

Viewpoint in Occupational Health

The interplay between psychological stressors and biological hazards among healthcare workers during the COVID-19 pandemic

Paola TOMAO¹, Salvatore ZAFFINA², Reparata Rosa DI PRINZIO^{3,*}, Nicoletta VONESCH⁴, Francesco CHIRICO^{5#}, Nicola MAGNAVITA^{6#}

Affiliations:

¹ Occupational and Environmental Medicine, Epidemiology and Hygiene Department, Italian Workers' Compensation Authority (INAIL), Monte Porzio Catone (Rome), Italy. E-mail: p.tomao@inail.it. ORCID: 0000-0001-6690-0069.

² Occupational Medicine Unit, Bambino Gesù Children's Hospital IRCCS, Roma, Italy. E-mail: salvatore.zaffina@opbg.net. ORCID: 0000-0002-8858-5423.

³ Occupational Medicine Unit, Bambino Gesù Children's Hospital IRCCS, Roma, Italy. Alta Scuola di Economia e Management dei Sistemi Sanitari (ALTEMS) - Università Cattolica del Sacro Cuore, Roma, Italy. E-mail: repdip@gmail.com. ORCID: 0000-0001-5956-1038

⁴ Occupational and Environmental Medicine, Epidemiology and Hygiene Department, Italian Workers' Compensation Authority (INAIL), Monte Porzio Catone (Rome), Italy. E-mail: n.vonesh@inail.it.

⁵ Postgraduate School of Occupational Health, Università Cattolica del Sacro Cuore, Rome, Italy. E-mail: francesco.chirico@unicatt.it. ORCID: 0000-0002-8737-4368.

Postgraduate School of Occupational Health, Università Cattolica del Sacro Cuore, Rome, Italy. Department of Woman, Child & Public Health Sciences, Fondazione Policlinico A. Gemelli IRCCS, Roma, Italy. E-mail: nicolamagnavita@gmail.com. ORCID: 0000-0002-0988-7344.

#Last co-authorship

*Corresponding Author:

Reparata Rosa Di Prinzio, Occupational Medicine Unit, Bambino Gesù Children's Hospital IRCCS, Rome, Italy. E-mail: repdip@gmail.com

Abstract

Despite the advent of modern technologies, biological risks still cause concern in workplaces. Healthcare workers (HCWs) are exposed to a wide range of occupational risks including biological and psychosocial ones. During the COVID-19 pandemic, HCWs experienced unprecedented levels of distress, especially due to the risk of SARS-CoV-2 contagion and the fear of spreading the virus in the work and social community. This emotional overload led to an increase in mental health disorders (e.g., anxiety, depression, and burnout) that can hinder patients' safety and the quality of care. After outlining the international safety regulation on biological risks, we discussed the interplay between biohazard and psychosocial risk, focusing on how to prevent occupational infections in healthcare using comprehensive action strategies that aim to ensure a healthy work environment to improve, protect, and promote the health and safety of all workers.

Take-home message: Occupational infections, particularly those caused by emerging agents and/or responsible for epidemics, still cause concern in health care workers globally and require prompt action to implement health and safety programs.

Keywords: Healthcare workers; occupational infections; infectious diseases; biological risk assessment; biological risk management.

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INTRODUCTION

Despite the advent of modern technologies, biological risks still cause concern in workplaces. Biological agents encompass various microorganisms, including spores, fungi, toxins, and allergens from natural sources that may harm human health. Worldwide, an estimated 320,000 employees die annually from occupational infectious diseases, 5,000 of whom are in the EU [1].

Healthcare workers (HCWs) are exposed to various occupational hazards, including biological, chemical, physical, ergonomic, and psychological stressors [2,3]. In addition, concerns about exposure to contagious diseases such as HIV, Hepatitis B and C, and tuberculosis have influenced the career choices of many health professionals [4,5].

