Anaesth Crit Care Pain Med 39 (2020) 163–166

ELSEVIER

SFAR
Société Française d'Anesthésie et de Réanimation

Anaesthesia Critical Care & Pain Medicine

Editorial

COVID-19: A critical care perspective informed by lessons learnt from other viral epidemics

ARTICLE INFO

Keywords:
Infection control
Outbreak
SARS-CoV-2

1. Introduction

The world is closely watching the outbreak of respiratory illness associated with the novel beta coronavirus SARS-CoV-2. The first cases were reported in Wuhan, Hubei Province, China [1]. At the time of writing the number of reported cases of the resulting disease, COVID-19, is already over 64,000 and shows no immediate signs of stabilisation. Although the majority remain in Wuhan and Hubei province, cases have been reported in all provinces of China and over 27 countries across the globe. The aim of this editorial is to review the management of critically ill patients with COVID-19 infection.

2. COVID-19

Initially termed 2019-nCoV, sequencing showed that now officially named SARS-CoV-2 is 80–89% similar to bat severe acute respiratory syndrome related coronaviruses found in Chinese horseshoe bats [2,3]. In addition, it is about 79% akin to severe acute respiratory syndrome coronavirus (SARS-CoV) and 50% related to Middle East respiratory syndrome coronavirus (MERS-CoV). The latter two coronaviruses have their immediate origins from civets and camels, respectively [4,5]. Although it is uncertain how COVID-19 transmission from animals to humans occurred, epidemiological studies suggested an intermediary wild animal host sold in the Huanan Seafood Wholesale Market [6]. Currently, while human to human transmission is certain, the mechanism of transmission remains controversial [2,7,8]. Although it is likely that COVID-19 transmission is primarily via droplets and fomite contact, airborne transmission events cannot yet be excluded. Transmission via the faecal-oral route remains a possibility as SARS-CoV-2 RNA, but not live virus, has been detected in stool [9]. Molecularly, like SARS-CoV, the SARS-CoV-2 virus likely uses ACE-2 as entry receptor, which is highly expressed in the lung and gastrointestinal tract [10–12].

3. Natural history and disease progression

Initial symptoms are non-specific and include fever, cough, sore throat, rhinorrhea, myalgia or fatigue, sputum and headache [1,6]. Patients typically complain of dyspnea one week after symptom onset, and some progress to develop acute respiratory distress syndrome. The median time from presentation to mechanical ventilation is 10.5 days, and while initial reports from the Chinese epicentre suggest that between 23 to 32% of hospitalised patients require ICU admission [1,6,13], this rate appears to be lower, approximately 10%, in Hong Kong and Singapore (personal observation LL/GMJ). Other organ dysfunctions reported in these cohorts include acute kidney injury (3%) and septic shock (4–8.7%). Patients requiring ICU care were older and had more comorbidities than those that did not.

As of 16th February 2020, only 4 deaths have been reported outside China, but the mortality of COVID-19 reported in initial hospitalised cohorts in China ranges from 4.3 to 15% [1,6,13]. These findings should be interpreted in context since the hospitalised cohorts may have a significantly higher mortality than community patients with mild symptoms who may not seek hospital care.

4. Diagnosis and treatment

Infection is confirmed by positive test to SARS-CoV-2 by real-time RT-PCR, isolation in cell culture of SARS-CoV-2 from clinical specimens, or rising serum antibody concentrations. If laboratory confirmatory tests are not available, clinical and epidemiological criteria such as those advocated by the US Centers for Disease Control and Prevention (CDC) may be used (https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-criteria.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fclinical-criteria.html). Based on current best evidence, supportive treatment and organ support remain the focus of ICU care. Specific treatments such as the use of corticosteroids to control the inflammatory response, and antivirals, particularly the combination of lopinavir/ritonavir and ribavirin have been used, but are unproven to improve outcomes [1]. The cautionary experience of SARS-CoV provided a lesson of the desperate pursuit to find effective treatment. During this outbreak, the use of high-dose corticosteroids (> 3 g methylprednisolone in the acute phase of disease) used to modulate the immune response was not conclusively shown to improve outcomes, but resulted in devastating steroid induced complications [14].

As respiratory failure is the predominant complication of COVID-19, attention to the delivery of appropriate lung protective

https://doi.org/10.1016/j.accpm.2020.02.002

strategies during mechanical ventilation and prevention of hospital acquired infections is likely to contribute to improved outcomes in critically ill patients.

