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# Reducing the risk of COVID-19 transmission in hospitals: focus on additional infection control strategies

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## Abstract

Hospitals under pressure from the COVID-19 pandemic have experienced an additional challenge due to clusters of hospital-acquired COVID-19 infection occurring on non-COVID-19 wards. These clusters have involved both staff and patients and compromise staffing, bed management and routine care, especially delivery of elective surgical procedures. They have also contributed towards the overall morbidity and mortality of the pandemic. COVID-19 infection rates are rising again, so it is important to consider implementing additional activities designed to impede transmission of SARS-CoV-2 in acute hospitals. These aim to protect staff, patients and visitors, and conserve safe and continued access for patients needing routine and emergency surgical interventions. Current infection prevention strategies include hand hygiene; patient and staff screening; surveillance; personal protective equipment; cohorting and isolation; and enhanced cleaning. Additional activities include restriction of staff and patient movement; COVID-19 pathways for wards, operating theatres and outpatient services; bathroom management; and ensuring fresh air in the absence of effective mechanical ventilation systems. Seasonal pressures and spread of more contagious and/or vaccine-tolerant variants will continue to disrupt routine and emergency care of non-COVID-19 patients, as well as increase the risk of COVID-19 infection for staff and patients. Supplementary practical and cost-effective actions to limit spread in hospitals are explored in this article.

**Keywords** COVID-19; hospital-acquired clusters; infection mitigation; infection prevention and control; SARS-CoV-2; ventilation

## Background

The COVID-19 pandemic has caused untold disruption worldwide. Hospitals have admitted increasing numbers of sick patients with SARS-CoV-2 coronavirus, some of whom have required long term critical care. The pressure on healthcare systems has been compounded by numerous COVID-19 clusters

in hospitals, caused by transmission of the virus to non-COVID-19 patients and staff. Even with the usual infection prevention policies, such as hand hygiene, masks, social distancing and cleaning, there has been disruption and ward closures due to new COVID-19 infections.<sup>1</sup> It is clear that additional activities are required to protect staff and patients.

The interruption of routine services has impacted on all specialties, but especially elective surgery for a range of operations. In particular, waiting lists for cancer, cardiac and orthopaedic services have escalated and staff are struggling to resume normal services while dealing with the aftermath of the pandemic. Increased admissions of frail elderly patients for elective surgery offers a real challenge to busy hospitals also trying to prevent hospital-acquired infection.

SARS-CoV-2 is a novel virus and its major transmission pathways are still hotly debated. Original guidance from the World Health Organization (WHO) decreed droplet and fomite spread and excluded the possibility of airborne transmission outside the designated 1–2 metre zone. Since the virus has now been found in air far distant to affected patients, there has been a move to study both short- and long-range spread of respiratory particles containing viable virus in hospital rooms.<sup>2</sup> Even normal speaking leads to airborne virus transmission in confined environments. If airborne spread enhances the risk of ward-based clusters of COVID-19, then current ventilation parameters in the healthcare environment require urgent review with the aim of reducing transmission between staff and patients as far as possible.<sup>3</sup>

Given that the virus survives in air and on surfaces for hours, it is possible that transmission also occurs between people and contaminated surfaces.<sup>4</sup> Confirmation of effective preventive strategies has been impeded by technical difficulties with environmental sampling and viral culture.<sup>5</sup> SARS-Cov-2 is an enveloped RNA virus, which renders it particularly vulnerable to the usual methods of airborne capture. Both surface swabbing and tissue culture inoculation require highly specialized expertise and it is likely that reported environmental contamination and viability are a gross underestimate.<sup>5</sup> Matching genotypic strains between different environmental reservoirs and infected/colonized individuals would provide the evidence required to formulate effective infection prevention practices.<sup>6</sup> Unfortunately, much of what is advised at present is not supported by definitive proof. Therefore, infection prevention and control staff need to apply a package of procedures based on tried and tested principles until such time as new evidence is forthcoming.

