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## RESEARCH ARTICLE

### Protecting Healthcare Workers on the Frontline of the COVID-19 Pandemic: interventions and observations from a Prospective Study

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#### ABSTRACT

**Background:** Healthcare workers were at high risk of contracting COVID-19 during the pandemic due to their frontline commitment. This risk was higher than in the general population because they were exposed to the virus both at work and outside the hospital. Healthcare workers suffered from physical and psychological stress, which could lead to mental health problems.

**Aims:** The aim of the study was to evaluate the effectiveness of four proactive interventions implemented to protect workers' health during the COVID-19 pandemic at the “Federico II” University Hospital in Naples, Italy. The study aimed to prevent both clinical and non-clinical risks, such as infections contagion and work-related stress.

**Methods:** A prospective observational study was conducted between April 9 and May 21, 2020, at the “Federico II” University Hospital. Healthcare personnel, who worked during the study period, were subject to four proactive interventions: (I) Classification based on the risk of exposure to SARS-Cov-2; (II) Healthcare surveillance: diagnostic surveillance (nasopharyngeal swabs for SARS-Cov-2, rapid antigen tests and serological for the detection of IgM/IgG antibodies against SARS-Cov-2), clinical and epidemiological surveillance (physical examination and contact tracing), individual psychological support; (III) Contacts-tracing;(IV) Constant training and information. The study analysed the number of positive swabs in healthcare workers and hospitalised patients during the same period, comparing the incidence of cases with international data. Feedback from psychologists and occupational doctors was also collected to evaluate the impact on non-clinical risks.

**Results:** The study found a low correlation between positive swabs in healthcare workers and patients, suggesting that the preventive measures in place were effective. Furthermore, feedback from psychologists and occupational doctors did not report an increase in stress-related sick leaves, thanks to the proactive actions.

**Conclusions:** The considered proactive interventions proved to be useful to protect healthcare workers during the pandemic. The study highlights the importance of a proactive approach instead of a reactive one, and the necessity to contemplate both the protection from biological risks and the psychological support.

## Introduction

Healthcare workers have been the cornerstone of the response to SARS CoV-2 pandemic, a potentially fatal disease caused by the virus COVID-19, transmitted through droplets generated during coughing or sneezing by symptomatic or asymptomatic people<sup>1</sup>, through direct or indirect contact.

During the pandemic, hospitals could be the epicenter of this new circulating infection, and healthcare workers were at high risk of contracting these diseases due to their frontline commitment. The risk of infection for healthcare workers was higher than in the general population because they were exposed to SARS-CoV-2 both at work and outside the hospital<sup>2,3</sup>. According to the Italian National Institute of Health (ISS), until November 9, 2020, 50.759 healthcare workers had been infected with COVID-19, about 5.7% of the total number of positive cases (891.563 total cases diagnosed in Italy)<sup>4</sup>.

Given that during the pandemic the development of the vaccine and the search for effective therapeutic protocols were still ongoing, healthcare workers suffered increasing pressure both due to the clinical risk and the non-clinical risks related to their work activity<sup>5</sup>.

Healthcare workers were, indeed, subject to severe physical and psychological stress, which could lead to increasing mental health problems. Although the risk of infection is the most evident problem during a pandemic, it is necessary to consider that healthcare professions themselves are characterized by psychosocial risk factors related to work organization, ability to manage emergencies and daily confrontation with situations of suffering. These elements are accentuated during a pandemic because they are added to other concerns such as the fear of being infected and infecting family members, separation from families (often for long periods), physical stress due to the use of Personal Protective Equipment (PPE), mourning for the loss of patients and colleagues and changes in work practices and procedures<sup>6</sup>.

In this article, the authors report their experience and describe the proactive interventions they activated for the evaluation, prevention, and management of both clinical and non-clinical risks to which healthcare workers were exposed while guaranteeing patient care at their hospital, during the COVID-19 pandemic. The objective of the four proactive interventions, implemented during the study period, was to protect the health of workers involved in the fight against COVID-19.

A prospective observational study has been conducted between April 9 and May 21, 2020, (42 days/6 weeks), at the "Federico II" University

Hospital in Naples, Italy. All healthcare workers at the University Hospital agreed to participate in the study and provided their verbal consent after being informed of the purpose and procedures, which, in any case, did not require any additional changes or interventions compared to their ongoing clinical practice. The study was conducted in accordance with the Declaration of Helsinki, and ethical approval was obtained from the Ethics Committee of the University of Naples (n. 243/2020), according to national and international guidelines for human research.