5. Infection control

Lack of clear knowledge of the mechanisms of COVID-19 transmission makes it difficult to develop evidence-based infection control protocols to prevent transmission to healthcare workers (HCW) and other patients. Certainly, ICU HCW are at particularly high risk of nosocomial transmission because of potential exposure to aerosolised respiratory secretions during intubation, tracheal suctioning, bronchoscopy and respiratory circuit disconnection, as well as environmental contamination [15–18]. Thus, it is currently prudent to assume higher precautionary measures in ICU than those currently recommended by the CDC (respiratory droplet and contact precautions). Suspected or confirmed cases should ideally be isolated in a negative pressure airborne infection isolation room (AIIR) with sufficient air changes ($>$ 12/h) and personnel trained to use personal protective equipment (PPE) for airborne precautions. All support and sanitary staff, often forgotten, should also receive appropriate PPE and infection control training, particularly as there may be a risk of faecal transmission [9]. If full airborne precautions are not possible due to limited facilities or overwhelming numbers of cases, other measures that may decrease risk of nosocomial transmission include cohorting of patients in dedicated wards, or physical separation, supported by disciplined use of PPE, universal contact and droplet precautions and adequate ward ventilation [15,19–21]. Encouragingly, with strict PPE protocols combined with rigorous implementation, the reported risk of staff contracting SARS-CoV in one ICU was low, despite suboptimal physical space, ventilation and complete absence of AIIR facilities [22].

6. High-risk procedures

6.1. Use of NIV and HFNO

Limited data suggests that the use of high-flow nasal oxygen (HFNO) may prevent intubation in severe hypoxemic respiratory failure [23]. Within the ICU, and with HCW protected by high-level PPE (including an N95 mask), non-invasive ventilation (NIV) and HFNO use during SARS-CoV and 2009 influenza epidemic was not clearly associated with an increased risk in HCW [24,25]. However, a recent meta-analysis demonstrated that there may be an increased risk of viral transmission to HCW who treated patients receiving NIV [18]. Since the mode of COVID-19 transmission remains unclear and mortality benefit of HFNO and NIV in severe pneumonia is unproven, we do not currently recommend their use in suspected or confirmed cases of COVID-19. If used, patients must be closely monitored in ICU or high care areas, and airborne respiratory precautions strictly adhered to.

6.2. Intubation

The timing and decision to intubate patients with COVID-19 should be made on a case-by-case basis. The threshold for intubation may be lower in COVID-19 since use of high-flow nasal oxygen (HFNO) or non-invasive ventilation may potentially increase the risk of transmission to HCW [18]. Disease transmission risk of viral respiratory infections during intubation has been shown to be high [18,24], and therefore early, controlled intubation may also increase the safety margin of intubation and by allowing adequate preparation time for this high-risk procedure. Airborne precautions should be applied throughout.

Some additional measures to reduce transmission risk include intubation in an AIIR, and limiting non-essential staff to reduced exposure time [24,26]. Placing bacterial/viral filters in circuits and between the mask and bag valve mask (BVM) resuscitator during manual mask ventilation may serve to reduce viral particle dispersion into the atsmopshere [27]. Intubation in COVID-19 patients should be performed by those experienced in airway management to increase first-pass success [28,29]. Video laryngoscopy improves intubation rates and allows the operator to be further away from the patient's oropharynx [30].

Standard use of rapid sequence induction to avoid or minimise BVM ventilation may be preferable as BVM was previously associated with SARS-CoV nosocomial infection [31]. Pre-oxygenation under these conditions using a well-sealed BVM with appropriately placed viral filter is recommended. Directly connecting the ventilator circuit to the ET tube immediately after intubation, rather than the BVM resuscitator, eliminates the need to reconnect and facilitates expired gas scavenging. In-line "closed suctioning systems" should be used to maintain a closed circuit.