This article summarizes key components of infection prevention and control needed to reduce the risk of SARS-CoV-2 in hospitals, with more detailed focus on additional measures to protect routine clinical practices. While there is increasing emphasis on air exchange and quality in hospitals in the wake of this pandemic, there are ongoing issues that deserve further consideration, such as the risk of short range aerosol transmission in staff rooms, changing rooms, toilets and bathrooms.<sup>7</sup> The latter, in particular, has received little attention despite offering a potential transmission hub for all users. Other important actions include the safe management of operating theatres and outpatient clinics, and restricting staff and patient movement throughout the hospital.

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## Current practices

Table 1 shows the main components of current practices aimed at controlling COVID-19 in the healthcare environment.<sup>6,8–13</sup> These include the presence of an infection protection and control team (IP&C); staff and patient screening; ongoing surveillance; a managerial COVID-19 risk-based strategy; emphasis on hand hygiene; isolation and cohorting of infected patients; surface and equipment cleaning/decontamination; personal protective equipment (PPE) including universal masking; and a staff vaccination programme. Despite implementing traditional IP&C activities, however, many hospitals have identified multiple outbreaks of healthcare-acquired clusters of SARS-CoV-2 infection among patients and staff.<sup>1,14</sup> These have occurred on non-COVID-19 wards, which has entailed ward closures with consequent serious disruption of routine services. It is clear that usual IP&C practices are not sufficient to impede these clusters. Summarized below are some additional activities that could be implemented in order to reduce the risk of healthcare-acquired COVID-19 infection.

## Additional practices

### Managing toilet and bathroom use

Hospital toilets and bathrooms may act as a contact hub point where healthcare transmission of SARS-CoV-2 occurs between users.<sup>15</sup> The mode of spread arises through three mechanisms: firstly, inhalation of faecal and/or urinary aerosol from an individual shedding SARS-CoV-2; secondly, airborne transmission of respiratory aerosols between users face-to-face or during short periods after use; and thirdly, from fomite transmission via frequent touch sites such as door handles, sink taps or toilet roll dispenser. Toilet facilities are often compact, inadequately ventilated, heavily used and subject to maintenance and cleaning

issues.<sup>15</sup> In this respect, both patient and staff toilets could present a high risk of infection in the healthcare environment.

There are a number of activities aimed at reducing the potential transmission risk in toilets. For example, users should always wear a mask before entering a hospital bathroom and keep it on throughout their visit. They should put the toilet lid down (if present) before flushing. Adding disinfectant to toilet bowl before use (care with choice of product) may reduce the risk of infectious aerosol after flushing, especially if the toilet does not have a lid. Hand hygiene reminders (electronic, posters, etc.) in the bathroom or on the outside door are always useful, along with instructions for mask use. Hands should be dried after washing with disposable paper towels rather than using air dryers. This is because automated hand dryers may encourage circulation and recirculation of contaminated air and/or fomites.

The cleaning frequency for toilet and hand touch sites in the bathroom can be increased, especially if heavily used. This is because the risk of acquisition is directly proportional to the frequency of touch. Cleaning staff should receive training in how to decontaminate a bathroom during an outbreak, as well as issued with all the requisite equipment and cleaning fluids to do the job. They also require training in self-protection, given the as yet unknown risk from toilet areas. All staff should be encouraged to report any maintenance or functional issues, especially blockages and/or flooding. Calls about malfunctioning or leaking toilets and sinks should be prioritized by Estates and/or plumbing personnel.<sup>15</sup>

It may be possible to limit the number of users at any one time in multiple toilet bathrooms as well as ring-fence the time interval between users. This is especially important if the bathroom lacks windows or sufficient ingress of fresh air. While this helps to reduce droplet transmission by allowing infectious droplets to settle, it is unlikely to affect risks from aerosol transmission.<sup>16</sup>

### Current infection prevention and control activities implemented during the COVID-19 pandemic; rationale and key reference(s)

