

Literature Review: Occupational Safety and Health Risk Factors of Healthcare Workers during COVID-19 Pandemic

Kajian Pustaka: Keselamatan Kerja dan Faktor Risiko Kesehatan Tenaga Kesehatan pada Pandemi COVID-19

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ABSTRACT

Introduction: The pandemic of COVID-19 has major effects, particularly on hospitals and health workers. At the beginning of March, more than 3,300 health workers have been contracted with COVID-19 as reported by China's National Health Commission. Twenty percent of healthcare workers in Italy have also also infected and some died. To minimize the risk of transmission to health workers, knowledge of the risk factors that influence the transmission is needed. Thus, this study aims to determine risk factors related to occupational safety and health for healthcare workers during the COVID-19 pandemic. **Methods:** The literature was searched on Pubmed, Google Scholar, WHO, and the Ministry of Health instruments were implemented. 8 relevant studies were reviewed. **Results:** According to the analysis results of several studies, the use of PPE that is less consistent and not suitable with the risk of exposure will increase the risk of infection. The risk of infection is also increased by poor hand hygiene. According to the Kaplan-Meier curve, the working duration of ≥ 15 hours will increase the risk of infection. The risk of infection also exists for health workers who carry out risky procedures that generate airborne particles such as resuscitation, as well as environmental factors such as negative pressure rooms and traffic control bundling. **Conclusion:** Risk factors related to occupational health and safety during this COVID-19 pandemic for healthcare staff are: compliance with the use of PPE, hand hygiene, working hours duration, risky procedures, and environmental factors.

Keywords: COVID-19, healthcare workers, personal protective equipment, occupational safety

ABSTRAK

Pendahuluan: Pandemi COVID-19 memberikan dampak signifikan terutama pada rumah sakit dan tenaga kesehatan. Pada awal Maret, lebih dari 3300 tenaga kesehatan dilaporkan terinfeksi oleh Komisi Kesehatan Nasional China. Di Italia, 20% tenaga kesehatan dilaporkan ikut terinfeksi dan sebagian dilaporkan meninggal dunia. Untuk meminimalkan risiko infeksi terhadap petugas kesehatan, diperlukan pengetahuan terkait faktor risiko yang berpengaruh. Penelitian ini ditujukan untuk mengevaluasi faktor risiko terkait kesehatan dan keselamatan kerja bagi tenaga kesehatan selama pandemi COVID-19. **Metode:** Prosedur pencarian online menggunakan instrumen Pubmed, Google Scholar, WHO, dan Kemenkes. Kemudian dilakukan kajian pada 8 literatur yang dianggap relevan. **Hasil:** Berdasarkan hasil analisis dari beberapa literatur, penggunaan APD yang kurang konsisten dan tidak sesuai dengan risiko paparan akan meningkatkan risiko infeksi. Kebiasaan hand hygiene yang kurang juga meningkatkan risiko infeksi. Menurut hasil kurva Kaplan-Meier, durasi kerja dari tenaga kesehatan yang ≥ 15 jam akan berisiko lebih tinggi terkena infeksi. Risiko infeksi juga ada pada tenaga kesehatan yang melakukan prosedur yang berisiko menimbulkan airborne particles seperti resusitasi, serta faktor lingkungan seperti ruangan bertekanan negatif dan dan traffic control bundling. **Simpulan:** Faktor risiko dalam keselamatan dan kesehatan kerja pada tenaga kesehatan selama pandemi COVID-19 antara lain: kepatuhan pada penggunaan APD, hand hygiene, durasi jam kerja, prosedur yang berisiko, serta faktor lingkungan.

Kata kunci: alat pelindung diri, COVID-19, keselamatan kerjat, tenaga kesehatan

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INTRODUCTION

A severe acute respiratory syndrome known as COVID-19 is caused by novel Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). The most common symptoms include fever, cough, and shortness of breath 2 to 14 days after exposure. The first reported cases were in China on December 31, 2019. Afterwards, the increase in cases and transmission occurred rapidly, not only in China but in several countries worldwide. World Health Organization (WHO) declared COVID-19 as a pandemic on March 11, 2020 (McMichael et al., 2020). There are more than 100,000 reported cases and 3,500 deaths resulted from this virus worldwide. COVID-19 is also considered to have a higher death rate compared to influenza. WHO estimation on COVID-19 global mortality is 3.4% (Adams and Walls, 2020). First confirmed cases of COVID-19 in Indonesia were reported in March 2020 (McMichael et al., 2020).

