



## How to care for the chronic tracheostomy ventilated individual and transitioning from ICU to home

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### SILOS CAN STILL EXIST IN A “TRACHEOSTOMY TEAM”

The following is a hypothetical scenario which unfortunately does occur in real life. A surgeon (or intensivist) inserts the tracheostomy. The respiratory therapist manages the ventilation. The physiotherapist handles “complex secretion management” with the mechanical insufflation-exsufflation device. The nurse performs stoma care and “simple” tracheal suctioning. Vocalization and swallowing are under the purview of the speech and language therapist.

All look to the physician (an internist or neurologist) for direction – for cuff deflation, for downsizing the tube – but receive none because the physician has not received formal training on tracheostomy management.

The poor patient continues to use a large tracheostomy with an inflated cuff and remains mute and “Nil per Os” several months after the initial tracheostomy insertion.

CASE 1

Lawrence is a fifty-year-old gentleman recuperating from a severe bacterial pneumonia, on a background of previous right lower lobe resection for malignancy. He has been intubated for nineteen days and has just been tracheostomized. He is still completely ventilator dependent. He is not in shock, and renal function is normal. He has indicated that he would like to be discharged home and he intends to undertake his rehabilitation at home. Is that possible?

CASE 2

Mary is a feisty thirty-year-old lady who sustained a C2-C3 cervical cord injury during an Equestrian competition. She has also been tracheostomized but would like to be free of the “tube” so that she can “get on with living”. How would you help her? At home? Is that possible?

CASE 3

Jonathan is a lecturer with bulbar onset motor neuron disease. He caught COVID and required intubation and has just been tracheostomized. He would like to find out if he could live well with his tracheostomy.

The patient is ostensibly receiving multi-disciplinary care, but in reality, the team members operate within their narrow professional silos. To avoid this tragic state of affairs, transdisciplinary training and good team communication is essential. In particular, the team leader (usually the physician) needs to understand all the intricacies of tracheostomy management.

## CONSIDERATIONS

Patients who have received a tracheostomy invariably ask if they can be decannulated. The three examples illustrate the heterogeneity of conditions leading to people who end up receiving tracheostomies. The following considerations in Box 1 will help determine if decannulation is a feasible goal.

### Box 1

- Is the upper airway function intact? This is arguably the most important determinant of the need for a tracheostomy. Assessing the articulation of speech, severity of sialorrhoea and the extent of swallowing impairment prior to the events leading up to tracheostomy is helpful. An individual with severely and permanently impaired upper airway function will likely need the tracheostomy permanently.
- Is continuous ventilatory support likely to be necessary? Some centres have reported excellent outcomes in Continuous Noninvasive Ventilatory Support (CNIVS) using a variety of ventilatory interfaces as well as noninvasive secretion management. However, the ventilator user and the care team surrounding the ventilator user must be skillful in all aspects of noninvasive ventilatory support and airway clearance for this to work. In practice, such patients may occasionally need intubation and even tracheostomy transiently if the person needs surgery, or has a major but reversible deterioration. However, he/she can be extubated or decannulated to CNIVS when stable, provided the healthcare teams looking after such a ventilator user are skilled in these techniques.

## PRIORITIES

Assuming that the ventilator user will be ventilated via the tracheostomy for the short to medium term, our preference is to equally prioritise periods of ventilator free breathing (for the purpose of working towards ventilator liberation) AND restoring speech and swallow if this is possible. Even if Alternative and Augmentative Communication (AAC) tools are available and possible, verbal speech is usually faster, more convenient, and hence most likely to optimize autonomy and quality of life of the ventilator user.

## RESTORATION OF SPEECH AND SWALLOW

Restoration of speech and swallow offers important physiological and psychological benefits and should be a top priority for most tracheostomized patients. The only exceptions are for people with pre-existing severe speech and swallowing impairment from neurological disorders.

Verbal speech is possible if there is airflow through the vocal cords. This can be done in three ways:

- 1 Cuff deflation to allow air leak from the ventilator circuit, with or without the use of the speaking valve.
- 2 Finger occlusion, speaking valve or tracheostomy cap use with cuff deflation/ cuffless tracheostomies in individuals breathing without assistance
- 3 Above cuff vocalization using insufflation of medical air or oxygen via a tube into an outlet above the cuff for individuals who cannot tolerate cuff deflation.