Infection control activity	Rationale	Key reference
1. Infection prevention and control (IP&C) team	Manage risks associated with healthcare-acquired or nosocomial infection (HAI)	Loveday et al. <sup>8</sup>
2. Screening	Patient and staff screening is key for controlling introduction of SARS-CoV-2, especially among asymptomatic or pre-symptomatic persons	Yau et al. <sup>9</sup>
3. Hand hygiene	Cornerstone of infection prevention practice; reduces risk of viral transmission between contaminated hand-touch sites and mucous membranes	Garg et al. <sup>10</sup>
4. Isolation & cohorting	Crucial for all infected patients; ring fencing elective surgical units minimises infection risk	Patterson et al. <sup>11</sup>
5. Cleaning	Increased cleaning targets 'frequently touched' surfaces to reduce exposure risk	Kampf et al. <sup>12</sup>
6. Personal Protective Equipment	Masks, gloves, aprons, gowns and visors provide a physical barrier to protect staff and patients	Garg et al. <sup>10</sup>
7. Surveillance	Ongoing surveillance of positive SARS-CoV-2 provides data on infection rates and trends in order to inform control practices	Hamilton et al. <sup>6</sup>
8. Staff vaccination	Local vaccine programme reduces risk of hospital admission and serious illness	Shah et al. <sup>13</sup>

Table 1

This is because the smallest virion-carrying aerosols can remain airborne for several hours. One method for limiting users would be installation of an indicator at the entrance, e.g. a red/green light or sensor above the entrance to the bathroom. A green light permits entrance; a red light inhibits it. This system is currently employed by radiology departments to inhibit access during radiographic investigations. A simpler and cheaper way would be a notice on the door with user times, supported by a practical policy for the duration of non-use.

Increasing ventilation in toilets can be done firstly by opening any windows and/or by propping open doors to encourage air to circulate. The latter precludes designated fire doors and there should be no risk to privacy or security from inappropriate access. Not all toilets and bathrooms have windows, however, and some may also be used to change into/out of uniforms. It might be possible to leave doors (and any windows) open for short periods, along with managing additional 'trickle' or other type of vents, that may be present. Kitchen-type extractor fans can be placed on the wall directly outside a poorly ventilated bathroom in non-clinical areas, to encourage egress of air towards the outside.<sup>17</sup>

#### Staff rooms/canteen

A major risk for COVID-19 transmission is mask removal prior to eating and drinking. There is little that can be done for bed-bound patients in multi-bed bays other than improving the ventilation (see below), but a variety of measures could alleviate the risk for staff at leisure in staff rooms, offices and canteens. Staggering break times for staff is an option, with numbers per room allocated on a strict time basis. If windows are present in staff rooms, then opening these before break times can alleviate any lingering aerosol from prior occupancy. During cold weather, window opening can be managed in order to conserve thermal heat as far as possible, i.e. keep windows open between staff use and close them during use. Staff should comply with social distancing regulations and avoid face-to-face positioning. If the room lacks a sink, then staff should clean their hands before entry and use wipes as necessary while eating. If possible, hand-touch sites in the room should be wiped over on departure and before the next personnel entry. The room can remain empty as long as practical between staff use. Doors may be left open in rooms without windows, with extractor fans placed on outside walls in non-clinical areas.<sup>17</sup>

Canteens and kitchens should mobilize window opening as far as possible, while recognizing the need to conserve thermal energy during cold weather. There should be a hand hygiene station placed at each entry/exit, along with frequent cleaning of all hand-touch surfaces. Again, staff numbers should be curtailed in order to allay crowding by use of a shift system if practicable. Visitors should be assigned a separate dining area from staff.

#### Changing rooms

Staff changing rooms tend to be small and poorly ventilated and this represents an infection risk for healthcare personnel. Staff should retain or change their masks before changing into or out of uniforms and this merits provision of an appropriate clinical waste receptacle for discarded masks and any other disposable PPE.

