



# Personal Protective Equipment and Nurse Self-efficacy due to Coronavirus Disease-19 Pandemic: A Systematic Review

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## Abstract

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**BACKGROUND:** High number of nurses who infected and died from contracting coronavirus disease (COVID)-19 put them in a difficult situation during the COVID-19. Personal protective equipment (PPE) is the final line of protection for nurses from the risk of healthcare-associated infections, while self-efficacy plays an important role in surviving stressors during the pandemic.

**AIM:** This review aims to analyze factors related to the use of PPE and nurse self-efficacy during the COVID-19 pandemic.

**METHODS:** A systematic and comprehensive search using Preferred Reporting Items for Systematic Reviews and Meta-Analyses with six electronic databases was used. Nine cross-sectional, three cohorts and survey, one case-control, and one surveillance study met the inclusion criteria.

**RESULTS:** From 104 articles screened, 16 articles were included in this review. High self-protection was the main factor preventing nurses from contracting COVID-19 infection. Lack of PPE and low cautiousness were the primary factor for nurses of contracting COVID-19. Increased stress, anxiety, depressive symptoms, and insomnia were associated with nurse's low self-efficacy.

**CONCLUSION:** The best protection for nurses from COVID-19 exposure is the availability and consistent use of PPE. Moreover, the consideration for designing staff training programs and psychological support was recommended for building nurses' self-efficacy.

## Introduction

The novel coronavirus disease since 2019 (COVID-19) has become a worldwide threatening pandemic. This disease outbreak begins at the end of 2019 in Wuhan, Hubei Province, China, on March 11, 2020 [1]. The pandemic took a toll of more than 200,000 infected cases around the world in less than 3 months and doubled in less than 2 weeks and soon the WHO has finally declared it as a pandemic [2], [3]. Globally, as of 08:17 am GMT, August 26, 2021, there have been 214,796,388 confirmed cases of COVID-19, including 4,477,495 deaths reported to the WHO [4]. The increasing infected and death cases have called for the disease to be declared a global emergency [5].

Health care workers (HCWs) including nurses are always on the frontline dealing with pandemic situations. Nurses constitute the largest part of the health care workforce in an epidemic, carrying out most of the tasks related to the infectious disease containment [6]. They are at elevated risk of contracting

COVID-19 compared to others. The shortage of HCWs and an overwhelming number of confirmed cases during the pandemic, nurses overworked and faced numerous stressors, put them more vulnerable to the exposure. The study showed that 10% of medical staff in America were infected by COVID-19 every week [7]. Nurses to be at the greatest risk of getting exposed to the infection [8], the International Council of Nurses analysis from the National Nursing Associations, the official figures, and the media reports from a limited number of countries, indicated that more than 230,000 HCWs contracted the disease, and more than 1500 nurses died from the virus [9].

The nurse's safety must be ensured to protect them against the virus and prevent its transmission to others. Once a front-liner contracts the disease turn endangers subsequent patients. To prevent exposing others to health and safety risks, nurses follow strict safety and health procedures that entail long working hours, fatigue, and psychological distress. However, these are not the only risk factors present. The cautiousness of being infected or unknowingly infecting

others was the main source of anxiety in nurses [10]. Moreover, other sources of anxiety include lack of personal protective equipment (PPE), cautiousness of harboring and transmitting the novel coronavirus at work, lack of access to COVID-19 testing, doubt of support from the institution when infected, the uncertainty of being deployed in an unfamiliar ward or unit, and the lack of accurate information regarding the disease [11].

Occupational pressure and psychological distress during the outbreak of infectious diseases experienced by HCWs. The difficult situations faced by nurses are high stressors, working under physical and psychological pressure [12], [13]. When under pressure, nurses with low self-efficacy experience difficulties, stress, and anxiety, which interfere with their job performance. However, there is a lack of systematic appraisal and more critiques observed in the existing studies. Therefore, identifying the factors related to the use of PPE and self-efficacy among frontline nurses, in preventing coronavirus exposure is imperative. Meanwhile, a systematic review is required in summarizing this research regarding the evidence obtained.

## Methods

### Study design

This study was undertaken by the systematic reviews and meta-analyses (PRISMA) guidelines [14].

