## Weaning by Surgical Tracheostomy and Portable Ventilators Released ICU Ventilators During Coronavirus Disease 2019 Surge in London

### To the Editor:

In March 2020, London experienced a surge in critically ill patients requiring mechanical ventilation due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection (coronavirus disease 2019 [COVID-19]). Given a finite number of ICU beds at our institution, we were forced to modify our conventional weaning approach. The aim was to increase ICU capacity, in order to meet the need for more venovenous extracorporeal membrane oxygenation (ECMO), for which our hospital the Brompton is the largest U.K. severe acute respiratory failure regional center. Since recovery from COVID-19-related acute respiratory distress syndrome (ARDS) is in the order of weeks (1), we considered a surgical tracheostomy and portable ventilator-tracheostomy weaning strategy and protocol on the basis that it would expedite step down of patients to a non-ICU level 2 (high dependency) care.

Normally, surgical tracheostomy accounts for a minority of tracheostomies and is performed in the operating room mainly in patients unsuitable for percutaneous tracheostomy (2). However, survival outcomes for both percutaneous and surgical approaches are similar (2, 3). During the pandemic, our practice moved toward a surgical approach influenced by existing expertise in head and neck, thoracic surgery (which had experienced a marked reduction in elective activity), the risk of aerosol generation by bedside percutaneous tracheostomy, and the high workload of critical care physicians. Importantly, our institution also had existing multidisciplinary experience in tracheostomy management, respiratory weaning, and management of long-term domiciliary tracheostomy ventilation.

Here we report the results of that integrated service during the first wave of the COVID-19 pandemic in London. Although not a clinical trial, we compared our data with those obtained using a conventional approach at our neighboring hospital, Chelsea and Westminster hospital, which has a general ICU, to provide context. At the Brompton Hospital, eligible patients who failed conventional readiness-for-extubation criteria underwent surgical tracheostomy.

Thereafter, patients were transferred onto portable, tracheostomy-licensed ventilators (Trilogy 100; Phillips Healthcare, Phillips Centre, Guildford, United Kingdom; or NIPPY3+; Breas Medical Ltd, Warwickshire, United Kingdom), that do not require a combined air/oxygen medical gas supply. Once stable on a portable ventilator, patients were stepped down to a high dependency unit for ongoing respiratory weaning (tracheostomy-portable ventilator weaning [TW] group). At the Chelsea and Westminster hospital, such patients received a standard weaning (SW) strategy in the ICU using an ICU ventilator (Drager XL; Dräger Medical UK Ltd, Hemel Hempstead, Herts, United Kingdom) until liberation from mechanical ventilation occurred (SW group) (4).

In total, 52 patients with reverse transcriptase-quantitative polymerase chain reaction confirmed SARS-CoV-2 associated ARDS who were mechanically ventilated on ICU for over 7 days, received a tracheostomy between March 24, 2020, and May 11, 2020. Of those, 47 required ongoing respiratory support. Thirty-two patients underwent TW and 15 patients SW. The overall age (mean, SD, range) was 55.7, 9.5, 29–77 years. There was a male predominance of 82.4%. Two of the TW group and none of the SW group received prior venovenous ECMO. Sequential Organ Failure Assessment scores (mean, SD) were similar between the TW group 9.9, 2.9 days and SW 10.1, 2.0 days ($p$ = not significant [NS]). ICU ventilator days prior to tracheostomy were (mean, SD, and range) 19.9, 9, 10–35 for the TW group and 17.3, 4.4, 14–26 SW ($p$ = NS). Patients required an ICU ventilator following tracheostomy (mean, range) 3, 1–6.5 days in the TW group (prior to full establishment on portable ventilator) and 10, 6.25–17 days in the SW group ($p$ < 0.05). Time from tracheostomy to decannulation (mean, SD, and range) was 12.47, 6.2, 4–27 overall; 12.68, 6.8, 4–27 TW, 12, 4.75, 5–22 SW ($p$ = NS). All but four patients in the TW group were decannulated, three patients in the SW remained ventilated at census day. ICU ventilator days saved per patient (median, range) in the TW group was 8.5, 3–21 compared with 0 in the SW group. This amounted to 32 ICU ventilators released and 230 ICU ventilator days saved (Table 1). One patient died in SW group unrelated to the tracheostomy. There were two replacement tracheostomies within 1 day, no procedure-related mortality, one early cuff leak, and three periprocedural desaturations. Two surgical wound site skin ulcers were recorded. One healthcare infection of a staff member involved in the TW weaning pathway was reported in the context of widespread staff sickness.

