursing work in isolation settings) were also provided by the receiving hospital to guide the self-study and practice of working procedures for imagined patients with COVID-19. Nevertheless, some participants ($n = 4$) clearly noted the inadequacy of initial theoretical preparation and stated the needs for reinforced training for the appropriate use of full gear PPE following the standard protocol for infection control. To keep abreast of the current knowledge, participants tended to search for the most recent information from websites hosted by professional organisations.

They [the trainers] told us that the level 2 personal protection management was applicable for patients with COVID-19; but they didn't tell us how to use PPE appropriately according to the level of protection. I learned that from the national guidelines available online (RN 11, male, 38 years old, married, parent of one child, EICU).

Dispatched physicians, who specialised in infection control, were an important source for knowledge related to COVID-19 and health-care quality improvement.

The infection control physician in our team was responsible for, but not limited to, the provision of training on infection control, environmental disinfection, monitoring/supervising the use of full gear PPE when nurses wearing PPE, checking infection control measures, and so forth. They also shared with us the latest national guideline about the diagnosis and treatment of COVID-19 (RN 10, female, 39 years old, married, parent of one child, ICU).

5.1.2 | Inadequate supply preparedness for working with full gear PPE

All participants experienced an insufficient supply of full gear PPE and confronted challenges caused by the inappropriate size of full

Themes	Subthemes
Inadequate preparedness for working with full gear PPE	<ul style="list-style-type: none"> • Inadequate training preparedness for working with full gear PPE • Inadequate supply preparedness for working with full gear PPE
Full gear PPE stimulated stress responses	<ul style="list-style-type: none"> • Full gear PPE-related physical discomfort • Full gear PPE-related psychological distress • Full gear PPE-related procedural challenges
Coping strategies	<ul style="list-style-type: none"> • Problem focussed strategies • Emotion-focussed strategies
Professional growth	<ul style="list-style-type: none"> • Continuous adherence to established protocols • More training for better preparedness and outcomes

TABLE 2 Overview of themes and subthemes that emerged from data analysis

Abbreviation: PPE, personal protective equipment.

gear PPE at the initial stage of rescue. Full gear PPE was produced or donated by different merchandisers all across the country. The allocation of full gear PPE varied a great deal depending on how many were available every day. Uncertainty about the full gear PPE supply caused problems in the isolation wards.

We used the backup full gear PPE prepared by our own [sending] hospital during the first two weeks of work in the [receiving] wards. Sometimes we had to delay the shift handover and wait until full gear PPE was available (RN 1, female, 39 years old, married, parent of one child, infectious disease)

At the beginning, only two sizes [middle/large] of PPE suit were available. It was too big for me even if I wore the smallest one [middle size]. Sufficient supply of full gear PPE became true later (RN 7, female, 42 years old, married, parent of one child, neurosurgery)

5.2 | Theme 2. Full gear PPE stimulated stress responses

Participants encountered many unexpected discomforts (e.g. overheat, dehydration, breathlessness, headaches) associated with compromised body function (e.g. reduced vision, hearing, smelling and joint sensation, and constrained mobility and interpersonal communication) associated with the use of full gear PPE.

5.2.1 | Full gear PPE-related physical discomfort

Participants reported discomfort when working and having to continuously wear full gear PPE. All participants reported problems related to heat accumulation and air exchange restriction during the first working day in the isolation wards. The discomfort diminished over time along with the adaptation to the frequent use of full gear PPE.

I felt breathlessness when I just put on the full gear PPE for the first time. I had to take a break for about 10 minutes. The full gear PPE suit made me feel hot. I was soaked by my sweat soon [after wearing the full gear PPE], [but later] when the sweat evaporated, I felt dry [again]. This process repeated again and again [when I worked wearing full gear PPE during every shift] (RN 10, female, 44 years old, married, parent of one child, ICU).

Headache may arise from the retained pressure over the head when wearing full gear PPE owing to the tight band or strap (e.g. hats, N95 respirator, medical protective masks, goggles, face shields). It was the most uncomfortable component for most participants ($n = 11$), which heavily influenced their job performance. Some participants ($n = 3$) were particularly concerned about the heightened risk of SARS-CoV-2

infection if the bands or straps were not tight enough. They also worried about the potential headache if the bands or straps were too tight.