The pandemic of COVID-19 has major effects, particularly on hospitals and health workers (Lancet, 2020). This is due to the fact that an increase in COVID-19 cases is not accompanied by an increase in the number of hospitals and health workers. These limitations have resulted in increased pressure on hospitals, particularly health workers. This stress can be in the form of diseases that have the potential to burden the capacity of the health system as well as adverse impacts on the health workers, such as the risk of infection (Adams and Walls, 2020). China's National Health Commission has announced that approximately 3,300 health workers have been infected, while in Italy, 20% of health care workers have been infected and some died (Lancet, 2020).

To minimize disease transmission while treating COVID-19 patients, the Centers for Disease Control and Prevention (CDC) recommends that all healthcare workers use personal protective equipment. It consists of gloves, N95 or air-purifying respirators, face shields or goggles, and gowns. Besides, the CDC also recommends improving hand hygiene by washing hands properly, improving environmental hygiene, and increasing safety for health workers (Adams and Walls, 2020). However, as the pandemic increases, providing personal protective equipment for health workers becomes another major problem. A lack of personal protective equipment is a problem that occurs in many countries nowadays (Lancet, 2020). Therefore, this literature study is conducted to understand

occupational safety and health risk factors for health workers during this pandemic.

METHODS

This literature review was conducted in March 2020. Studies included were narrative reviews, systematic reviews, meta-analyses, retrospective cohort studies, cross-sectional studies and focus group discussions related to the occupational safety and health of healthcare staff during the COVID-19 pandemic. The literature was searched in four databases, namely PubMed, Google Scholar, WHO, and the Ministry of Health of the Republic of Indonesia. The keywords used were COVID-19, health workers, personal protective equipment, risk factors, and occupational safety and health. The inclusion criteria for the literature used in this literature review were the articles found in the databases with the topic relevant to the keyword provided. Meanwhile, the exclusion criteria for this literature review were the articles which were incomplete, used a language other than Indonesian and English, or had an inconclusive result. The selection of sources were done using the keywords, and 28 articles were found. This literature review was limited to articles published in 2001 and was written in Indonesian and English, so only 8 articles were considered eligible for the literature review. Data were then collected and presented in a tabular form and were analyzed descriptively both qualitatively and quantitatively. Furthermore, the 1A2C level of evidence was determined based on the classification issued by the Oxford Center for Evidence-based Medicine Level of Evidence (Howick et al., 2011).