### Search strategy

This review included the search studies, sought on six electronic databases, namely, ProQuest, EBSCOhost CINAHL, Wiley Online Library, Science Direct, Springer, and Google Scholar. The search terms used were as follows: PPE, COVID-19 OR 2019-ncov, nurse exposure, and self-efficacy, and were conducted in January–August 2020. After the initial search, the titles and abstracts were selected for full-text review (Figure 1).

### Inclusion and exclusion criteria

All studies on the application of PPE and nurses' self-efficacy during the COVID-19 pandemic were included in the study. The results were restricted to only research articles expressed in English.

### Data extraction and assessment of study quality

The articles were independently assessed for the inclusion and exclusion criteria, while data were

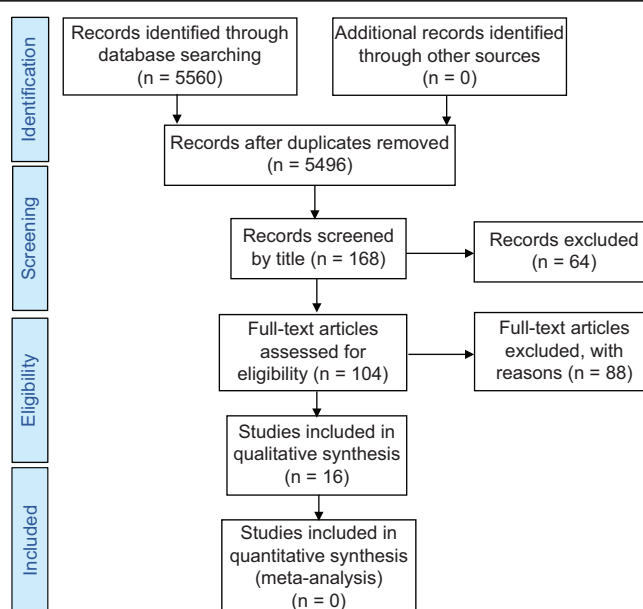


Figure 1: Flow diagram showing selection of articles for review

extracted and resolved for any differences. The following baseline data were extracted from each study, namely, publication year, data collection period, geographical location, and the main findings. The data extracted included the types of PPE recommended, nurses' specific risks and considerations, PPE shortages and rationing, and the factors related to their self-efficacy during the COVID-19 pandemic.

### Narrative synthesis

This was designed based on the heterogeneity and the types that have been published during the emerging COVID-19 pandemic, and a narrative synthesis was performed according to the guidance in the systematic reviews [15]. Then, each article was summarized using bullet points in documenting the key aspects, focusing specifically on the factors related to the use of PPE and nurse self-efficacy during the COVID-19 pandemic.

## Results

### Types of studies

A total of 5560 studies were found in the initial search. After reviewing the duplicates, 5496 studies were screened by their titles and abstracts, leaving 104 full-text reviews for further eligibility tests. Finally, 16 articles were included in this systematic review (Figure 1). Nine cross-sectional, three cohorts and surveys, one case–control, and one surveillance study design met the inclusion criteria (Table 1). The data were collected from all the articles through questionnaires, and no clinical trials studies were found.

