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SPECIAL ARTICLE

Anaesthesia and COVID-19: infection control

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Summary

The world is currently facing an unprecedented healthcare crisis caused by a pandemic novel beta coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The pathogen is spread by human-to-human transmission via droplets exposure and contact transfer, causing mild symptoms in the majority of cases, but critical illness, bilateral viral pneumonia, and acute respiratory distress syndrome (ARDS) in a minority. Currently, controlling infection to prevent the spread of SARS-CoV-2 is the primary public healthcare intervention used. The pace of transmission and global scale of SARS-CoV-2 infections has implications for strategic oversight, resource management, and responsiveness in infection control. This article presents a summary of learning points in epidemiological infection control from the SARS epidemic, alongside a review of evidence connecting current understanding of the virologic and environmental contamination properties of SARS-CoV-2. We present suggestions for how personal protective equipment policies relate to the viral pandemic context and how the risk of transmission by and to anaesthetists, intensivists, and other healthcare workers can be minimised.

Keywords: airway management; COVID-19; infection prevention and control; personal protective equipment; SARS-CoV-2; viruses

Editor's key points

- SARS-CoV-2 is a highly infectious virus that causes a severe acute respiratory syndrome in humans known as COVID-19.
- The virus is transmitted by droplet and aerosol transmission, and requires meticulous technique to prevent transmission including respiratory precautions.
- Tracheal intubation is a high-risk procedure that requires a respirator, disposable gown, at least double gloves and disposable eye protection.
- Specific infection control measures are required for critical care, obstetrics, and paediatrics to minimise transmission.

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After the severe acute respiratory syndrome (SARS) outbreak of 2002–3, and subsequently the H1N1 pandemic in 2009–10, severe acute respiratory infection (SARI) was established as a surveillance definition by the WHO to enable timely detection of emerging respiratory infectious diseases.[1] On December 30, 2019, the first bronchoalveolar samples of a novel pneumonia-causing virus were extracted from a patient in Wuhan Jinyintan Hospital in China.[2] The pathogen has been identified as a novel ribonucleic acid (RNA) beta coronavirus, with phylogenetic similarity to SARS-CoV[3] (which causes SARS), and has been named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) or coronavirus disease 2019 (COVID-19). The virus has been classified in the UK as a High Consequence Infectious Disease (HCID), although the case fatality rate (estimated to range from <6%[4] to 0.25%[5]) is lower than that characteristic of most HCIDs. This article contains an overview of personal learning points in infection control from the first SARS epidemic, a review of relevant evidence, and suggestions on how to minimise the risk transmission by and to anaesthetists, intensivists, and other healthcare workers.

Personal lessons from SARS

> *"That men do not learn very much from the lessons of history is the most important of all the lessons of history".*
>
> Aldous Huxley

The novel coronavirus SARS epidemic provided motivation and an important evidence base in establishing infection control guidelines for highly infectious novel respiratory pathogens.[6]

Data on healthcare worker infections from the SARS epidemic, and subsequent studies have informed the evidence base around limiting droplet transmission.[7,8] After universal droplet precautions and standard wearing of N95 masks by healthcare workers, there was eventual effective termination of transmission of SARS within acute healthcare facilities.[9]

The 251 cases of confirmed coronavirus SARS in healthcare workers who were infected after exposure to patients with SARS highlighted important lessons to learn regarding personal protective equipment (PPE). When standard PPE (in this case, an N95 mask, eye protection, gown, and gloves) was used appropriately then the risk of transmission was low.[10] However, healthcare workers were often exposed to a high viral load in the emergency department or ICU before standard PPE was donned for emergency intubation procedures. Subsequent interviews with staff involved in intubating infectious patients confirmed variable adherence to standard PPE recommendations.[7,11]

In 2003, Toronto quickly stopped all elective surgery and barred all visitors and relatives, and only essential on-call staff were allowed into the hospital, radically reducing the footfall of people in the building. Everyone who entered the building was instructed to wash their hands with alcohol gel, put on a face mask, asked to complete their contact details in a register, and patients and staff had their symptoms screened and temperature checked. Health authorities placed 8000 people in quarantine early in the epidemic. The rapid implementation of basic recommendations for screening and prompt isolation of all suspect patients and staff, together with quarantine of contacts, was ultimately effective in preventing significant healthcare worker and patient infection.