Dirty laundry bins should also be provided. Changing rooms should be cleaned two to three times per day, concentrating on hand touch sites and integral bathrooms if present. Use should be staggered if possible, especially for personnel after a shift. If windows are present, then these should remain open between periods of use. There should be ample provision of surgical scrubs for theatre staff, covered and stored in contained areas, and not left on shelves or trolleys open to the air. Theatre footwear, boots and clogs should be stored appropriately and cleaned before and after use. Staff should never go home wearing used scrubs or uniforms (<https://www.forbes.com/sites/joshuacohen/2020/04/05/wearing-medical-scrubs-in-public-in-the-age-of-coronavirus/>).

#### Staff and patient movement throughout the hospital

It is imperative to reduce staff and patient movement throughout the hospital, creating so called care bubbles wherever possible (<https://www.nipcm.hps.scot.nhs.uk/scottish-covid-19-infection-prevention-and-control-addendum-for-acute-settings/#a2752>). If patients are admitted through accident & emergency, they should be tested and accommodated in an admission or holding ward while waiting for COVID-19 test results. Transfer to another ward will depend on the result, although emergency intervention should not be withheld whatever their COVID-19 status. Elective patients should be tested directly before admission and sent straight to the appropriate ward if negative. Patients should not be transferred between wards unless their condition warrants immediate transfer, e.g. move to critical care. Patients needing specialist interventions, such as radiological investigations, should wear masks during transportation and visits staggered so that they do not have to wait in waiting areas and departments can be cleaned between patients.

Staff should stay on their base ward or department throughout their shift other than canteen visits. Meetings may be conducted electronically rather than face-to-face. Porters represent a critical work force responsible for patient and equipment transportation and must adopt safety measures to protect themselves and others. They should be issued with wipes and hand gels and asked to clean items such as wheelchairs between patient use. It might be possible to assign portering duties to specific departments and/or individuals in order to include ancillary personnel in a departmental 'bubble'. This would include staff involved in rehabilitation and physiotherapy. Junior medical staff should be allocated to as few wards as possible so that they do not have to visit multiple wards in the hospital during their hours of duty.

Visiting should be discouraged unless there are compelling reasons for a visit to go ahead ([https://www.publichealth.hscni.net/sites/default/files/2020-10/COVID-19\\_infection\\_prevention\\_and\\_control\\_guidance\\_complete.%203.2%20%2818\\_06\\_2020%29.pdf](https://www.publichealth.hscni.net/sites/default/files/2020-10/COVID-19_infection_prevention_and_control_guidance_complete.%203.2%20%2818_06_2020%29.pdf)). Visitors can be asked to wear a mask and provide a record of recent test results and/or a vaccination certificate. Lateral flow (rapid antigen) kits can be stored on wards for immediate testing of individuals if required.

#### Surgical outpatient pathways

In order to protect elective surgical patients accessing outpatient clinics, it is advisable to create an elective pathway that

minimizes the risk of hospital-acquired COVID-19. This would comprise a separate entrance to outpatient and pre-admission/screening clinics, if geography permits, as well as temperature checks at presentation; managed waiting areas; masks; hand hygiene; and restricted entry, etc. Patients should attend alone unless a companion is required for vulnerability or mobility issues. To reduce the risk from overcrowding, patients may be asked to wait outside or in cars before their appointment slot. Low priority patients may be assessed by video call or telephone so that only those needing immediate care are required to attend the outpatient department. Point-of-care testing facilities can be set up in the clinic so that patients do not have to traverse the main hospital. These could also include preoperative screening, such as blood tests, ECG and certain radiological investigations, along with allocation of trained and administrative personnel assigned to outpatients. COVID-19 screening can be included if surgery is imminent or scheduled before a later admission date. Any patient requiring investigation in specialist departments, such as MRI scanning, should be invited to attend during periods designated solely for outpatients, subject to prior COVID-19 screening if possible.