**Table 1: PPE and nurses self-efficacy due to the COVID-19 pandemic**

Author/study year	Study site	Study design	Sample size	Instrument	Main findings
Jin et al., 2020 [19]	Zhongnan Hospital of Wuhan University, China	Cross sectional	105 HCWs of which 55 were nurses	Validated questionnaire	Majority thought that they were infected in working environment in hospital, due to lack of protective equipment, and most staff experienced psychological stress and emotional changes during their isolation period
Wang et al., 2020 [20]	Zhongnan Hospital of Wuhan University, China	Cross sectional	92 medical staffs of which 35 were nurses	Self-administered questionnaire	High self-protection score was the main factor preventing medical staff from contracting COVID-19 infection. The main factor contributing to COVID-19 infections among medical staff was touching the cheek, nose, and mouth while working
Papagiannis et al., 2020 [21]	Five public hospitals, Greek	Survey	461 HCWs of which 86 were nurses	A personal interview questionnaire	There was a high level of knowledge concerning COVID-19 pandemic among the Greek health care workers, and was significantly associated with the positive attitudes and practices toward the preventive health measures
Chattarjee et al., 2020 [22]	India	Case control	751 HCWs of which 309 were nurses	20-item brief questionnaire	The use of PPE was independently associated with the reduction in odds of getting infected with COVID-19
Liu et al., 2020 [17]	Four hospitals in Wuhan, China	Cross sectional	420 health-care professionals of which 304 were nurses	Online questionnaire	All the participants in the 420 studies had direct contact with COVID-19 patients and performed at least one aerosol-generating procedure
Delgado et al., 2020 [23]	Latin America	Cross sectional	936 health-care professionals of which 28 were nurses	12-item structured questionnaire	HCWs in Latin America had limited access to essential PPE and support from health-care authorities during the COVID-19 pandemic.
Chu et al., 2020 [18]	Tongji Hospital, Wuhan, China	Retrospective cohort study	54 medical staffs	Medical staff infection data	Suggest training for all hospital staffs to prevent infection and preparation of sufficient protection and disinfection materials
Bashirian et al., 2020 [24]	Hamadan, Iran	Cross sectional	761 HCWs of which 231 were nurses.	Self-reported questionnaire	Threat and coping appraisal were the motivators to conduct COVID-19 preventive behaviors. Consideration of personnel self-efficacy and their knowledge regarding the effectiveness of protective behaviors in designing staff training programs are recommended
Hu et al., 2020 [13]	Two hospitals in Wuhan, China	Cross sectional	2014 eligible frontline nurses	Online survey questioner	Mental health outcomes correlated positively with skin lesion and negatively with self-efficacy, resilience, social support, and frontline works' willingness
Fusco et al., 2020 [25]	Infectious diseases hospital in Naples, Italy	Surveillance study	115 HCWs of which 57 were nurses	Serology testing for COVID-19 records	The overall prevalence of the current or probable previous infection was 3.4%. The infection rate among HCWs was reasonably low. Most of the infected HCWs had been asymptomatic, supporting the need for periodic screening of HCWs for COVID-19
Felice et al., 2020 [26]	Italy	Survey	388 HCWs of which 101 were nurses	Online survey questioner	Only 22% of the HCW considered PPE adequate for quality and quantity. The females and respondents working in high-risk sectors were mostly affected psychologically and with high workload
Xiong and Lin, 2020 [27]	Fujian Province, China	Cross sectional	223 nurses	Survey questionnaire	The self-efficacy was negatively correlated with anxiety
Shahrour and Dardas, 2020 [28]	Jordanian Hospital, Jordan	Cross sectional, descriptive, and comparative design	448 nurses	Web-based survey questionnaire	Age, ASD, and coping self-efficacy significantly predicted psychological distress. Furthermore, coping self-efficacy was found to ameliorate the effect of psychological distress on nurses' traumatic experience
Xiao et al., 2020 [29]	Wuhan, China	Cross sectional	180 medical staffs of which 98 were nurses	Questionnaire	The anxiety levels were significantly associated with that of stress, which negatively impacted self-efficacy and sleep quality. Furthermore, anxiety, stress, and self-efficacy were mediating variables associated with social support and sleep quality
Al-zoubi et al., 2020 [16]	King Abdullah University Hospital, Jordan	Retrospective single center cohort study	337 HCWs of which 228 were nurses	Swabs using real-time reverse transcriptase RT-PCR records	The prevalence of COVID-19 among HCWs depended on a range of factors, including the PPE availability, the health-care setting, and access to testing. The prevalence of COVID-19 among asymptomatic HCWs taking care of patients was 0%
Wei et al., 2020 [30]	Wuhan Union Hospital, China	Prospective cohort study	14 HCWs of which 12 were nurses	Medical records	Among the 14 HCWs, 12 were confirmed cases, the other two were suspected cases. Most of them were either exposed to the index patients or infected coworkers, without knowing they were COVID-19 patients

HCW: Health care worker, PPE: Personal protective equipment.

### Infections related to PPE use

From the studies included in this review, high self-protection was the main factor preventing nurses from contracting COVID-19 infection. The types of PPE used were as follows: Gloves, N95 masks with a tight seal around the mouth and nose, the face and eye protection include shields and goggles, and the clothing includes gowns, aprons, head covering, and shoe covers [16], [17]. The protective equipment, such as clothing, N95 masks, and goggles, were given to the first-line medical staff including nurses in fever clinics and wards, while others were given surgical masks. This explained that the lower infection rates among the medical staff were a result of less exposure [18].