Differences in the approach for COVID-19

COVID-19 requires a different strategic approach to SARS, most notably because of the exceptionally large numbers of hospitalised patients and international pace of transmission. On January 30, 2020, the WHO announced that the COVID-19 outbreak was a Public Health Emergency of International Concern. Shortly afterwards, on March 11, 2020, the WHO upgraded the situation to pandemic—the first pandemic caused by a coronavirus. Between March 19 and March 29, 2020, the number of confirmed cases of COVID-19 increased from 250 000 in 163 countries to more than 700 000 patients in 177 countries, meaning almost all countries are now hosting the disease. By way of contrast, between 2012 and 2019 Middle East respiratory syndrome (MERS) infected 2494 patients in 27 countries, although more than 80% of cases occurred during 2012–4 in Saudi Arabia; the 2002–3 SARS outbreak resulted in 8437 cases in 26 countries.

The global epidemiological crisis of COVID-19 has implications for strategic oversight, resource management, and responsiveness in infection control. One of the key differences from the prior SARS and MERS outbreaks has been a requirement to consider on a global scale the provision of infection control and healthcare worker protective equipment.

The main transmission risks for all coronaviruses are exposure to droplets and contact transfer of virus. Droplets are heavy and usually disperse within a maximum 2 m radius after coughing and sneezing by an infected patient. A notable exception is when we carry out procedures with patients that generate artificial aerosols (small particle nuclei, which may penetrate standard surgical masks and contaminate a wider dispersal radius).[12] Aerosol generating procedures include, for example tracheal intubation, noninvasive ventilation (NIV), high-flow nasal oxygen (HFNO) provision, bronchial suctioning, bronchoscopy, and sputum induction. These procedures place clinicians in close proximity to the upper respiratory tract source of viral load, which has been linked to an increased risk of transmission of coronaviruses.[12]

The minimal infective dose is defined as the lowest number of viral particles that causes an infection in 50% of individuals. Data on the human infectious dose by aerosol and surface contact (fomite) transmission routes are still lacking for the SARS-CoV-2 pathogen. However, in mouse models for SARS-CoV, a relatively low dose of only a few hundred viral particles was required.[13,14] Early data from China found a strong association between COVID-19 disease severity, high viral load, and prolonged viral shedding[15]; although these findings have not been consistently replicated, and the true pattern of contagion is likely to be more complex. Although small, retrospective studies of SARS implicate viral exposure dose as being proportional to the severity of clinical outcomes,[16,17] there is still no direct equivalent evidence for disease outcome in COVID-19. Assessing transmissibility to healthcare workers, who are potentially repeatedly exposed to higher numbers of viral particles, may help determine future viral prophylaxis or early treatment strategies.

Although the stability of aerosolised SARS-CoV-2 on common environmental materials appears to be similar to that of SARS-CoV under experimental conditions,[18] the epidemiological characteristics of the COVID-19 outbreak are very different to those of SARS. One potential explanation may be earlier and higher accumulation of viral load in the upper respiratory tract of infected individuals.[19] The viral nucleic acid shedding pattern of patients infected with SARS-CoV-2

were higher in a small case series of 18 patients[20] than for patients with SARS-CoV.[21] In the same study, the viral load in a single asymptomatic patient (tested because of close contact with known cases) was similar to that in symptomatic patients, which may support reports of transmission earlier in the course of infection.[22] These patterns appear similar to patients with influenza[23] and imply value in early case detection to prevent the transmission of infections. Despite these findings, it is important to appreciate that, based upon generalised principles of viral transmission, asymptomatic COVID-19 carriers are likely to disperse less viral load and ultimately be less contagious than symptomatic individuals, but at present we are unable to quantify by how much.

