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Use of A New Inexpensive Powered Air-Purifying Device in Facilitating Safe Performance of Tracheostomy in COVID-19 Patients

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ABSTRACT

Purpose: This retrospective cohort study describes use of novel PPE and technique to facilitate safe performance of tracheostomy in 9 patients requiring mechanical ventilation in a COVID-19 designated ICU.

Materials and methods: Standard personal protective equipment - including double gloves, full body overall with hood, shoe covers, a single-use N95 mask and a face shield -was employed by all team members. In addition, a single use low cost powered air-purifying respirator (PAPR) was developed in order to increase safety, visibility, and comfort. This device was worn in addition to standard PPE, covered the entire head and upper torso and employed a belt-worn pump delivering approximately 150 l/min air via a viral filter to the user.

Tracheostomy was performed by a 3-person otolaryngologist and critical care physician team using video laryngoscopy and a single stage dilation percutaneous tracheostomy kit. Mechanical ventilation was paused from after wire passage until dilation and placement of the tracheostomy tube.

Results: No blood oxygen desaturation or other complications were noted during or after the procedure, with no procedure related mortality. No team members subsequently developed COVID-19.

Conclusions: Using novel PPE tracheostomy can be performed safely for both patient and staff despite active COVID-19 infection.

Keywords: COVID-19; Tracheostomy; Powered air-purifying respirator; PAPR; Ventilator weaning

INTRODUCTION

Risk factors for severe COVID-19 (particularly obesity) also represent risk factors for failed ventilator weaning and airway management difficulties.[1] International guidelines have suggested deferring tracheostomy in COVID-19 patients until infectivity is reduced as shown by two negative PCR swabs.[2] However, in our institution, four extubation failures early during the COVID-19 epidemic in patients who had been successfully

weaned according to ventilator parameters were attributed to upper airway issues and muscle weakness. We therefore elected to perform tracheostomy without waiting for negative COVID-19 PCR tests. As such, concerns for effective infection control and staff protection were raised.

METHODS

This retrospective cohort study included mechanically ventilated patients hospitalized in the COVID-ICU (C-ICU) at the Shaare Zedek Medical Center, Jerusalem, Israel. Data analysis and publication were approved by the Shaare Zedek Medical Center Institutional Review Board with waiver of informed consent (REF# 18820).

RESULTS

Overall 19 patients required mechanical ventilation. Of these, 2/19 died prior to weaning, 8/19 were weaned successfully, 3 failed extubation (one patient twice) and 9/19 underwent tracheostomy, including 3 with a body mass index (BMI) > 30. Indications for tracheostomy were failed extubation (n=3), weakness (n=2) and prolonged reduced consciousness (n=4). Patients were intubated for a median of 25 days (interquartile range [IQR]: 15-28) prior to tracheostomy. Informed consent from a court designated guardian was obtained prior to the procedure.

Tracheostomy was performed by a critical care physician and otolaryngologist. Anesthesia and management of the endotracheal tube were implemented by a critical care team physician.

Standard personal protective equipment (PPE - including double gloves, full body overall with hood, shoe covers, a single-use N95 mask and a face shield) was employed by all team members. In addition to the standard PPE, a single use low cost powered air-purifying respirator (PAPR) was developed and used (Figure 1). Unlike many standard PAPR, this device covers the entire head and upper torso and allows the wearer to don standard PPE under the device. A belt-worn device pumps approximately 150 l/min air via a viral filter to the user, increasing safety, visibility, and comfort. Hospital safety protocol dictated that PPE, including gloves, were not to be removed inside C-ICU. As such, sterilization of gloves donned prior to entry into the C-ICU was accomplished using a 70% ethanol solution and a sterile gown and gloves were donned on top of PPE (Figure 2). Sterilization of patient skin was obtained with a chlorhexidine-alcohol solution.

Figure 1: Single use low cost powered air-purifying respirator (PAPR) developed and used for airway procedures in the COVID-19 intensive care unit.