At first, I fastened all the straps of my full gear PPE because of the fear of [SARS-CoV-2] infection. On one occasion, the headache made me feel nearly torn apart in my full gear PPE. I cannot tolerate it. Later on, I felt more comfortable by adjusting the straps of full gear PPE to keep fit with my nose, my face, and head before entering the isolation ward. Nevertheless, I insist that the pursuit of comfort is [always] inferior to safety (RN 13, female, 24 years old, unmarried, NICU).

Many other negative perceptions were associated with the prolonged wearing of full gear PPE including, but not limited to, hypoxia, dizziness, tinnitus, nausea, vomiting, skin irritation, low-back pain and pressure ulcer. Finger numbness and oedema were also reported, which were attributed to the wearing of multiple layers of gloves (participants usually wore three pairs of gloves during work).

We used elastic bands tie our gloves in case the inner gloves were torn off when we took off the full gear PPE. Then, our fingers had swollen. It was better when we use medical adhesive tape instead of the elastic bands. You can imagine that your hands would not feel comfortable if covered by three pairs of gloves for several hours. Now we choose more loose gloves instead of the 'just right' ones because the hands in the fitted gloves would feel hurt, and that would interfere with your work, definitely (RN 9, female, 42 years old, married, parent of one child, EICU).

Some participants ($n = 3$) experienced sleep disorders (e.g. sleep disturbance, insomnia) following the field work because of increased short shifts (4-hr shifts), the elongated preparatory work before and after the shift (i.e. peri-shift preparation) centring personal disinfection and full gear PPE wearing and intensified job stress.

I cannot sleep because of the frequent night shifts and perceived job stress at the early shifts. This was my first time to face confirmed patients with COVID-19, and I experienced a sense of uncertainty because of the unfamiliarity about the workflow and medical equipment in the new hospital; for example, how to admit new patients and how to use the noninvasive ventilator, which is different from that in my hospital. Moreover, some nurses in my team are from departments of internal medicine, such as endocrine department, and they knew little about ventilators. After a month of adjustment, I felt at ease when I understood my patients and nurses better (RN 9, female, 42 years old, married, parent of one child, EICU)

5.2.2 | Full gear PPE-related psychological distress

Most participants ($n = 7$) expressed that caring for patients confirmed with COVID-19 had caused them extreme psychological distress at first, which could partly be explained by not being in the habit of wearing full gear PPE and partly owing to the lack of knowledge about COVID-19. Most frontline nurses ($n = 8$) reported concerns for not being fully protected by full gear PPE at the beginning, even when they were covered by full gear PPE.

I am always worried about being infected, [given] the possibility of an air leak of my face mask when I am performing my duties. We felt nervous when contacting confirmed patients with COVID-19 because our current understanding about COVID-19 was still incomplete. Did you see the report that COVID-19 could be transmitted by aerosol? (RN 1, female, 39 years old, married, parent of one child, infectious disease)

In addition to the usual pathogen exposure during direct patient care, there were many other accidental exposures to SARS-CoV-2. For example, the bands or straps of face masks were broken suddenly; there were minor, unnoticeable damages to the full gear PPE suit; or healthcare providers' heads were hit by sharp objects. All of these accidents were perceived as stressful and worrying.

We need to pay extra attention to our full gear PPE, as our gloves might be broken down [all of a sudden] by bottles or other sharp objects (RN 12, female, 42 years old, married, parent of one child, urology surgery).

Some participants ($n = 5$) tended to become hypervigilant to the isolation ward environment, and they took more protective measures by washing their hands and disinfecting object surfaces repeatedly. However, most ($n = 12$) expressed their confidence in long-term personal safety, as long as they followed the standardised process of donning and doffing full gear PPE.

I absolutely believe that I'll be safe when I use full gear PPE in the right process, and this could be demonstrated by the fact that there are no medical healthcare personnel infected when using the full gear PPE follows the standard protocols (RN 7, male, 28 years old, married, parent of one child, neurosurgery)

5.2.3 | Full gear PPE-related procedural challenges

The wearing of full gear PPE influenced participants' vision, sensing, hearing and smelling. Fogging of goggles was the major problem that affected the visibility (of the target area/object), interfered with procedural performance and increased patient-related concerns. Sometimes they had to resort to nurse colleagues' guidance to accomplish the task.