Recognition of the relative contributions that short-range, large droplet, or airborne ('aerosol-transmissible') infectious agents make to infection transmission also has significant implications for how healthcare workers need to manage infected patients. PPE is usually more costly for aerosolisable agents than for those only transmitted by large droplets or direct contact because of two key properties of aerosols: firstly, a propensity to follow air flow, therefore needing a much tighter seal around the PPE covering a healthcare worker's airway; and secondly, the small particle sizes of aerosolised agents, which require appropriate filtering capacity.[24]

The COVID-19 crisis has resulted in unprecedented global demand for PPE, with the rapid pandemic escalation leaving limited time for equipment reserve preparation. In the UK alone, the HNS supply chain delivered more than 170 million Filtering Face Piece 3 (FFP3) respirator masks in 2 weeks[25] in March 2020. Although PPE is only one part of safe and effective infection control, concern has escalated regarding how to mitigate against actual or impending shortages of critical equipment in areas of high demand. Much of the evidence of PPE efficacy has been derived from translation of studies using SARS or modelling systems as surrogates, although increasing pathogen-specific evidence on environmental contamination and airborne transmissibility[18,26] are factoring into the decision-making process.

SARS-CoV-2 shares similarities in environmental inoculation to SARS-CoV: both coronaviruses are detectable at 72 h after contact with surface materials (albeit with an exponential decay in viral titres).[19] Viral particles in droplets can be detected for at least 3 h after being coughed into the air.[19] Fine aerosols remain airborne for several hours in still air and in disturbed air the particles settle onto surfaces faster. Although surface sampling from the rooms of patients with COVID-19 showed extensive environmental contamination, post-cleaning samples were negative, suggesting that current decontamination measures are sufficient. Air sampling of patient rooms was also negative, although patients in the study had mild upper respiratory tract symptoms only and did not undergo any aerosol generating procedures.[26]

A series of regularly updated international recommendations on healthcare infection control throughout early 2020 have reflected three challenges: applying the learning from previous pandemic and inter-pandemic periods; a rapidly evolving understanding of the risk of infection transmission for COVID-19; and finally, a need to be proportionate regarding equipment utilisation during a pandemic. During this time the WHO,[27] European Centre for Disease Prevention and Control (ECDC),[28] and Public Health England (PHE)[29] all moved from a 'one size fits all' strategy, to one in which PPE use is risk stratified and the appropriate PPE is selected for the task required. Thus incremental contact, droplet and airborne precautions against COVID-19 have been established in the UK,[29,30] meaning that all clinical areas considered to have frequent aerosol generating procedures, including ICU and operating theatres have similar PPE precautions. An exception to this standard is during neuraxial anaesthesia for elective Caesarean delivery, during which the risk of conversion to an aerosolising general anaesthetic is considered low and predictable in advance, hence droplet precautions are adequate for anaesthetists.[31] A risk adaptive approach is recommended for other environments, where precautions should follow the risk of transmission during different clinical interactions. A common feature of all recommendations is that, irrespective of PPE required for each task, the equipment is used carefully and correctly, focusing particularly on safe removal.

The COVID-19 patient

The most detailed description of the clinical characteristic of COVID-19 patients derives from a cohort study of 1099 patients with laboratory confirmed infections across mainland China.[32] Important infection control characteristics includes a median (inter-quartile range [IQR]) incubation period of 4 (2–7) days.[32] SARS-CoV-2 virus can initially be detected 1–2 days before symptom onset from upper respiratory tract samples. In moderate cases, the virus persists for 7–12 days and up to 2 weeks in severely affected patients.[1] Prolonged viral RNA shedding has been reported in a virologic assessment of 18 patients in Singapore, with a median (range) duration of viral RNA shedding from the nasopharynx of 12 days (1–24).[33] Although SARS-CoV-2 RNA can be detected with polymerase chain reaction (PCR) testing over long periods in bodily fluids, this does not necessarily correlate with the period that each individual is infective for. A small German case series indicates live virus viability may last only for the first week of symptoms,[34] with incompleteness of this evidence exposed in varied national recommendations for the de-isolation of COVID-19 patients.[35]

SARS-CoV-2 RNA has also been detected in multiple asymptomatic individuals, some with similar viral load to symptomatic patients.[20] Potential transmission from asymptomatic persons has also been reported.[36] Provided that there are sufficient resources, there is a clear benefit to extending testing for COVID-19 as widely as possible. However, where resources are limited during the pandemic, testing of symptomatic persons should have priority. Findings regarding the transmission and infective potency of the virus warrant further urgent study to establish whether more aggressive measures are needed to ensure the safety of healthcare workers looking after asymptomatic patients.

