Prioritising intubator safety in a pandemic: the details matter

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ABSTRACT
Our ED-intensive care unit has instituted a new protocol meant to maximise the safety of physicians, nurses and respiratory therapists involved with endotracheal intubation of patients known or suspected of being infected with the novel SARS-CoV-2. The level of detail involved with this checklist is a deviation from standard intubation practices and is likely unfamiliar to most emergency physicians. However, the two-person system used in our department removes the cognitive burden such complexity would otherwise demand and minimises the number of participants that would typically be exposed during endotracheal intubation. We share this checklist to demonstrate to other departments how adopting international airway guidelines to a specific institution can be achieved in order to promote healthcare worker safety.

INTRODUCTION
As one of the academic hospitals within the initial COVID-19 epicentre of the New York metro area, our ED has cared for many persons under investigation, with over 4400 patients subsequently confirmed to be infected with the novel SARS-CoV-2 virus by April 2020.1 Our hospital and departmental leadership quickly altered patient flow to avoid overwhelming the ED by opening a forward operating tent;2 but the critically ill are still being triaged directly to our resuscitation rooms, calling into question just how dangerous the procedure is regarding assembly of COVID-19 intubation packs. At the time of intubation, all other staff exit the room but stands at least six feet away from the patient. The ‘buddy’ wears an N95 respirator, face shield, gown and gloves. Other staff that are typically involved in the intubation (eg, respiratory therapy, nursing staff, additional physicians) are asked to wait outside the room with personal protective equipment (PPE) on so that they can assist with the procedure should the need arise or to enter immediately once the procedure is over. At our institution, the rooms either have a window or glass door to facilitate monitoring. In our experience so far, the presence of the buddy and the checklist has mitigated the threat cognitive overload that one would otherwise expect with one person being responsible for so many detailed tasks.

The detailed checklist is divided into multiple phases. The initial Supply Procurement phase is further simplified by our creation of COVID-19 intubation packs. These pre-made bundles reduce the time and stress needed to gather the essential items for protective preoxygenation and are readily accessible even for patients arriving emergently via emergency medical services. The pack includes all the supplies required to assemble our uniquely modified bag-valve mask (BVM) used for continuous positive airway pressure (CPAP) preoxygenation,3 as well as the equipment to secure the endotracheal tube and provide inline suction. Induction and neuromuscular blockade medications, push-dose vasopressors, our standard airway box and a portable video laryngoscope are also collected in this phase.

One of the key details emphasised in our strategy is the use of an inline viral filter for all methods of advanced ventilation (eg, non-invasive face mask, endotracheal tube or supraglottic airway). By ensuring that the viral filter is consistently present, only minimal virus is allowed to enter the room during exhalation regardless of device used.

The Out-of-Room Setup focuses on proper assembly of our modified BVM4 (figure 1 and video 1) so that it is immediately ready to be placed on the patient once the intubator enters the room. This setup is able to provide CPAP with single-use equipment that prevents a ventilator from contamination and avoids the threat of circuit disconnects. Modifications include attachment of the viral filter, appropriately sized CPAP mask, PEEP (peak end expiratory pressure) valve, endtidal carbon dioxide (ETCO2) sensor adaptor, multipurpose adaptor and secondary oxygen tubing. Given that this setup is unique and relatively complex compared with standard BVM configurations, the order of assembly is essential for reducing the expulsion of aerosolised virus. Simultaneous recitation of the steps minimises the potential for assembly error. Final PPE is donned at this time with

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DISCUSSION
This checklist is specifically designed for a two-person team with the primary intubator responsible for completing each task while all steps are recited aloud by a ‘buddy’ who has a physical copy of the checklist to reference during the entire procedure. This system is intended to remove the cognitive load of the intubator and ensure completion of all steps without jeopardising safety. At the time of intubation, all other staff exit the room while the ‘buddy’ remains in the

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Box 1: Steps for the in-room setup portion of the granular COVID-19 protected intubation checklist

**In-Room Setup**—Enter with ‘buddy’, who should stand 6 feet away from patient’s head until viral filter attached to endotracheal tube (ETT).

1. **Setup.**
   1. Put non-invasive positive pressure ventilation (NIPPV) mask with connected modified bag-valve mask (BVM) mask on the patient with viral filter (see figure 1).
   2. Attach bag-valve mask (BVM) oxygen tubing to wall at 20 lpm.
   3. Attach supplemental oxygen to wall at 6 lpm.
   4. Put procedure table on patient’s right side of the bed.
   5. Open airway box.
   6. Take out size 8.0 ETT, attach syringe, test cuff and place on table.
   7. Take out scalpel and laryngeal mask airway (LMA) and place on table.
   8. Close box and remove it from table.
   9. Remove video laryngoscopy (VL), turn on, place on table.
   10. Open bougie and place on table.
   11. Place inline suction set-up on table.
   12. Place BVM mask on table.
   13. Setup endotracheal tube attachment device (ETTAD) by removing the three stickers and fix straps, place on table.
   14. Check wall suction setup and place Yankauers on upper right corner of bed.
   15. Attach end tidal carbon dioxide tubing to monitor.
   16. Position patient (ears to sternal line, face parallel to ceiling).
   17. Ensure vascular access.

the intubator ideally using a powered air purifying respiratory.