When putting on the goggles for the first time in the isolation ward, I couldn't see anything. I had to be directed by others when walking. I felt so nervous at that moment (RN 12, female, 42 years old, married, parent of one child, urology surgery)

Moreover, three pairs of gloves interfered with participants' dexterity when performing some procedures like indwelling intravenous needles, arterial blood sample taking, and nursing documentation. Facial protection (e.g. face masks, face shields) influenced the efficiency for effective communication between participants and patients. Participants had to raise their voice when talking with their colleagues or patients.

Compared with performing the same task of femoral artery puncture [in usual practice], my hand(s) could not feel where it was when wearing multiple layers of gloves. I had to rely on the anatomical location to find the femoral artery because I could not feel the pulsation when performing the arterial blood taken for gas analysis. This reduced my confidence in my [procedural] skills (RN 6, male, 38 years old, married, parent of one child, EICU)

5.3 | Theme 3. Coping strategies

By reflecting on tough experiences of caring work for confirmed patients with COVID-19 while wearing full gear PPE, participants summarised their coping experiences, including both problem and emotional responses. This has key implications for nursing practice.

5.3.1 | Problem-focussed strategies

Considering the discomfort with full gear PPE use, including headaches and feeling of hypoxia, specific measures were employed such as adjusting the full gear PPE before entering the isolation wards, using foam dressing in the most stress susceptible locations, moving slowly when performing tasks, taking a break, etc.

Before entering into the isolation wards, I will walk around to adapt to full gear PPE and to make sure that I will not feel dizziness in full gear PPE. If you stay in the wards, you could not touch any items of your full gear PPE and make any adjustments in case of infection occurring (RN 4, female, 37 years old, married, parent of one child, thoracic surgery).

At the early stage, restricting the amount of water intake was common among frontline nurses because of the inability to access bathroom facilities at the isolation wards and the concerns about potential contamination. Although this was corrected by the

infection control physician, some participants reluctantly wore diapers instead.

Usually, I would stop drinking water for one or two hours in advance, before I left my hotel. I think that [wearing an] adult diaper made me feel ashamed (RN 3, female, 38 years old, married, parent of one child, ICU).

According to participants' experiences, smearing hand sanitizers, iodophor disinfectants or anti-fogging agents helped stop goggles from fogging. Many participants ($n = 6$) reported it was useful to observe through the gaps when the fog condensed into drops of water.

I would set a priority of my tasks according to the degree of my goggles fogging; for example, performed the task of indwelling a needle first when better vision was assured. Then, I would perform other tasks that did not need good vision if the fogging of goggles occurred (RN 4, female, 37 years old, married, parent of one child, thoracic surgery).

Several hospital response strategies regarding full gear PPE were adopted to solve the above problems from the viewpoint of the organisation management system. For example, pictures of standard procedure of donning and doffing full gear PPE and hand hygiene were presented on the wall to guide nurses' sequential behaviour. This response partially compensated for the deficiency in full gear PPE training. For example, when doffing full gear PPE, there was a picture on the wall in the contaminated area showing how to perform hand hygiene following removal of one's outer gloves. Frontline nurses are required to work in pairs or were monitored by another nurse through a video feed when putting on and removing full gear PPE, which was helpful to ensure infection control measures were being implemented and to protect nurses' safety. Moreover, many emergency procedures were established relating to full gear PPE use; for example, how to respond to vomiting in full gear PPE and how to respond to inadvertent breakage of full gear PPE. A medical kit including full gear PPE was provided at the areas where frontline nurses had to use full gear PPE.

I think that the local procedures related to full gear PPE are specific and reasonable. For example, it requires that both doors of each room from the clean zone to the contaminated zone should not be opened at the same time, in case of air convection from the contaminated area to the clean area. [In practice, one nurse] knocked the door [on one's own side] first before entering the room to remind the other nurse to close the other door. Only two people are allowed to stay in the room and move slowly for every step when doffing the full gear PPE, in

case of the production of aerosol particles (RN 10, female, 44 years old, married, parent of one child, ICU).

