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Editorial

EDITORIAL

Outbreak of a new coronavirus: what anaesthetists should know

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In December 2019, an outbreak of pneumonia of unknown origin developed in Wuhan of Hubei Province, China.[1] By January 7, 2020, Chinese scientists confirmed that the outbreak was caused by a novel coronavirus, initially referred to as the 2019-nCoV,[2] and recently renamed as severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2), and the disease is now termed coronavirus disease 2019 (COVID-19) by the WHO. As of February 12, 2020, more than 75,748 confirmed cases of COVID-19 have been reported in 28 countries (including China) and international conveyance (cruise ship in the Japanese territorial waters), with approximately 99% of cases occurring in mainland China.[3] The WHO declared a public health emergency of international concern (PHEIC) on January 30, 2020 in response to the rapid growth of the outbreak and reports of human-to-human transmission in several countries.[3] Here, we summarise how key events unfolded, review the current understanding of COVID-19, contrast the outbreak of COVID-19 with the experience with severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), and discuss how anaesthetists should prepare themselves in view of this outbreak.

Tracking the course of the outbreak

The evolving story of the COVID-19 outbreak has advanced over a remarkably short time frame (Fig 1). On December 31, 2019, the Wuhan Municipal Health Commission reported a cluster of pneumonia of unknown origin, all linked to the Huanan Seafood Wholesale Market. This market harboured a variety of live and deceased exotic wildlife, including live bamboo rats, palm civets, badgers, and wolf cubs. It is notable that a quarter of the initially reported 27 pneumonia cases presented with severe disease.[45] Within days, the cause of the pneumonia was identified as a novel coronavirus (2019-nCoV).[2] On January 19, 2020 the WHO issued a warning that the virus may have the ability to spread from human to human.[3]

Wuhan is a major transportation hub within China with a population of 11 million. On a typical day, approximately 3500 people take flights to other countries from Wuhan, and the number increases with holidays and the Chinese Lunar New Year. Within 1 month, the number of confirmed COVID-19 cases rose to more than 9000, surpassing the number of SARS and MERS cases reported to date. Similarly, global fears escalated as cases spread to other countries. Extensive control measures were put into place, starting with massive decontamination efforts and, ultimately, closure of the Huanan Seafood Wholesale Market, banning the trade of wildlife and poultry in wet markets, contact tracing of cases, exit screening at airports, lockdown and quarantine measures that progressed to include adjacent cities (an estimated 50–60 million people affected), school closures, extension of the Lunar New Year holiday, prohibition of mass gatherings, and building of two new hospitals (1000 and 1600 beds) to care for infected individuals. Other nations instituted airport screening, travel bans, and evacuating citizens from Hubei Province and quarantining them through the incubation period.[6] Despite these measures, the case counts continued to increase in the outbreak epicenter, and countries with imported cases reported clusters of human-to-human transmission. On January 30, 2020, the WHO declared a PHEIC, calling for intensified international collaborative efforts to halt the outbreak.[3] Although Chinese authorities have heavily restricted movement from Wuhan, this austere measure came at the same time as the Spring Festival, a time when the number of outbound travellers from Wuhan is estimated to be more than 15 million.