6.3. Cardiopulmonary resuscitation

The increased transmission of SARS-CoV to HCW previously reported during cardiopulmonary resuscitation (CPR) was likely due to virus aerosolisation during BVM ventilation [31]. Preventive measures may include using apnoeic oxygenation during CPR, or careful two-person BVM ventilation to allow an effective face seal by two handed mask holding (with inline bacterial/viral filter), and early intubation when indicated. The use of mechanical CPR devices to replace HCW CPR may reduce the risk of facemask leakage for the HCW, and decreases their own minute ventilation, thus potentially reducing the risk of disease transmission. For patients already receiving mechanical ventilation in ICU, the ventilator may be set to volume control, with a large negative pressure trigger and high-pressure alarm setting to avoid a need for disconnection and change to manual BVM ventilation.

7. Crisis management

One of the greatest challenges in emerging epidemics is uncertainty amongst HCW about transmission risks, and fear of becoming a victim of the outbreak disease. ICU is a high-risk area where a larger number of "high transmission risk" procedures are performed. Clear concise communication and leadership are critical to tackle stress, fear, fake news and mistrust during the crisis [32]. Staff morale is vulnerable and emotional support should be proactively made available. Frontline staff must be made to feel safe by constant exposure to clear protocols and rigorous training. Expansion of critical care beds to cope with increased numbers of patients by opening more ICU beds, and converting wards and other monitored areas for ICU provision is often recommended in outbreak disaster plans. However, experience from SARS-CoV showed that rapid and excessive expansion may overwhelm staff, lead to excess infections in HCW, and compromise care [33]. Thus, expansion should be matched by safe staffing to guarantee an appropriate quality of care and staff safety, which necessarily limit expansion. It has been suggested by an expert consensus group with first-hand experience of outbreak expansion that this is realistically limited to a maximum of 50-100% of baseline capacity [34]. Alternatively, restricting normal critical care to provide only core and essential provisions, may allow greater expansion and more patients to have limited life sustaining interventions under conditions of limited resources [35]. Should these measures be overwhelmed, individual patient triage and appropriate rationing of ICU care will be required to provide greatest benefit for the greatest number of patients [36,37]. A structured triage approach incorporating triage admission criteria that can adapt to the scale of crisis, are fluid and adaptable depending on the evolution of the outbreak and change in response to resource pressures is necessary. A process of development and implementation that provides transparency, an appeal mechanism, documentation of decisions and that is culturally and socially sensitive is recommended [34].

8. Perspective of Western Europe and France

The epicentre of the epidemic in China provided an early warning for Europe to allow the preparation of preventive measures, and specific organisational processes were rapidly adopted. Patients returning from China, and in particular from Hubei province are quarantined for 14 days. Anyone who develops symptoms that could suggest a coronavirus infection are encouraged to call a single emergency number and if COVID-19 is suspected, they are managed at their location by a specialised medical team equipped with PPE to prevent viral contamination, and when necessary, hospitalised in an intensive care unit. In ICUs suspected and confirmed cases are isolated with protective measures against staff contamination and placed in specific rooms with a negative pressure airflow. Based on the experience of SARS-CoV and H1N1 influenza outbreaks, seriously ill patients are referred to specialised units that have ECMO capability if required. Although one 80-year old Chinese tourist with co-morbidities has died in hospital, the majority of patients who have tested positive for SARS-CoV-2 to date have not yet shown signs of severe respiratory failure and some have been discharged from hospital after the contagious period. Currently, ICUs continue to manage patients with severe H1N1 influenza, utilising ECMO when indicated, and are therefore well prepared for the treatment of severe contagious viral infections.

9. Conclusion

Should community outbreaks occur globally, the management of critically ill patients with COVID-19 infection will be challenging. The lack of specific treatment is compounded by uncertainties about its mode of transmission and clinical outcomes. Given these knowledge gaps, it becomes essential that as much robust high-quality evidence as possible is gathered in the early stages of the disease. A strong appeal is made for the ICU community to come together globally, and for the contribution of data by all ICUs to local, regional and international databases. COVID-19 patients pose risks to ICU staff, but the precise magnitude of this risk is currently unclear. Adequate precautions, good hand hygiene, plentiful supplies of properly fitted N-95 masks and other essential PPE, filters for circuits, clear and robust protocols, teamwork and communication are all needed to address these concerns. ICU management teams have the responsibility to make these needs known to relevant authorities to ensure proper forward planning and adequate procurement. Painful lessons were learned from the recent SARS-CoV and influenza epidemics. It is time to apply what we have learned, and rise to the challenge of COVID-19.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395(10223):497–506.

[2] Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet 2020;395(10223): 514–23.

[3] Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet 2020;395(10224):565–74.

