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Review Article

SARS-CoV-2 Transmission Pathways. Basis for Protection of Healthcare Workers in Otorhinolaryngology Departments

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Abstract

Recommendations have been reported regarding the organization of medical and surgical practices in the current COVID-19 pandemic. Protection of healthcare workers daily exposed to viral transmission is paramount. An evolving understanding of viral transmission pathways is a crucial prerequisite for adapting collective and personal protective equipments.

Keywords: COVID-19; Transmission; SARS-CoV-2; Protection

Introduction

Facing the current COVID-19 pandemic, many countries had to adopt strategies to avoid overwhelming healthcare systems. Lockdown of the population aims to flatten the curve of infections. Postponement of non-urgent surgical procedures enables to increase medical resources to treat infected patients.

Quarantine of population had already been adopted during middle ages outbreaks coming from Asia: the Black Plague pandemic (1348 - 1352), the Morbus Cholera pandemic (1830) and the Spanish Flu (1928) [1]. Because of the rapid spread of SARS-CoV-2 over the world, protection for healthcare workers is a challenge, for their own safety, to help in continuity of cares and to reduce risk of viral transmission within healthcare settings. Many cases of infected healthcare members have been first reported in China [2,3], followed by other countries over the world. The risk of viral infection of physicians and nurses in ENT practices is high. Better understanding of viral transmission is the basis of scientific recommendations in the current active or the gradual declining pandemic.

Characteristics of coronavirus

Coronavirus's name is coming from the crown arrangement of proteins identified under electronic microscopy at the surface of the virus. The viral genome is depending on the virus strain mostly hosted in animals [4]. Bats are the main hosts. Mutations in the virus structure is responsible for the ability of the virus to attach to new receptors types, jumping from an animal host to a human host (zoonosis) [5]. Correlation between genomic sequences of SARS-CoV-2 of bats and humans is ranging between 88 and 96%. Transmission to humans usually occurs through food consumption of intermediate host (pangolin) [6,7]. Then adaptive properties of the virus enable human-to-human transmission, leading to previous epidemics such as SARS in China and MERS in Saudi Arabia. However, the replication rate of the current SARS-CoV-2 is much higher than other strains.

ACE2 (Angiotensin Converting Enzyme 2) is the cells receptor for the virus in animals. Human-to-human transmission would be secondary to the virus characteristics to recognize this receptor in humans 4). The S-glycoprotein virion on the surface of the virus allows its anchoring to the receptor. After fusion of the membranes, the viral RNA is injected into the cell before replication. The virus primarily attacks respiratory cells and then spreads to other cell types. Virus-cell interactions induce an immune response in humans through the intense release of cytokines and chemokines that cause lung lesions, visible in chest CT-scan even in asymptomatic patients [6].

Diagnosis of viral infection

Chest CT-scan imaging shows high sensitivity but low specificity in the early stage of the disease [7,8]. Therefore, normal chest CT-scan cannot be considered a sufficient criterion to rule out infection in a patient [9,10].

Similarly, sensitivity of viral RT-PCR test on nasal samples is low (56 - 83%) [11,12] and virus identification may be delayed [11].

Serological tests are not recommended for early disease [13,14] due to low sensitivity and low specificity [15,16].

There is therefore no test to date that can formally rule out infection in a patient in the early stage of the disease. However, similar viral loads have been recorded in both symptomatic and asymptomatic patients, suggesting a high potential of viral transmission [6].

With no effective treatment to date and no prospect of short-term vaccine, understanding viral transmission pathways is crucial to adapt protective equipments of healthcare workers.

Transmission by droplets

Projection of droplets from the naso-pharyngeal area is the main human-to-human transmission pathway [17,18]. Otolaryngologists are therefore exposed to viral infection in the clinics and operative rooms. Personal protective equipment by mask is crucial. FFP2/N95 masks provide 95% droplet filtration capacity and a higher efficiency than surgical masks [19].

Trans-conjunctival ocular contamination route is also suspected [20], as other strains of coronavirus have previously been identified in tears [21]. Eye protection should therefore be provided by googles and/or full-face shields.

Transmission by aerosols

Identification of SARS-CoV-2 in air samples at 1 meter from an infected patient for more than 8 hours, as well as detection of SARS-CoV-2 particles smaller than 5 microns in the air for at least 3 hours, strongly suggest the risk of airborne viral transmission [18]. Viral particles excreted via droplets can reach 2 meters. Airborne virus could travel several hundred meters through bioaerosols, as previously demonstrated with SARS, MERS and H1N1 viruses [22,23].

Aerosolizing procedures

Healthcare workers could be infected through aerosolizing procedures. Their origin may be physiological, by coughing or sneezing during nasopharyngeal fibroscopy or mechanical, during intubation, endoscopy and cervical surgery opening upper airways [24].

Application in surgery concerns also procedures using high-speed drills. Any procedure able to increase air speed reduces the size of aerosol particles. Mastoidectomy procedures using high-speed drills could expose healthcare staff to viral infection within operating rooms. Several recommendations concerning the organization of surgical procedures and safety measures, before, during and after surgery have already been reported [18,25-28].

Transmission through surfaces

Viral particles projected by droplets or suspended in the air through bio-aerosols can settle on surfaces, according to ventilation and air humidity conditions within clinics and operating rooms. Survival time of the virus on inanimate surfaces has been reported to range from a few hours to 5 days, particularly on plastic, stainless steel and paperboard surfaces, usually encountered in healthcare settings [29].

This highlights the value of protective equipments by gloves, regular hand cleaning with soap and hydro-alcoholic solutions and regular application of 62 - 71% alcohol-based solutions able to inactivate the virus on surfaces.

Conclusion

Preserving healthcare workers, exposed to viral infection, is a priority in the context of the current COVID-19 pandemic and in the gradual recovery of surgical activities as the pandemic declines in some countries. Better knowledge of viral transmission pathways enables to adapt protective procedures, particularly without short-term prospect of vaccine, treatment and evolution of the pandemic over the world.

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