In order to evaluate the effectiveness of preventive interventions implemented for clinical risks, it was decided to analyze the number of positive swabs (cases) detected in both healthcare workers and patients hospitalized during the same period and, then, to compare the incidence of cases in the healthcare personnel of the University Hospital considered and the international data available regarding the same period of time.

Analyzing the correlation between the number of positive swabs of the patients hospitalized and those in healthcare workers, in the same hospital, is useful to evaluate preventive interventions for healthcare worker safety for several reasons.

On one hand, if a strong correlation between the number of positive swabs in patients and healthcare workers was found, it suggests that there could be a high risk of transmission of the virus between the two groups. This could highlight that the preventive interventions for clinical risks were not effective enough.

On the other hand, if there is a low correlation or no correlation between the two groups, it suggests that healthcare workers are not getting infected from patients at the same rate as patients are getting infected from other sources. This could imply that the preventive measures put in place are effective.

To evaluate the impact on non-clinical risks it was decided to collect the data on stress-correlated motivated sick leaves and feedback from the appointed psychologists and occupational doctors through their periodic reports.

## Context Analysis

Our University Hospital is a major academic medical center located in Southern Italy. It provides free healthcare services along with educational and scientific research work. It included 18 buildings, and offers surgical specialities and a third level medical aid. It is the regional reference center for rare adult and paediatric diseases, the reference center for HIV treatment, the largest birth center in Southern Italy and is a highly qualified hospital in both surgery and medicine practice. Furthermore, it

is part of the kidney and bone marrow transplant network<sup>7</sup>.

It is equipped with 800 beds overall. Usually has a Neonatal Intensive Care Unit with 20 beds and an Adult Intensive Care Unit with 8 beds, as well as a Paediatric Infectious Disease Department with 8 beds.

The occupancy rate of the intensive care beds is consistently higher than 90%.

In response to the COVID-19 emergency, the hospital guaranteed

1- Healthcare assistance to pregnant patients as a regional referral center for maternal and child care<sup>8</sup>;

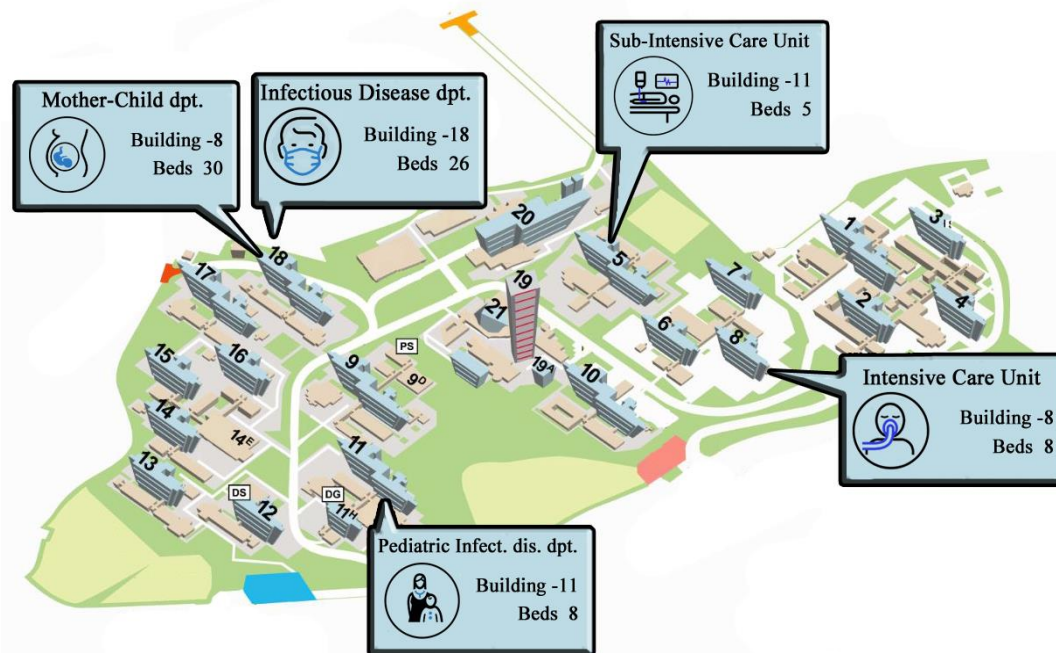
2- Assistance to paediatric patients as a regional referral center for paediatric infectious diseases;