In China significant numbers of healthcare workers have been infected, representing 1716 of 44 672 patients (3.8%), with a disproportionately high number classed as severe or critical (247 of 1668 [14.8%], but thankfully, a low number of deaths, at five cases or 0.3%).[37] There is an indication, however, that inadequate PPE for Chinese healthcare workers at the beginning of the epidemic was a problem,[38,39] and it is difficult to establish whether healthcare workers were originally infected within a household, rather than in a healthcare setting.[1] Italy has experienced a similar proportion of healthcare workers infected.[40] Again, detailed epidemiological investigation is needed to identify barriers to prevent this pattern replicating on an international scale, alongside measurements of the efficacy of utilised PPE.

A significant minority of patients in China (5%) experienced critical disease requiring intensive care admission.[32] Although subject to varied context-sensitive factors influencing critical care provision, in Northern Italy the early proportion of patients with critical care requirements were higher still, at 16% of positive tested patients.[40] The rapid growth in patient numbers has caused major problems in providing an adequate surge critical care capacity response.[41]

The basic reproduction number (R_0) is used to describe the transmission potential of an infective disease. It is the average number of secondary infections that a typical patient will infect in an uncontrolled setting where everyone is susceptible.[42] High-quality estimates of R_0 for COVID-19 range from 2.2 to 3.3,[43–45] which is higher than for recent influenza epidemics[28] and SARS.[45] Individual quarantine alongside contact monitoring, even if imperfect, is likely to synergise with social distancing and help mitigate the COVID-19 pandemic by reducing the R_0.[46]

Intubation and operating rooms

Intubating a patient with COVID-19 is a high-risk procedure owing to the proximity of the healthcare workers to the patients' oropharynx and the exposure to airway secretions, which can carry a high viral load.[47] During the SARS outbreak in 2003, healthcare workers performing intubations were shown to be at a significantly increased risk of nosocomial transmission.[48] This risk was shown to be greatly reduced when PPE was used appropriately and infection control measures were followed.[10]

The availability and suitability of facemasks and respirators has escalated into an emotive and scientific debate. A fluid-resistant surgical facemask protects the wearer against sprays of bodily fluids and large droplets, whereas N95, FFP2, and FFP3 respirators are thought to protect the wearer against aerosolised and airborne pathogens as well. In laboratory studies, an FFP2 mask filters at least 94% of all particles that are 0.3 μm in diameter or larger; N95 masks block at least 95% and FFP3 masks block at least 99%. However, recent meta-analysis of clinical trials showed that there were no statistically significant differences in preventing influenza or respiratory viral infections using N95 respirators and surgical masks.[49] Failure to translate laboratory studies of superior protection into a clinical context may be related to compliance and training difficulties, alongside significant discomfort associated with real-world use, meaning intervention adherence is compromised.

No single PPE strategy is without problems or benefits, as case report[50] and future effectiveness data for COVID-19 patients will likely testify. According to guidelines published by PHE and the WHO, surgical facemasks should be worn when working in close contact with patients with suspected COVID-19 or in any area where COVID-19 patients have been cohorted together.[27,29] This is in contrast to guidance by the ECDC, which suggests the use of a class 2 or 3 FFP masks for assessing and managing suspected and confirmed COVID-19 cases, and only to use surgical facemasks in a crisis scenario of shortage of FFP2 and -3 respirators.[51]

Current UK guidelines on airway management for patients with suspected or confirmed COVID-19 compiled by the Royal College of Anaesthetists and Intensive Care Society state that PPE for airborne precautions is effective and must be worn at all times during intubation and all other aerosol generating procedures.[52] PPE for airborne precautions involving aerosol generating procedures should include a respirator, a disposable gown, at least double gloves, and disposable eye protection.[27] UK national guidance suggests the usage of FFP3 respirators for all high-risk aerosol generating procedures, whereas the WHO recommends FFP2 or N95 respirators.[27,53] FFP3 respirators have to comply with the European standard EN 149: 2001. Aprons should also be used if gowns are not fluid resistant.[54] Disposable theatre caps might offer additional protection from infection by limiting contamination of hair.