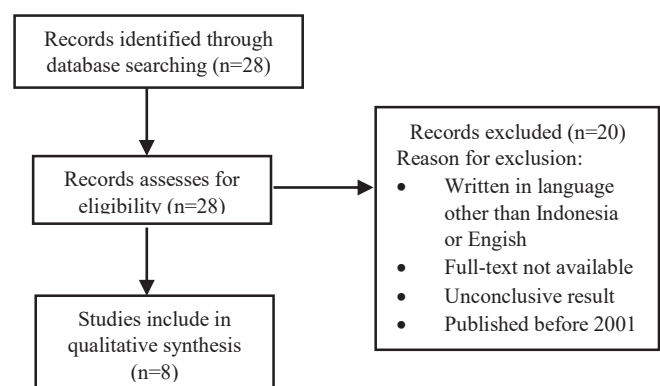


Figure 1. Flow Chart of the Search Process of Articles

Table 1. Summary of reviewed studies

Author	Title	Publication Year	Study Design	Findings
Ran <i>et al.</i> , 2020	Risk Factors of Healthcare Workers with Corona Virus Disease 2019: A Retrospective Cohort Study in a Designated Hospital of Wuhan in China	2020	Retrospective cohort study	Healthcare staff have an increased risk of being contacted COVID-19 while working in the high-risk department and having suboptimal hand hygiene after exposed to the patients during a long hour shift.
Kim <i>et al.</i> , 2016	Surveillance of the Middle East respiratory syndrome (MERS) coronavirus (COV) infection in healthcare workers after contact with confirmed MERS patients: incidence and risk factors of MERSCOV seropositivity	2016	Prospective cohort study	Seropositivity of MERS-COV IgG in healthcare workers was 0.3% after having contact with MERS patients. The seropositivity in participants without the appropriate use of PPE was 0.7%. Moreover, the seroprevalence of MERS-CoV IgG was higher among the subjects without appropriate use of PPE.
Wizner <i>et al.</i> , 2018	Exploring respiratory protection practices for prominent hazards in healthcare settings	2018	Systematic review – a meta-analysis	Further study is needed to investigate the surgical masks used, as themasks tend to be used in specific cases, namely surgical smoke and antineoplastic drugs, where respiratory protection is suggested. To improve hazard identification, risk assessment, effective respirator selection usage for HCWs, guidelines, instruments, and training should be improved.
Yassi <i>et al.</i> , 2005	Research Gaps in Protecting Healthcare Workers From SARS and Other Respiratory Pathogens: An Interdisciplinary, MultiStakeholder, Evidence-Based Approach	2005	Literature review and focus group discussion	Future studies in preventing healthcare workers (HCWs) from acquiring severe acute respiratory syndrome (SARS) and other respiratory pathogens are prioritized as follows: 1) Priority 1: Improving health and safety in the workplace via organizational factors; 2) Priority 2: Recognizing SARS and other respiratory pathogens transmissions; 3) Priority 3: Mitigating the risk through engineering controls and adequate personal protective equipment.
Chen <i>et al.</i> , 2009	Which preventive measures might protect health care workers from SARS?	2009	Retrospective cohort study	Adequate air ventilation at wards and several simple preventive measures, such as using appropriate personal protective equipment, may decrease or prevent SARS transmission among healthcare workers in hospitals.
Peck <i>et al.</i> , 2004	Lack of SARS Transmission among Healthcare Workers, United States	2004	Retrospective cohort study	In the US, current standards of adherence to infection preventive measures might be ineffective if many high-risk infection procedures. Despite the implementation of infection control measures during working hours, unprotected exposures among health workers may still occur. New infection prevention programs should also include some efforts to improve overall adherence to personal protective equipment aside from focusing particularly on patients and occasions with the greatest risk of transmission.

RESULTS

Our search in databases results in 8 articles that were eligible for the literature review (the search process is summarized in Fig. 1), and we summarized the eligible studies in Table 1.

Risk Factors for Healthcare Workers During COVID-19 Pandemic

In a study conducted at a hospital in Wuhan, the risk factors observed from health workers were the use of PPE for protective factors, risky procedures

Lanjutan Table 1

Author	Title	Publication Year	Study Design	Findings
Al-Amri et al., 2019	Knowledge and Practices of Primary Healthcare Physicians Regarding Updated Guidelines of MERS-CoV Infection in Abha city	2019	Cross-sectional study	This study found a knowledge gap among personal healthcare (PHC) doctors in Abha City, resulting in their suboptimal practice in MERS-CoV infection. CME about MERS-CoV infection was attended by less than one-fourth of PHC doctors. However, Saudi PHC doctors and MBBS trained physicians who did not engage in a related CME event were significantly less practice-related adhered to the MERS-CoV infection guideline. Thus, more MERS-CoV-related CMEs should be held to increase knowledge.
Schwartz, King, and Yen, 2020	Protecting Health Care Workers during the COVID-19 Coronavirus Outbreak -Lessons from Taiwan's SARS Response	2020	Literature review	The Taiwan CDC discovered that during the SARS epidemic, Traffic Control Bundling (TCB) was a method that has been proven successful in limiting infection rates for health care workers in Taiwan. Zero healthcare staff and two patients acquired nosocomial SARS infection in the 18 hospitals that introduced TCB, while 115 healthcare staff and 203 patients acquired SARS at the 33 control hospitals.

and working hours, and also the importance of knowledge of healthcare workers. The results of this study stated that inappropriate use of PPE, long working hours, and high-risk procedures can be risk factors for infection of health workers, and knowledge and training of healthcare workers is important during this pandemic (Ran et al., 2020). Besides, there are additional factors that can influence risk factors for infection such as hospital environmental factors, hospital infection control, and organizational factors (Peck et al., 2004; Yassi et al., 2005; Chen et al., 2009; Al-Amri et al., 2019).

