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Health Care Workers Protection During SARS-CoV-2 Pandemic

Zaštita zdravstvenih djelatnika tijekom pandemije SARS-CoV-2

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Summary

The infection risk among frontline health care workers (HCW) is one of the most concerning aspects of COVID-19. Knowledge about SARS-CoV-2 transmission is still insufficient. However, direct, person-to-person contact appears to be the main route. Secondary transmission can also occur and intensive care units have shown greater contamination than general wards. Risk of transmission by infectious aerosols distributed through the ventilation system duct is considered to be very low. Screening and triaging everyone entering a health care facility is crucial in order to prevent rapid spread among hospital personnel and patients. Recommendations on airborne precautions in the health care setting vary by location, but are universally to be implemented when aerosol-generating procedures are performed. Surgical masks or respirators are currently critical supplies that should be reserved for HCW. Both types of masks need to be used in combination with other personal protective equipment measures. COVID-19 patients should be cohorted and only patients undergoing aerosol generating procedures should be placed in airborne infection isolation rooms.

Sažetak

Rizik od zaraze jedan je od najvažnijih aspekta bolesti COVID-19 koji zabrinjava zdravstvene djelatnike na prvoj liniji. Znanje o načinu prijenosa SARS-CoV-2 još uvijek je nedovoljno. Međutim, čini se da je izravan kontakt, s osobe na osobu, glavni put prijenosa zaraze. Sekundarni prijenos je također moguć, pri čemu je veća kontaminacija zabilježena u jedinicama za intenzivnu njegu bolesnika za razliku od općih bolničkih odjela. Smatra se da je rizik od prijenosa infekcije zaraznim aerosolom koji se širi kroz ventilacijske sustave vrlo nizak. Skrining i trijaža svih osoba koje dolaze u zdravstvenu ustanovu od presudne su važnosti kako bi se spriječilo brzo širenje virusa među bolničkim osobljem i pacijentima. Preporuke o mjerama za suzbijanje širenja infekcija koje se prenose zrakom u zdravstvenim ustanovama razlikuju se ovisno o lokaciji, ali ih treba univerzalno primjenjivati kod svih postupaka kod kojih se stvara aerosol. Kirurške ili respiratorne maske trenutno su najvažnija oprema koja bi trebala biti rezervirana za zdravstveno osoblje. Obje vrste maski potrebno je koristiti u kombinaciji s drugom osobnom zaštitnom opremom. Pacijente s COVID-19 treba grupirati, a samo pacijente koji se podvrgavaju postupcima koji stvaraju aerosol treba smjestiti u posebne sobe za izolaciju.

Introduction

The risk for infection among frontline health care workers (HCWs) is one of the most concerning aspects of COVID-19, not only because they are at higher risk of infection but also because they can amplify outbreaks within health care facilities if infected. A study from Nguyen et al. reported that frontline HCWs had at least a threefold increased risk of reporting a positive COVID-19 test compared with general community.[1] By early September, at least 7,000 HCWs have died worldwide due to COVID-19.[2] Reducing the risk of HCWs infection is of paramount importance but faces numerous problems, mainly shortage of protective equipment, lack of staff and insufficient data on virus transmission.

Transmission

Knowledge about the routes of transmission and transmission risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is still insufficient. At the moment, the risk of spreading from animals to humans is considered to be low although the beginning of the outbreak was connected with a seafood market in Wuhan and probable animal to human transmission.[3,4]

Person-to-person contact is considered to be the main route of transmission with the highest risk during close-range contact (approximately 6 feet or 2 meters) and via respiratory droplets produced when an infected person coughs, sneezes, talks or sings. Other possible routes include indirect (secondary) transmission, if a

susceptible person touches contaminated surfaces and then mucous membranes, and transmission through aerosolized secretions which is still controversial.[4,5]

Guo et al. tested air and surface samples to determine the level of contamination in hospital wards. Contamination was greater in intensive care units than in general wards and SARS-CoV-2 was widely distributed on floors, computer mice, trash cans, sickbed handrails and was detected in air approximately 4 m from the patients.[6]

Our knowledge about other potential routes of transmission, e.g. via non-mucous membranes, blood, vertical and faecal-oral is still sparse. Infectious virus was isolated from urine and faeces.[7]

In several reports, the virus was detected in faeces even after clearance from respiratory specimens suggesting possible faecal-oral transmission.[8,9] According to joint WHO-China report, faecal-oral transmission is not a significant factor in the spread of infection and has not been clinically described.[10]