Correct donning and doffing of PPE are key to avoiding transmission and should be performed with a trained member of staff and a buddy system following local guidelines. Donning should start with fitting the FFP3 respirator and doffing should end with the removal of the FFP3 respirator, a 'mask on first, mask off last' approach. The majority of self-contamination errors happens during doffing.[55]

Enough time should be allocated for preparation of airway equipment and fitting of PPE outside the intubating room. A checklist or cognitive aid should be used for preparation and intubation. Communication in full PPE can be challenging. Preparing team members, assigning roles, and setting out the airway plan before donning and entering the intubation room, improves safety and team effectiveness. Intubating teams should be limited to one experienced intubator, one skilled assistant (such as an intensive care nurse or operating department practitioner), and one team leader who acts as a backup intubator and administers drugs.[52] A runner should be placed outside the room to assist the intubating team. A strategy to target the most successful first attempt at intubation logically dictates that the most experienced anaesthetist is hands-on with the airway and that videolaryngoscopy is used to limit exposure risk.

High-flow nasal oxygen and noninvasive ventilation

HFNO delivers humidified, warmed oxygen via specialised nasal cannula at flow rates up of to 60 L min^{-1}. Paediatric circuits typically deliver a lower maximum flow of up to 25 L min^{-1}. The WHO advises that HFNO should be used for selected adult patients with hypoxaemic respiratory failure[56] and that HFNO can reduce the need for intubation.[57] Patients using HFNO should be in a monitored area, and anaesthetists should be available to intubate the patient should they clinically deteriorate, or not improve after a short trial of ~1 h.[56]

Exhaled aerosol dispersion of viral load during HFNO is of concern for the personal safety of staff caring for these patients in close proximity. A number of studies have measured air dispersion during HFNO,[58,59] although precisely how this relates to viral droplet or aerosol particles remains unclear. Mean (standard deviation [SD]) dispersion distances increased from 65 (15) to 172 mm (33) as flow increased from 10 to 60 L min^{-1}. This increased to 620 mm laterally if the HFNO fit was loose.[59] Consequently, current WHO recommendations suggest that HFNO should be avoided where airborne precautions and negative-pressure, airborne infection isolation rooms are not available.[56,60]

Both NIV and HFNO should be considered aerosolising procedures.[58,60] The use of NIV has previously been associated with the transmission of the virus to healthcare workers during the previous SARS outbreak[61]; however, since that outbreak in 2003 improvements in mask design may have reduced this risk. Measured air dispersion with a full-

facemask continuous positive airway pressure (CPAP) system has been subsequently compared to CPAP with nasal pillows.[59] Air dispersion with full-facemask CPAP was negligible at both low (5 cm H_2O) and high (20 cm H_2O) pressure ventilation. CPAP with nasal pillows performed worse with a maximum mean (SD) dispersion of 207 mm (11) at 5 cm H_2O, up to a dispersion distance of 332 mm (34) at 20 cm H_2O. Therefore patients on CPAP should ideally be cared for in negative-pressure facilities with staff wearing PPE appropriate for airborne contamination.[62] The New and Emerging Respiratory Virus Threats Advisory Group (NERVTAG) recommends that where necessary, patients using NIV should be isolated in side rooms with doors closed.[62] If necessary, several patients, all of whom should have confirmed COVID-19, can be cared for in a 'cohort bay'. Appropriate filters should be used in all CPAP and NIV circuits.[61]

HFNO has been used to prolong the apnoea phase during tracheal intubation and to reduce intubation rates in acute respiratory failure. In China it has been used in patients with COVID-19,[63] but there are no studies looking at virus spread by aerosol droplet production and transmission with HFNO. Environmental bacterial contamination has been investigated comparing high-flow nasal therapy to face mask in critically ill patients with pneumonia.[64] This was not associated with increased air or contact surface contamination by either Gram-negative or total bacteria, and these findings were supported by systematic review.[12] However, for patients with COVID-19 in the absence of any evidence of survival benefit compared to conventional oxygen therapy and the potential for greater environmental viral contamination national guidance recommends the avoidance of HFNO.[65]

