

Airway management in COVID-19: Time to start thinking outside the box?

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In umbra, igitur, pugnabimus!
Dienekes of Sparta, Thermopylae, 480 BC

Faced with limited time, severely constrained resources and a lack of manpower in the face of the overwhelming numbers in Xerxes' invading Persian Army, the Greeks strategised to halt their foe using two natural barriers which restricted movement: the Straits of Atremisium, and the narrow pass at Thermopylae. King Leonidas of Sparta led 7 000 mettlesome troops to engage at the *Hot Gates*, preparing to face a force today believed to have exceeded 150 000 fighters. When told that the Persians were so multitudinous that each volley of their arrows would block out the sun, Herodotus writes that the plucky Spartan soldier, Dienekes, replied laconically: "In the shade, then, we will fight!" The Battle of Thermopylae is history interwoven with legend, but speaks of the power of strategic interventions applied at the right place, at the right time, by the right people, even in the face of overwhelming odds.

For more than a year, the SARS-CoV-2 pandemic has dominated our lives, conversations, clinical practice, and research agendas.¹ The inexorable deluge of cases and global deaths (exceeding 100 million and 2 million, respectively)² is easily compared to volleys of arrows blocking out the sun; wave after wave of COVID-19 patients may feel like the hopeless enormity of Xerxes' army. Yet our patients are not the enemy; they are the casualties of a war we are still being forced to learn to fight from the trenches. Tactically, we may make some mistakes, but strategically, we must retain the upper hand.

Anaesthesiologists have emerged as having an ideal armamentarium for this battle. We are well versed in the practical arts of intensive care, are unfazed by the critically ill patient, and are effective members of high-performance teams. Indeed, it is not by chance that so many talented (and sorely needed) intensivists are anaesthesiologists by training. Our core understanding of equipment, physics, physiology and the pharmacological manipulation thereof give us a niche – but more importantly, a responsibility – in being amongst those who stand ground against COVID-19.

If any arena is the home ground for anaesthesiologists, it is that of airway management. Many fears and challenges have been raised in this field for COVID-19, and often we do not yet have definitive answers.³ Since the beginning of the pandemic, it has been recognised that contact and droplet spread of this

commonly respiratory illness are the predominant modes of infection, but the spectre of aerosol transmission remains a significant (albeit only partially proven) fear.⁴⁻⁶ This brings uncertainty into COVID airway management; the very air takes on a dark shadow of foreboding, as we wonder if these infinitesimal infective arrows will find a chink in our armour.

Early recommendations and decisions surrounding airway management for COVID-19 were based on some evidence from previous pathogens such as the original SARS outbreak, expert opinion⁷⁻¹⁰ and much supposition (if not superstition). Certainly, data from SARS showed increasing risks of healthcare worker (HCW) infection with performance of airway management tasks.^{11,12} Earning the moniker "aerosol-generating procedures" (AGPs), odds ratios for transmission ranged from 1.2 for tasks like nasogastric tube insertion to 6.6 for tracheal intubation.¹¹ However, elucidating the causal relationships with specific tasks from the overall infection of HCWs who are often working in complex and chaotic environments, on the background of spread within communities, is challenging (or perhaps impossible). Still, data gathered in this pandemic show that easily 1 in 10 practitioners performing airway management will contract COVID-19 despite the use of PPE,¹³ although improved levels of PPE may be associated with lowered transmission rates.^{3,14} Growing information from China and then Europe (especially Italy) early in the pandemic allowed the formation of recommendations to help protect staff and patients,¹⁵ but we should be willing to reconsider our practices as information grows and understanding evolves.

The fundamental unresolved concern is the role of aerosols in transmission. Indeed, even the definitions of aerosols, small and large droplets are subject to some debate, but here we will take the word to refer to particles containing virus which are small enough to remain suspended in the air for some time, rather than settling as droplets on surfaces. That the virus can be aerosolised and can survive for a few hours in the air has been demonstrated.¹⁶ Whether this can cause transmission of the disease is very hard to prove, although suggestive case studies exist.¹⁷ This remains, however, as one author's former mentor described: "An area of expert opinion hitherto unsullied by substantial evidence..."

Being faced with so much uncertainty in the face of growing necessity has led to a great deal of invention. We have modified and created protocols, formed new teams, tried to repurpose old drugs, changed our goals, invented new devices, and used known therapies in novel ways. Some efforts have led to great successes: the adoption of high-flow nasal oxygenation (HNFO) or non-invasive ventilation (NIV) in order to delay or avoid intubation and mechanical ventilation is a prime example.^{18,19} Sometimes, successes lead to challenges due to unexpected consequences: strain on the oxygen supply chain and in-hospital delivery due to widespread use of HFNO refers. At other times, innovations may be a good idea, but on close examination, either lack the intended effect, compound the problem, or have more deleterious consequences.²⁰