Physicians, nurses, laboratory technicians, and clinical waste handlers are at risk of acquiring vector-borne, airborne and blood-borne occupationally transmitted infections. Occupational infections may be transmitted by inhalation, ingesting contaminated material, accidental inoculation by a needlestick injury through skin wounds or contact with the mucous membranes [4]. In the unparalleled COronaVirus Disease-19 (COVID-19) crisis, HCWs treating COVID-19 faced several health, safety, and psychological challenges [6]. In Italy, the National Institute for Insurance Against Accidents at Work (INAIL) has recognized SARS-CoV-2-related infection as a 'biological injury' in healthcare professionals, frontline workers, and all types of workers in contact with the public, including non-healthcare personnel in hospitals with technical, support and cleaning tasks. Law no. 27 of 24 April 2020 has protected workers who have contracted SARS-CoV-2 infection at work, according to the consolidated legal principle that equates the infectious cause with the violent cause of an accident [7–9]. The INAIL has also protected cases of contagion from COVID-19 infection occurring on the way to and from the workplace, defined as accidents in itinere ("commuting accidents"). The risk of contagion indeed is very high in crowded means of transport [10]. However, recognizing COVID-19-related psychiatric disorders such as adjustment disorders and posttraumatic stress disorders in HCWs may be more difficult in times of pandemic, which represents per se a source of relevant stress in the general population.

An Italian multicenter study on the prevalence and mortality from COVID-19 showed that the variability in the risk of infection experienced by Italian HCW, ranging from 3% to 22.0%, reflects the distribution of SARS-CoV-2 disease in the patient population of the hospitals where they worked [11]. HCWs at the frontline of response to COVID-19 are at a higher risk of acquiring the disease [12,13].

The ongoing COVID-19 pandemic has shown thus the vulnerability of healthcare systems worldwide and demonstrated the importance of coordinated and global strategies for ensuring HCWs, community, and patient safety [4,14–17].

In the first phase of the pandemic, HCWs in contact with patients and their body fluids, without adequate knowledge, procedures and protective devices, faced a relevant risk of infections. In addition, the perceived risk of disability, and even death, reinforced by stigma, segregation and exclusion, may have increased their anxiety and distress levels [18].

Some studies about the psychosocial stressors experienced by HCWs during the COVID-19 pandemic showed that women, nurses, and HCWs directly engaged with COVID-19 patients and those with pre-existing psychological problems are at increased risk of psychopathological consequences of the pandemic. Adverse psychological outcomes among HCWs include fear, anxiety, depression, stress, burnout, sleeping problems and posttraumatic stress disorder (PTSD) symptoms [19–21]. During the COVID-19 pandemic, new psychosocial risk factors have been propelled by the fear of contagion amplified at the beginning of the pandemic by the lack of personal protective equipments (PPEs). Additionally, the high number of infected or deceased colleagues, the concern of representing a threat to family members [16,23], and workplace violence by those infected or their relatives against frontline nurses and HCWs [20,23] have raised the awareness to support and protect HCWs for maintaining the sustainability of the healthcare system.

In literature, it is well known that HCWs employed in an emergency setting are particularly at risk of PTSD because of the highly stressful work-related situations they are exposed to, including management of critical medical conditions, caring for severely traumatized people, and frequent witnessing of death and trauma [24]. Conversely, protective factors such as individual resilience, training, good workplace climate, and organizational factors may prevent the onset of PTSD symptoms in frontline HCWs [24]. For this reason, some studies showed a higher prevalence of fatigue and PTSD in non-frontline that in frontline HCWs [24,25]. With this premise, it is necessary to explore the complex relationship between the risk of biological injury in a pandemic context, the exposure to new psychosocial stressors and the onset of adverse long-term outcomes, including PTSD and suicide risk among HCWs.

DISCUSSION

International safety regulation on biological risks

According to the International Labour Organization (ILO), the prevention of accidents or injuries due to exposure to biological hazards is supported by laws and regulations, guidelines, and several national, community and enterprise prevention systems [26].

In workplaces where the deliberate use of biological agents is performed (e.g., microbiological laboratories), occupational exposure can be easily monitored and controlled. On the contrary, in the case of unintentional exposure to biological agents (e.g., nursing activities in hospitals), prevention and protective measures may be more challenging to implement. Therefore, they should strictly depend on the risk assessment evaluation.

In Europe, according to Directive 2000/54/EC (as amended, on the protection of workers from risks related to exposures to biological agents at work), microorganisms are classified into four risk groups based upon the pathogenicity of the agent, the mode and ease of transmission, host range and the local availability of effective preventative measures and treatments [27]. Furthermore, details

regarding the reduction of risks, hygiene measures, use of PPEs, training of workers, and environmental and containment actions are described to protect employees' health and safety and to prevent the release of pathogens into the environment.

The European Parliament has felt the need to amend the Biohazard Directive based on what has been observed during the pandemic. As a result, a new Directive, which provides suitable safety measures to protect workers in the event of a pandemic, is being drawn up. The preparatory material, produced by a panel of experts, has been available since March 2022 [12].