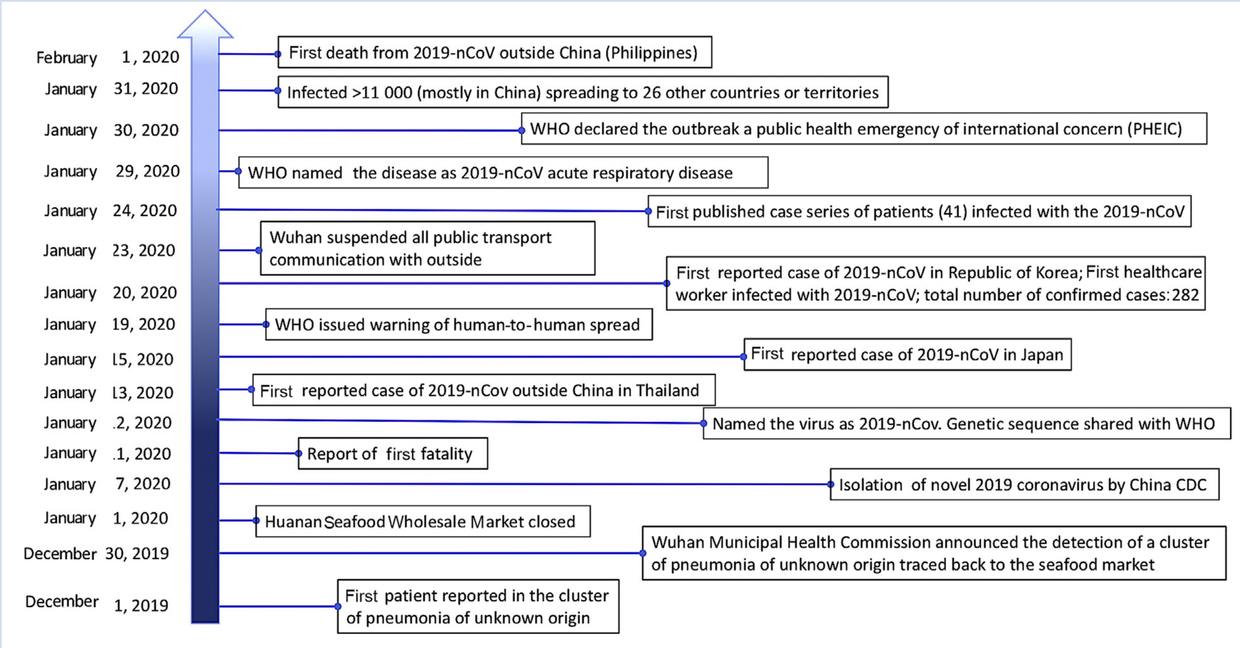

Figure 1. Timeline of the outbreak of 2019-nCoV/coronavirus disease 2019 (COVID-19).

What is 2019-nCoV/COVID-19?

The 2019-nCoV or SARS-CoV-2 is an enveloped RNA virus that belongs to the Coronaviridae, a family of viruses that can infect humans and several animal species. To date, seven human coronaviruses have been identified (HCoV-229E, HCoV-NL63, HCoV-OC43, HCoV-HKU1, SARS-CoV, MERS-CoV, and SARS-CoV-2).[7] The SARS-CoV-2 belongs to the subgenus Sarbecovirus and most closely resembles a bat coronavirus, with which it shares 96.2% genetic sequence homology.[2 8 9] The current belief is that COVID-19 was introduced into humans through an as yet unidentified intermediary animal, and it has since propagated through human-to-human spread. Human-to-human transmission occurs primarily through respiratory droplets that travel up to 2 m and may enter the respiratory tract of individuals within range or contaminated surfaces, leading to infection through contact transmission.[10] The average incubation period is 5 days, but it ranges from 1 to 14 days.[10 11] The basic reproductive number (the number of cases one infected individual generates), R_0, is estimated to be 2.68 (95% confidence interval: 2.47–2.86).[12] Whilst asymptomatic transmission (during the incubation period, before onset of symptoms in infected individuals) has been suggested, it remains controversial and currently does not appear to be a major factor for infection transmission.[10]

Infections in humans result in a spectrum of clinical disease, from mild upper respiratory tract infection, mostly commonly characterised by fever (82%) and cough (81%), to severe acute respiratory distress syndrome (ARDS) and sepsis. The median age of infected individuals is between 49 and 56 yr.[1 13] Children are rarely diagnosed with 2019-nCoV, a phenomenon that has not yet been explained. Characterisation of the first 99 cases of 2019-nCoV within Wuhan demonstrated that 33% had severe illness, with 17% developing ARDS, 4% requiring mechanical ventilation, and 4% having sepsis.[13] The case fatality rate is currently estimated at 2% based on the confirmed cases reported for the ongoing outbreak.[3] However, as mild and subclinical infections are currently under-reported, the true case fatality is likely lower than this.[14] People with co-morbidities, such as diabetes mellitus and cardiovascular disease, appear to be at higher risk for death.[1 13]

Table 1 Comparison of the outbreak from severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and 2019-nCov/coronavirus disease 2019 (COVID-19) respiratory syndrome. CoV, coronavirus.