This was not a randomized clinical trial. The weaning strategy at the Brompton Hospital was necessitated by a clinical imperative to create ICU beds, and for this reason, ethical committee approval was not sought. When the first surge of the pandemic receded, both groups were assessed separately and compared as a service evaluation of safety and efficacy for this novel pathway. Consequently, these data have limitations, including the lack of case matching of patients, an absence of a baseline control group of patients without tracheostomy, and reduced availability of high

**TABLE 1. Comparison of Standard Weaning and Tracheostomy-Portable Ventilator Weaning: Demographics and Outcomes**

| Demographics/Outcomes | Standard Wean at Chelsea and Westminster (n = 15) | Tracheostomy-Portable Ventilator Wean at Royal Brompton (n = 32) |
|---|---|---|
| Age, mean (SD) | 53.7 (5.4) | 56.7 (10.9) |
| Male sex, n (%) | 12 (81.3) | 25 (80.0) |
| Admission ICU Sequential Organ Failure Assessment score, mean (SD) | 9.9 (2.9) | 10.1 (2.05) |
| Venovenous extracorporeal membrane oxygenation, n (%) | 0 | 2 (6.5) |
| Intubation-tracheostomy days, median (IQR) | 17 (14–21) | 18 (14–24) |
| Tracheostomy-decannulation days, median (IQR) | 12 (9–14) | 12 (7–18) |
| Tracheostomy-ICU ventilator duration days, median (IQR) | 10 (6.25–17) | 3 (1–6.5) |
| ICU ventilator days saved, median (IQR) | 0 | 8.5 (3–21) |

IQR = interquartile range.

flow nasal oxygen/noninvasive ventilation as weaning strategies due to perceived aerosol generating risks.

Despite these limitations, we believe liberation of 32 ventilators, a median of 8.5 per patient, and 230 ICU ventilator days, during a healthcare emergency where critical care capacity was severely limited, is an example of effective implementation of a novel strategy with future implications for critical care weaning.

Challenges in embedding the new service swiftly, while maintaining recommended safety standards of tracheostomy care, necessitated a robust, coordinated yet flexible safety, training, and education program for multidisciplinary staff (5). This integrated model of surgical tracheostomy weaning of respiratory critical care patients by a specialist mobile weaning team, using tracheostomy-licensed ventilators, appears safe, effective and may be transferrable to other healthcare systems where ICU resource limitation is a reality during this pandemic. It addresses a specific aspect, not highlighted in current best practice guidelines, that is, in liberating resources effectively (6).

The authors have disclosed that they do not have any potential conflicts of interest.

**Suveer Singh, MD, PhD,** Critical Care and Respiratory Medicine, Royal Brompton Hospital, Imperial College, London, United Kingdom; **Matthew Hind, MD, PhD,** Respiratory Medicine, Royal Brompton Hospital, Imperial College, London, United Kingdom; **Simon Jordan, MD, FRCS,** Thoracic Surgery, Royal Brompton Hospital, Imperial College, London, United Kingdom; **Patrick Ward, MD, FRCA,** Anesthesia, Chelsea & Westminster Hospital, London, United Kingdom; **Deborah Field, MSc, RGN**; **Michael Polkey, MD, PhD,** Respiratory Medicine, Royal Brompton Hospital, Imperial College, London, United Kingdom; **Jonathan Collier, PhD, FRCS,** Craniomaxillofacial Surgery, Chelsea & Westminster Hospital, Imperial College, London, United Kingdom; for the Brompton-Chelsea Covid-19 tracheostomy consortium