The risk of SARS-CoV-2 transmission by infectious aerosol distributed through the ventilation system duct is considered to be very low. Well-maintained heating, ventilation and air-conditioning (HVAC) systems securely filter large droplets containing SARS-CoV-2. Spread of SARS-CoV-2 aerosols (small droplets and droplet nuclei) is possible through HVAC systems within a building or vehicle and stand-alone air-conditioning units if air is recirculated.[11]

Viral Shedding and Period of Infectivity

An infected person can transmit the virus during the course of illness and during the incubation period. According to Wei et al. pre-symptomatic transmission occurs 1–3 days prior to the symptoms onset.[12] Soon upon the symptoms onset, viral RNA levels in the upper respiratory specimens are the highest.[13]

The Ct or cycle threshold value is the number of cycles required for the fluorescent signal (which is generated in a positive PCR reaction) to cross the threshold[14]

The lower the viral load, the higher the number of cycles to cross the threshold. Higher viral loads, which are inversely related to Ct value, were detected soon after symptom onset and were higher in the nose than in the throat.[15]

Some reports describe that the presence of viral RNA in respiratory samples does not indicate infectivity and does not imply the fact that infection can be transmitted.[16,17] A major drawback of PCR is that it fails to determine virus infectivity as opposed to virus isolation.[18] Correlation between successful isolation of SARS-CoV-2 in cell culture and Ct value of RT-PCR targeting E gene suggests that the patients with Ct value above 33 to 34 are not contagious.[19] Infectious virus has not been isolated from upper respiratory specimens more than nine days after illness onset.[20] In some immunocompromised persons with severe COVID-19, recovery of replication-competent virus has been documented between 10 and 20 days after symptom onset. In a study by van Kampen et al. serum neutralizing antibody titre of at least 1:20 ($p<0,001$) was independently associated with non-infectious SARS-CoV-2. Hypothetically, serological assays and quantitative RT-PCR, if available, could thus be used to discontinue or de-escalate infection prevention and control precautions.[21]

Protective Measures

The main route of SARS-CoV-2 transmission is direct person-to-person contact, while possible routes include secondary transmission via contaminated surfaces and through aerosolized secretions. An infected person is considered to spread the infectious virus 1-3 days prior to and up to 9 days upon the symptoms onset.

According to the main routes of transmission, general protective measures include maintaining proper social distance (at least 2 meters), hand washing with soap and water or use of hand sanitizers that contain at least 60% alcohol, routine cleaning and disinfection of touched surfaces and cloth face covering usage. The masks are crucial for source control, i.e. they represent a barrier and prevent respiratory droplets from traveling into the air.[22]

According to CDC, masks should be worn in public settings and during contact with individuals from another household. Children under the age of 2 years, persons with breathing difficulties, unconscious or people otherwise unable to remove the mask without assistance should not wear masks.[22]

Preschool or early elementary school children should wear masks at times when it is difficult to maintain a distance of 2 m from others. Masks of proper size and fit should be ensured for children and parents should frequently remind and educate them on the importance of wearing the masks.[22]

The study objectifying virus dissemination in exhaled air has proven that surgical masks reduce emission of coronaviruses in respiratory droplets and aerosols while influenza virus emission is reduced only in respiratory droplets.[23]

A recent report, based on mathematical modelling, showed that the R value (number of people on whom an infected individual passes the virus) would decrease from 4.0 to below 1.0 if an entire population wore face coverings that were only 75% effective.[24]

Two protective measures used to prevent the spread of infection to susceptible individuals are isolation and quarantine. Separation of SARS-CoV-2 positive per-

son from people who are not sick is called isolation. Separation and movement restriction of people who were exposed to SARS-CoV-2 and haven't developed symptoms yet is called quarantine.[25]

According to CDC, for most SARS-CoV-2 positive people/individuals isolation can be discontinued 10 days after symptom onset and resolution of fever for at least 24 hours without the use of fever-reducing medications and with improvement of other symptoms. Also, isolation for asymptomatic SARS-CoV-2 persons can be discontinued 10 days after the date of their first positive RT-PCR test.[25] Longer period of isolation is reserved for those with severe illness and immunocompromised.

Infection Control in Health Care Settings

Reflecting the current uncertainty regarding transmission mechanisms, recommendations on airborne precautions in the health care setting vary by location. Airborne precautions are universally recommended when aerosol-generating procedures are performed.