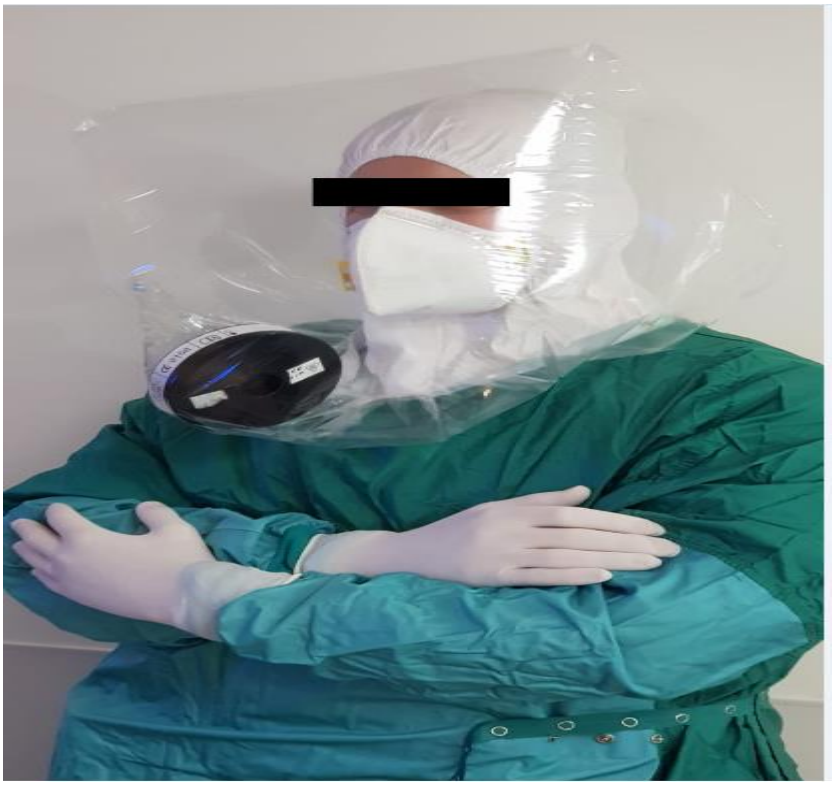

Figure 2: Single use low cost powered air-purifying respirator (PAPR) with sterile gown for performance of sterile procedures including tracheostomy.

Following pharmaceutical paralysis and pre-oxygenation, the endotracheal tube was withdrawn until cuff visualization in the pharynx using video-laryngoscopy. Neither direct laryngoscopy nor bronchoscopy were utilized. Tracheostomy was performed using a single stage dilation percutaneous tracheostomy kit (Smiths Medical, Minneapolis, MN, USA). Following tracheal puncture and passage of the wire, mechanical ventilation was paused until dilation and placement of the tracheostomy tube was completed and the cuff inflated. Only then was mechanical ventilation resumed via the tracheostomy and placement confirmed via standard techniques. This stage took less than 120 seconds and was not associated with a decrease in blood oxygen saturation.

Currently, all extubated patients have been discharged from the hospital. Of the tracheostomy patients (median follow-up from admission 42 days [IQR: 33-54]), three have been discharged after removal of their tracheostomy tubes, an additional three patients have undergone decannulation but remain hospitalized, one remains ventilated and two have died (due to causes unrelated to tracheostomy).

All tracheostomy patients were COVID-19 positive via PCR swab at the time of their surgery. No clinical or laboratory evidence of COVID-19 infection was detected in the participating personnel.

DISCUSSION

Tracheostomy is sometimes necessary for airway management in the critically ill; however, it may be an aerosol spreading procedure. As such, performing this procedure in COVID-19 patients has unique aspects: [3]

1) Futility. Due to high mortality in ventilated COVID-19 patients, [4] concerns of futility have been raised. [5] We performed tracheostomies after median 25 days (IQR 15-28) ventilation. There was no procedure-related mortality, and 6/9 (67%) have been successfully weaned.

2) Infectious risk. It has been suggested that percutaneous tracheostomy may aerosolize viruses. To reduce this risk, we employed novel advanced PPE, refrained from bronchoscopy, and ceased ventilation from tracheal puncture until inflation of the tracheostomy balloon cuff. All tracheostomies succeeded without complication and none of the team developed signs of COVID-19 infection.

3) Technique. It has been suggested that open technique should be used in patients with BMI>30. Percutaneous tracheostomy was performed in three patients with high BMI without complication.

This cohort demonstrates that tracheostomy can be performed safely for both patient and staff despite active COVID-19 infection with good results.

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