SARS-CoV-2 in the hospital environment and risk of COVID-19 nosocomial transmission

MASK WEARING TO REDUCE VIRUS TRANSMISSION IN HOSPITALS

Evidence summary by Hospital Environment/SAGE Environment and Modelling / SAGE Hospital Onset COVID-19 Infection Subgroups

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Summary/context:

- There is some mechanistic evidence to show that medical/surgical face masks can block a significant proportion of droplets emitted by people infected with influenza and seasonal coronavirus.

- There is limited evidence from practice to support the extended use of medical/surgical face masks by all healthcare workers, i.e. beyond patient facing interactions, to reduce the transmission of SARS-CoV-2 in hospitals.

- A similar argument exists for the use of face coverings by the public visiting hospitals.

- Given the
    - ongoing potential for asymptomatic or pre-symptomatic COVID-19 in healthcare workers (or members of the public) in hospitals;
    - ~10-fold increased rate of COVID-19 in healthcare workers compared with members of the public; and
    - clear evidence for transmission of SARS-CoV-2 in hospitals and healthcare associated cases of COVID-19, including ongoing hospital outbreaks,

  it is reasonable to consider the extended use of facemasks by healthcare workers (and face coverings by the public) in hospitals.

- There are considerable implementation challenges for a recommendation for extended use of medical/surgical face masks by all healthcare workers, which need to be addressed; these include sufficient availability of masks, clear messaging, and an exit strategy (likely based on prevalence of COVID-19 in healthcare workers and the incidence of hospital outbreaks of COVID-19).

- The extended use of facemasks by workers in other healthcare settings should be considered, although supply chain issues are also pertinent here.

SARS-CoV-2 in the hospital environment

SARS-CoV-2, the virus causing the COVID-19 pandemic, has 79% homology with SARS-CoV (1), and a similar receptor-binding domain (2). SARS-CoV-2 transmission occurs through/following droplet dispersion during an expiratory event (breathing, talking, coughing, sneezing) (3). This can result in

surface/environmental contamination with SARS-CoV-2 viral particles (4). Studies investigating surface contamination in healthcare areas reserved for COVID-19 patients observed virus genetic material in high contact areas (bed rails, tables, etc.), particularly in the immediate environment surrounding COVID-19 patients (4-8). Two new studies (9, 10) have confirmed these observations, and confirmed previously reported contamination of high contact objects for staff (e.g. telephone, computer keyboard and mouse, hand gel sanitizer dispenser) (4, 8). Wu et al. have also observed SARS-CoV-2 contamination on water machine buttons and lift buttons (9). These are frequently touched surfaces that can become contaminated with viral particles following contact with contaminated hands (11), but which may be ignored during routine cleaning (9). During the SARS-CoV outbreak in 2003, objects such as water fountain buttons were identified as an important source for hospital acquired coronavirus infection (12).

Studies investigating SARS-CoV-2 in air samples from COVID-19 patients' rooms (4-7, 9, 13, 14) have occasionally detected presence of low levels of viral RNA (4, 6, 7, 13). While SARS-CoV-2 is believed to spread via aerosols, viral transmission via droplets/surface contamination is also likely to be a key route (5, 13, 15).

Current evidence of mask protection against SARS-CoV-2

Medical masks, also called surgical masks, fit relatively loosely on the face and do not reliably prevent inhalation of small airborne particles. They are intended primarily to prevent microorganism transmission from the wearer to other people, but can reduce hand-to-face contact and facial contact with droplets (16). Mask wearing reduces the main forward plume of exhaled breath (and by implication small droplet aerosols) that reaches someone else's breathing zone, although leakage occurs around non-tight fitting masks (17, 18).

A recent study in patients (n=11) with seasonal coronaviruses (NL63, OC43 and HKU1) has shown that surgical face masks significantly reduced detection of viral RNA in aerosols and showed a trend in reducing viral RNA in droplets (19). Also, a study in Taiwan compared practices in 19 hospitals that had one or more nosocomial infections with SARS-CoV among healthcare workers versus those in 31 hospitals with no such nosocomial infections. While this study has methodological weaknesses, in a univariate analysis of control measures, multiple practices were significantly associated with effective prevention of nosocomial SARS infection, including wearing a surgical mask in either non-risk wards or outpatients (both p=0.015); however, wearing masks was not significantly associated with preventing nosocomial SARS-CoV transmission in a multivariate analysis (20). A small 2009 trial of Japanese hospital workers (n=32), including nurses, doctors, and co-medical personnel (21), found that wearing a surgical mask on hospital premises did not decrease the incidence of (self-reported) upper respiratory tract infection. The authors noted exposure to upper respiratory tract infection outside the hospital as a significant confounder.

Since surgical face masks usually contain droplets larger than 5.0 µm, and droplets that carry SARS-CoV-2 are typically larger than this (10-100 µm), it is reasonable to think that their use could offer some protection from droplet transmission of COVID-19 (22). However, information on the effectiveness of masks against transmission of SARS-CoV-2 is still limited at this time (23). A contact tracing study reported a patient with cough symptoms that travelled in 2 different buses in the same day, while unaware he had COVID-19. He did not wear a face mask on the first bus where there was

presumed transmission of SARS-CoV-2 to 5 of 39 people also travelling; he wore a face mask on the second vehicle (minibus), and none of the 14 people also travelling became infected. This is anecdotal 'evidence' that wearing face masks in enclosed spaces may reduce virus transmission (24).

Of note, there are recent non-peer reviewed reports from a US hospital (Brigham and Women's Hospital in Boston) that coronavirus infections in healthcare workers decreased by at least half following the implementation of a policy to use masks by all healthcare workers in late March (and the extension of the requirement to patients in early April) (25).