3- Creation of a triage zone before entering the hospital for all non-deferrable emergency services<sup>9</sup>;

4- Separate pathways for infected and non-infected patients<sup>10</sup>;

5- Conversion of hospital areas into COVID-19 wards to meet the growing demand for hospital beds with the addition of 77 beds fully dedicated to Covid-19 positive patients<sup>7</sup>. (Figure 1)

**Figure 1-** Distribution of Beds Dedicated to Covid-19 positive patients.



## Materials and Methods

Healthcare personnel, who worked during the study period, were subject to four proactive interventions:

(I) Classification based on the risk of exposure to SARS-Cov-2;

(II) Workers healthcare surveillance:

- diagnostic surveillance (nasopharyngeal swabs for SARS-Cov-2, rapid antigen tests and serological for the detection of IgM/IgG antibodies against SARS-Cov-2),
  - clinical and epidemiological surveillance (physical examination and contact tracing)
  - individual psychological support;
- (III) Contacts tracing
- (IV) Constant training and information;

## I - Classification based on the risk of exposure to SARS-Cov-2

The Classification allowed the identification of three areas of risk:

- Red area (high risk) for healthcare workers who assist COVID-19 patients (75 workers);
- Yellow area (medium risk) for healthcare workers in advanced triage units (124 workers);
- Green area (low risk) for healthcare workers who assist non-COVID-19 patients (307 workers).

The type of Personal Protective Equipment (PPE) to be provided to workers was identified based on their classification in these three risk areas (Table 1). However, since the risk could not be completely ruled out, even healthcare workers classified in the green areas were still provided with essential PPE to deal with emergencies. The PPE included FFP2 or FFP3 masks, goggles or face shields, long-sleeved waterproof shirts, and gloves.

**Table 1-** PPE distribution in the risk areas

PPE	RED AREA	YELLOW AREA	GREEN AREA
Surgical mask	x	x	x
FFP2 mask	x	x	
FFP3 mask	x	x	
Googles	x		
Face shield	x	x	x
Long-sleeved water-resistant gown	x		
Disposable gown		x	x
Gloves	x	x	x
Disposable shoes		x	x
Disposable waterproof socks	x		

## II – Workers' healthcare surveillance

The classification of workers into the three risk areas strongly influenced the second intervention, which consisted in the development and implementation of a health surveillance protocol for each worker. All healthcare workers working in the Red Zone, in fact, underwent nasopharyngeal swabs for the detection of SARS-Cov-2 through RT-PCR test, every 7 days from the beginning of the observation period, given the information on the incubation time of the disease. However, considering that the diagnostic performance with the RT-PCR method for the detection of SARS-Cov-2 depends on the quality and type of the respiratory tract sample, as well as the operator's ability<sup>11</sup>, diagnostic accuracy was increased by combining serological tests for the detection of IgM/IgG antibodies against SARS-CoV-2 with the swab.

Healthcare workers in the Yellow Zone underwent serological tests with venous sampling every 7 days from the beginning of the observation period and nasopharyngeal swabs for SARS-Cov-2 every 15 days; workers in the Green Zone were monitored with rapid serological tests on a weekly basis. In case the serological tests, both rapid and on venous sampling, detected the presence of IgM/IgG antibodies against SARS-Cov-2, the worker was immediately subjected to a nasopharyngeal swab and placed in isolation until the test result.

As part of the health surveillance protocol, we also ensured direct and periodic contacts between the occupational physician and the workers concerned. In fact, healthcare workers were contacted by their occupational physician at the end of each work cycle (i.e., morning, afternoon, and night shifts plus rest, for a total of 5 days) through a hospital computerized platform, to which each worker is registered. With the same frequency,

after the health surveillance visit, workers were supported by an individual online counselling service, with psychologists and psychiatrists, for the timely detection of any specific risks related to work during the pandemic. Through cognitive-behavioural psychotherapeutic approach, workers were helped to recognize and verbalize their emotions and to replace pandemic-related anxiety thoughts (possibility of being infected, infecting others, difficulty adapting to the new work environment) with more rational, less catastrophic, and less all-encompassing thoughts, to reduce their emotional suffering and help maintain a greater sense of self-confidence in managing these stressful situations.

