

The Kelley Circuit: A solution for the management of in-hospital self-ventilating tracheostomy patients, providing humidification and filtration, with closed-circuit suctioning.

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Introduction

Several professional organisations have issued guidance (1, 2) for the management of tracheostomised patients as a response to the COVID-19 outbreak, and the risk of aerosol generating procedures (AGPs) in this patient group. Protection for potential aerosol contamination of patients as well as staff must be optimised.

Therefore, the use of closed suction is recommended but this is currently only utilised with the ventilated patient.

The Kelley Circuit provides humidification and electrostatic filtration, in a closed system and addresses the following:

- Humidification and filtration upon inspiration (protection for patient)
- Filtration upon expiration (protection for the healthcare professional)
- Closed – circuit suctioning in a non-ventilated patient group (protection for patient and health care professional)

The Kelley Circuit

The Kelley Circuit (Figure 1) combines the ProTrach® XtraCare™ HME with electrostatic filter (3) with a closed-circuit suction system (4, 5).

Watch instructional video here:

<https://youtu.be/PGd5-VhLXcE>

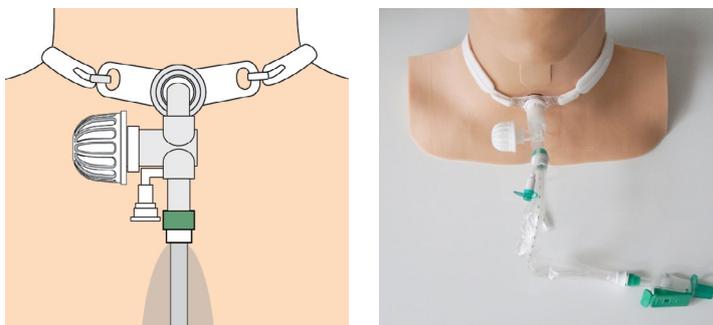


Figure 1. The Kelley Circuit with a closed circuit suction system attached to the ISO 15 hub of the tracheostomy tube and the ProTrach XtraCare attached to the ventilator hub on the side.

ProTrach® XtraCare™ Device information and Technical Data

The ProTrach® XtraCare™ HME combines a Heat and Moisture Exchanger (HME) with an electrostatic filter for self-ventilating patients. The device has an optional O2 adaptor attachment.

The integrated electrostatic filter provides filtration irrespective of the direction of the airflow and therefore provides the patient with humidification and filtration upon inspiration whilst also protecting others around them during expiration. Bacterial and Viral Filtration Efficiency is >99% (6, 7).



Figure 2. ProTrach® XtraCare™ HME, shown with and without O2 Adaptor

Table 1. Technical data Provox® XtraCare™ (from Instructions for Use)

Dead space	5.5 ml
Pressure drop* after 30 min at	
• 15 l/min	41 Pa
• 30 l/min	86 Pa
• 60 l/min	189 Pa
Pressure drop* after 24 h at	
• 15 l/min	44 Pa
• 30 l/min	93 Pa
• 60 l/min	204 Pa
Moisture loss* at	
• VT=250 ml	12.4 mg/l
• VT=1000 ml	19.3 mg/l
Filtration efficiency**	
• Virus (VFE)	>99.0%
• Bacteria (BFE)	>99.0%
• Particles (PFE) 0.1 µm	>99.0%

* According to ISO 9360

**According to ASSTF F2100

Observations thus far

In the first instance, we selected four tracheotomised patients that had not tested positive for COVID-19. All were able to self-ventilate requiring various levels of supplemental oxygen. Prior to using this new setup, two patients were on supplemental O₂ via Opti-Flow™ at 30l/min, one was on supplemental O₂ via Opti-Flow™ at 20 l/min, and one was on pressure support ventilation 8/5 and undergoing weaning trials. (See Appendix for further clinical data.)

Findings were as follows:

- No significant change in respiratory rate
- Two patients subjectively exhibited a reduction in sputum production and number of tracheal suctionings required in 24 hours
- No change in secretion viscosity
- Increase in dead space did not compromise respiratory wean
- Positive clinician experience, easy to use within current skill set, reduced staff anxiety during suctioning procedure and when caring for the patient.

Conclusion and ongoing recommendations

In conclusion, the Kelley Circuit appears to be a feasible solution for in-hospital management of self-ventilating tracheostomy patients amidst the COVID-19 outbreak. Following our provisional evaluation, we plan to extend this practice to the ward based tracheostomy cohort with a view to not only protect a vulnerable patient group, but also reduce the associated risk of AGPs.

In this clinical application, it was found beneficial to exchange the ProTrach® XtraCare™:

- Every 12 hours
- When work of breathing increased as a result of mucus or moisture in the device, indicated by increased expiratory noise
- At regular intervals, for example at the beginning or end of a shift
- At least once every 24 hours (manufacturers guidance)

Manufacturers recommendations were followed regarding replacement of the closed suction system every 24 hours.

References

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Disclaimer

- Clinicians reading this message should make independent, informed decisions about the care of their patients based on the individual condition and circumstances of each case.

Appendix**Case study 1. Male. 81 y/o.**

History of chronic renal failure; dialysis complications resulting in right MCA stroke in December 2019, with low GCS and intubation for respiratory failure. Ventilator acquired pneumonia with resulting tracheostomy. Weaned from vent 6 weeks ago.

	On OptiFlow™ with Tracheostomy interface 30l/min	On ProTrach® XtraCare™ HME after 3 days
Average daily RR	11-14 bpm	9-15 bpm
Average daily FiO2	28%	21%
Average daily sputum production	Moderate sputum production on 6 suction over 24 hours	Minimal sputum production on 3 suction over 24 hours

Case study 2. Male. 67 y/o.

Admitted to hospital in October 2019 with reduced levels of consciousness, confusion and generalised weakness. Intubated due to worsening renal failure, low GCS and unprotected airway. Tracheotomy performed 4 weeks ago and weaned to tracheostomy mask 1 week prior.

	On OptiFlow™ with Tracheostomy interface 30l/min	On ProTrach® XtraCare™ HME after 3 days
Average daily RR	16-22 bpm	20-24 bpm
Average daily FiO2	24%	21%
Average daily sputum production	Moderate sputum production on 10 suction over 24 hours	Moderate sputum production on 6 suction over 24 hours

Case study 3. Male. 51 y/o.

Cerebral vascular accident in August 2019 resulting in global weakness. Tracheotomy performed in August 2019. On ICU for long term ventilator wean.

	On OptiFlow™ with Tracheostomy interface 20l/min	On ProTrach® XtraCare™ HME after 3 days
Average daily RR	23-25 bpm	22-24 bpm
Average daily FiO2	30%	21%
Average daily sputum production	Minimal to moderate sputum production on 8 suction over 24 hours	Minimal to moderate sputum production on 7 suction over 24 hours

Case study 4. Male. 90 y/o.

Admitted for abdominal surgery, multiorgan failure post surgically – tracheostomised for ventilator wean.

	Ventilated – PS 8, PEEP 5	On ProTrach® XtraCare™ HME during weaning from ventilator on first 6-hour trial
Average daily RR	15-18 bpm	12-13 bpm
Average daily FiO2	21%	21%
Average daily sputum production	Copious sputum production on suction over 6 hours (number of suction not documented)	Copious sputum production on 2 suction over 6 hours