While surgical masks do not form a seal around mouth and assure only one-way protection, the respirators are protective devices designed to achieve a very close fit and efficient filtration of airborne particles.[26,27]

Three most commonly discussed disposable respirator types are N95 and filtering face piece masks (FFP2 and FFP3). They differ in their filter capacity of all particles that are 0.3 microns in diameter or larger. Namely, FFP2 removes at least 94%, N95 at least 95% while FFP3 removes at least 99% of such particles.[27] Surgical masks or respirators are currently critical supplies that should be reserved for health care workers.[22]

During the outbreaks of viral respiratory illnesses (such as influenza), standard surgical masks are as effective as respirators for preventing infection of health care workers.[28]

To date, no head-to-head trial of these masks in COVID-19 pandemic has been published. Both types of masks need to be used in combination with other personal protective equipment (PPE) measures such as long-sleeved gown, eye protection, gloves as well as proper don and doff.[29]

Screening and triaging everyone entering a health care facility is crucial in order to control infection. Source control measures, hand hygiene practices, monitoring points of entry to the facility, screening stations for patients, health care practitioners and visitors outside the facility for symptoms consistent with SARS-CoV-2 infection and exposure to SARS-CoV-2 should be constantly implemented.

According to WHO, everyone entering a health care facility should also wear their own face cloth because of the potential for asymptomatic and pre-symptomatic transmission.

Those with symptoms compatible with SARS-CoV-2 infection and those self-isolating should call beforehand and schedule an appointment according to a triage protocol. If they do not have their own face covering, they should be offered, where applicable, a facemask or cloth face covering. If a cloth face covering cannot be tolerated, a tissue should be held against one's mouth and nose to contain respiratory secretions when coughing, sneezing or talking. A patent with suspected or confirmed SARS-CoV-2 infection should be placed in a single-person room with the door closed.[30]

Only patients undergoing aerosol generating procedures (AGP) should be placed in airborne infection isolation rooms (AIIRs).[30] The following procedures are considered likely to generate aerosols capable of transmitting respiratory pathogens: tracheal intubation and extubation, suction, nebulization, bronchoscopy, noninvasive positive pressure ventilation, manual ventilation, cardiopulmonary resuscitation, airway surgery, upper and lower endoscopy, dental procedures, etc.[31]

High-flow nasal oxygen (HFNO) is used in patients suffering from COVID-19 for management of patients suffering from acute hypoxemic respiratory failure. Although HFNO was not recommended until patient was cleared of COVID-19, recent studies suggest that the risk of transmission is low and that FFP2 mask with standard PPE provide sufficient protection.[32,33]

According to ECDC, personal protective equipment (PPE) varies between health care workers who perform the first assessment and those collecting specimens. PPE is not necessary for health care workers not exposed to direct contact, e.g. during first assessment while the patient wears a medical mask and keeps a distance of at least 1.5 meters, or if a physical barrier is present. Since respiratory specimen collection (e.g. nasopharyngeal swab) provokes coughing and/or sneezing, health care workers collecting diagnostic respiratory samples in enclosed spaces should wear respirators, eye protection, gloves and gown. In case of shortage of respirators and for drive-through or outdoor testing facilities, a surgical mask can be used.[34]

Patients suffering from confirmed COVID-19 should be cohorted in a separate ward or section of the hospital in order to optimize the use of PPE. During contact with suspected or confirmed cases health care workers should wear a well-fitted respirator, gloves, goggles and long-sleeved gown.[34]

A proper use of PPE is essential. The process of putting on PPE is called *donning* while the process of removal is called *doffing*. There are several ways to safely remove PPE without contaminating the surrounding objects. It is crucial to keep in mind which surfaces of

PPE are contaminated and to perform hand hygiene between steps if hands become contaminated as well as immediately after removing all PPE.[35]

The duration of potential air infectiousness after a SARS-CoV-2 positive patient leaves the room is still unknown. Factors such as room size and ventilation system design (ex. flowrate and system location) are crucial to determine the amount of time during which rooms or areas used by ill persons should be closed prior to disinfection.[36]

Conclusion

The understanding of the routes and transmission possibilities of SARS-CoV-2 is still insufficient. Source control seems to be the most important measure for reducing transmission overall as well as in health care setting. Other important measure is the PPE usage and therefore, all HCWs must be trained in its usage. In health care facilities, airborne precautions are recommended when aerosol-generating procedures are performed. Infection of HCWs and its consequences are one of the most concerning aspects of COVID-19 and therefore, critical supplies should be reserved for HCWs.

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