In addition, the sick leave request register was consulted daily and the workers were called by phone to evaluate their health status, including any psychological problems, and if the absence was due to COVID-19 infection<sup>12</sup>.

## III - Contacts tracing

Contact tracing has been an essential public health measure to combat the COVID-19 pandemic, along with active case finding, testing, and physical distancing. To limit the spread of the virus within the hospital, after the outbreak of the emergency, all healthcare workers were asked to report symptoms related to COVID-19 to their occupational physician by phone, and in suspected cases, to refrain from going to work. Furthermore, to ensure effective contact tracing after exposure to a suspected or confirmed COVID-19 case, even outside the hospital, workers were always monitored within 24 hours and an epidemiological investigation was conducted according to the guidelines of the European Centre for Disease Prevention and Control (ECDC)<sup>13</sup>. The worker who had close contact with positive cases underwent a

nasopharyngeal swab for SARS-CoV-2 using the RT-PCR test.

#### **IV - Constant training and information**

The information to healthcare workers was guaranteed as indicated in the health surveillance protocol. The training was planned with a two-day event with a frontal method, and the subsequent dissemination of epidemiological, clinical, and preventive information to workers by occupational physicians. The frontal event took place at the Hospital on February 13 and 14, 2020, for a total of 10 hours of training, seven days before the "outbreak" of the pandemic in Italy (first confirmed case on February 21 in Lombardy and February 26 in Campania Region).

The speakers involved were university professors of Infectious Diseases, Hygiene and Public Health, Anaesthesia and Critical Care, Occupational Medicine, Gynaecology and Paediatrics.

The topics addressed were:

- Epidemiology and nosological classification of the virus in adults and in the mother and child fields;
- Management of suspected or confirmed infection case, from diagnosis to hospital admission and therapeutic treatment;
- Prevention and safety measures for healthcare workers, with particular reference to the management of PPE, dressing and undressing procedures, and correct use of PPE in all care environments<sup>14</sup>;
- Procedures for environmental and surface sanitization.

The event was advertised ten days before the scheduled date with a press release on the University Hospital website and with the distribution of informative brochures to all workers. Participant registration was online, and learning was assessed with an end-of-course questionnaire. Remarkably, the event was attended by 85% of the hospital staff.

The data analysis was conducted considering all healthcare workers in the three high-risk areas from April 9th to May 21st, 2020.

The workers classified as high-risk in the Red Zone were 26 doctors (34.7%), 34 nurses (45.3%), and 15 paramedics (20%). Overall, the staff worked 153 hours a day, divided respectively into 58, 49, and 46 hours. The workers classified as high-risk in the Yellow Zone were represented by 40 doctors (32.3%), 53 nurses (42.7%), and 31 paramedics (25%) for a total of 254 daily work hours (97 hours for doctors, 81 hours for nurses, and 76 hours for paramedics). Finally, 113 doctors

(36.8%), 150 nurses (48.9%), and 44 paramedics (14.3%) were classified as workers in the Green Zone, for a total of 460 daily hours.

The workload for healthcare workers classified in the Green Area was reduced due to the conversion of hospital wards into COVID-19 wards, resulting in a reduction of deferrable health care assistance.

To better analyse the relevance of the preventive interventions, it was decided to focus the statistical analysis of the results only on the workers classified in the red and yellow areas (199 healthcare workers), and therefore exposed to a higher risk of infection.

The number of positive swabs among the personnel and the patients were confronted and their possible correlation checked through the Linear Regression Analysis.

The data on stress-correlated motivated sick leaves were collected from the University Hospital system of Human Resources.

Feedback about workers mental health was collected from the appointed psychologists and occupational doctors through their periodic reports.

#### **Results**

During the study period (6 weeks), in the red and yellow areas, 1009 rhinopharyngeal swabs were performed on healthcare workers: 504 in the red area staff - with an average of 6.72 swabs per worker - and 505 swabs in the yellow area workers - with an average of 4.1 swabs per worker.