### Operating theatres

It is important to nominate operating theatres for patients with a recent negative COVID-19 test, as opposed to patients with unknown COVID-19 status requiring emergency surgery.<sup>18</sup> Elective, day patients and in-patients can be tested in a timely fashion before planned surgery in order to minimize transmission risk in the theatre suite. Surgery should only be performed in a known positive patient if the benefits outweigh the risks from the higher mortality and pulmonary complications of COVID-19 alongside the usual surgical and anaesthetic risks. While all theatres should be subjected to routine ventilation monitoring and maintenance, those used for patients of unknown status should receive priority for regular review and upgrade if necessary. In particular, the requirement for filter testing and replacement have achieved much greater significance during the COVID-19 pandemic.<sup>19</sup> This is because SARS-CoV-2 has been isolated from air conditioning filters in the healthcare environment. There should also be an agreed time interval between each procedure in order to allow sufficient time for one complete air change in the entire operating theatre suite as well as targeted cleaning before the next operation. Equipment used for patients of unknown COVID-19 status may require additional cleaning attention, particularly items used for intubation and mechanical ventilation.

Day patients should be allocated their own waiting areas, theatre and recovery ward if possible, with independent access.<sup>18</sup> Keeping day surgery staff apart from those that care for in-patients is advised since day patients arriving from the community are more likely to have come into contact with the virus. This may be alleviated to some extent by testing within a 72-hour period before surgery but the risk of carriage is still greater than that from in-patients under constant review. All theatre, anaesthetic and allied portering staff should submit regular COVID-19 tests and change into their own clothes in designated changing facilities on completion of a shift. No one should return home in theatre scrubs or footwear.

### Improving ventilation throughout the hospital

Ideally, patients with suspected or confirmed COVID-19 would be placed in isolation rooms where air is exhausted to the outside with at least 12 ACH (air changes per hour) (<https://www.cdc.gov/infectioncontrol/guidelines/isolation/index.html>). Many UK hospitals are reliant on natural ventilation, however, with only window or external vent ingress of outside air. For obvious reasons, windows tend to remain closed during cold weather. This compels the ward to retain relatively stagnant air, which will only be replaced with fresh air from outside if windows, vents or outside doors are opened. Current evidence for survival of SARS-CoV-2 suggests that viable virus contained in tiny respiratory particles can remain suspended in air for hours in the absence of removal through air currents and/or natural or mechanical ventilation.<sup>3,4</sup> This means that an infected individual may shed viable virus into ward air, placing staff, visitors and patients at risk of acquisition. The risk is elevated in smaller spaces, such as staff rooms, offices and bathrooms. The possibility of inhaling infectious viral particles depends on the time interval spent in a high-risk environment, accompanied by the unique characteristics of an individual regarding infectious load and viral spreading abilities.<sup>20</sup> Physical parameters such as temperature and humidity also affect the risk of acquisition by impacting on survival time of the virus.<sup>4</sup>

There are a number of features known to increase the risk of COVID-19 infection due to airborne transmission. These include the geographical layout of a ward; natural versus mechanical ventilation;<sup>21</sup> staff room and bathroom position and access; door and window placement and opening frequencies; staff behaviours and timing regarding breaks; bed occupancy rates, staffing levels and workload; partitions/curtains between beds or bays; people traffic (including visitors); PPE etiquette; and so on. Given the potential for airborne transmission as key to ongoing ward transmission, there are several practical actions which would mitigate the risk from airborne spread of SARS-CoV-2:

- i) ***Open the windows in staff areas, including offices, as often and for as long as possible, depending upon security and thermal comfort***

According to COVID-19 guidelines from the European Centre for Disease Prevention and Control (ECDC), there should be frequent air exchange through window opening for naturally ventilated closed spaces (<https://www.ecdc.europa.eu/sites/default/files/documents/Heating-ventilation-air-conditioning-systems-in-the-context-of-COVID-19-first-update.pdf>). A room with windows wide open, on opposite walls, provides about 40 air changes per hour, and clears 90% contamination in 5 minutes. This may be contrasted against a room with closed windows and NO ventilation; there are 0.1–0.5 air changes per hour, and it would take 5–25 hrs to clear contamination. So a staff room, with closed windows, could act as a hub for transmission from one day to the next. Furthermore, staff will be taking their masks off to eat and drink. There is a similar risk of lingering airborne virus in staff changing rooms, with added risk from direct access to toilet facilities sited in changing rooms.

