UNIVERSITY OF LEEDS

This is a repository copy of *What's new in reducing the impact of tracheostomy on communication and swallowing in the ICU*.

White Rose Research Online URL for this paper:
https://eprints.whiterose.ac.uk/201488/

Version: Published Version

Article:
Mills, C.S. orcid.org/0000-0002-3436-3876, Cuthbertson, B.H. orcid.org/0000-0003-4174-9424 and Michou, E. orcid.org/0000-0002-7245-0882 (Cover date: 2023) What's new in reducing the impact of tracheostomy on communication and swallowing in the ICU. Intensive Care Medicine. ISSN 0342-4642

https://doi.org/10.1007/s00134-023-07064-1

Reuse
This article is distributed under the terms of the Creative Commons Attribution-NonCommercial (CC BY-NC) licence. This licence allows you to remix, tweak, and build upon this work non-commercially, and any new works must also acknowledge the authors and be non-commercial. You don't have to license any derivative works on the same terms. More information and the full terms of the licence here: https://creativecommons.org/licenses/

Takedown
If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

White Rose university consortium
Universities of Leeds, Sheffield & York

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk/

Intensive Care Med
https://doi.org/10.1007/s00134-023-07064-1

WHAT'S NEW IN INTENSIVE CARE

What's new in reducing the impact of tracheostomy on communication and swallowing in the ICU

Claire S. Mills[1,2*], Brian H. Cuthbertson[3,4] and Emilia Michou[5,6]

© 2023 The Author(s)

Approximately 14% of ventilated patients in the intensive care unit (ICU) receive a tracheostomy, which has a profound impact on communication, swallowing and other co-morbidities [1, 2]. Difficulties for patients often originate before tracheostomy insertion, primarily as a result of prolonged endotracheal intubation with post-extubation dysphagia and laryngeal injury being very common [3]. Whilst insertion of a tracheostomy increases the odds for functional communication and oral intake, it can exacerbate prior difficulties, particularly by preventing airflow through the laryngo-pharynx.

Patients report that voicelessness is one of the most distressing aspects of their ICU experience [4] and voice is valued more highly than other communication options [1]. Thirst is frequently experienced by ICU patients [4] and recommencing oral intake is an important recovery milestone for patients that improves psychological well-being [1]. Two key characteristics of dysphagia in tracheostomised patients in ICU are reduced laryngo-pharyngeal sensation and reduced subglottic pressures.

The importance of restoring laryngo-pharyngeal airflow and subglottic pressure

Consensus is that the optimal way to reduce the impact of tracheostomy on communication and swallowing is to restore laryngo-pharyngeal airflow and subglottic pressure. The two main ways to achieve this are by (1) deflating the tracheostomy cuff and using a one-way valve (OWV), (2) applying an external airflow via the subglottic port with the cuff inflated.

One-way valves

OWVs can be used safely in ventilated patients with no evidence of negative effects on ventilation [5]. However, serious adverse events (e.g. gas trapping, barotrauma, asphyxiation and death) can occur with misapplication of OWVs, particularly if used with a fully or partially inflated cuff, or where there is reduced airway patency. Airway patency assessment is typically a subjective clinical evaluation. Some guidance suggests a 40–50% reduction of tidal volume (V_t) is indicative of adequate patency for OWV use [5], but there has been a lack of evidence to support this. A recent study comparing four non-invasive measurements to assess upper airway patency, reported 86% of patients with a transtracheal pressure (TTP) of ≤ 9 cmH_2O and 93% of patients with a TTP of ≤ 5 cmH_2O were successful with a OWV trial [6]. There was no significant difference in the percentage reduction in V_t, but there was significantly higher loss of V_t in successful patients (268.5 ml $\pm$ 177.2 ml) compared with unsuccessful patients (88.6 ml $\pm$ 99.6 ml) [6].