Individuals may tolerate cuff deflation poorly for several reasons. Patients with high respiratory system impedance (from stiff lungs or severe chest wall restriction) would experience increased leak if with a cuff-less or cuff deflated tracheostomy, and hence may suffer from inadequate ventilation, manifested as dyspnea, hypercapnia or hypoxaemia (Figure 1). We like to use volume targeted pressure modes for these patients. The variable inspiratory pressure targeting a reasonable tidal volume removes the need for a dual prescription.

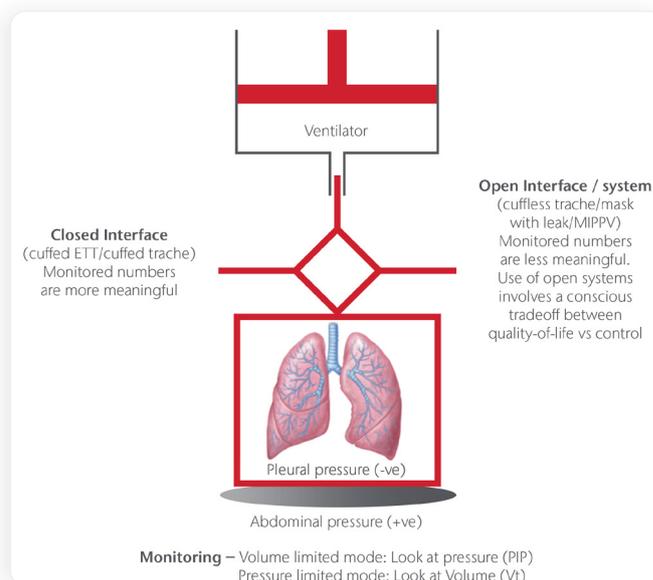


Figure 1 illustrates the interplay of leak, lung and chest wall compliance in an open versus a closed system and highlights what to monitor.

Some patients dislike the sensation of air jetting up into their upper airway. We generally utilize progressive deflation – partial deflation (cuff pressure at 5 to 10 cm H<sub>2</sub>O) for short periods (5 minutes initially, and slowly extending to 30 minutes) progressing to full deflation for prolonged periods (hours). It is important to thoroughly clear tracheal and oral secretions when initially performing cuff deflation for leak speech.

Above cuff vocalization (ACV) involves the application of oxygen or medical air at flows of up to 7L/min via an above-cuff port. This allows vocalization for individuals who cannot tolerate cuff deflation. Unfortunately, our team does not have extensive experience with this technique.

Restoration of airflow past the vocal cords is helpful for restoring sensation and function of the vocal cords. A positive subglottic pressure also decreases the risk of aspiration of oral contents. Finally, deflation of the cuff improves the patency of the upper oesophageal junction. As such, interventions to improve speech also help with swallowing function.

## Choosing the appropriate “next” tracheostomy

Going back to our cases Lawrence, Mary and Jonathan, the three persons introduced at the beginning of this article. Lawrence and Mary both should have relatively or completely intact bulbar function, and so could potentially be decannulated to non-invasive ventilation. On the other hand, Jonathan would likely need a permanent tracheostomy or even a laryngectomy, given his bulbar onset ALS complicated now by COVID pneumonia.

The usual steps to decannulation would involve:

- 1 Cuff deflation and restoration of airflow to the upper airway
- 2 Downsizing
- 3 Switching to a cuffless tracheostomy, this could happen simultaneously with step 2
- 4 Capping trials with or without concurrent non-invasive ventilation trials
- 5 Decannulation

A recent Spanish trial showed success decannulating ICU patients after a period of ventilator free breathing facilitated with high flow humidified oxygen (Martinex G H et al. *N Engl J Med*, 2020).

Many intensivists are concerned about the risk of pulmonary aspiration with downsizing. This has been covered in the discussion above about restoration of speech and swallow. Many are also concerned about “increased work of breathing” when we switch to a tracheostomy tube of smaller diameter. This concerns merits a little more discussion.