[4] Li W, Wong SK, Li F, Kuhn JH, Huang IC, Choe H, et al. Animal origins of the severe acute respiratory syndrome coronavirus: insight from ACE2-S-protein interactions. J Virol 2006;80(9):4211–9.

[5] El-Kafrawy SA, Corman VM, Tolah AM, Al Masaudi SB, Hassan AM, Muller MA, et al. Enzootic patterns of Middle East respiratory syndrome coronavirus in imported African and local Arabian dromedary camels: a prospective genomic study. Lancet Planet Health 2019;3(12):e521–8.

[6] Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet 2020;395(10223):507–13.

[7] Phan LT, Nguyen TV, Luong QC, Nguyen TV, Nguyen HT, Le HQ, et al. Importation and human-to-human transmission of a novel Coronavirus in Vietnam. N Engl J Med 2020. http://dx.doi.org/10.1056/NEJMc2001272.

[8] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of Novel Coronavirus-infected pneumonia. N Engl J Med 2020. http://dx.doi.org/10.1056/NEJMoa2001316.

[9] Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, et al. First case of 2019 novel Coronavirus in the United States. N Engl J Med 2020.

[10] Li W, Moore MJ, Vasilieva N, Sui J, Wong SK, Berne MA, et al. Angiotensin-converting enzyme 2 is a functional receptor for the SARS coronavirus. Nature 2003;426(6965):450–4.

[11] Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature 2020. http://dx.doi.org/10.1038/s41586-020-2012-7.

[12] Zhang H, Kang Z, Gong H, Xu D, Wang J, Li Z, et al. The digestive system is a potential route of 2019-nCov infection: a bioinformatics analysis based on single-cell transcriptomes. bioRxiv 2020. 2020.01.30.927806.

[13] Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel Coronavirus-infected pneumonia in Wuhan, China. JAMA 2020. http://dx.doi.org/10.1001/jama.2020.1585.

[14] Griffith JF, Antonio GE, Kumta SM, Hui DS, Wong JK, Joynt GM, et al. Osteonecrosis of hip and knee in patients with severe acute respiratory syndrome treated with steroids. Radiology 2005;235(1):168–75.

[15] Teleman MD, Boudville IC, Heng BH, Zhu D, Leo YS. Factors associated with transmission of severe acute respiratory syndrome among health-care workers in Singapore. Epidemiol Infect 2004;132(5):797–803.

[16] Chen WQ, Ling WH, Lu CY, Hao YT, Lin ZN, Ling L, et al. Which preventive measures might protect health care workers from SARS? BMC Public Health 2009;9:81.

[17] Booth TF, Kournikakis B, Bastien N, Ho J, Kobasa D, Stadnyk L, et al. Detection of airborne severe acute respiratory syndrome (SARS) coronavirus and environmental contamination in SARS outbreak units. J Infect Dis 2005;191(9):1472–7.

[18] Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to health-care workers: a systematic review. PLoS One 2012;7(4):e73579.

[19] Cheng VC, Chan JF, To KK, Yuen KY. Clinical management and infection control of SARS: lessons learned. Antiviral Res 2013;100(2):407–19.

[20] Jiang S, Huang L, Chen X, Wang J, Wu W, Yin S, et al. Ventilation of wards and nosocomial outbreak of severe acute respiratory syndrome among healthcare workers. Chin Med J (Engl) 2003;116(9):1293–7.

[21] Varia M, Wilson S, Sarwal S, McGeer A, Gournis E, Galanis E, et al. Investigation of a nosocomial outbreak of severe acute respiratory syndrome (SARS) in Toronto, Canada. CMAJ 2003;169(4):285–92.

[22] Gomersall CD, Joynt GM, Ho OM, Ip M, Yap F, Derrick JL, et al. Transmission of SARS to healthcare workers. The experience of a Hong Kong ICU. Intensive Care Med 2006;32(4):564–9.

[23] Ou X, Hua Y, Liu J, Gong C, Zhao W. Effect of high-flow nasal cannula oxygen therapy in adults with acute hypoxemic respiratory failure: a meta-analysis of randomized controlled trials. CMAJ 2017;189(7):E260–7.

[24] Fowler RA, Guest CB, Lapinsky SE, Sibbald WJ, Louie M, Tang P, et al. Transmission of severe acute respiratory syndrome during intubation and mechanical ventilation. Am J Respir Crit Care Med 2004;169(11):1198–202.