	SARS	MERS	COVID-19
Timeline	November 2002 to July 2003	June 2012 to present	December 2019 to present
Location of first detection	Guangdong, China	Jeddah, Saudi Arabia	Wuhan, China
Animal origin	Civet	Camel	Non-aquatic animal (?)
Confirmed cases	8096	2494	12 404
Fatality	744 (10%)	858 (37%)	259 (~2%)
Global impact	26 countries	27 countries	26 countries
Date of virus identification	April 2003	October 2012	January 7, 2020

Comparison with the SARS and MERS outbreak

Several similarities and differences exist amongst the SARS, MERS, and 2019-nCoV viruses (Table 1). All three coronaviruses were introduced into humans from wild animals (masked palm civets in SARS, camel in MERS, and unclear intermediary for 2019-nCoV).[15 16] All three can cause severe respiratory distress symptoms and death, although fatality rates range considerably, with MERS being the most lethal (case fatality rate: 35%).[16] There have been no further documented cases of SARS since July 2003, but MERS continues to be reported sporadically, generally as a result of animal-to-human contact or transmission in healthcare facilities and within families. Compared with SARS, with which it shares nearly 70% genetic homology, 2019-nCoV appears to be more transmissible (higher R_0) but less fatal.[13]

The current outbreak of COVID-19 has benefited from several advancements that have resulted in a different experience from the SARS outbreak in 2002–3.

Improved reporting, transparency, and communication

Health officials in China exhibited a much higher degree of transparency early in this outbreak and were quicker to notify the WHO after they discovered the cluster of pneumonia of unknown origin. The identification of the aetiological virus occurred promptly in early January, and the full genome sequence data were shared on the Global Initiative on Sharing All Influenza Data platform.[8] The update International Health Regulations (2005) was signed 2 yr after the SARS outbreak by 194 member states, with legal binding on the protection of all people of the world from international spread of disease.[17] Global surveillance and alerting systems developed since SARS enabled rapid dissemination of information on the emerging outbreak. Public health officials and the WHO have held numerous press conferences to inform the public on important developments. Scientific papers have been published with rapid peer review to share the clinical and epidemiological characteristics of the virus within the medical community.

Technological advancements

During the SARS outbreak, the aetiological virus was identified 5 months after the outbreak began. In contrast, the virus and the genomic characteristic were identified within 2 weeks of the discovery of the COVID-19 outbreak.[8] This is very significant, as this information allows rapid development of real-time polymerase chain reaction diagnostic tests specific to SARS-CoV-2.[18] This has allowed some countries to have diagnostic testing available before the first case arrived in their countries—a significant step in curbing the spread of the virus globally. Early identification of the full genome also aids in vaccine development. Companies, such as Tencent (Shenzhen, China) and Alibaba (Hangzhou, China), provide databases running in real time to release the latest statistics needed for contact tracing and for management of essential supplies (such as masks and gowns). Technology has also accelerated information sharing through social media and the internet, which was still in its infancy during the SARS outbreak.

Infection prevention and control and public health infrastructure expansion.