It is true that under laminar flow conditions, the airway resistance in a tube is directly proportional to the length, and inversely proportional to the fourth power of the radius of the internal diameter. Hence, if airflow were laminar, the lowest resistance, and hence least additional work of breathing, would occur if a short tracheostomy tube with the largest internal diameter were employed. However, this assumes that ALL the airflow is happening within the tube, and none around the tube. It means lengthening ventilator free breathing trials with a cuffed tracheostomy until patient is completely “liberated” from the ventilator. Indeed such an approach is not uncommon in the ICU, and it is also not uncommon to observe desaturation and worsening hypercapnia in patients with very limited ventilatory capacity once the tracheostomy cuff is deflated, as the anatomical dead space from the upper airway is substantially more compared to the equipment dead space within the channel of the tracheostomy. One can debate whether such an approach of “keeping cuffed till fully liberated” is helpful for the general ICU patient (verbal communication is definitely difficult if not impossible), but it would be meaningless for Lawrence, Mary and Jonathan, as all of them are expected to need ventilatory assistance, invasive or non-invasive, for a substantial duration.

As such, especially in the case of patients expected to need ventilatory assistance, our recommendation would be to continue ventilation through the tracheostomy, and proceed with cuff deflation and downsizing of the tracheostomy, with the intention of diverting airflow through the upper airway progressively.

## STEPS TO DISCHARGE

As the discharge process takes time it is important to start the process as soon as possible. See Figure 2, for the process that occurs at our institution and the steps involved for discharge.

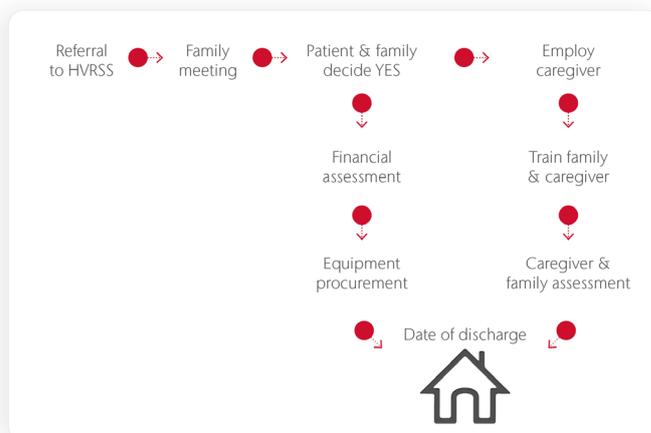


Figure 2 shows the process for discharge at our center. In Singapore, it takes at least 2 to 3 months to safely discharge a tracheostomized ventilation user.

HVRSS: Home Ventilation and Respiratory Support Service

## EQUIPMENT

The tracheostomized ventilator user will need a full suite of equipment to be assembled before home discharge is possible.

The ventilator should be tracheostomy compatible, preferably a multi-mode life support ventilator. Non-life support devices may be acceptable if only nocturnal ventilatory assistance is needed. However, they should still be tracheostomy compatible, and require adequate range of modes, pressure limits, and alarms, as well as internal battery. A secondary means to provide ventilation must be in place if the ventilator malfunctions. In most countries, this takes the form of a second ventilator. If this is not possible, the caregivers must be trained and tested competent in providing manual ventilation via a manual resuscitation bag.

A manual resuscitation bag (together with an air-cushion mask, and some gauze pad and tape to occlude the stoma) should ALWAYS be within reach of the tracheostomy ventilated individual, for emergency ventilation in the event of ventilator malfunction or tracheostomy dislodgement. If caregivers are trained to reinsert a dislodged tracheostomy, an obturator or even a spare tracheostomy tube (could be of the same size or a smaller size) should be made available. All these items could fit neatly into an “emergency tracheostomy box” (see Figure 3).



Figure 3 is an example of the contents of an emergency tracheostomy box. It contains all that is needed to re-insert the tracheostomy in the emergency situation. Tracheal dilators may not be included in a “home” box if the patient is discharged with informal caregiver’s rather than registered nurses.

Humidification of inhaled air is important to prevent drying out of secretions, which might result in life-threatening airway obstruction. Humidification may be via passive heat moisture exchangers (HME) or active heated humidifiers. Active humidification is indicated if cuff deflation is practiced, as the patient exhales via the upper airway, rendering the HME ineffective.

A nebulizer machine and nebulization chambers are necessary and helpful for administration of inhaled saline or medications.

Pulse oximetry (SpO<sub>2</sub>) is a necessary monitor for ventilator users. A low SpO<sub>2</sub> could indicate either hypoventilation (due to leakage, equipment malfunction or inadequate settings, diseases such as pleural effusions) or gas exchange issues (atelectasis, pneumonia, pleural effusions). Continuous SpO<sub>2</sub> monitoring is not usually necessary during the daytime as the clinical condition can be gauged by subjective sensations and clinical observations. However, continuous nocturnal SpO<sub>2</sub> monitoring may be necessary in patients on tracheostomy ventilation with cuff deflation or cuffless tracheostomies, as the leakage renders the tidal volume and minute ventilation monitors inaccurate and useless.