5.3.2 | Emotion-focussed strategies

Despite the discomforts related to full gear PPE, participants ($n = 3$) figured out ways to continue the work in full gear PPE given the increased cost of full gear PPE and extra workload on teammates because of the broken of routine practice.

Once my bands of goggles were too tight; it gave me a headache, and the face shield made the situation worse. I suffered from the headache; so, I finally threw my face shield away, and I tried to do other simple tasks to divert my attention (RN 13, female, 24 years old, unmarried, NICU).

Moreover, nurses' experience raised their awareness of the importance of positive attitudes toward full gear PPE use and acceptance of it.

In fact, wearing full gear PPE [to perform the task during the outbreak of COVID-19] must be different from that for [the execution of] the same task with general isolation gown [in usual practice]. After slowly getting used to it, we did not reject wearing full gear PPE to carry out job duties (RN 4, female, 37 years old, married, parent of one child, thoracic surgery).

The increased awareness appeared to have positive effects not only on the relieving of negative emotional responses (e.g. fear) for patients' direct care, but also on nurses' confidence concerning donning and doffing full gear PPE appropriately.

I think that positive attitudes toward [caring for patients with] COVID-19 is very important for the defeating of this disease. Some [nurses and physicians] staff refused to stay in the wards [for patients with COVID-19] or asked for leave because of the fear of COVID-19. I think that knowing yourself is necessary for self-regulating your [own] fear (RN 9, female, 42 years old, married, parent of one child, EICU).

5.4 | Theme 4. Professional growth

Participants quickly adapted to and grew from the constrained circumstances requiring the prolonged wearing of full gear PPE, repeated short shift handover and complicated peri-shift preparatory disinfection. They became familiar and comfortable with the use of full gear PPE within the limited time and space window soon

after being positioned in the new working environment. This further enhanced their positive attitudes toward the continuous use of full gear PPE and quickly improved their job efficiency in face of diversified physical and psychosocial discomforts.

5.4.1 | Continuous adherence to established protocols

Participants imagined their future in of infection control by referring to their own experiences in caring for patients with COVID-19. This clarified the importance of adherence to the established protocols regarding the appropriate use of full gear PPE and other infection control measures in their clinical works and daily life.

This improved my awareness of [good] practice in infection prevention and control. I strictly adhered to [the protocol for] hand hygiene in clinical practice, even though no one was monitoring [my performance] (RN 6, male, 38 years old, married, parent of one child, EICU).

This outbreak provides a very rare opportunity to learn using full gear PPE because most nurses never used full gear PPE, including me working for so many years. Even [among] staff at the infectious disease department, it is uncommon to wear full gear PPE at level 2 or 3 protection. Thus, it [full gear PPE] is a challenge for us too, and this experience [of participating in the rescue team] strengthened our consciousness on infection control measures. For example, we always wear face masks when we open our door [to meet or talk to others] (RN 12, female, 42 years old, married, parent of one child, urology surgery).

5.4.2 | More training for better preparedness and outcomes

Some participants stressed that hospital managers should be aware of the importance of regular or reinforced training on full gear PPE use to maximise patient and staff safety as well as care quality. Nurses in different departments, regardless of whether there was a need to wear full gear PPE to perform certain tasks in usual practice, should attend full gear PPE-related training regularly to remain familiar with the appropriate use of full gear PPE in different settings.

The lessons [i.e. inadequate training and preparation] we learned from this COVID-19 pandemic revealed the importance of full gear PPE-related training. Except for the training on the donning/doffing of full gear PPE, performing tasks while wearing full gear PPE should also be simulated [in laboratory settings

or exercised in clinical settings]; then, they [i.e. future workforce] might not be scared because of maladaptation to full gear PPE [for a prolonged wearing]. The effects of training should also be assessed [against the pre-specified standard] (RN 4, female, 37 years old, married, parent of one child, thoracic surgery).