[25] Rello J, Perez M, Roca O, Poulakou G, Souto J, Laborda C, et al. High-flow nasal therapy in adults with severe acute respiratory infection: a cohort study in patients with 2009 influenza A/H1N1v. J Crit Care 2012;27(5): 434–9.

[26] Reynolds MG, Anh BH, Thu VH, Montgomery JM, Bausch DG, Shah JJ, et al. Factors associated with nosocomial SARS-CoV transmission among healthcare workers in Hanoi, Vietnam, 2003. BMC Public Health 2006;6:207.

[27] Heuer JF, Crozier TA, Howard G, Quintel M. Can breathing circuit filters help prevent the spread of influenza A (H1N1) virus from intubated patients? GMS Hyg Infect Control 2013;8(1):Doc09.

[28] Hirsch-Allen AJ, Ayas N, Mountain S, Dodek P, Peets A, Griesdale DE. Influence of residency training on multiple attempts at endotracheal intubation. Can J Anaesth 2010;57(9):823–9.

[29] Phua GC, Govert J. Mechanical ventilation in an airborne epidemic. Clin Chest Med 2008;29(2):323–8. vii.

[30] Lewis SR, Butler AR, Parker J, Cook TM, Smith AF. Videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation. Cochrane Database Syst Rev 2016;11:CD011136.
[31] Christian MD, Loutfy M, McDonald LC, Martinez KF, Ofner M, Wong T, et al. Possible SARS coronavirus transmission during cardiopulmonary resuscitation. Emerg Infect Dis 2004;10(2):287–93.
[32] Hawryluck L, Lapinsky SE, Stewart TE. Clinical review: SARS - lessons in disaster management. Crit Care 2005;9(4):384–9.
[33] Report of the Select Committee to inquire into the handling of the Severe Acute Respiratory Syndrome outbreak by the Government and the Hospital Authority July 2004. Hong Kong 2004.
[34] Gomersall CD, Tai DY, Loo S, Derrick JL, Goh MS, Buckley TA, et al. Expanding ICU facilities in an epidemic: recommendations based on experience from the SARS epidemic in Hong Kong and Singapore. Intensive Care Med 2006;32(7): 1004–13.
[35] Rubinson L, Nuzzo JB, Talmor DS, O'Toole T, Kramer BR, Inglesby TV. Augmentation of hospital critical care capacity after bioterrorist attacks or epidemics: recommendations of the Working Group on Emergency Mass Critical Care. Crit Care Med 2005;33(10):2393–403.
[36] Christian MD, Joynt GM, Hick JL, Colvin J, Danis M, Sprung CL, et al. Critical care triage. Recommendations and standard operating procedures for intensive care unit and hospital preparations for an influenza epidemic or mass disaster. Chapter 7 Intensive Care Med 2010;36(Suppl 1):S55–64.
[37] Christian MD, Sprung CL, King MA, Dichter JR, Kissoon N, Devereaux AV, et al. Triage: care of the critically ill and injured during pandemics and disasters: CHEST consensus statement. Chest 2014;146(4 Suppl):e61S–74S.

Lowell Ling[a], Gavin M. Joynt[a,*], Jeff Lipman[b,c,d], Jean-Michel Constantin[e,f], Olivier Joannes-Boyau[g]

[a]*Department of Anaesthesia and Intensive Care, The Chinese University of Hong Kong, Hong Kong, China*
[b]*Intensive Care Services, Royal Brisbane and Women's Hospital*
[c]*The University of Queensland Centre for Clinical Research, Brisbane, Australia*
[d]*Nîmes University Hospital, University of Montpellier, Nîmes, France*
[e]*Medecine Sorbonne-Université, DMU DREAM, AP–HP Sorbonne Université, Pitié-Salpêtrière Hospital, Paris, France*
[f]*GRC ARPE, Medecine Sorbonne-Université, Paris, France*
[g]*Service d'Anesthésie-Réanimation Sud, Centre Médico-Chirurgical Magellan, Centre Hospitalier Universitaire (CHU) de Bordeaux, 33000, Bordeaux, France*

*Corresponding author
E-mail address: gavinmjoynt@cuhk.edu.hk (G.M. Joynt).

Available online 20 February 2020