Personal Protective Equipment (PPE) for Healthcare Workers

The use of PPE is a topic that often appears and is discussed in research related to the safety of health workers during a pandemic. In research conducted by Kim et al., (2016) in Korea, it is shown that all health workers infected with MERS-CoV were not wearing PPE. Overall, awareness among health workers about the importance of using PPE when in contact with patients is quite good, yet, in several studies, it was found that the use of PPE is often inconsistent and incompatible with the exposure risks faced (Yassi et al., 2005; Kim et al., 2016; Wizner et al., 2018; Ran et al., 2020). In studies conducted in America, the use of surgical masks was used more often than respirators such

as N95. The study concluded that the procedure for using PPE by health workers may be correct, but the use of surgical masks sometimes does not match the risk of exposure faced in these situations, where it may be more effective to use a respirator. The three main reasons for not using PPE after the risk of exposure are a non-inclusion of PPE in the applicable safety and health protocols, minimal exposure and no provision of PPE by superiors (Wizner et al., 2018).

According to a focus group discussion (FGD) of frontline healthcare workers in Toronto, Canada, it was found that the use of N95 respirators as PPE was recommended to protect against droplet transmission of respiratory infections. However, based on existing findings, fit testing in the use of N95 masks is rarely done, so there is a decrease in the effectiveness of these masks (Yassi et al., 2005).

On March 19, 2020, WHO has issued a recommendation for PPE during the COVID-19 pandemic as a protective factor for the healthcare workers against COVID-19 infection. The PPE standards recommended when dealing with COVID-19 positive patients are medical masks, gowns, gloves, and goggles. Meanwhile, the use of N95 respirators is only used if it is to carry out aerosol-generating procedures on positive patients with COVID-19 (World Health Organization, 2020b).

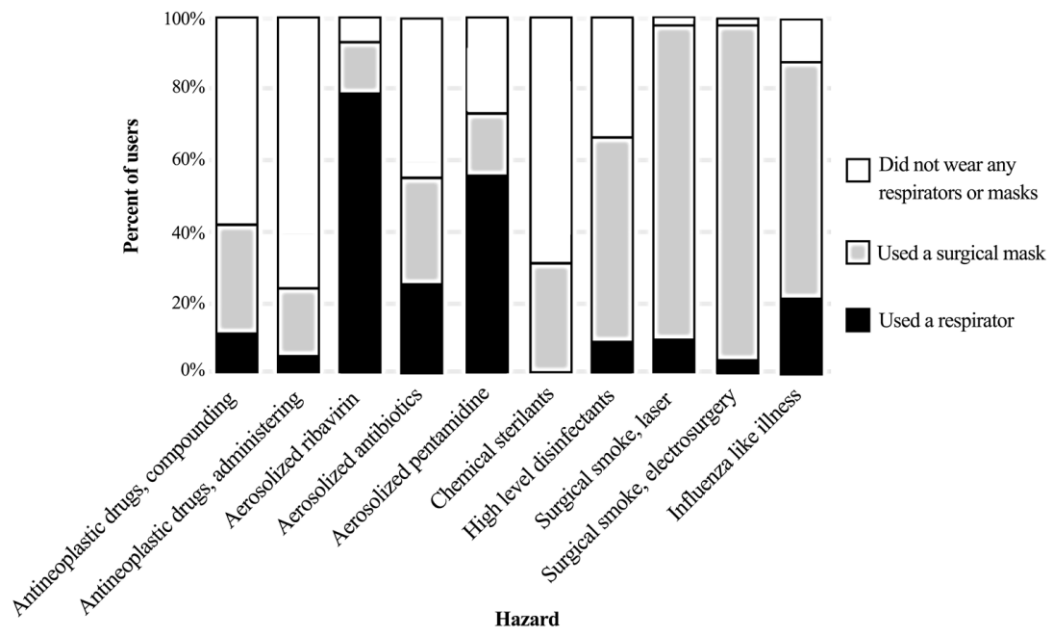


Figure 2. Use of a Respirator and Surgical Mask during Risk Exposure (Wizner et al., 2018)

High-Risk Procedures and Working Duration among Healthcare Workers during COVID-19 Pandemic

Research that investigated the impact reduction of the COVID-19 spreading among health workers have been conducted in several hospitals in Wuhan City and divided into two categories, namely High-Risk Department and General Department. The High-Risk Department is a department responsible for intervention procedures or surgery that results in respiratory aerosols formation, such as the departments of pulmonary, infection, ICU, and surgery, whereas the General Department is a clinical department with a low risk of infection. Figure 4 provides Kaplan-Meier survival curve estimating COVID-19 by comparing HRD and GD among 72 participants in the study. The analysis found that the cumulative proportion of disease-free workers would decline with daily working hours, which was more prominent in HRD ($P < 0.05$). Specifically, all staff in HRD have a higher risk of infection if they work 15 hours per day (Ran et al., 2020).

