In sum, we found that very few (one in 220) cases had a positive COVID-19 PCR within 7 days pre-procedure; this rate was substantially lower (one in 442) if testing was specifically for 'pre-procedural' indications. Pre-procedural testing is intended to protect patients from morbidity and clinicians and staff from exposure. However, when prevalence is low, testing costs (i.e. financial, resources) coupled with procedural delays from false positive results cannot be ignored. The exact point prevalence of COVID-19 active infection in Miami during the study period is not known; yet, antibody testing of residual sera collected by a commercial laboratory from April 6, 2020 to April 10, 2020 estimated COVID-19 prevalence of past infection in South Florida to be 1.9% (95% confidence interval: 1.0–3.2%).[7] With 5% community prevalence, a positive result from a test with 70% sensitivity and 99% specificity will be found in likely uninfected people approximately one in every five tests (Supplementary Fig. S2).

Our data are limited by their single-centre nature. We were unable to reliably assess the indication for COVID-19 testing in all cases; however, ineffectively excluding symptomatic patients likely biases us towards overestimating screening positivity rates.

Our analysis shows that there is little role for obtaining more than one test pre-procedurally. And, as we learn more about the incubation period, risk of asymptomatic transmission, and exposure potential of COVID-19, it will be important to reconsider policies advocating for testing every patient pre-procedurally, even once.

Authors' contributions

Responsible for the conception and design of the study, revising the article critically for important intellectual content, and final approval of the submitted manuscript: all authors
Responsible for data acquisition: HBG, PRW, MMS
Responsible for data analysis and primary manuscript drafting: HBG

Declarations of interest

The authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2020.08.011.

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Tracheal intubation in COVID-19 patients: update on recommendations. Response to *Br J Anaesth* 2020; 125: e28–37

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Editor—We thank Sethi and Sethi[1] for their interest and comments on our paper[2] that combined a report of experiences in Wuhan, China, early in the pandemic accompanied by consensus recommendations made by international experts. This unusual approach was adopted to meet the needs of the rapidly emerging global crisis by simultaneously reporting data and providing guidance.[2] We now provide some updates to our recommendations based on further developments.

The recommendation to consider a fluid bolus before induction of anaesthesia came from several co-authors. Early in this pandemic, a restrictive fluid strategy was common as part of a strategy to minimise hypoxaemia in patients with acute lung injury. However, restrictive fluid strategies were modified in the light of increased recognition of severe dehydration and high rates of acute renal failure in patients with COVID-19. Indeed, supplies for renal replacement therapy were often a greater limitation to critical care delivery than was availability of ventilators. A more liberal resuscitative approach is now adopted by many. Jaber and colleagues[3] showed a decrease in life-threatening complications in the ICU after the implementation of a tracheal intubation management protocol that included fluid loading before tracheal intubation unless contraindicated.

Regarding 'prophylactic use of vasopressors', we advocate 'immediate availability and appropriate use of prophylactic cardiovascular-stimulating agents'. This is in line with guidelines for avoidance of cardiovascular collapse in the critically ill.[4] We do not agree that comparing results between two hospitals in our retrospective and observational study provides value for guiding clinical practice because of the potential for multiple confounding factors. Of note, the four cardiac arrests occurred in Hospital B, where prophylactic vasopressors were not administered.

Hypotension and cardiac arrest are common during induction of general anaesthesia in critically ill patients. Cardiac arrest during tracheal intubation is associated with poor outcome.[5] The cases in our series support this: all the four cardiac arrests in Hospital B occurred during induction of anaesthesia, and each was followed by immediate advanced life support and successful resuscitation, without cardiac defibrillation. However, all four patients subsequently died from multiple organ failure. Anaesthetic drug choice, fluid administration, and use of cardiovascular-stimulating drugs whether during or after induction of anaesthesia all contribute to safe emergency tracheal intubation. The use of these interventions may be affected by available time and efforts for pre-induction patient preparation, availability of induction agents (such as etomidate or ketamine), and clinical judgement. Considering the observed high incidence of cardiovascular collapse in our series, we believe we provided a balanced approach with our recommendation for the prophylactic use of fluids and vasopressors and the use of alternative anaesthetic induction agents. Optimising patient condition before induction of anaesthesia and minimising hypoxaemia with timely and prompt tracheal intubation at the first attempt may also increase safety.

About one in eight (12.9%) of the patients in our series was unconscious. Causes included profound hypotension, severe hypoxaemia, carbon dioxide retention, electrolyte disturbance, and acute encephalomyelitis. This illustrates the severity of illness amongst patients referred to critical care at that stage of the pandemic.