Ventilation data from the same document advises window opening for at least 15 minutes three times a day for occupied rooms.

ii) ***Improve ventilation on naturally ventilated hospital wards***

There are several ways that ventilation can be improved on the wards. Windows can be opened in store rooms and other rooms left vacant for whatever reason. Windows could be opened overnight (subject to security assessment) in offices, day rooms, waiting areas and other rooms. It is advisable to open windows in patient rooms and bays in turn, if only for short periods (i.e. 15 minutes) at varying intervals during the day (<https://theconversation.com/covid-19-its-freezing-outside-but-you-still-need-to-open-your-windows-154044>; <https://www.gov.uk/government/news/new-film-shows-importance-of-ventilation-to-reduce-spread-of-covid-19>). A structured window opening regimen can be embedded within nursing or domestic duties and operated on a shift basis. A complete air change within a room is potentially achieved in minutes (ECDC). This would not only physically remove any lingering respiratory particles, but would contribute towards viral inactivation. This is because the components of fresh air have a well-documented anti-viral effect termed the open air factor.<sup>22</sup> Risk of thermal discomfort for patients would be at a minimum given the short time period required for an air-change, but should there be concerns over patients being cold, then extra blankets would not go amiss. Provision of additional bedclothes is a small price to pay for protecting hospital patients against COVID-19. Even door management practices (as instigated in transplant units) would help dilute stationary air or direct air flow away from areas at risk.

As already mentioned, for indoor areas such as changing rooms or bathrooms without windows or any other directed ventilation, install a large kitchen extraction fan (if there is a convenient outside wall) to help direct the indoor contaminated air to the outside. There should be a risk assessment of trajectory of exhaust air, to make sure that it will not flow back into patient or staff areas. For patient rooms, opening a window and placing a fan in its opening to blow outward creates a small negative air pressure in the room; this encourages air from the room to flow out of the window.<sup>17</sup>

iii) ***Improve ventilation in outpatient clinics and treatment rooms***

Most of the rooms in ambulatory clinics do not meet current ventilation recommendations. The building design of outpatient clinics presents further challenges when considering aged heating, ventilation, and air conditioning (HVAC) systems, windows that do not open, and repurposed space used as examination and/or treatment rooms. When patient volumes are high, this would increase the transmission risk for other patients and clinic staff. Some professional bodies have endorsed the use of portable high efficiency particulate air (HEPA) filtration units to assist with ventilation for suboptimal areas when other ventilation

options are not available to help clear potentially infectious particles. Initial studies suggest that HEPA units can be used to remove airborne contaminants in these areas.<sup>23</sup> The units should not replace appropriate PPE or N95 masks when aerosol-generating procedures are performed but, as an additional infection control intervention, they can decrease inhalation risk by reducing overall particle concentrations in small clinical rooms. There are other technologies, notably ceiling or upper room fixtures emitting ultra-violet (UV) light at wave lengths able to inactivate SARS-CoV-2. These products are marketed as non-toxic to humans in constant proximity.<sup>24</sup> As with HEPA units, however, UV fittings currently lack sufficient study and may be expensive to install and maintain.

iv) ***Improve ventilation in public areas throughout the hospital***

The remainder of the hospital would also benefit from enhanced ingress of fresh air (<https://www.theguardian.com/education/2003/aug/06/highereducation.uk1>). This would help to dilute contagious particles in hospital air as well as encourage fresh air to infiltrate wards when entrance doors are opened.<sup>22</sup> Once again, security and thermal comfort require assessment before an 'open window' policy is implemented. Such a policy deserves a champion, i.e. porter or security officer, who could be charged with managing a fresh air strategy, such as opening windows along corridors. Different window types demand different ways of opening. For sash windows, obtaining maximum flow of air through the window is to slide the sashes so the window is open equally at the top and bottom. By separating the in-flow and out-flow, cooler incoming air efficiently flushes the warm air out of the room. The warm air inside the room flows out of the top opening and the cooler air from the outside enters through the lower opening. Again, cold weather may influence the timing and duration of window opening in public areas.