The WHO worldwide, the Centers for Disease Control (CDC) and the US Occupational Safety and Health Administration (OSHA) in the United States, the European Centre for Disease Control and Prevention (ECDC) in Europe, other institutions such as the Australian National Centre for Disease Control (AMA), and the National Collaborating Centre for Infectious Diseases (Canada), have developed and continuously updated guidance documents regarding strategies for occupational infections control. The primary purpose of these documents is to reduce workers' exposure to biological hazards, protect them against transmission of infectious diseases, and monitor work-related injuries, ill health, diseases, and deaths.

The annual Global Health Emergency Preparedness Report, 2019 of The Global Preparedness Monitoring Board (GPMB) highlights the increase in outbreaks occurring during complex humanitarian emergencies, as well as from an unprecedented convergence of ecological, political, economic, and social trends, including population growth, increased urbanization, globally integrated economy, widespread and more rapid displacement, conflict, migration, and climate change [28].

Between 2011 and 2018, WHO recorded 1,483 epidemic events in 172 countries. Diseases such as influenza, severe acute respiratory syndrome (SARS), Middle East Respiratory Syndrome (MERS), Ebola, Zika, plague, yellow fever, and others are representative of a new era of high-impact and rapidly spreading epidemics, which are more frequently detected and increasingly challenging to manage. Over the past 50 years, many pathogens have been circulating, including those that emerge/re-emerge naturally and deliberately released. The recent COVID-19 pandemic has well-documented some of the dramatic consequences of spreading epidemic-prone pathogens in healthcare settings [29].

Moreover, many infections caused by antimicrobial-resistant pathogens acquired during the delivery of healthcare services have a significant impact on public health. Infection Prevention and Control (IPC) systems are built from the evidence of documented cases of infections in patients, HCWs, and visitors to healthcare facilities and should be implemented worldwide. The recent WHO Global Report [30] highlights the impact of diseases and antimicrobial resistance and the associated harm caused to patients and HCWs, by providing for the first time an analysis of the global status of IPC implementation and an overview of strategies and resources available to improve the situation. It also provides a demonstration of the cost-effectiveness of IPC interventions. The Report is primarily directed to those responsible for decision-making and policy formulation in the field of IPC at national, sub-national, and facility levels. However, no country or healthcare system can claim to be free of healthcare-associated infections (HAIs), no matter how sophisticated they may be.

Strategy on occupational safety and health

Recently, the ILO has adopted the Global Strategy on Occupational Safety and Health and approved the "Technical guidelines on biological hazards" to identify new instruments in biological hazards [26]. In the EU, the biological risk assessment needs to be categorized based on its potential to cause harm (namely, infection, allergy, and toxicity), the severity of its potential harm, the reservoir of the agent, its stability in the environment, its possible aerosol generation or splatter, the mode transmission, and its communicability within a population. Moreover, the availability and effectiveness of preventive and protective measures, including medical treatments, regardless of whether the pathogen is rare or not, partially, or fully eradicated to account for the risk of re-emergence, and its ability to be weaponized should be considered. Furthermore, workers' health status should be considered, including their medical history and vaccinations; baseline antibody titer information for agents of interest, when appropriate; the use and availability of prophylactic treatments in case of contact.

The assessment of biological risks allows us to effectively identify hazards, manage the risks for the biosafety and biosecurity of workers, and develop prevention and mitigation strategies to control or reduce the risks to an acceptable level. Therefore, the biological risk management system should be built upon continual improvement through a cycle of planning, implementing, reviewing, and improving processes and actions.

The present pandemic caused by SARS-CoV-2 has negatively affected workplaces worldwide; the Coronavirus emergency has heavily influenced data regarding the 2020-2021 injuries worldwide.

In Italy, infectious disease caused by work exposure is considered, from an insurance point of view, as a hybrid form of illness-injury due to the assimilation of infectious cause to that of violent cause. On 17 March 2020, INAIL (the National Institute for Insurance against Accidents at Work) published its decision to recognize as accidents at work cases of COVID-19 infection affecting physicians, nurses, and other employees of the National Health Service and any other healthcare organization (public or private) insured by it as an accident at work [31]. The recognition of COVID-19 as an accident at work is under INAIL's policy for dealing with cases of infectious and parasitic diseases, as with other European Countries [32].