Health workers in China generally work a long shift, with an average of more than 54 hours each week. Moderate working hours will benefit the health workers, while prolonged working hours (> 10 hours/day) may escalate the infection risk (Ran et al., 2020).

The Importance of Healthcare Workers's Knowledge and Training related to the COVID-19

A previous study using the Gershon study found that most healthcare workers have already had a high level of personal knowledge on Universal Precautions (UP). However, in some circumstances, high levels of knowledge are not accompanied by high levels of compliance. This knowledge is affected by several other factors including age and attitudes regarding the safety of coworkers. Another study by the Gershon group found that healthcare workers under 40 years of age adhere more to UP. Moreover, the authors concluded that younger health workers receive more training and calls for complying with UP. Focus group members also stated the necessity for repeated training. In addition, better tracking techniques for tracking trained health workers should be developed. Workers believe that in terms of time commitment to frontline workers, the "train-the-trainer" model must be considered. (Al-Amri et al., 2019).

Infection Control in Hospitals

Research on preventive measures for protection from SARS in Hospitals in collaboration with Sun Yat-Sen University in 2008 focused on health workers. Of the 19 risk factors surveyed, 15 were significantly associated with infection in healthcare

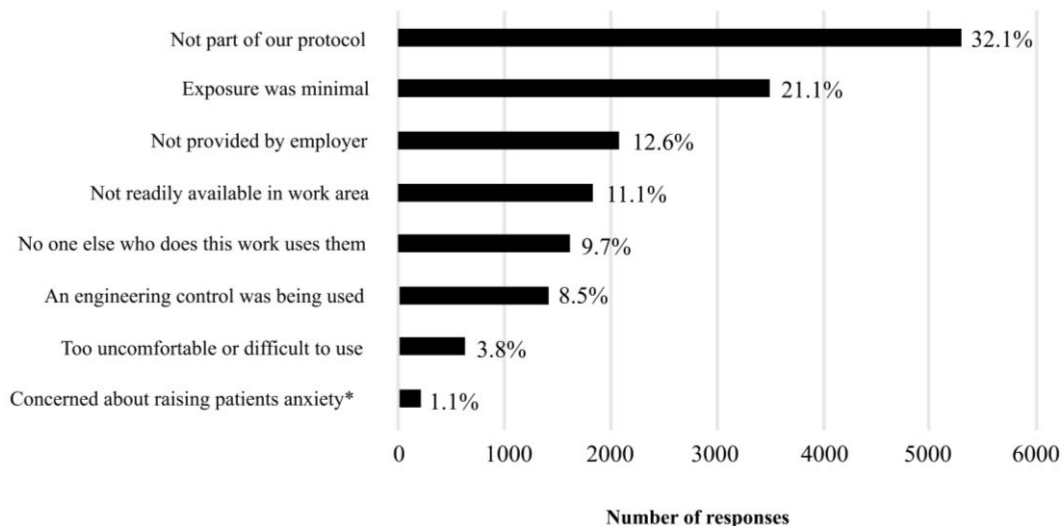


Figure 3. Reasons for Not Using a Respirator during Risk Exposure (Wizner et al., 2018)

workers. There were only a few things that were not significantly related, such as wearing face protection, washing hands after handling patients, and washing the nose after treating SARS patients (Chen et al., 2009).

The study stated that performing intubation in SARS patients significantly increases the risk of infection in healthcare workers. Conversely, using PPE will protect medical personnel from infection. The use of proper ventilation can also significantly reduce the number of infected medical personnel. The incidence of infection is noted to be lower in medical personnel who consistently avoid direct contact with patients while they are treating the patients (Chen et al., 2009).

A study related to SARS transmission to health workers conducted in America in 2004 said that out of 102 health workers, 45 received exposure without wearing a mask, and the remaining 72 received exposure without wearing eye protection. In this study, 66% of healthcare professionals reported to interact with patients when the patients were coughing. 40% of these health workers received exposure without a mask, and 52% wore PPE without at least one of the following tools: protective clothing, gloves, or goggles. Another 11 health workers reported interactions with patients with active diarrhea, while 1 health worker reported exposure when the patient vomited. There were 5 health workers with high potential for exposure to droplets and aerosols such as tracheal intubation and suction, and 4 others administered drugs through aerosols. After exposure to one positive confirmed case, 17 health workers showed clinical symptoms, most of which was cough (Peck et al., 2004).