As OWVs prevent air escape via the tracheostomy, subglottic pressure can be restored. It can also restore physiological positive end-expiratory pressure, cough, facilitate vocalisation, and improve airway protection. A recent randomised controlled trial (RCT) used videofluoroscopy, high-resolution manometry (HRM), and computed tomography and computational fluid dynamic simulation analysis to compare swallowing metrics in patients who had used OWV for 2 weeks with patients with an inflated cuff [7]. The OWV group had a mean subglottic pressure of 6.95 cmH_2O, comparable to normal

*Correspondence: claire.mills13@nhs.net
[1] Speech and Language Therapy Department, Leeds Teaching Hospitals NHS Trust, Leeds, UK
Full author information is available at the end of the article

subglottic pressures measured directly (5.5–9.5 cmH_2O), and improvements to velopharyngeal maximum pressure, upper oesophageal relaxation, and reduced aspiration and penetration. Another recent RCT highlighted the feasibility and safety of early use of OWVs with a reported shorter time to decannulation with early cuff deflation and OWV (as early as 12–24 h after insertion) compared with late use (48–60 h) [8].

There continues to be widespread use of 'leak speech' or 'ventilator-adjusted leak speech', where the cuff is deflated but a OWV is not used. Although similar speech function can be achieved with both leak speech and OWV [9], no studies have evaluated the impact of leak speech on subglottic pressures or swallowing function.

Above cuff vocalisation

Above cuff vocalisation (ACV) (also known as 'Talking Tracheostomy' and 'External Subglottic Air Flow'), involves application of an external airflow via the subglottic suction port. The only RCT reported improvements to quality-of-life, including speech score, and moderate patient independence and satisfaction [10]. However, there was increased ICU and hospital length of stay compared to the control group, 10 of whom proceeded to OWV trials [10]. The first systematic review of ACV highlighted the limited and low-quality evidence available and variation in practice [11]. A recent survey of healthcare professionals (HCPs) (presented at the 33rd European Society for Intensive Care Medicine Congress) found limited implementation in practice, but confirmed the variety of potential benefits for patients including improving communication, swallowing, sensation, cough and quality-of-life [12, 13]. Both the systematic review and survey have demonstrated the variability in application, implementation and practice, which has highlighted areas for further research [11, 12]. More recently, a qualitative study exploring HCPs' experiences of ACV has reinforced these findings, showing that the subjectivities and uncertainties surrounding ACV are leading to variations in practice and the purpose for which ACV is used, which results in varying opinions regarding whether ACV is 'worth a try or a last resort' [Unpublished data presented at the 2022 Critical Care Canada Forum, 14].

There are a wide variety of minor complications, such as discomfort, strained vocal quality and stomal air escape. Serious adverse events include subcutaneous emphysema, air trapping, bleeding, and tracheal dilation secondary to misapplication of the airflow to the cuff [11, 12]. As with OWV, airway patency is essential for successful and safe use. However, the objective measures for airway patency described above could not be used for ACV without cuff deflation, and assessment currently relies on subjective clinical assessment.

Some of the variation in practice and opinions may be due to the different tracheostomy tube designs. For example, the subglottic port of the Portex® tube has a 2 mm lumen with a single lateral exit, whereas the TRACOE® tube has a 4 mm lumen with bilateral exits. Passing high airflows through a narrow lumen will increase the velocity of the air. It is unclear what forces and pressures are applied to the laryngo-tracheal mucosa, what intra-luminal pressures build-up during glottal closure with continuous airflow application, or how these vary with tube design. A recent study evaluated the pressures exerted by tracheostomy tubes and found when in position, 15 of 17 tubes applied pressure to the posterior tracheal wall above the threshold for mucosal injury (3.99 kPa) [15]. Similar research is needed to evaluate the impact of different airflows on laryngo-tracheal mucosa with different tubes.

Various proposals for the mechanism of action have been suggested including improvement in laryngo-pharyngeal sensation and subglottic pressures as laryngo-pharyngeal airflow improves [11]. The extent of the improvement to sensation and pressures is likely to depend on airflow delivery and rates.

Future directions

Despite the growing body of evidence supporting the use of OWVs and ACV, more research is needed to optimise these interventions to improve outcomes and safety (Fig. 1).

Take-home message

Early restoration of laryngo-pharyngeal airflow and subglottic pressure is likely to reduce the negative impact of tracheostomy. Both OWVs or ACV could be used early after tracheostomy insertion, whilst the patient is still ventilated, to restore laryngo-pharyngeal airflow and improve subglottic pressure. Early prioritisation of these interventions may improve short and longer-term sequelae of tracheostomy. Future research should focus on optimising approaches for OWV and ACV use to enhance patient outcomes.