Since the SARS outbreak, the WHO has declared five PHEIC. As a result of these events, significant investments have been made into public health and infection prevention programmes in many jurisdictions. Public health programmes coordinate rapid case finding, tracing of contacts of cases, and isolation measures to mitigate spread, and guide decision-making on broad public health measures, such as social distancing when required. Hospital infection prevention and control programmes aid with case identification through screening and testing, and they execute isolation infection prevention measures to ensure healthcare settings are safe from infection transmission. The latter is of utmost importance, as both the SARS and MERS viruses have disproportionately infected healthcare providers and healthcare settings have been hotspots of infection transmission.

What anaesthetists need to know in response to this outbreak

During the SARS outbreak, 21% of the infected individuals globally were healthcare workers.[15] In Canada, a final count of 251 cases of SARS was confirmed; 43% of them were healthcare workers, the majority were from Toronto.[15] Concerns were raised about infections in healthcare workers despite apparently appropriate personal protective equipment (PPE). Analysis of this experience uncovered several important lessons.[19]

First, the protection of healthcare workers is not just about PPE; it encompasses all principles of infection prevention and control.[20] Whilst the initial focus for protecting anaesthesiologists or personnel involved in aerosol-generating medical procedures (tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, and bronchoscopy) was on the need for more stringent PPE, such as powered air-purifying respirators or double gloves during the SARS outbreak, further investigation did not support a risk of transmission with tracheal intubation if appropriate precautions and more standard PPE were used.[21 22] In areas, such as the emergency department or ICU where SARS patients were managed, there were 'uncontrolled situations characterized by multiple opportunities for extensive contamination and staff exposure prior to the intubation event'.[21] Healthcare workers were exposed to risk of infection before PPE was used. It reflects the importance of triage, early recognition, and prompt isolation for suspected cases of infected patients.[20]

Second, a post-SARS investigation interviewing healthcare workers involved in the intubation of SARS patients in Toronto highlighted non-compliance or sub-optimal adherence to the use of PPE.[23] Although much is unknown about the 2019-nCoV, it is believed to spread from person to person amongst close contact via respiratory droplets and contact transmission. Strict adherence to the use of PPE, including procedure mask, eye protection, gown, and gloves, is highly effective in limiting droplet and contact transmission.[21]

The current WHO and Centers for Disease Control and Prevention guidance for the protection of personnel during aerosol-generating medical procedures in patients with confirmed/suspected 2019-nCoV centres around principles of clear communication, minimising personnel in the room during the procedure, appropriate use of PPE, and avoidance of procedures that generate high amounts of aerosols. Some considerations are provided as follows to help prepare for airway management of confirmed/suspected COVID-19 patients.[20 24 25] These suggestions are by no means comprehensive. Hospitals should develop local plans for aerosol-generating medical procedures in suspected/confirmed COVID-19 patients using a collaborative approach that engages anaesthesiologists, intensivists, emergency medicine physicians, respiratory therapists, resuscitation team members, infection prevention and control, occupational health and safety specialists, and environmental services staff.

Preparing the patient and procedure room

Transfer of a suspected or infected COVID-19 patient to the room for aerosol-generating medical procedures requires planning. Considerations include:

(i) The room should be adequately ventilated; for aerosol-generating medical procedures performed outside the operating theatre, a negative pressure/airborne isolation room with minimum 12 air changes h^{-1} is preferred.
(ii) The patient should wear a face mask during transport to the procedure room.
(iii) The staff involved in the care of the patient should don PPE as required by their hospital's policy for management of COVID-19.
(iv) Hand hygiene must be performed by staff before and after all patient contact, particularly before putting on and after removing PPE.
(v) The number of individual staff members involved in the resuscitation should be kept to a minimum with no or minimal exchange of staff for the duration of the case, if possible.