The current review showed that the cautiousness of contracting COVID-19 due to lack of PPE was the primary factor contributing to the high percentage of nurses unable to perform their duties to an acceptable standard. Nurses believed that infection was caused by inadequate provision of protective equipment and also the inadequate protection provided by the available

PPE, wearing only a surgical mask to care for patients with confirmed cases [19]. Meanwhile, 43 (41.8%) thought that their infection was related to unprotective equipment, such as masks and gloves. Furthermore, there were insufficient reserves of protective equipment in the hospital for a pandemic of such severity [18]. The previous studies showed that most nurses had access to basic PPE, however, many health-care professionals did not have the required equipment recommended by the WHO, particularly disposable and N95 masks [20].

Inappropriate or insufficient infection control measures, such as inconsistent use of PPE and reuse of N95 respirators, were the risk factors of infection in health care. The PPE was not enough at the workplace, however, was readily available in high-risk specialty sectors [21]. HCWs did not have enough PPE, as they often use a nursing mask and not the surgical mask [22]. Initially, when making contact with the patient, their condition was not noticed at that time and the infectiousness of SARS-CoV-2 was also underestimated, therefore, posing greater infection risk. In addition, the use of PPE was independently

associated with the reduction of being infected with COVID-19 [23]. Furthermore, the infected medical staff was initially asymptomatic, leading to clustered infection in a department [18]. Contrastingly, most of them had been asymptomatic in the preceding 30 days [24].

### **COVID-19 related to Hospital-Acquired Infections (HAIs)**

The unrecognized transmission of pathogens in health-care settings led to the colonization and infection of both patients and medical personnel. Most nurses were infected in the working environment and referred to as HAIs [19]. After having close contact with confirmed and suspected patients, they, in turn, mingle with their colleagues at work. Among them had worked more than 7 hours a day in an environment with a high risk of infection [19]. As patients frequently make contact with their caregivers and visitors, they were also at high risk of getting infected. This complicated the infections of medical staff, making it difficult to detect the first infected patient [18]. The exposure to the infected several other colleagues was also another important reason for the infection of COVID-19 in HCWs [22]. The disease was contagious during the incubation period, moreover, much medical staff was not adequately protected and become infected through unwitting contact with the patients [18].

At present, there are three methods of COVID-19 transmission. The top three perceived infection routes were through droplet, contact, and aerosol. They also included direct transmission, whereby droplets released by an infected person while sneezing, coughing, and talking were directly inhaled by an uninfected individual in close contact. Aerosol transmission, whereby droplets and aerosols from an infected person remain airborne for long periods and are mixed with air, subsequently causing the infection through inhalation [25]. The contact transmission occurs from virus droplets deposited on objects' surfaces. This results in contamination of the hands.

The main factor leading to the infection of medical staff was touching the cheek, nose, and mouth while working. In such cases, the infection occurs when contaminated hands touch the mucosa of the mouth, nasal cavity, and eyes. Touching of mouth, nose, and eyes with contaminated hands or gloves by medical staff during work could cause infection. Protective behaviors of HCWs against COVID-19 showed that wearing a glove for all procedures and using a face mask at any time were the least frequent preventive behaviors. The study showed that 7.9% and 3.7% of participants never used gloves or a mask during patient care, respectively [26]. Meanwhile, 87% and 84.6% always washed their hands frequently with water and soap and avoided mixing with others during the shift [26]. Not touching the cheek, nose, and mouth while working and having high self-protection score were the two

superfactors that could reduce the risk of COVID-19 infection in medical staff [25]. This emphasized the need to strengthen the hand, oral, and nasal hygiene practices, especially during epidemics of respiratory infectious diseases. Active personal hygiene measures reduce the risk of COVID-19 transmission, and the vast majority followed special advice from the hospital infectious committee [27].

For nurses, the top three perceived infection causing procedures were sputum suction care, basic nursing, and pharyngeal swab collection (a swab of the throat) [19]. Nurses were responsible for the care of patients in the hospital with severe COVID-19, which included performing aerosol-generating procedures on a routine basis [17]. Around one in 10 HCWs is involved in tracheal intubation for suspected or confirmed patients. However, HCWs performing endotracheal intubation had higher risks of being infected [23].