Regarding 'rapid sequence induction' (RSI), it has been widely taught for many years that RSI does not include mask ventilation. This has recently been challenged, and whilst 'modified RSI' is a loose and undefined term, we suggest that most would regard mask ventilation during RSI to be a modification of classical teaching.[6] Casey and colleagues[7] recently confirmed that mask ventilation after induction of anaesthesia and before tracheal intubation could ameliorate severe hypoxaemia in critically ill patients. We agree that infection control issues suggest that mask ventilation should be avoided when possible. We advocate the use of preventative measures, such as apnoeic oxygenation. Further, we propose that it is not controversial to recommend the use of mask ventilation when severe hypoxaemia supervenes.[8] We recommend using two-hand two-person mask ventilation with a 'VE' grip to assure a tight seal, combined with the use of a viral filter. The airway team should be dressed in airborne-precaution personal protective equipment (PPE) throughout this aerosol-generating medical procedure. Supervised donning and doffing of PPE remain a critical step in the avoidance of cross-infection in healthcare workers.

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Distanced-based dynamic behaviour of aerosol particles during aerosol-generating medical procedures

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Keywords: aerosol-generating procedures; COVID-19; direct laryngoscopy; SARS-CoV-2; simulation; tracheal intubation; videolaryngoscopy

Editor—The coronavirus disease 2019 (COVID-19) pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has put the safety of healthcare providers at risk,[1] especially after aerosol-generating medical procedures such as tracheal intubation and extubation.[2] To improve the safety of healthcare providers, many aerosol-generating medical procedures have been modified and adapted in most clinical practices. For instance, recent guidelines for airway management in patients with COVID-19[3] recommend that all intubations be performed with videolaryngoscopy instead of direct laryngoscopy, not only to improve the success rate of a first-pass tracheal intubation, but also to distance healthcare providers from the airway and infectious aerosols. These recommendations are based on the assumption that increased distance from the patient's airway decreases the potential exposure to infectious droplets. However, the assumption that distance decreases infection risks remains unproved in the setting of aerosol-generating procedures. We therefore examined the relationship between distance and concentration of aerosols during simulated intubation of an airway manikin.

An aerosol nebuliser (Airlife Misty Max 10 Disposable Nebulizer, Carefusion, San Diego, CA, USA) introduced aerosolised saline into the trachea of an airway manikin to simulate passive breathing during intubation.[4] The particle concentrations ($\mu g\ m^{-3}$) of particulate matter with diameter <1 mm (PM_1), <2.5 mm ($PM_{2.5}$), and <10 mm (PM_{10}) were measured using a particle counter (Digital PM2.5 Air Quality Detector, Greekcrit, Banggood, Guangzhou, China).[4] One particle counter was placed 30 cm above the manikin's head and the other was positioned 60 cm above the manikin's head to approximate the height of the healthcare provider performing an aerosol-generating procedure using direct laryngoscopy or videolaryngoscopy. Measurements were taken every second for 5 min in the following sequence: (a) at time 0 min, the nebuliser was then activated for 3 min to simulate passive breathing during manual ventilation and intubation; (b) at time 3 min, the nebuliser was discontinued to simulate a secured airway; (c) measurements continued for an additional 2 min until particle concentrations reached baseline levels. The measurements were performed five times. The mean particle concentrations and their 95% confidence intervals are plotted (Fig. 1). All measurements were performed on a surgical bed at the centre of a standard operating room with laminar flow and an hourly air exchange rate of 27 with the door closed.

This study objectively measured and supports the assumption that increased distances decrease the particle concentrations for all particulate matter diameter sizes (PM_1, $PM_{2.5}$, and PM_{10}). However, this effect was limited to the first 30 s during an aerosol-generating procedure as seen in Figure 1. Beyond 30 s, the increased distance by 30 cm did not offer continued decreases in particle exposure. Particle concentrations became similar with multiple peaks between the two distances above the manikin's head. Although the mechanism of the observed multiple peaks is unclear, this may reflect the time required for redistribution and equilibration of aerosolised particles, especially those with smaller diameters, within the high dynamic airflow of a standard operating room. Because aerosolised SARS-CoV-2 droplets fall within two diameter sizes, between 0.25 μm and 1 μm and >2.5 μm,[5] we estimated the particle concentration of 'PM_{covid}' by summing the particle concentrations of PM_1 with the difference of PM_{10} minus $PM_{2.5}$. PM_{covid} mirrored the behaviour of the other particulate matter diameter sizes. Thus, although the benefit of decreased particle concentrations as a result of increased