PPE considerations

(i) Specific PPE components selected for aerosol-generating medical procedures may vary slightly by hospitals. However, the underlying principles are the same: to protect the healthcare provider from inhalation of and contact with aerosols and droplets that may be generated during the procedure. PPE components that may be used to accomplish this level of protection include:
  (a) A particulate respirator (US National Institute for Occupational Safety and Health-certified N95, EU standard FFP2, or equivalent); all healthcare workers should have an updated respirator fit test;
  (b) Eye protection, through the use of goggles or a disposable face shield;
  (c) Gown with fluid resistance; and
  (d) Gloves.
(ii) Any PPE component that becomes heavily soiled during aerosol-generating medical procedures should be replaced immediately.
(iii) Careful attention must be paid to donning and doffing of PPE to avoid potential exposure and self-contamination, which is highest during removal of PPE. All healthcare workers attending to aerosol-generating medical procedures should be trained and comfortable with PPE use, including safe donning and doffing.
(iv) After removing protective equipment, the healthcare worker should avoid touching the hair or face before cleaning hands.
(v) PPE should be disposed of carefully in a touch-free disposal or laundering bin.

Minimisation of the aerosol generation

To minimise the aerosols generated during airway instrumentation, some factors to consider include the following:

(i) Airway management should be reserved for the most experienced anaesthetist, if possible.
(ii) A high-efficiency hydrophobic filter interposed between face mask and breathing circuit or between face mask and airway bag can be used, if available.
(iii) A thorough preoxygenation with 100% oxygen and rapid sequence induction (RSI) should be considered to avoid manual ventilation of the patient, which can result in aerosolisation of virus from airways.
(iv) RSI may need to be modified if the patient has a very high alveolar–arterial oxygen gradient, is unable to tolerate 30 s of apnoea, or has a contraindication to succinylcholine. If manual ventilation is anticipated, small tidal volumes should be applied.
(v) Awake fibreoptic intubation should be avoided unless specifically indicated, as the atomised local anaesthetic and the coughing episode during anaesthetising of the airway can aerosolise the virus. Consider the use of a videolaryngoscopy.
(vi) Tracheal intubation rather than the use of laryngeal mask is favoured.
(vii) In managing patients with respiratory distress from coronavirus infection outside the operating theatre, non-invasive ventilation should be avoided, if possible, to prevent generation of aerosol of virus in the room, and early intubation should be considered in a rapidly deteriorating patient. Whilst resuscitating the critically ill patient, chest compressions should be held during intubation to avoid exposing the face of the intubating clinician to aerosols, and neuromuscular blockers should be considered before intubation, if possible.

Conclusions

The current outbreak of COVID-19 has rapidly expanded over a short time. Confirmed cases continue to increase despite austere measures applied by the Chinese government and public health officials around the world. Up to one-third of affected patients may require a higher level of care in hospital, including mechanical ventilation in the early report.

Anaesthesiologists are experts in airway management and will be on the frontlines of managing critically ill patients. Learning from previous experiences with SARS and understanding the current epidemiological factors of the COVID-19, anaesthesiologists are much better prepared to protect themselves during aerosol-generating medical procedures. A good knowledge of infection prevention and control, vigilance in protective measures, strict adhesion of donning and doffing of PPE, and preparedness for the care of infected patients are of utmost importance.

Authors' contributions

Writing/editing of paper: all authors.
Approval: all authors.

Declaration of interest

The authors have no conflicts of interest to declare.