In this edition of the Journal, Swart and colleagues present a simulation-based randomised crossover study on *"The influence of a Perspex intubation box on time to intubation"*.²¹ This is highly topical and timeous work: since the early days of the pandemic, concerns about AGPs and global shortages of PPE have driven many practitioners, engineers and even the lay public to create similar barrier systems. Many units and hospitals have instigated this practice, and substantial sums have been spent (either through sponsorship or direct purchasing) on these devices. The media hailed heroic efforts, and journals were flooded with reports, designs and small case series. However, a scoping review of the evidence for these untested devices completed in early June 2020 found no evidence of benefit, some suggestions of harm, and decried a lack of suitably designed simulation or clinical studies.²²

The work by Swart et al. assessing the influence on mean time to intubation in a simulation model joins other methodologically strong work which will ultimately allow definitive analysis of the technique. As in the earlier study by Begley et al.,²³ this study showed prolonged times to intubation with the aerosol box, using both direct and videolaryngoscopy. Regrettably, Swart and colleagues did not assess the incidence of damage to PPE caused by the box, which was a concerning finding in the Begley study. However, the Swart study is also in keeping with a recent systematic review and meta-analysis by Lim et al. which again shows increased time to intubation when using an aerosol box.²⁴ Of note, this effect was also independently present when analysing simulation studies using manikins, and studies in live patients.

Rapid innovation clearly has a role in responding to a crisis, where allowing the duration of delays traditionally associated with the formal research process from ethical approval to peer-reviewed publication may exact a cost in mortality. However, the list of therapies, innovations and ideas which appeared attractive earlier in the pandemic but have been discarded continues to grow: hydroxychloroquine, early aggressive invasive mechanical ventilation,^{25,26} high-dose anticoagulation^{27,28} and even indiscriminate use of steroids²⁹ all come to mind. Will, like steroids, a more nuanced application of intubation barrier methods, perhaps with negative pressure extraction, be shown

to be effective? The matter of Perspex, it turns out, is far from clear. More fundamentally, we need to consider the balance of risk in being too slow to adopt life-saving new strategies even though evidence is paltry, and the harm due to moving too swiftly.

In a parallel, we need to consider also the risk-benefit ratio whenever adopting new devices and technologies: the so called MacGyver bias may lead to overestimation of the value of apparently simple and effective solutions or alternatives.³⁰ Once again, in the aerosol boxes debate, concerns remain regarding whether aerosol boxes may hinder airway management (especially in difficult cases), further degrade already PPE-limited performance,³¹ cause PPE damage breakage, increase the environmental contamination through access ports,³² cause "secondary aerosolisation" upon removal or cleaning, and potentially increase physical and mental workload.^{22,33}

Where then, are we now? It is clear that in a small proportion of infections, SARS-CoV-2 can cause a severe hypoxaemic viral pneumonia, but these patients often respond well to HFNO, NIV, and permissive hypoxia.¹⁸ Patients who fail these therapies, however, are the epitome of the "physiologically difficult airway"³⁴ and desaturate rapidly and profoundly during airway management. This constitutes a clear risk to patients, and may be accompanied by circulatory collapse and cardiac arrest far more commonly than in our routine practice, either as a direct result of the hypoxaemia, or due to COVID-19 itself. We have thus altered practices around the use of NIV techniques, when to intubate, and have tried, abandoned and adopted different medications. Great hope is placed in vaccination, but this may be delayed in Africa. Consequently, we need to face the reality that we will have to co-exist with SARS-CoV-2 in epidemic and endemic phases for years. Healthcare systems and individual HCWs need to redesign structures and protocols,³⁵ and definitively change their approach to be prepared for a hybrid future where we provide care for COVID patients (taking into account the different age, mortality and clinical patterns),^{36,37} while still maintaining the non-COVID services. Particularly, we must recognise that patients who may not have severe coronavirus disease may require surgery despite a known increase in perioperative risk of pulmonary and other complications and increased risk of mortality, on the background of very low ICU availability.³⁸ Finally, we must acknowledge the very real risk to staff who perform airway management. International studies have demonstrated an infection rate of approximately 10%,¹³ and the scores of HCWs who have already died is a burden we are forced to carry. While higher levels of PPE seem to be associated with decreased rates of HCW infection, it is clear that it is our practices and not just our protection that matter.³

We clearly need to keep *thinking outside the box*, and continue revising our airway management practice as evidence evolves.

Prevent, protect and prepare

The first fundamental philosophy for COVID-19 airway management is adequate PPE. While the ubiquitous use of N95 or

equivalent (or better) respirators is logical, rather than becoming bogged down in the minutiae of the type of gown or number of layers of gloves, we must focus on PPE as part of a holistic infection prevention and control (IPC) strategy. This requires extensive staff training, buddy systems, practice through simulation, and ongoing feedback to combat 'pandemic fatigue'.^{39,40} With rigorous IPC practices, it may be possible to greatly limit or even prevent any staff infections in the workplace.³

Avoid invasive airway management where possible

Wherever feasible, avoidance of intubation in severe COVID-19 through the use of NIV or HFNO may decrease complications, mortality, and certainly risk to staff. For patients requiring surgery, increased use of regional or neuraxial anaesthesia can likewise be applied.