### **Nurses self-efficacy during COVID-19 pandemic**

Previous reviews found that self-efficacy among frontline nurses was associated with the increased stress, anxiety, depressive symptoms, and insomnia. Self-efficacy was negatively correlated with anxiety ( $r = -0.161$ ,  $p < 0.05$ ) [28]. The majority of nurses (64%) are experiencing acute stress disorder (ASD) due to the COVID-19 pandemic and are at risk for post-traumatic stress disorder (PTSD) predisposition [29]. Furthermore, more than one-third of nurses (41%) are also suffering significant psychological distress [29]. Age, ASD, and coping self-efficacy significantly predicted psychological distress. More specifically, younger nurses are more prone to experiencing psychological distress than the older. The higher scores on ASD showed more resultant psychological distress while coping self-efficacy was the protective factor [29]. Another study also found that anxiety levels were significantly associated with stress and insomnia, and negatively impacted self-efficacy and sleep quality [30]. In addition, anxiety, stress, and self-efficacy were mediating variables associated with social support and sleep quality [30].

## **Discussion**

### **PPE recommendations**

The use of PPE was an important strategy in protecting health-care personnel from contaminating and preventing the spread of pathogens to subsequent patients. Nurses needed to wear procedural masks or respiratory protective equipment (N95), eye protection, gowns, and gloves when giving treatment to COVID-19 patients. A lack and non-availability of

PPE were the main issues highlighted in this current review. All protective measures were important for workers to be safe when working. A high self-protection score means that there was the availability of PPE, which was used correctly [25]. Health-care systems should ensure adequate availability of PPE and develop additional strategies in protecting HCWs from COVID-19 [31].

An assessment of the PPE supply chain and equitable access to it should be a part of the deliberate and informed decision about resource allocation [31]. However, global shortages of masks, respirators, face shields, and gowns caused by surging demand have led to efforts of conserving PPE through extended use or reuse [32], [33]. Studies showed that sufficient availability of PPE with high quality reduced the spread of COVID-19, however, the reuse or its inadequate supply conferred comparably increased risk [31]. The greater risk associated with PPE reuse was related to either self-contamination during repeated application and removal, or breakdown of the clothing materials from extended wear.

Frontline nurses in charge of examining and caring for the infected patients should constantly wear PPE all the time during their shift. Having the right type or size of PPE and wearing it correctly was crucial in preventing COVID-19 infection. Consistent use of PPE was important in reducing HAIs [34]. Therefore, it was expected to use PPE appropriately according to the task risk level recommended to be performed by nurses [1]. Studies indicated that appropriate PPE in addition to adhering to standard recommendations had effectively protected nurses from SARS-CoV-2 infection in clinical settings with a high risk of exposure [17]. Contrastingly, most infections occurred through contact and airborne transmission [25].

The fact that some infected HCWs had been asymptomatic for the preceding 30 days supported the need for periodic screening for COVID-19 among them [24]. The prompt exclusion of infected HCWs from the workplace also supported the need for periodic screening. Therefore, it was necessary to improve surveillance of HCWs and to identify the best approach in protecting them, as well as to control and ensure a safe working environment [16]. To protect the HCWs and their families, staff should undergo routine medical checks, including temperature and RT-PCR tests. In addition, HCWs should isolate themselves in the hospital residence and maintain social distancing from family members and other staff.

There was a need to improve the availability of PPE and the HCWs' training. Therefore, the protection of HCWs by authorities should be prioritized through education and training, the readiness of staff, incentives, availability of PPEs, and psychological support [35]. In addition, nurses should be well trained regarding hand hygiene, putting on and taking off PPE, and performing aerosol-generating procedures.

It was also necessary to receive training and education through online mandatory courses according to the updated protocols as issued by the WHO and Centre for Disease Control (CDC) to protect them from hospital-acquired COVID-19 infection. The education should include information on the type of virus, its transmission, disease signs and symptoms, diagnostic criteria, vulnerable patient groups, its treatment, and management protocols. The hospital personnel training should include the type of PPEs, their proper use, cleaning, reuse and disposal, and the nurses' and patient hygiene. In addition, guidelines for all specialties of health-care providers should be issued to protect individuals and prevent the transmission of the infection to nurses and patients. Moreover, standard cleaning and disinfection measures for individuals and premises should be performed religiously to further prevent the spread of the virus and minimize the risk of cross-infection.