Staff adherence to mask use within the hospital

Healthcare workers are likely to be adherent to PPE guidelines in COVID-19 hospital areas, but staff adherence to prolonged face mask use in low risk areas, e.g. staff areas, is a factor to consider. In household studies that required mask wearing for several hours of the day, adherence was poor, ranging from 25 50% at best (26-28). However, healthcare worker compliance appears higher in a hospital setting. In a Japanese trial (mentioned above), self-reported full compliance with mask use or non-use (according to test group) was good, with 84% of the healthcare workers being compliant for 79%-99% of the time; it is possible that cultural issues may have driven such a high compliance rate (21). A study of PPE usage among hospital workers in Hong Kong during the SARS pandemic, found N95 or surgical mask usage in the hospital to be ~95%, even when workers were not directly contacting patients (29). There is currently no evidence that a similar level of compliance will translate to the UK setting.

A recent systematic review on the challenges reported by healthcare workers in previous epidemics (SARS-CoV, H1N1, MERS, tuberculosis, or seasonal influenza) (30), reported that healthcare workers were more motivated to follow PPE guidance as a measure of protection for themselves, their families, or their patients. However, some professionals found the use of masks uncomfortable and difficult when it could make patients feel isolated, frightened or stigmatised. Overall, staff adherence to infection prevention and control guidelines was more likely when it reflected national or international guidelines, and when information was communicated clearly and consistently. Healthcare professionals also stated the importance of including all staff (cleaners, porters, kitchen staff, and other support staff), when implementing infection prevention and control guidelines.

International recommendations on use of masks by the public

Taiwan, Singapore and Hong Kong have imposed the use of face masks when entering healthcare premises (22, 31-33). Additionally, the policies of countries such as South Korea, China and the Czech Republic that, in addition to other measures, recommended the generalised use of masks from the beginning of the pandemic, led to widespread use of masks in countries hit hard by the pandemic, such as Italy and Spain (34), despite the fact that the World Health Organisation (WHO) does not recommend its use by the general public (35).

Both WHO and the European Centre for Disease Prevention and Control (ECDC) suggest that the use of face masks/coverings by the population may contribute to the decreased spread of respiratory diseases, including COVID-19 (35), by reducing the excretion of respiratory droplets from asymptomatic and pre-symptomatic individuals (36); however, both organizations are clear that the

use of masks must be a complement to all other recommended protection measures, such as hand hygiene, respiratory etiquette, and social distancing.

Therefore, on 19 May 2020, WHO still recommends that masks are reserved for those caring for a person with COVID-19 or for those experiencing symptoms like coughing or sneezing (37). However, the WHO also mentions that authorities should consider extending the use of masks when risk of exposure to SARS-CoV-2 is higher due to local clusters of infection, or for those working in close contact with the public (e.g. community health worker, cashier) (35). Similarly, at this time, the ECDC suggests that the use of face masks in the community could be considered when visiting busy and/or enclosed spaces (e.g. grocery stores or shopping centres), or when using public transport (36). ECDC is clear that medical masks should be prioritised for healthcare workers, although non-medical masks could be an option for the public (36).

The Centers for Disease Control and Prevention (CDC) recommends the use of cloth face coverings to help slow the spread of COVID-19 in areas with high risk of community-acquired infection and when social distancing is difficult or not possible (38).

As part of their approach to easing lockdown measure, several governments have mandated use of non-medical/ homemade masks/ face coverings in closed spaces and/ or public transportation (e.g. Italy, France, Spain, Portugal, Czech Republic, and Belgium). Some governments, including UK, have advised but not mandated wearing of face coverings in enclosed spaces, particularly when social distancing cannot be maintained (39, 40).

Evidence on efficacy of cloth face-coverings (non-medical masks)

In addition to the lack of available scientific evidence of mask wearing by the general public, concerns on the supply of masks for healthcare and frontline workers have added to the reluctance of public authorities to advocate universal public mask wearing (23). Homemade textiles masks have been suggested as alternatives for the public to minimise supply issues, as they can be made easily and can be washed and reused (36, 38).

There is limited evidence regarding the respiratory protection that non-medical / homemade masks can offer for the wearer, and there are no established quality standards for self-made face masks (36, 41). One study reported a low filter efficiency (3-33%), and high penetration (up to 97%) of NaCl aerosol particles in homemade masks (42). A trial comparing the use of cloth and medical masks by healthcare workers also showed penetration of microorganisms by 97%, compared with a rate of 44% for medical masks (43).

A study assessing different homemade masks, reported a 100% cotton shirt and a pillowcase as the most suitable household materials for an improvised face mask. Although these masks significantly reduced the number of microorganisms expelled by volunteers compared with no face protection, they were still inferior to a surgical mask (44). Cloth (versus surgical) masks were associated with a higher difficulty of breathing, warming/sweating, glasses misting up, and slurred speech (45).

Finally, a recent systematic review examined the value of wearing facemasks in community settings to prevent the development of respiratory illness. The authors concluded that the evidence is not sufficiently strong to support widespread community use of facemasks as a protective measure

against COVID-19, but that use for short time periods in some transient higher risk situations may be justifiable (46).

Limitations

The data presented has been researched using peer-reviewed publications and reports from respectable institutions in Healthcare and Infectious Diseases. Due to the limited data available, whenever possible, we draw parallels to studies on SARS-CoV prevalence and transmission during a previous outbreak.

The implementation challenges for a recommendation for extended use of facemasks by healthcare workers have not been considered in this review (but are acknowledged in the Summary).

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