Critical care

The burden of rapidly escalating case numbers[32] is presenting new challenges for maintaining infection control in critically unwell patients. A typical ICU solution relies upon isolating contagious patients in neutral or negative pressure side rooms, possibly with neutral pressure anti-rooms. This engineering solution permits flexibility in the clinical management of ventilation for infected patients, including aerosol generating procedures such as NIV and HFNO.[61] However, the rapid mismatch in ratio of intensive care beds to patients needing critical care has led to a rapid need to develop surge capacity[41] and to innovate with models of critical care provision in facilities that may not have the same engineering solutions for infection control (e.g. most operating theatres operate with a positive pressure air flow system). This means that as new ways of delivering critical care for patients develop, new and pragmatic approaches to the management of infection control are also needed.

PPE for COVID-19 has moved from a 'one size fits all' to a risk-stratified approach.[27–29] Similarly, ICU supportive management for COVID-19 is adopting an adaptive approach, accounting for forthcoming trials of CPAP/NIV[61] and consideration of HFNO, which the Australian and New Zealand Intensive Care Society (ANZICS) COVID-19 guideline has recently advocated.[66] There are no randomised or propensity matched studies on early *vs* late intubation for COVID-19; hence data on noninvasive forms of ventilatory support remain anecdotal. Despite the infection control dilemmas, cohorting of patients into ward areas and avoiding intubation presents a viable treatment strategy that has additional advantages of optimising resource utilisation, particularly nurse to patient ratios. These benefits need to be balanced by two factors: PPE for staff and the burden of increased oxygen flow required.[67]

Impact on oxygen supplies for widespread use of NIV is likely to be considerable. Some noninvasive ventilatory modalities are very oxygen hungry, using the high flow to provide inspiratory pressure. Once these devices are deployed over and above basal consumption plus an increase in ventilator usage, the maximum flow rate through the Vacuum Insulated Evaporators (VIE) oxygen stores can quickly be reached. This results in oxygen failure to the entire hospital starting at the sites most distal to the regulator, with the only remedy being to limit the number of devices pulling oxygen through the regulator or to use more efficient equipment.

Airflow within hospital wards can dramatically affect the risk of nosocomial transmission of some coronavirus strains. In situations where critical care patients need to be cohorted into large bays or other facilities, it is possible to convert entire ICUs into negative pressure areas.[68]

Obstetrics

Although pregnant women do not appear to exhibit greater susceptibility to COVID-19 than the general population, establishing robust infection control within maternity departments presents unique challenges. In particular, this entails containing a risk of postnatal transmission from mother to neonate and procedures to accommodate unscheduled patient presentations to labour ward and emergency care—all within an environment of high patient turnover. Performing common procedures for obstetric patients, such as neuraxial anaesthesia, is made more technically difficult and time consuming by PPE. These indirect risks mandate a change in approach for team working, information dissemination and decision making in the labour ward.

Although evidence is limited at present, antenatal vertical transmission appears rare.[69] Placental samples, amniotic fluid, cord blood, neonatal throat swabs, and breastmilk samples from COVID-19 infected mothers have all tested negative in case series.[70,71] There is currently no evidence concerning transmission through genital fluids.

Women presenting to the labour ward should be screened before admission, then risk stratified, and resultant care provided in an appropriate environment. Increased ventilation during labour, particularly when coupled with symptoms secondary to COVID-19 lung sequelae, may increase airborne transmission. For these reasons, surgical facemasks should be worn by parturients. Entonox®, BOC Healthcare, UK (requiring removal of the facemask) is not classified as an aerosol generated procedure[31] but should only be used in combination with a standard single-patient <0.05 μm pore size hydrophobic filter[51] to prevent the delivery system becoming contaminated with the virus. Although thrombocytopenia appears to be more common in COVID-19 infected patients,[32] neuraxial anaesthesia is not otherwise contraindicated and early epidural analgesia appears to be a preferred and pragmatic option for providing safe patient care.[31] Use of birthing pools should be avoided in suspected or confirmed cases, given the inability of staff to use adequate PPE for healthcare staff during water birth.