However, even with adequate PPE, HCWs caring for COVID-19 patients remained at high risk, highlighting the importance of not only ensuring PPE quality and its availability but also its other aspects of appropriate use, including correct application and removal, and clinical environment [31]. Therefore, the core factors for preventing this infection were timely and proper use of PPE by HCWs [25]. This indicated that effective procedures in protecting staff from infection were very important. Therefore, this implemented a more stringent protocol for nurses as a necessary precaution, which included wearing N95 respirators and surgical masks at the same time.

### ***Nurses self-efficacy improvement***

The current review suggested that nurses were encountering a considerable degree of stress, anxiety, depression, and insomnia due to the pandemic. The fact that they were exposed to the virus daily and were cautious of infecting themselves, families, or patients, therefore, they faced long working hours, high mental workload, stress, and emotional fatigue. Moreover, they were exposed to high doses of pain, emotional suffering, stigma, and physical and psychological violence, due to society's carelessness [1], [36]. There was also fret in the US and the UK regarding the increased levels of stress, anxiety, and exhaustion among HCWs and how all these factors were affecting the efficacy and absenteeism among the personnel [37], [38]. The positive coping strategies and the increased social support were attributed to the decreased psychological distress, increased self-efficacy, improved sleep quality, and decreased levels of anxiety and stress among the nurses [30], [39].

The psychological status of nurses in the public hospital during the COVID-19 outbreak needs more attention. Although, improving their self-efficacy in dealing with emerging infectious diseases was helpful to

their psychology. Therefore, self-efficacy is commonly defined as having a belief in the ability to succeed and occurs when the individual rises to the challenge of a difficult task and is motivated intrinsically [40]. Mental health outcomes were statistically and negatively correlated with self-efficacy and resilience. The self-psychological adjustment was the core skills for improving nurses' self-efficacy and played a critical role in coping with stress. Mental resilience was the foundation of psychological adjustment, which was an individual's response to stress, and was enhanced through facilitation and training [12]. Taking effective psychological support measures helped frontline nurses psychologically, by relieving and stabilizing fear, anxiety, or sadness caused by the pandemic. These measures also improved resistance and adaptability to crisis and prevented mental disorders.

This condition warrants attention and support from policy-makers. To prevent psychological distress and manage stressful conditions, psychological evaluations and counseling sessions should be available for vulnerable staff. To preserve mental well-being, nurses should practice healthy eating, physical activity, a minimum of 6–8 h of sleep, and communication with family and friends [35]. Providing social and emotional support to HCWs during the pandemic reduced anxiety and stress levels, and increased their self-efficacy [30]. A significant relationship between the knowledge of using PPE with the self-efficacy of COVID-19 management was observed. This means that nurses with the knowledge of using PPE have 2780 times opportunities of acquiring good self-efficacy in managing the condition [41].

## Conclusion

The best protection for nurses from COVID-19 infection is the availability and consistent use of PPE. Furthermore, for health-care professionals to deliver safe care, there is a need for training on the appropriate use of equipment. Until there is a vaccine or proven treatments available, the requirement for nurses to limit their workload and take sensible precautions is imperative in reducing transmission, flattening the curve, protecting themselves and patients, as well as reducing the death tolls.

The insights from this review helped authorities in various countries where the COVID-19 case has not yet been recorded to plan strategically ahead. Moreover, while HCWs carry out their duties to patients, the government is expected to put in place a system for future pandemics that safeguard and preserve the nurse workforce. Therefore, these management strategies should be promptly implemented to enhance safety and optimize resource allocation. However, in

the case of rationing PPE, these decisions should be transparent, collaborative, accountable, and adaptable as evidence of the pandemic evolves, rather than disguising the guidelines. As a result, this poses both moral and ethical dilemmas to patient-focused health-care professionals, thereby creating a sense of inadequacy, undervaluation, and workforce stress. The consideration for designing staff training programs and psychological support was recommended for building nurse self-efficacy. The prompt interventions at the national levels are needed to improve mental health by preventing and managing skin lesions, building self-efficacy and resilience, providing sufficient social support, and ensuring that the front-liners work willingly.

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