There were 7 positive swabs (0,7 %) for SARS-Cov-2, (3.5 % of the total yellow and red operators): 4 men (57.1%) and 3 women (42.9%), with an average age of 56.2 years. Among these, 3 were doctors (42.9%), 3 were nurses (42.9%), and 1 were social workers (14.2%).

In the same period, 5748 patients hospitalised in the red and yellow areas were examined and 8622 rhinopharyngeal swabs were performed, approximately 205 swabs/day. A total of 513 swabs were positive for SARS-Cov-2.

The number of swabs performed on healthcare workers remained stable during the study period and was not influenced by the percentage of SARS-Cov-2 positive patients.

The regression analysis (Figure 2) did not show a statistically significant association between the patient's swabs positivity rate and the rate of positive swabs performed on healthcare workers ( $R^2 = 0.5\%$ ,  $p\text{-value} = 0.57$ ).

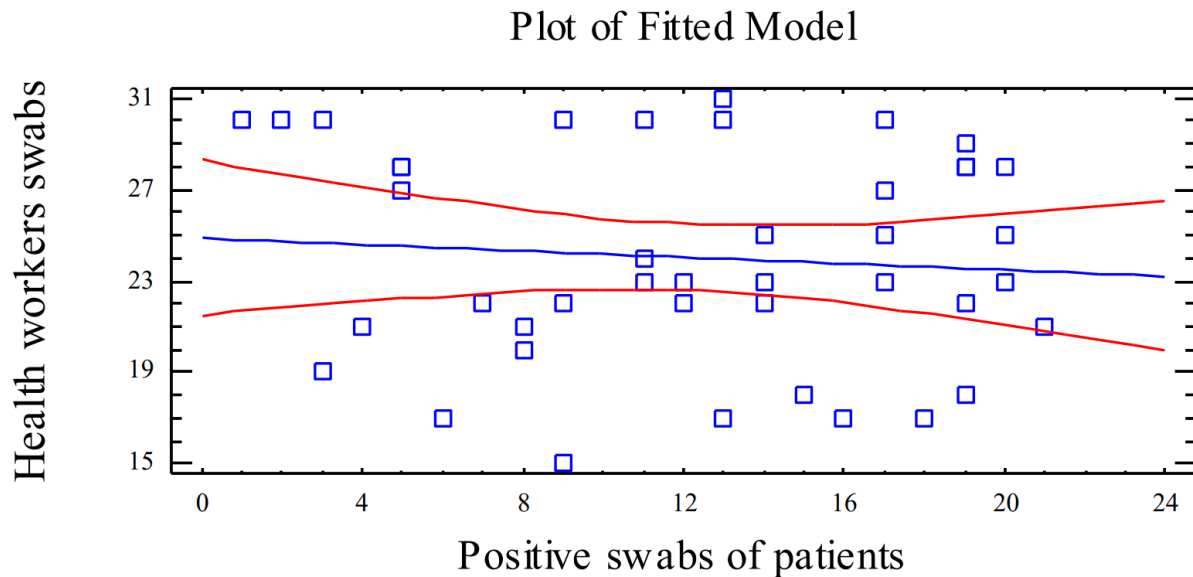
After the analysis of the Human Resources System, none of the sick leaves in the considered period resulted from stress work-correlated or referable to it.

The periodic reports by psychologists and occupational doctors showed positive feedback from the assisted workers on the psychological support received.

Periodic feedback questionnaires were administered to healthcare workers, assessing their emotional well-being, stress levels, and their evaluation of the psychological support provided by the organization. When asked, "Do you consider the psychological support provided to be

appropriate and beneficial for the continuation of your activities?" 78% responded with "Strongly Agree" 19% responded with "Agree," and only a mere 3% did not provide a response. These results highlight the overwhelmingly positive perception of the psychological support offered to healthcare workers, demonstrating its effectiveness in sustaining their well-being and ability to carry out their crucial tasks.

**Figure 2-** Linear regression analysis between the total positive nasopharyngeal swabs and the number of swabs performed on healthcare workers (HCWs). Each point represents a day of the period study.



### Discussion

Healthcare workers have been universally recognized as more susceptible subjects since the beginning of the COVID-19 pandemic, with higher risks of infection than the general population.