References

1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020; **395**: 497–506
2. Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med Adv* 2020; **24**. https://doi.org/10.1056/NEJMoa2001017. Acccess Published January
3. Wold Health Organization. *Novel coronavirus (2019-nCoV) situation report*. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports. [Accessed 9 February 2020]
4. Parry J. China coronavirus: cases surge as official admits human to human transmission. *BMJ* 2020; **368**: m236
5. Cheng VCC, Wong SC, To KKW, Ho PL, Yuen KY. Preparedness and proactive infection control measures against the emerging Wuhan coronavirus pneumonia in China. *J Hosp Infect 2020 Adv* 2020; **18**. https://doi.org/10.1016/j.jhin.2020.01.010. Acccess Published January
6. Holshue ML, DeBolt C, Lindquist S, et al. First case of 2019 novel coronavirus in the United States. *N Engl J Med Adv* 2020; **31**. https://doi.org/10.1056/NEJMoa2001191. Acccess Published January
7. Lu RJ, Zhao X, Li J, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *Lancet Adv* 2020; **29**. https://doi.org/10.1016/S0140-6736(20)30251-8. Acccess Published January
8. Chan JF, Kok KH, Zhu Z, et al. Genomic characterization of the 2019 novel human-pathogenic coronavirus isolated from a patient with atypical pneumonia after visiting Wuhan. *Emerg Microbe. Infect* 2020; **9**: 221–36
9. Zhang LS, Shen FM, Chen F, Lin ZG. Origin and evolution of the 2019 novel coronavirus. *Clin Infect Dis Adv* 2020; **3**. https://doi.org/10.1093/cid/ciaa112. Access Published February
10. Centers for Disease Control and Prevention. *2019 Novel coronavirus*. Available from: https://www.cdc.gov/coronavirus/2019-ncov/faq.html. [Accessed 8 February 2020]
11. Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med Adv* 2020; **29**. https://doi.org/10.1056/NEJMoa2001316. Acccess Published January
12. Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. *Lancet Adv* 2020; **31**. https://doi.org/10.1016/S0140-6736(20)30260-9. Acccess Published January
13. 2019 Chen N, Zhou M, Dong X, et al. Novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet Adv* 2020; **29**. https://doi.org/10.1016/S0140-6736(20)30211-7. Acccess Published January
14. Ghani AC, Donnelly CA, Cox DR, et al. Methods for estimating the case fatality ratio for a novel, emerging infectious disease. *Am J Epidemiol* 2005; **162**: 479–86
15. World Health Organization. *Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003*. Available from: https://www.who.int/csr/sars/country/table2004_04_21/en. [Accessed 7 February 2020]
16. World Health Organization. *Middle East respiratory syndrome coronavirus (MERS-CoV)*. Available from: http://www.who.int/emergencies/mers-cov/en/. [Accessed 9 February 2020]
17. World Health Organization. *International health regulations* 2005. Available from: https://apps.who.int/iris/bitstream/handle/10665/246107/9789241580496-eng.pdf;jsessionid=CEB2B12AFC7EB3DE9E2993B7CFA6E5AB?sequence=1, . [Accessed 9 February 2020]
18. World Health Organization. *Novel coronavirus (2019-nCoV) technical guidance: laboratory testing for 2019-nCoV in humans*. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/laboratory-guidance. [Accessed 9 February 2020]
19. Hung CT, Ho PL. High-risk procedures: how to play it safe. In: Chan JCK, Taam Wong VCW, editors. *Challenges of severe acute respiratory syndrome*. Hong Kong: Saunders Elsevier; 2006. p. 205–24
20. World Health Organization. *Novel coronavirus (2019-nCoV) technical guidance: infection prevention and control*. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/infection-prevention-and-control. [Accessed 9 February 2020]
21. Nicolle L. SARS safety and science. *Can J Anesth* 2003; **50**: 983–8
22. Loeb M, McGeer A, Henry B, et al. SARS among critical care nurses, Toronto. *Emerg Infect Dis* 2004; **10**: 251–5
23. Caputo KM, Byrick R, Chapman MG, Orser BA. Intubation of SARS patients: infection and perspectives of healthcare workers. *Can J Anaesth* 2006; **53**: 122–9
24. Centers for Disease Control and Prevention. *Interim infection prevention and control recommendations for patients with confirmed 2019 novel coronavirus (2019-nCoV) or persons under investigation for 2019-nCoV in healthcare settings*. Available from: https://www.cdc.gov/coronavirus/2019-nCoV/hcp/infection-control.html. [Accessed 9 February 2020]
25. University of Toronto. *Coronavirus and safety precaution*. Available from: https://www.anesthesia.utoronto.ca/news/coronavirus-and-safety-precautions. [Accessed 9 February 2020]