A cuff pressure manometer is necessary if the ventilator user requires tracheostomy cuff inflation. Excessive cuff pressure leads to tracheal mucosal injury and can even contribute to fistula formation (tracheoesophageal or tracheoinominate fistula).

Equipment for airway clearance include a suction machine with suction catheters, and in the case of individuals with ineffective cough, an MI-E device. Without effective airway clearance sputum plugs can occur (see Figure 4).



Figure 4 is a picture of a plug of mucus that was found adherent to outer cannula of the tracheostomy. Patient's tidal volume had dropped, and we were unable to insert a suction catheter to usual depth.

Supplemental oxygen is often unnecessary for individuals with neuromuscular conditions but may be necessary for individuals with lung pathology. However, our ventilator users generally have oxygen concentrators at home because supplemental oxygen may still be needed for neuromuscular patients during an acute infection.

Non-respiratory equipment needs would depend on the mobility status of the ventilator user. The completely tetraplegic individual would require an adjustable hospital bed, pressure relief mattress, hoist, wheelchair and commode.

## MANPOWER AND TRAINING

For a tracheostomized ventilator user to transition safely to home, a care-team must be assembled to look after all his needs. In some states in the United States of America, only registered nurses and respiratory therapists are allowed to care for tracheostomized individuals. However, in most other countries “informal caregivers” are employed for this task.

In determining the size and composition of the care team, we need to consider the financial and manpower resources available, the clinical needs of the ventilator user, the skills of the care team members, and adequate provision for rest and recuperation for the caregivers. Caregiving is demanding and stressful and caring for tracheostomized ventilator users is especially so. Examples of knowledge required to look by the care team are listed in Box 2.

### Box 2

- A concise understanding of respiratory physiology – the importance of oxygen uptake and carbon dioxide (CO<sub>2</sub>) acid-base regulation. How air is moved into the lungs. How the body clears secretion. Breathing during sleep.
- Ability to recognize breathing insufficiency, including physical signs like decreased chest expansion, signs of respiratory distress.
- Ability to interpret vital signs and at least understand when life threatening danger exists.
- Simple understanding of ventilator modes – pressure limited vs volume limited; knowing what changes to expect in each of these modes if there is worsening of respiratory system impedance.
- Understanding of the airway anatomy and the impact of tracheostomy blockage or malplacement on ventilatory parameters.
- Ability to perform airway clearance.
- Ability to perform rescue breathing through a patent tracheostomy.
- Ability to perform rescue breathing via the upper airway, with stoma occluded, should the tracheostomy be dislodged.
- Ability to remove and insert a tracheostomy.

These items pertain only to the tracheostomy and breathing. It is our practice to test the caregivers on these items before the ventilator user is allowed to be discharged (Figure 5). We also review and rehearse these items regularly with the caregivers whenever we visit them.



Figure 5 shows pictures of the way that we have delivered training to care givers. The picture on the left shows training being delivered on a mannequin and received by a trainee via a video call. The picture on the right shows training being delivered in a community hospital setting.

There are of course many other skills and knowledge domains that need to be covered before a tracheostomized ventilator user can be safely looked after at home. These include feeding, general nursing care, safe transfers, administration of medication etc. Often videos and notes can help as an aid memoir by the trainee (Figure 6).