Donning PPE is time consuming, yet expedient delivery of a neonate remains time critical in situations of neonatal distress. As challenging as the moral dilemma regarding staff,

patient, or neonatal prioritisation is, protection of staff must be of utmost importance. Women and their families need to be told about possible delays and obstetricians encouraged to declare early decisions for theatre delivery, in order to account for additional time required.

Precautionary separation of mother and neonate is another moral challenge in obstetric infection control, with insufficient evidence to guide management indicated by divergent strategies adopted by different countries.[31,72,73] Breastfeeding is likely to involve sharing of infective airborne droplets and, if conducted, should involve strict adherence to precautions to limit viral spread.

Paediatrics

Experience from China suggests that COVID-19 is generally a mild disease in the paediatric population.[74,75] In one report of 2134 children infected in China, only one patient died, giving a mortality rate of 0.05%.[76] Reassurance of parents and carers is therefore important, although it is sensible to assume that children with respiratory comorbidity or immunosuppression may be more susceptible to severe disease. A particular difficulty in managing children presenting to the emergency department is the significant overlap of clinical signs and symptoms between COVID-19 and more common paediatric respiratory illnesses. Management of paediatric patients with suspected or confirmed COVID-19 is also complicated by the need to manage accompanying parents and carers, who are likely to be infected and therefore present an infection risk to healthcare workers and other patients. In the UK, the Royal College of Paediatrics and Child Health and the Paediatric Intensive Care Society have recently produced guidance for the management of children with suspected or confirmed COVID-19.[77,78]

Education

A rapidly evolving situation demands a flexible approach to learning to acquire new knowledge and skills at short notice. Staff training plays a key role in developing individual and organisational preparedness and should include cross-skilling non-critical care staff from theatres and anaesthesia into critical care roles.[79] Modalities that have been used are simulation,[80] lectures, workshops, hands-on practice,[81] and acquiring knowledge at the bedside under the supervision of suitably competent mentors. A number of resources have been created such as websites,[52] webinars,[82] and Massive Open Online Courses.[83] All aim to efficiently train a large number of staff in a short period of time. Topics include personal and patient safety, particularly PPE donning/doffing, airway management and cardiopulmonary resuscitation for coronavirus patients, proning, sedation, vasopressors and inotropes, and principles of critical care.[82] The use of policies, protocols, and cognitive aids such as checklists, helps with decreasing cognitive load when operating in a complex and unfamiliar environment. Through training and simulation, the process of management of complex and potentially hazardous clinical cases in unfamiliar environments, can be rehearsed and refined.

Conclusions

Our concluding summary of the coronavirus SARS experience in Toronto was that 'SARS should serve as a new red flag, marking a need to change the way we practice infection control and ultimately directing us toward the evolution of a 'new normal'.[5] This age of 'new normal' of rapid healthcare system isolation, quarantine and infection control precautions was evidence based and was effective against a novel coronavirus SARS epidemic in 2003.

Anaesthetists need to participate in an encompassing and hierarchical strategy to contain COVID-19 viral transmission. This includes organisational adaptation (e.g. use of appropriate processes for transferring patients around the hospital, engineering control of pressure in isolation rooms); ensuring early isolation control of infected patients; and supporting effective decontamination of equipment and healthcare environments.[29]

Every viral outbreak provides an opportunity to learn important lessons to improve clinical care and reduce future viral outbreak transmission. However, many lessons, like early isolation, have only limited windows to be applied before they become redundant. The COVID-19 pandemic is fast-changing, and our response must be equally dynamic and responsive if we are to counter the spread of this important new pathogen.

Our pragmatic approach to infection control management of this novel coronavirus pandemic for anaesthetists and intensivists addresses the delicate balance between patient safety and staff safety. The COVID-19 'new normal' is once again isolation, quarantine, and fully trained staff practising exemplary infection control to best protect themselves and others.

Authors' contributions

Conception of the article: DK
Drafting of manuscript: PO, DK, with contributions from MN, SB, SC, DH, EH, AP, MB
All authors reviewed and revised drafts of the manuscript and approved the final version

Declarations of interest

The authors declare that they have no conflicts of interest.

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