An investigation by the Taiwan CDC found that the application of the Traffic Control Bundling (TCB) could reduce the infection rate of health workers during the SARS outbreak in Taiwan. TCB includes triage outside the hospital (whether in a tent or other designated areas) to select patients who fall into the contamination zone and risk zoning which includes contamination zone, transition zone, and clean zone; each zone is separated by a checkpoint. In 18 hospitals that implemented TCB, there were no health workers who contracted SARS infection, and only 2 patients were infected with SARS. Meanwhile, at 33 other hospitals that did not implement TCB, 115 health workers and 203 patients were infected with SARS (Schwartz, King, and Yen, 2020).

Organizational, Environmental, and Individual Factors Associated with COVID-19

In research on the protection of health workers from SARS and respiratory pathogens, at least 3 things are mentioned to strengthen the foundation of protection, namely organizational factors, environmental factors, and individual factors. Organizational factors are determined by workplace safety which is manifested broadly, including workplace culture and safety climate that lead to specific policies and procedures such as the existence of training programs. The safety climate refers to workers' perceptions of safety in the place where they work. Meanwhile, training leads to a workplace safety program, and good training is training that allows workers to comply with work safety rules (Chen et al., 2009).

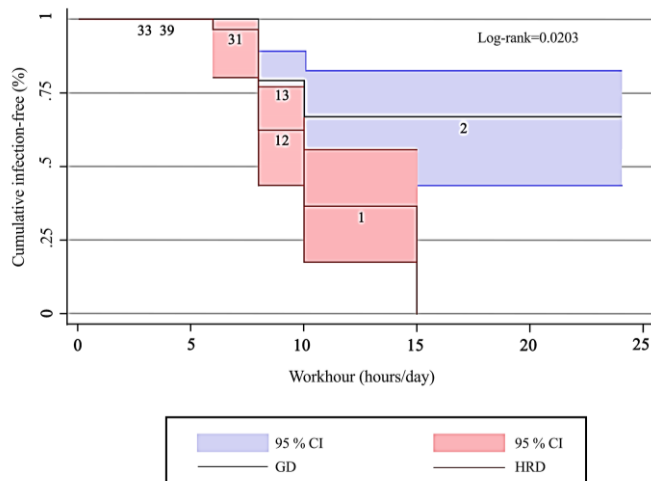


Figure 4. Kaplan-Meier Curve (Ran et al., 2020)

Environmental factors include the use of negative pressure rooms, distance restrictions, specific respiratory protection namely N95 masks, and other PPE as keys to the spread of respiratory diseases such as TB. Individual factors include knowledge, perceptions of risk, beliefs, behavior, past experiences, and sociodemographic characteristics. Moreover, the use of PPE depends on time, comfort in carrying out tasks, comfort in relationships with others, and dexterity in handling (Chen et al., 2009).

DISCUSSION

Health workers are at the frontline responders during this pandemic. When the vanguard is paralyzed, the health system can break down. The application of a work safety system is important to recognize the risk and hazards of health workers so that special measures can be applied to protect the safety of health workers in dealing with this pandemic. According to World Health Organization (2020a), the dangers faced in this pandemic include exposure to pathogens that are at risk of infecting health workers, long working hours, psychological stress, work fatigue, and stigma.

The concept of physical space separation as the control of environmental factors during an outbreak, pandemic, or epidemic has been applied long ago (Yassi et al., 2005). This concept is one of the main keys to the success of controlling the SARS epidemic (Le et al., 2004). During a pandemic, physical distancing must be done by maintaining physical distance, and as much as possible avoiding crowds, especially by health workers to reduce exposure to the risk of transmission (Ministry of

Health of the Republic of Indonesia, 2020; World Health Organization, 2020b).

Health workers, including doctors, nurses, medical analysts, and radiographers, are vulnerable to being exposed to the COVID-19 virus agent. Therefore, adequate PPE and personal hygiene are needed. According to Liang (2020), the self-protection of health workers related to COVID-19 is divided into three levels. Level I self-protection requires disposable surgical caps, masks, rubber gloves, and uniforms. Level I protection also includes a triage site and a general outpatient department. Similar to level 1, level II self-protection uses PPE but it is added with an N95 mask. The use of PPE is increasing due to the coverage locations that have a higher risk of exposure, such as the isolation ward area (including the ICU), the outpatient department for fever patients, and the specimen examination area. Furthermore, level III self-protection is intended for those with the highest risk of exposure, namely for staff who will perform actions such as intubation, tracheostomy, bronchofibroscopy, and others. These procedures carry the risk of contact with the patient's body fluids. Therefore, a more complete PPE is needed, consisting of disposable PPE namely surgical caps, N95 masks, and rubber gloves, work uniforms, disposable medical protective uniforms, and face-to-face respiratory protective devices.