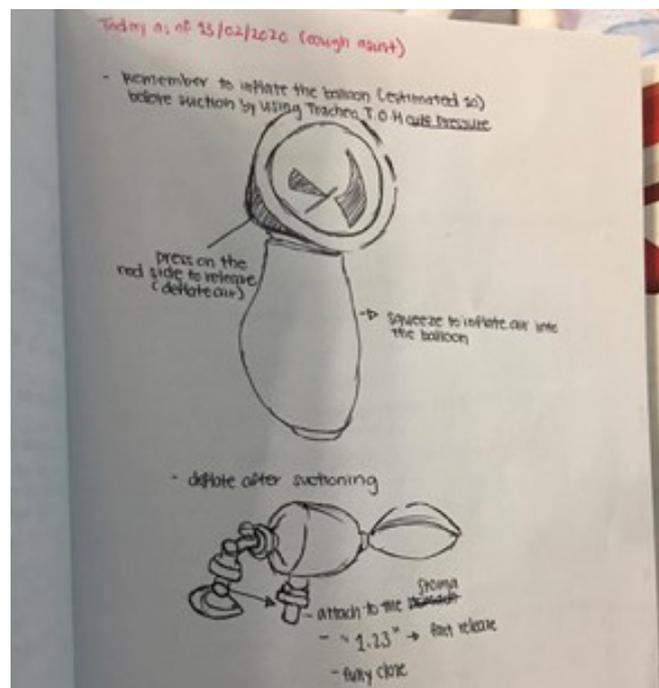


Figure 6 shows an example of a “informal” caregiver’s detailed notes in response to the training that they received out our center.

## ONGOING CARE

Who should provide professional oversight and care for the tracheostomized ventilator user after discharge? Whilst the general practitioners (GP) and district nurses may be the “default” community care providers, they may not be the best team unless they have received extensive training and are regularly involved in such care.

Some countries depend on GPs to provide this care, but regularly admit ventilator users into the chronic ventilation centres for all ventilator and tracheostomy issues. Other centres have established chronic ventilation nurses and therapists performing home visits, with decision support by physicians familiar with chronic ventilation issues (these chronic ventilation physicians may have received their training as pulmonologists, intensivists, rehabilitation physicians, but are currently actively involved in chronic ventilation care).

In our setting in Singapore, there is a difference in practice between paediatric chronic ventilation and adult chronic ventilation teams. The paediatric practice requires yearly laryngeal tracheobronchial examination under general anaesthesia, and this is often combined with bilateral ear and dental assessments and treatments. In our adult practice, we perform laryngotracheobronchial examinations as needed, when there is bleeding or suspicion of injury or obstruction. Indeed, some patients have not undergone examination for years, to no detriment at all. The difference may originate from the difficulty in obtaining cooperation, with the children normally requiring general anaesthesia whilst the adults can tolerate topical anaesthesia.

The recent Covid-19 Pandemic has spurred a wider adoption of telemedicine; teleconsults, telesupport and telemonitoring are all possible. Perhaps the ideal care team would comprise specialist practitioners working in a network with community practitioners, leveraging on telemedicine to provide guidance and decision support.

## CONCLUSION

Chronic tracheostomy ventilation is a powerful tool that extends survival. However, to optimize the quality of life of the ventilator users, understanding of the disease trajectory, a good grasp of the knowledge and skills involved, a transdisciplinary approach, and ongoing training and good communication between ventilator user, the specialist professionals and all members of the care team is absolutely necessary.

## References

1. Bach JR, Goncalves MR, Hamdani I, Winck JC. Extubation of patients with neuromuscular weakness: a new management paradigm. *Chest*. 2010 May; 137(5): 1033-9. doi: 10.1378/chest.09-2144. Epub 2009 Dec 29. PMID: 20040608
2. McKim and Rocha : Tracheostomy Weaning from Longer Term Ventilation ( Book chapter) . In book: Ventilatory Support for Chronic Respiratory Failure. Edition: 225. Chapter: 25. Publisher – Informa Healthcare. Editors: Ambrosino, N, Goldstein Roger
3. Prigent H, et al. Speech Effects of a speaking valve versus external PEEP in tracheostomized ventilator-dependent neuromuscular patients. *Intensive Care Med*. 2010 Oct;36 (10), 1681-7. doi: 10.1007/s00134-010-1935-0. Epub 2010 Jun 10. PMID: 20535605.
4. Martinex G H et al. High-Flow Oxygen with Capping or Suctioning for Tracheostomy Decannulation. *N Engl J Med* 2020;383:1009-17. doi: 10.1056/NEJMoa2010834
5. Hess D R and Altobelli N P. Tracheostomy Tubes. *Respir Care* 2014;59(6):956-973. doi:10.4187/respcare.02920
6. Gross R D et al. Physiologic Effects of Open and Closed Tracheostomy Tubes on the Pharyngeal Swallow. *The Annals of Otolaryngology, Rhinology and Laryngology*. March 2003;112(2):143-52. doi:10.1177/000348940311200207
7. Hoit J D et al. Clinical Ventilator Adjustments that improve speech. *Chest*, 2003;124(4):1512-1521