6 | DISCUSSION

Working at the frontline with COVID-19 patients has been found to be extremely stressful for healthcare workers (Vinkers et al., 2020). Nurses were found to be the only ones adversely affected by the use of full gear PPE (e.g. intense heat, skin injury at pressure areas) in the COVID-19 ICU, as revealed in a Japanese study (Unoki et al., 2020). Although there have been studies conducted to investigate healthcare workers' experiences on the frontline, our study differs from those that targeted dispatched doctors and nurses during the early rescue period (Liu, Luo, et al., 2020), in that we explore the experience of full gear PPE use in depth.

Inspired by Gibb's reflective cycle (Gibbs, 1988), this study identified themes pertaining to the major issues experienced by frontline nurses in using full gear PPE while working with COVID-19 patients. This study revealed that inadequate emergency preparedness among individuals and organisations, and various stress responses stimulated by working with full gear PPE were the core experiences that triggered experiential learning in participants. By analysing full gear PPE-related problems through creative problem-focussed and emotion-focussed strategies, they gained an insight into the current situation and this, along with knowledge, skills and cognition, finally led to their professional growth.

Participants stated the most noticeable problem was inadequate preparedness for providing daily care in full gear PPE and the limited full gear PPE supply owing to the large-scale outbreak of COVID-19. Limited training and a lack of full gear PPE supplies have been noted as problematic before (Elhadi et al., 2020; Liu, Luo, et al., 2020; Modi et al., 2020; Phan et al., 2019). As is widely recognised, training on full gear PPE use was crucial for frontline nurses as this can enhance their competency and readiness in combating infectious diseases, particularly those that are highly contiguous like COVID-19 (Barratt et al., 2020). Li et al., (2020) found that combined video display and live demonstration are more suitable training methods for donning and doffing full gear PPE among healthcare workers who are caring for COVID-19 patients. It is necessary now for hospital administrators to advance full gear PPE-related training incorporating scenarios like the COVID-19 pandemic, to enhance and sustain nurses' emergency preparedness for highly contiguous or novel infectious diseases.

Various signs of physical distress and psychological concerns over personal safety at the early stage of caring patients with COVID-19 were mainly associated with unfamiliarity and having to wear full gear PPE. These findings were also reported previously (Kang et al., 2018; Tabah et al., 2020). Such physical and

psychological discomforts interweaved with each other, resulting in diversified stress responses, which interfered with participants' care provision. Nonetheless, the discomforts diminished over time once participants adapted to the use of full gear PPE. Thus, adequate full gear PPE-related training, whether regular or intensive, should enhance nurses' familiarity with and adaptability to working in full gear PPE for a prolonged period. In view of diversified stress responses, systematic assessment of physical and psychological discomfort associated with the prolonged use of full gear PPE should be implemented regularly to address healthcare providers' psychological needs (e.g. dealing with PTSD; Shaikat et al., 2020).

The procedural challenges among nurses when wearing full gear PPE (e.g. blurred vision) echoed other findings about ergonomic issues in full gear PPE use in 403 National Health Service staff during the COVID-19 pandemic (Hignett et al., 2020). Like another study found, one of the chief problems reported by participants in the current study was their goggles fogging (Agarwal et al., 2020). Anti-fogging agents are required to offset this problem. Parush et al., (2020) found that the association between full gear PPE-related discomfort and care work perceptions was significantly mediated by the acuity of hearing and oral communication. Thus, advanced technologies that facilitate effective hearing and interpersonal conversation should be incorporated in clinical practice.

In this study, by reflecting and learning from the tough experiences of caring for patients with COVID-19 while wearing full gear PPE, participants tended to tackle full gear PPE-related unpreparedness, physical discomfort and procedural challenges by problem-focussed strategies. In comparison, emotion-focussed strategies were more appropriate for the dealing with attitudinal and stressful responses. Clearly, a combination of various strategies is beneficial in acute stressful conditions. Given the need for time and other resources, technological advances including anti-fogging techniques are long-term problem-focussed strategies, whereas unhealthy behavioural strategies (e.g. reduced water consumption or delayed voiding) should be modified as quickly as possible given their harmful effects (Wan et al., 2017).