Systematise and streamline airway management to be as swift as safely possible

Clinical experience has shown that standardised systems which have been streamlined to promote rapid airway management and reduce apnoeic times are effective in limiting peri-procedural complications such as severe desaturation and cardiovascular collapse. Although allowing for individualisation for specific patient needs, this includes the use of modified rapid sequence intubations with adequate/accentuated dose adjustment, a protocolised team approach, use of videolaryngoscopy with a preloaded introducer for every case,^{15,41} and an experienced practitioner managing the airway.

"We not me": Use a team approach

A clear plan with well-defined roles (that emphasises the role responsibilities rather than staff designation) may be augmented with the consistent use of a checklist (See <https://youtube.com/playlist?list=PLhd5dX7V2doeliMRfi-cpvloMD1ZLc9uO>). Training the roles interchangeably and including non-anaesthetic staff in the various areas strengthens the ad hoc teams which are often required out of normal working hours. The team approach should emphasise closed-loop communication and the need to progress smoothly through the steps when challenges are encountered without the necessity of waiting for the inevitable deterioration in the patient's condition.⁴²⁻⁴⁴

A dedicated team approach with centralisation of intubation sites may help in improving safety and performance, thereby reducing complications.⁴⁵ Such an approach may also have implications on the mental well-being of the team members, which is undoubtedly an issue we are facing during the pandemic and into the future.^{46,47}

Expand your practice to "per-oxygenation"

Patients being intubated for mechanical ventilation as a final life-saving effort will inevitably have profound hypoxaemia, and desaturate exceptionally rapidly. Even patients with COVID-19 who are not *in extremis* but present for anaesthesia are at greater risk of peri-induction hypoxaemia. Focusing on optimal pre-oxygenation incorporating PEEP is vital. However, measures

to increase the safe apnoea time such as providing apnoeic oxygenation or "gentilation" during airway management should be considered. The increase in risk to practitioners of maintaining HFNC oxygenation during airway management when they have been exposed while working closely with the patient prior to intubation is not known, although we now recognise HFNC to be less of a risk for aerosol generation than initially presumed.¹⁹ Gentle ventilation during RSI is becoming widely practised in the setting of a physiologically difficult airway;⁴⁸ again, if a filter is used on the mask and a good seal maintained, it is logical (although unproven) that there will be decreased risk of aerosolisation. Applying a snug-fitting anaesthetic mask with filter over existing HFNC may also be effective. Finally, experience has taught that peri-induction desaturation is often slow to recover in severe COVID pneumonia; preparation of a suitable ventilator with appropriate limits and PEEP settings which is then rapidly connected can be of use.

Anticipate cardiovascular misadventure

Preliminary data show that cardiovascular collapse and even cardiac arrest is not uncommon during airway management for critically ill COVID-19 patients. Inotrope boluses are frequently required, and in some cases progress to the need for infusions prior to transfer or arrival in the ICU. Adequate IV access and pre-prepared inotropic agents are thus recommended.

Decrease disconnects

Unanticipated or planned disconnections of the ventilator circuit not only carry a risk of spreading droplets and aerosols, but any interruption to ventilation places the patient at risk of further desaturation, compounded by de-recruitment. One strategy is to have the ventilator prepared prior to intubation, so that it may be immediately connected once the tracheal tube is in place. Where patients need to be transferred longer distances, across different floors of the hospital or through public areas, the use of a transport ventilator placed on the bed can decrease the number of accidental disconnections which occur while handling a larger ventilator in tight spaces.

Document and share what you do

We continue to learn the nuances of managing COVID-19. It is thus imperative that we not only maintain good patient records and use debriefing as a tool to improve our practice, but also share lessons within and outside teams, gather research data, and contribute to global collaboration.

Those who know their classic history (or enjoy Hollywood blockbusters) know that Thermopylae was no victory for the Spartans. After holding out for days despite the odds, they were betrayed by a local who sold the secret of a hidden path around the blockade. Recognising the inevitability of being surrounded and defeated, Leonidas ordered the majority of his forces to fall back, while he fought alongside Dienekes with only 300 of the finest Spartans until the end. Neither man left Thermopylae. The battle was lost, but the delay and cost to the Persians was great, and their invasion failed: the war was won. So too for us in this

pandemic: we have struggled, sometimes lost, but we continue to innovate. The ground held through good airway management practices and other meaningful treatments has given time for testing of other therapies and development of vaccines. Even though we feel confronted by seemingly unassailable odds, let us continue the fight.

Dedication

This editorial is dedicated to healthcare workers such as Abdulraouf Mohamed Kdaish, Kgopotso Rudolph Mononyane and far too many others, in South Africa and globally, who have lost their lives in the ongoing battle against COVID-19. Resolutely, they went forth to fight in the shade; we will remember their indomitable light.

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