## REFERENCES

1. Zhou F, Yu T, Du R, et al: Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective cohort study. *Lancet* 2020; 395:1054–1062
2. Putensen C, Theuerkauf N, Guenther U, et al: Percutaneous and surgical tracheostomy in critically ill adult patients: A meta-analysis. *Crit Care* 2014; 18:544
3. Young D, Harrison DA, Cuthbertson BH, et al; TracMan Collaborators: Effect of early vs late tracheostomy placement on survival in patients receiving mechanical ventilation: The TracMan randomized trial. *JAMA* 2013; 309:2121–2129
4. Hosokawa K, Nishimura M, Egi M, et al: Timing of tracheotomy in ICU patients: A systematic review of randomized controlled trials. *Crit Care* 2015; 19:424
5. Wilkinson KA, Freeth H, Martin IC: Are we 'on the right trach?' The National Confidential Enquiry into Patient Outcome and Death examines tracheostomy care. *J Laryngol Otol* 2015; 129:212–216
6. McGrath BA, Brenner MJ, Warrillow SJ, et al: Tracheostomy in the COVID-19 era: Global and multidisciplinary guidance. *Lancet Respir Med* 2020; 8:717–725

## APPENDIX

The Brompton-Chelsea Covid-19 tracheostomy consortium: **Jonathan Collier, PhD, FRCS; Deborah Field, BSc, MA, RN; Simon Jordan, MD, FRCS; Matthew Hind, MD, PhD; Michael Polkey, MD, PhD; Suveer Singh, MD, PhD; Patrick Ward, MD, FRCA; Katherine Fogg, MD, FRCA; Arshad Ghori, MD, FRCA; Alkaterina Vlachou, MD, FRCA; Eric Lim, MD, FRCS; Aleksander Mani, MD, FRCS; Hilgardt Raubenheimer, MD, FRCS; Robert Pilling, MD, FRCA; Seth Galton, MD, FRCA; Andrzej Jandziol, MD, FRCA; Declan Collins, MS, FRCS; Jorge Leon-Villapolas, MS, FRCS; James Smellie, MD, FRCS; Jacqueline Durbridge, MD, FRCA; Peter Brooks, MD, FRCA; John Thornton, MD, FRCA; Gabriella Frunza, MD, FRCA; Robert Pilling, MD, FRCA; Isobel Jones, MS, FRCS; Joanne Atkins, MS, FRCS; Christopher Abela, MS, FRCS; Simon Eccles, MS, FRCS; Andrew Williams, MS, FRCS; Marcela Vizcaychipi, MD, PhD; Richard Keays, MD, FRCA, FRCP; Michelle Hayes, MD, FRCA; Linsey Christie, MD, FRCA; Alice Sissons, MD, FRCA; Christopher Lockie, MD, FRCA; Roger Davies, MD, FRCA; Elaine Manderson, MSc, RN; Lorraine Campbell, RN; Phil Molyneux, MD, PhD; Anita Simonds, MD, FRCP; Alana Hare, MD, FRCP; Elaine Pneh, MSc, RGN; Kate Good, MD, FRCA; Susanna Price, MD, PhD; Stephane Ledot, MD, FRCA; Maurizio Passariello, MD, FRCA;**

James Doyle, MD, FCICM; Tina Xu, MD, PhD; Brijesh Patel, MD, PhD; Christine Weaver, MD, FRCP; Benjamin Garfield, MD, PhD; Louit Thakuria, MD, PhD; Paolo Bianci, MD, FRCA; Shahana Uddin, MD, FRCA; Lisa Greaney, MS, FRCS; Nikki Zimbletta, MD, FRCA; Thomas Pickworth, MD, FRCA; David Alexander, MD, FRCA; Mary Lane, MD, FRCA; Giullia Crapelli, MD; Brian Keogh, MD, FRCA; TC Aw, MD, FRCA; Amira Elkhatteb, MD, FRCA; Sarah Trenfield, MD, FRCA; Lisa Newell; Noel Lee ; Andrew Snell ; Gary Davies , MD, FRCP; Kris Pillay, MD, MRCP; Olivera Potparic, FRCA; Darryl Dob, MD, FRCA; Steve Yentis, MD, FRCA; Ian Naldrett, MSc, RN; Rosie Cervera-Jackson, MSc, RN; Christine Ee, MSc, RN; Jo Tilman, MSc, RN; and Anoma Gunawardena, MSc, RN.