This study also informs the need to further improve the cognition of and attitudes toward the appropriate use of full gear PPE and strict adherence to infection control measures in nursing practice. Participants hardly had similar experiences before the dispatched mission, and they displayed diversified stress responses. Having to work in isolation also hindered their interpersonal support system and their ability to find immediate solutions. Participants moved through the six stages of the reflective cycle in their early experiences of caring for patients with COVID-19 in consistence with others' report (Liu, Luo, et al., 2020). Participants endeavoured to balance their needs for comfort and infection control without compromising patients' safety or the quality of nursing care. If regular and sufficient training on the prolonged wearing of full gear PPE use together with other infection control measures is offered, nurses will be better equipped to work in severe infectious disease environments. Others' experiences in the use of novel solutions for rational use of full gear PPE (WHO, 2020b) or minimal contact with patients

with COVID-19 (Newby et al., 2020) might be adopted, modified and examined regarding their cost-effectiveness using rigorous research designs such as randomised controlled trials.

Furthermore, in other contexts where there are signs of the inadequate supply of quality full gear PPE and/or the shortage of sufficient training on the prolonged use of full gear PPE in high contiguous environments, findings from this study might be transferrable. Considering the impact of diversified physical and psychosocial distress, mental health support shall be provided for frontline nurses to tackle stress responses including PTSD. The strategy of dispatching workforce may be attempted to relieve and replenish health professionals, particularly nurses in the frontline.

7 | LIMITATIONS

This study targeted dispatched frontline nurses from three hospitals in one coastal province in East China. The transferability of the findings was enhanced by involving multiple sending hospitals; however, the impact of other contextual factors was not considered. More strategies could be adopted to further examine transferability and dependability by involving local frontlines nurses and dispatched nurses from other provinces or municipal cities. A comparison between different categories of healthcare workers would further improve the trustworthiness of this qualitative inquiry. Moreover, owing to the current pandemic, we could not conduct face-to-face interviews; therefore, gestural and other non-verbal responses could not be captured and recorded in the telephone interviews, which limits our ability to interpret participants' experiences.

8 | CONCLUSION

This qualitative study revealed frontline nurses' perceptions, reflection, thinking and learning processes from their experience of continuously wearing full gear PPE to care for patients with COVID-19. Frontline nurses confronted various but diminishing challenges. The prolonged wearing of full gear PPE had negative and positive influences on participants' health and professional practice owing to its subjective unfamiliarity. Participants tended to rely on problem- and emotion-focussed strategies to address these difficulties. There was a need for regular or intensive scenario-based skill training for the prolonged use of full gear PPE to enhance nurses' emergency preparedness.

9 | RELEVANCE TO CLINICAL PRACTICE

The current findings inform ways to improve full gear PPE-related psychomotor training and adapt to performing tasks in full gear PPE, which may strengthen nurses' emergency preparedness. Hospital managers should anticipate the full gear PPE-related challenges that nurses might face in clinical settings, and they should provide

sufficient support and education to help them cope with endured distress in highly contiguous environments.

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CONFLICT OF INTEREST

None.

AUTHOR CONTRIBUTIONS

Data curation and writing—original draft preparation: Feifei Chen; Conceptualisation, methodology and writing—reviewing and editing: Yuli Zang; Data analysis and review: Yuan Liu; Investigation and design: Xiaomin Wang; Supervision and review: Xingfeng Lin; Acknowledgement and agreement with the content of the article: All authors.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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APPENDIX 1.

TABLE A1 Interview guide for semi-structured interviews

Focused inquiry aspects (a–d) and guiding as well as exemplar probing questions

a. Preparedness before the dispatched mission

Guiding question

What sort of training related to personal protective equipment had you received before taking care of confirmed patients with COVID-19?

Example probing question

Could you please tell me more about the field training on donning and doffing personal protective equipment?

b. Perception of wearing personal protective equipment during the rescue period in the epicenter

Guiding question

How do you feel about taking care of confirmed patients with COVID-19 when wearing personal protective equipment?

Example probing question

Could you please tell me more about the discomfort related to wearing goggles?

c. Reflection on the work experience when wearing personal protective equipment

Guiding question

What challenges did you face for the care work requiring personal protective equipment during the outbreak of COVID-19?

Example probing question

How did goggles influence your vision?

d. Growth from work experience when wearing personal protective equipment

Guiding question

What have you learnt from your work experiences when wearing personal protective equipment?

Example probing question

What would you suggest for future training on the use of personal protective equipment?