Due to their critical role in controlling the COVID-19 pandemic, healthcare workers needed to maintain their ability to continue working, and it was necessary to ensure that hospitals did not become sources of infection, leading to an interruption of health services. Therefore, it was important to implement infection prevention and control measures in healthcare institutions to limit infections associated with the provision of health services.

However, despite global attention, the toll on healthcare workers during the COVID-19 pandemic has been significant.

A systematic review showed that the prevalence of COVID-19 among healthcare workers in 2020 was around 7%, with a percentage of positive personnel for antibody research, around 11%<sup>15</sup>.

However, in stark contrast to these widely reported figures, our study conducted at the esteemed University Hospital revealed a notably lower prevalence of COVID-19 among healthcare workers, standing at a remarkable 3.5%. This discrepancy warrants careful consideration and further investigation.

It is particularly noteworthy that despite the challenging circumstances, the occurrence of epidemic clusters within our hospital was conspicuously absent.

Moreover, an intriguing aspect of our study was the lack of correlation found between the number of positive swabs among healthcare workers and their respective patients. This intriguing finding suggests that the stringent preventive measures implemented, such as personal protective equipment usage, frequent testing, and strict infection control protocols, played a pivotal role in mitigating the transmission of the virus within our healthcare facility.

The essential characteristic of the proactive interventions implemented that guided the entire

strategy, was the classification of workers based on the risk to which they were exposed during work. This aspect was essential to orient the contents of health surveillance (i.e. type of diagnostic investigation) and characterise the distribution of PPE (i.e. number and type) to the workers.

In particular, the diagnostic, clinical, and epidemiological surveillance protocol ensured a constant evaluation of workers' physical health by monitoring the clinical risks associated with infections. Based on the questionnaire results, it can be concluded that psychological support has made a significant contribution to non-clinical risk management. The introduction of online support services represents an innovative element in ensuring the safety and well-being of workers, which was not part of routine practices prior to the pandemic. Given the outstanding outcomes observed, it is recommended that such support be included not only as a response to emergencies but also as an ongoing measure. This type of activity enables constant contact, even in the absence of physical presence, providing reassurance to the workers.

The absenteeism rate among workers did not change during the pandemic compared to the rate recorded in the same period in 2018 and 2019. The comparison related only to a single hospital and the short period of observation are surely two of the main limitations of this work.

Cases detection and contact tracing were possible both through the health surveillance protocol and the identification of workers who reported to the occupational physician their contact with a diagnosed or suspected case of COVID-19. In the latter circumstance, the evaluation of the type of contact (in hospital or outside the hospital) as well as the mode of exposure (duration and place of contact, use of PPE, circumstance in which the contact took place) ensured the timely activation of the health surveillance protocol.

Finally, through training and constant information, workers were supported throughout the pandemic, in fact the continuous updating of the information and the sharing of the guidelines for the correct management of the disease contributed to containing the impact of the pandemic on healthcare workers.

Although the distribution of personal protective equipment and proactive monitoring of workers

have certainly contributed to reducing the risk of contracting COVID-19 among workers, it would be interesting to calculate the individual residual risk for each worker belonging to each risk area (red, yellow, and green).

It would be possible to perform such an assessment in a more comprehensive study that considers additional factors, such as the number of patients who have tested positive for SARS-CoV-2, the specific types and number of procedures performed on patients, and the length of time that workers have been exposed to aerosols, generated during these procedures.

## Conclusions

Within the "Federico II" University Hospital, the proactive interventions have contributed to ensuring the safety of healthcare workers by preventing the development of epidemic clusters. However, these interventions can certainly be improved through the comparison with other high-level healthcare centers, which can serve as a guide in different contexts. Although comparative health analysis presents problems related to costs and execution times, as well as the identification of unique indicators for comparison, that is an essential tool to ensure the validation of interventions.

Hospitals played an important role in the containment strategy of pandemics. The challenge of these diseases cannot be separated from the protection of healthcare workers, who are on the front line.

The value of a well-designed surveillance program and the importance of innovating methods, in tandem with evolving situations, are described in this article. The combination of contact tracing activities, risk assessment, and symptom surveillance has been effective in containing the transmission of COVID-19 among healthcare workers, while optimising the use of resources.

Last but not the least, the mental health support proved to be an indispensable tool in the healthcare facilities, particularly facing a new threat unknown to most of the western world workers.

**Conflict:** The authors have no conflicts of interest to declare.

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