Rightfully, there is some concern over the use of improvised or ‘MacGyvered’ medical devices. While such healthy scepticism is always fair, our example exists to fill a niche need for protective preoxygenation while preserving resources at risk for depletion in the pandemic setting. Our improvised BVM allows for the rapid creation of a closed system device to preoxygenate a patient without requiring a ventilator. During apnoea, this device cannot provide PEEP without being pressurised by a secondary oxygen source and this is why the ETCO2 adaptor is initially pressurised by a secondary oxygen source device cannot provide PEEP without being requiring a ventilator. During apnoea, this device to preoxygenate a patient without allows for the rapid creation of a closed system preserving resources at risk for depletion in need for protective preoxygenation while always fair, our example exists to fill a niche need for protective preoxygenation while always fair, our example exists to fill a niche need for protective preoxygenation while always fair, our example exists to fill a niche need for protective preoxygenation while.

Importantly, the operator must practice assembling this device prior to using it clinically, ideally to the point of mastery. This device allows apnoeic CPAP without having to ventilate the patient after paralysis.

After entry, the In-Room Setup steps continue to be recited by the ‘buddy’ while the intubator connects the patient and oxygen sources to the modified BVM and initiates CPAP preoxygenation. Intubation equipment is prepared in the usual fashion and special care is taken to ensure that a tube securement device and inline suction is laid out in anticipation for connection to a ventilator either by the physician or respiratory therapist. Induction proceeds similarly to our prepandemic approach but specifies ketamine and a high-dose rocuronium use to optimise safety. Ensuring complete paralysis theoretically further reduces the risk of coughing-induced viral transmission and augments first-pass success. No breaths are administered during the apneic period unless there is patient desaturation. Intubation is optimised by the use of a portable video laryngoscopy and a flexible bougie. Contingencies for failed intubation include standard supraglottic airway and surgical airway. The checklist also includes a step-by-step Doffing section because of the known risk of self-contamination, especially when using unfamiliar PPE.

Our checklist is not the only strategy developed during this pandemic to promote intubator safety. For example, ‘aerosol boxes’ are theorised to minimise viral spread during intubation, but studies suggest they do not. Any benefit can be offset by the use of proper PPE. Additionally, a recent investigation into the practicality of these devices found decreased first pass success, damage to PPE, delays in intubation, increased provider discomfort while checklists have a strong record of efficiency and success, particularly in acute care medicine.

Our institution had approximately 1 week of lead time prior to the surge. During the lead-up to the surge, this checklist was developed and revised by the emergency department critical care division and several practice-runs were performed, during which time edits were made. Feedback was also solicited both online and in the department. The beauty of the detailed protocol is that it allows for precise modification based on issues encountered in its use. For example, the initial iteration of the modified BVM used a standard nasal cannula under the mask to provide enough pressurisation for PEEP. However, concerns of airborne virus leaking next to the nasal cannula was taken seriously.
and the multipurpose adaptor and supplemental oxygen tubing was added instead. In the early days of use, the checklist called for the video screen of the laryngoscope to be wrapped in disposable bag. Overheating of the screen resulted in several unanticipated shutdowns of the monitor and the plastic bag step was abandoned.

Once distributed, there was either an ED-intensive care unit (ICU) attending or a resuscitation fellow familiar with this protocol available clinically every hour except for the early mornings. Instructional videos were shared with all attendings and residents via our internal website as rapidly deployed in-service training. Fortunately, our department has used airway checklists prior to every intubation for over 5 years, and this cultural precedence facilitated the adoption of the COVID-19-specific checklist among our physicians and nurses.

**LIMITATIONS**

One limitation of our strategy is that it does increase time to intubation. While the checklist times have not been recorded, it can be over 10 min at times as seen in video 1. This time was shortened during the surge by having all components of the protected intubation prepared ahead of time and placed back into the bag. This reduced the intubation time to solely that of donning PPE. During the donning period, another staff member was able to place the non-invasive mask and BPM set-up on the patient while the intubator was donning PPE. The additional delay to don PPE is an acceptable cost for maximal operator safety. While nothing substitutes intensive training, using the specificity of the checklist allows for adoption of the unfamiliar procedure. None of our 20 physician intubators have fallen ill since the onset of the pandemic and no one has missed any clinical time. The greatest difference between our department and others comes in the form of our ED-ICU. This unit uses a smaller and specific cadre of physicians and nurses who routinely and uniformly adhere to departmental policies deemed to be best practices specific to critical care, even when rapidly deployed. This makes educating staff a manageable task. However, we feel this could be achieved at institutions that do not have an ED-ICU by ensuring education of the physician and nursing leadership before disseminating to the staff at large. Ultimately, we feel that this checklist and setup is broadly applicable throughout a variety of departments and hospitals worldwide because it is inherently adaptable given its granularity.

**CONCLUSION**

The granular COVID-19 protected intubation checklist prioritises staff safety by emphasising conscientious attention to detail and largely follows recommendations from the Safe Airway Society.8 The ‘buddy’ system we employ allows us to benefit from the increase in detail while mitigating the downside of increased cognitive load. In submitting this checklist, we are assuming that other departments will face similar obstacles when additional COVID-19 surges occur.

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**Contributors**

Outlining, manuscript composition and revisions were provided by RNBN. AB, AD and SW provided significant manuscript editing. SW developed initial protocol for protected intubations to be used in our ED and oversaw manuscript development. BZ and SW created videos and images.

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