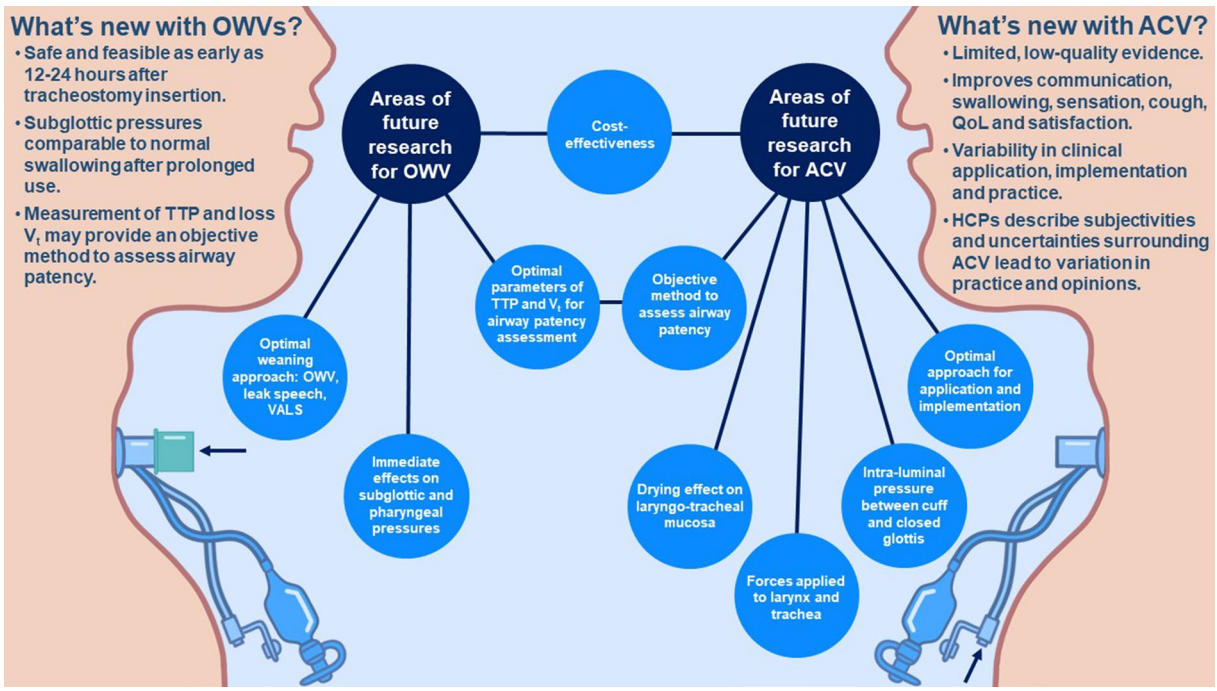

Fig. 1 Summary of what's new with OWVs and ACV and description of areas for future research. *OWV* one-way valve, *TTP* transtracheal pressure, V_t tidal volume, *VALS* ventilator-adjusted leak speech, *ACV* above cuff vocalisation, *QoL* quality-of-life, *HCP* healthcare professional

Author details
[1] Speech and Language Therapy Department, Leeds Teaching Hospitals NHS Trust, Leeds, UK. [2] Leeds Institute of Health Sciences, University of Leeds, Leeds, UK. [3] Department of Critical Care Medicine, Sunnybrook Health Sciences Centre, Toronto, Canada. [4] University Department of Anaesthesiology and Pain Medicine, Faculty of Medicine, University of Toronto, Toronto, Canada. [5] Speech and Language Therapy Department, School of Health Rehabilitation Sciences, University of Patras, Patras, Greece. [6] Centre for Gastrointestinal Sciences, The University of Manchester, Manchester, UK.

Acknowledgements
CM is funded by a Health Education England and National Institute for Health Research (NIHR) Clinical Doctoral Research Fellowship (ICA-CDRF-2017-03-036). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care. BHC is supported by a merit award from the University Department of Anesthesiology and Pain Medicine at the University of Toronto.

Data availability
Data sharing is not applicable to this article as no new data were created or analysed.

Declarations

Conflict of interest
The authors declare that there is no conflict of interest.