In an occupational safety strategy, the priority is preventing as well as reporting accidents at the workplace. Unfortunately, occupational infections and accidents are often under-notified since they may be challenging to characterize, and signs and symptoms can manifest long after exposure to the pathogen. In addition, in some cases, a physician could not be adequately trained to diagnose and detect an occupational infection.

Occupational surveillance is useful for identifying exposure risks and developing effective strategies to improve workplace safety. Such information is critical for determining the key areas where priority interventions should be provided for preventing and controlling risks. Trends in the incidence of biological injuries can indicate the effectiveness of the prevention and control measures adopted at the workplace [33]. Furthermore, the most susceptible workers may be protected by the intervention of occupational physicians (OPs).

OPs should collaborate in the risk management process and make medical examinations to screen individual susceptibility to the SARS-CoV-2 infection for releasing fitness for job decisions. The exposure of workers to infectious agents or microbes and their individual (i.e., innate, and

artificial) susceptibility to the infection are the main factors that may play a role in the occurrence of occupational diseases. Once they occur, occupationally airborne-transmitted infections like tuberculosis, meningitis, flu-like syndromes, and COVID-19 infection may spread inside and outside the hospitals by accelerating the outbreak spread within the community. However, most occupational diseases can be prevented by controlling the source of infection and its transmission route through infection prevention and control measures and by protecting the most susceptible workers with effective vaccines. Regarding vaccines, OPs should carry out appropriate health education and promotion activities based on evidence-based information to tackle misinformation. Finally, the medico-legal evaluation of the occupational or non-occupational aetiology of diseases caused by airborne transmitted agents like COVID-19 infection does not have the character of certainty. Indeed, it is often not possible to determine the exact moment of the accident, as happens instead for needle sticks and hematogenous infections. The probabilistic attribution of the pathology to the workplace rather than to the community depends on the demonstration of unprotected contact of the victim with an infectious patient. However, a detailed risk assessment regarding the type of work tasks, the environmental and social context, and the characteristics of the exposure to biological agents, including the routes of exposure, the pathogenicity, and the mechanisms of transmission and dissemination, can help frame the case [33].

How to prevent occupational infections in healthcare settings

A good prevention and protection program starts with a detailed risk assessment in the specific context, the most crucial step in occupational medicine methodology, with its dynamic and constantly updated nature. Awareness, information, and training of HCWs on biological hazards to increase risk perception in daily work is an essential requirement, leading to the proper application of safety procedures and effective use of available protective tools (e.g., standard precautions, adoption of needles and devices incorporating guards) and PPEs [34,35].

Risk assessment is never a static event. On the contrary, security procedures must be constantly updated in a highly dynamic event, such as an epidemic. For this reason, during COVID-19, emergency safety committees have been set up in the workplace, with the participation of managers, health personnel, workers' representatives, and technical personnel, to constantly adapt the safety measures to the changing environment and epidemiological picture.

The pandemic has posed new problems and required specific solutions. It has been possible to observe that the training of young doctors, indispensable for dealing with the emergency, requires specific methods different from those adopted for expert workers [21,23]. The training of workers in first aid and the implementation of first aid measures have been modified to protect the rescuer and the person to be rescued [15,17,18].

Specific diagnostic procedures have also received new impetus in the pandemic. For example, OPs performed point-of-care lung ultrasounds on infected workers forced to complete quarantine at home: the non-invasive method helped monitor the patient's condition and facilitate return to work [36,37]. In addition, OPs have been requested to collaborate with Local Health Unit for the containment strategy of the pandemic at the workplace and to manage through multidisciplinary teams post-COVID disorders, which may affect HCWs in the long-term and the return to work of HCWs affected by severe COVID-19 infections [38,39].

The OP is concerned with adapting work activities to the worker's characteristics, allowing each worker to operate in the right place according to the principle of ergonomics. Indeed, effective management of HCWs' emerging disabilities based on the company's temporary needs while respecting the protection of the worker's health status leads to substantial gains for the healthcare direction from the perspective of Total Worker Health © (TWH) [40–42]. With specific reference to biohazards, a recent Italian study showed how seasonal influenza vaccination reduces sickness absence during the winter months, increasing the wellbeing of the healthcare workforce and the quality of the offered health assistance and care [40].