Inadequate use of PPE can lead to a higher risk of infection. In 2005, when there was an outbreak of SARS CoV, based on research in one hospital in the United States hospital, 45% of health workers did not utilize the PPE, and as many as 65% of health workers interacted with patients who often coughed. This means that when the outbreak started to end, around 15% of health workers experienced coughs. There are still many exposures to health personnel even though the implementation of infection prevention and control has long been encouraged. Therefore, new initiatives are needed such as training on how important the use of PPE is to increase the compliance of health workers and an adequate supply of PPE for all health workers who have a high risk of disease transmission (Peck et al., 2004).

Besides using PPE, health workers are also required to maintain their hygiene. Objects around the patient and health workers that appear "clean" can become contaminated with the agent if they are touched by the gloves of the health worker or the patient. When these objects are touched by

other people, and those people touch their mucous membranes like nose or mouth, then the transmission will continue. Another way to eradicate this chain of transmission is to maintain personal hygiene such as washing hands with soap (Chen et al., 2009). The same results are also noted in research done by Ran et al. (2020), stating that hand hygiene, high duration of working hours, and repeated exposure make it easier to transmit nosocomial infections, especially in respiration. Therefore, the most important preventive measure regarding the spread of infection is hand hygiene because it significantly reduces the number of viruses or bacteria.

During a pandemic, health workers as the frontline in handling COVID-19 are at the very risk of being exposed to cases of infection. It is hoped that health workers will understand well the patterns, cycles, and modes of transmission of infection in a pandemic. Al-Amri et al., (2019) stated that only 3.5% of doctors understand the MERS pandemic pattern at that time. This results in a lack of knowledge in preventing transmission and controlling the infection.

The most important hospital operational protocols in handling COVID-19 today are the recognition of hazards, control of risk factors, and the selection of appropriate personal protective equipment (Wizner et al., 2018). Infection control is considered inadequate due to limited training time for health workers, inconsistent use of PPE, and the insufficient number of PPE needed. Work safety training is considered to have a major role in protecting health workers, especially during an outbreak (Yassi et al., 2005). Therefore, it is necessary to have special training for health workers. Guidelines for wearing and removing PPE in treating COVID-19 patients are needed (Liang, 2020). It is also necessary to implement Traffic Control Bundling (TCB) by health facilities because, with TCB in health facilities, nosocomial infections in health workers can be significantly reduced compared to health facilities that do not implement TCB (Schwartz, King, and Yen, 2020).

The emergence of COVID-19 has caused excessive anxiety in the community. This is marked by the emergence of various complaints in the community where there are no abnormalities in their physical condition. This is called a psychosomatic symptom (Gica et al., 2020). Of course, this cannot be tolerated because it can make things worse. This applies not only to the community but also to health workers where they work harder than usual.

Reflecting on Wuhan, health workers are faced with a high risk of infection, overwork, frustration, discrimination, and even emotional outbursts from patients and their families. This of course can affect the mentality of these workers. Symptoms will include stress, confusion, anxiety, depression, sleep disturbances, anger, and fear. If this is not resolved immediately, it will affect their activities and health. Several methods such as the shift system can take the health workers on a temporary break. Besides, a special team is needed to handle the mental health of health workers either in person or in the form of online consultation (Kang et al., 2020).

To prevent transmission to medical personnel, the Government has made an appeal containing procedures for transmission of COVID-19 in the workplace, including keeping all rooms, including floors, walls, and items in them in hygienic conditions. For medical personnel themselves, they must comply with the procedures for maintaining personal hygiene by carrying out proper handwashing procedures, using complete PPE, limiting unnecessary contact with patients, regulating working hours, and increasing their respective endurance.

CONCLUSION

Risk factors related to healthcare workers' occupational safety and health during COVID-19 pandemic include compliance with the use of PPE, hand hygiene, duration of work hours, risky procedures, and environmental factors.

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