Open Access
This article is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License, which permits any non-commercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc/4.0/.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received: 12 January 2023 Accepted: 29 March 2023
Published online: 20 April 2023

References

1. Newman H, Clunie G, Wallace S et al (2022) What matters most to adults with a tracheostomy in ICU and the implications for clinical practice: a qualitative systematic review and metasynthesis. J Crit Care 72:154145. https://doi.org/10.1016/j.jcrc.2022.154145
2. Zuercher P, Moser M, Waskowski J et al (2022) Dysphagia post-extubation affects long-term mortality in mixed adult ICU patients—data from a large prospective observational study with systematic dysphagia screening. Crit Care Explor 4:e0714. https://doi.org/10.1097/CCE.0000000000000714
3. Brodsky MB, Pandian V, Needham DM (2020) Post-extubation dysphagia: a problem needing multidisciplinary efforts. Intensive Care Med 46:93–96. https://doi.org/10.1007/s00134-019-05865-x
4. Rose L, Nonoyama M, Rezaie S, Fraser I (2014) Psychological wellbeing, health related quality of life and memories of intensive care and a specialised weaning centre reported by survivors of prolonged mechanical ventilation. Intensive Crit Care Nurs 30:145–151. https://doi.org/10.1016/j.iccn.2013.11.002

5. Sutt A-L, Anstey CM, Caruana LR et al (2017) Ventilation distribution and lung recruitment with speaking valve use in tracheostomised patient weaning from mechanical ventilation in intensive care. J Crit Care 40:164–170. https://doi.org/10.1016/j.jcrc.2017.04.001
6. Li J, Perez A, Schehl J et al (2021) The association between upper airway patency and speaking valve trial tolerance for patients with tracheostomy: a clinical retrospective study and an in vitro study. Am J Speech Lang Pathol 30:1728–1736. https://doi.org/10.1044/2021_AJSLP-20-00331
7. Han X, Ye Q, Meng Z et al (2022) Biomechanical mechanism of reduced aspiration by the Passy-Muir valve in tracheostomized patients following acquired brain injury: evidences from subglottic pressure. Front Neurosci 16:1004013. https://doi.org/10.3389/fnins.2022.1004013
8. Martin KA, Cole TDK, Percha CM et al (2021) Standard versus accelerated speaking valve placement after percutaneous tracheostomy: a randomized controlled feasibility study. Annals ATS 18:1693–1701. https://doi.org/10.1513/AnnalsATS.202010-1282OC
9. Prigent H, Garguilo M, Pascal S et al (2010) Speech effects of a speaking valve versus external PEEP in tracheostomized ventilator-dependent neuromuscular patients. Intensive Care Med 36:1681–1687. https://doi.org/10.1007/s00134-010-1935-0
10. Pandian V, Cole T, Kilonsky D et al (2020) Voice-related quality of life increases with a talking tracheostomy tube: a randomized controlled trial. Laryngoscope 130:1249–1255. https://doi.org/10.1002/lary.28211
11. Mills CS, Michou E, King N et al (2022) Evidence for above cuff vocalization in patients with a tracheostomy: a systematic review. Laryngoscope 132:600–611. https://doi.org/10.1002/lary.29591
12. Mills CS, Michou E, Bellamy MC et al (2022) Determining the prevalence, implementation approaches, and opinions of above cuff vocalization: a survey of health care professionals. Arch Phys Med Rehabil 103:394–401. https://doi.org/10.1016/j.apmr.2021.08.016
13. Mills C, Michou E, Bellamy M et al (2020) An international survey about above cuff vocalisation: what are the risks and benefits? ICMx 8(76):001507. https://doi.org/10.1186/s40635-020-00354-8
14. Mills CS, Michou E, Bellamy M et al (2022) Worth a try or a last resort: healthcare professionals' experiences of above cuff vocalisation. In: Critical Care Canada Forum 2022. https://criticalcarecanada.com/wp-content/uploads/94_Worth-a-try-or-a-last-resort-healthcare-professionals-experiences-of-ACV-Claire-Mills.pdf. Accessed 5 Dec 2022
15. Cathelain G, Perrier A, Folliot L et al (2022) Bench testing of tracheostomy tube-related insults using an instrumented manikin. Eur Arch Otorhinolaryngol 279:1593–1599. https://doi.org/10.1007/s00405-021-07054-3