Scientific research is also relevant to biohazard management, especially for HCWs. For instance, an Italian study found that the immune system's functionality in acting against the hepatitis B virus had a preserved ability to respond after full vaccination, even when antibody titers declined over time (the so-called 'non-responders'). The underlying mechanisms lie in the specific memory B cells, whose activity was comparable in non-responders and controls. Booster immunization resulted in neither antibody production nor increased memory B cell in non-responders [43]. This important finding is of utmost importance in practice, as it may lead to revising vaccination policies in occupationally exposed individuals. During COVID-19, the application of personalized occupational medicine in the field of vaccination showed how the precision immunization strategy could overcome individual fragility, thus allowing a susceptible worker to build up a lasting immune response against SARS-CoV-2 [44,45].

During the COVID-19 pandemic, it was found that the psychological component plays a key role in the proper management of biohazards among HCWs, noting the urgent need to intervene in the residual resilience capacity of workers to mitigate the intense psychological impact of the pandemic [22,46]. Therefore, constant, and updated training regarding potential health risks, as well as precautions to prevent exposure and measures to take in case of incidents, contributes to the improvement of the reporting system of any adverse event (including aggressions against HCWs [20,23,47], and thus to improve workplace safety.

Finally, as the COVID-19 pandemic highlighted, the cooperation between occupational and public health stakeholders played a decisive role in the battle against the novel coronavirus [48].

The psychosocial hazards among HCWs during the COVID-19 pandemic

Effective as they were [49], lockdown countermeasures during the epidemic quickly led to a radical change in daily living habits, causing a significant increase in distress and health problems in the world's working and non-working populations. In addition, if older adults had to deal with psychosocial concerns related to loneliness and social isolation due to pandemic-related restrictions [50], workers had to change their way of living, building up a new work-life balance.

In the healthcare sector, the issue of isolation was present in the workplace, especially for HCWs working in intensive care units, specialized in COVID wards and emergency departments, who constantly wore PPEs for long shifts, burdened by the physical and emotional overload of being infected and becoming active carriers of SARS-CoV-2 infection in the hospital community and society [19–23,51].

In addition, administrative staff working in healthcare facilities have experienced documented psychosocial distress due to agile work from home [52]. In this category of workers, the change in lifestyle habits has had detrimental effects on physical and mental health, causing weight gain, poor

sleep quality, increased musculoskeletal pain, headaches, higher levels of anxiety and depression, perceived fatigue, and lower job satisfaction [52].

Preventive and protective measures to address psychosocial hazards among HCWs before and after the COVID-19 pandemic

Throughout their working lives, HCWs face mental health challenges due to the inherent nature of their work. Indeed, their caregiving duties require special advocacy for empathy and compassion with mental clarity and the ability to disconnect when needed. This cognitive load may lead to fatigue and often to minor psychiatric disorders, such as anxiety and depression, and burnout, which in turn can lead to PTSD and suicide [52]. The COVID-19 pandemic exacerbated burnout and chronic fatigue, increasing HCWs' mental vulnerability and suicide behaviours [53–55]. Therefore, during the COVID-19 pandemic, mental health promotion programs were enriched with policies and best practices to reduce social stigma and expand access to mental health care. Comprehensive strategies include assessing and promoting coping and resilience skills and providing appropriate protective supplies and online support services [56,57]. Holistic strategy at multiple levels (organizational, individual, and collective) by involving all stakeholders (policymakers, workers, and society) helps mitigate the adverse effects associated with the pandemic by increasing the confidence and well-being of HCWs, thereby also protecting them from the biological risk [57,58]. In research, the forward-looking nature of health surveillance activities makes it feasible to carry out longitudinal studies that follow the evolution of the workers' health status in relation to the variation of the environmental and occupational conditions that occur, for example, in the various subsequent stages of a pandemic [59–62]. These studies can allow prevention to be adapted to varying stressors, saving resources, and maximizing results.

CONCLUSION

The World Health Organization encourages all countries to develop national programs for HCWs' occupational health and promote the immunization of workers against preventable infections. Furthermore, workers and employers must continuously strive together to ensure a healthy work environment that will improve, protect, and promote the health and safety of all workers.

New biosafety technologies and associated evolving guidelines have emerged to significantly improve ways to safely handle microbiological material. A combination of engineering controls, management policies, work practices, procedures, and medical interventions collectively defines the safety requirements. In addition, roles and responsibilities should be established for all workers involved before initiating activities. Finally, further efforts are necessary to reduce occupational infections, such as implementing a correct and prompt injury notification process and active adherence of workers to occupational health and safety programs.

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