## Conclusion

It is clear that there are additional actions that could be taken to minimize the risk of healthcare-acquired COVID-19 for patients, staff and visitors. The overriding need for UK hospitals is to improve the ventilation on the wards and in public spaces, and pay particular attention to the air quality in staff offices, changing/rest rooms and bathrooms. Indeed, any naturally ventilated enclosed space or room in a hospital deserves an immediate risk assessment for airborne transmission, especially if it is frequented by several people at the one time. This is because clusters of COVID-19 infection among HCWs and patients are likely due to aerosol accumulation in overcrowded and under ventilated hospitals.<sup>1</sup> The majority of hospitals and care homes in the UK rely upon natural ventilation which fails to optimize air exchange, particularly in cold weather. It is plausible that normally minimal levels of infectious respirable aerosols reach a threshold where classic airborne transmission becomes significant. While future research will confirm this scenario, hospitals

should strive to control what they can, eliminating physical, environmental and administrative risk factors to protect frontline workers and patients.<sup>3</sup>

Even with an adequate ventilation system installed, it is impossible to completely eradicate the risk for people at close range indoors. Staff understand the premise that the virus spreads through the air, and they also know that the same transmission mechanism would apply whether they are at home, in public venues such as supermarkets, or in the healthcare environment. However, immunization with government approved vaccines directed against SARS-CoV-2 has impacted on both community and healthcare rates of COVID-19.<sup>13</sup> Current admissions with COVID-19 occur primarily among people who have not had the vaccine. This has led to an ethical debate over mandatory COVID-19 vaccination for all healthcare workers.<sup>25</sup> Hesitant staff most frequently cite lack of information as the main factor in vaccine delay, which could be ameliorated by advertising and educational strategies managed by occupational health teams.

Ventilation aside, there are other relatively simple measures to ally COVID-19 risk in hospitals. Fitting lids to toilets is one example, but even the creation of a socially distanced waiting area, along with unidirectional pathway in an outpatient department provides a useful gesture towards risk reduction. Obviously, the presence of an on-site laboratory aids screening programmes as well as rapid identification of an infected individual in the hospital whether symptomatic or not. Managing staff and patient movement around the hospital should also be prioritized, since just one person could shed contaminated aerosol everywhere they go. High rates of patient boarding might be the single biggest risk for hospital transmission after inadequate ventilation.

Most of the cost-neutral recommendations suggested in this article could reduce the risk of further COVID-19 clusters, without compromising staff well-being or initiating concern. Such practices are not solely COVID-19 themed; however, they represent another layer of infection prevention that might also have an impact on other airborne pathogens such as influenza, respiratory viruses, norovirus, and *Clostridioides difficile* (since the latter produces airborne spores which take 48 hours to settle).<sup>22</sup> MRSA, VRE and coliforms are also present in the air, and anything to improve indoor ventilation might conceivably help reduce the infection risks from these for everyone in healthcare environments.

The role of ventilation in indoor transmission of viruses has been on neglected for years. It has taken a pandemic to focus attention on airborne pathogens but now that it has, we should embrace the opportunity and explore all possibilities for better indoor quality air.<sup>3,7</sup> ◆

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### Practice points

- Hospital-acquired COVID-19 clusters can occur despite recognized infection prevention and control actions
- Additional interventions are needed to safeguard elective and emergency surgical practices
- Frequent air change is recommended throughout the hospital, especially high-risk areas such as bathrooms, changing rooms, offices and staff canteen/rest rooms
- Strategies to improve delivery of fresh air include door and window opening, extractor fan placement, HEPA filtration units and UV light technologies
- Toilets are a likely hub of virus transmission and should be subjected to strict infection control precautions
- Movement of both patients and staff around the hospital should be reduced as far as possible