



This month's top papers: May 2025

Welcome to the latest blog in the literature podcast from the NTSP. We try to bring you a quick roundup of what is hot in the world of tracheostomy and laryngectomy publications by scouring internationally recognised journals and media and bringing you the highlights.

The papers we will discuss this month are detailed below, along with an automated transcript of the podcast. Please note that the transcript is generated by AI and so may not be totally accurate.

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This month's top papers

- Virtual Reality Emergency Tracheostomy Simulation: A Feasibility Study on Intensive Care Healthcare Professional Learning Outcomes.
- The Role of Ancient Greek Physicians in the Development of Tracheostomy: Pioneering Airway Interventions and Early Thoracic Surgery.
- Early versus Late Tracheostomy in Critically Injured Burn Survivors: A National, Multi-Database Analysis.
- Deployable machine learning-based decision support system for tracheostomy in acute burn patients.
- Outcomes of Virtually Assisted Personalized Tracheostomy Tubes for Congenital Airway Anomalies.

Virtual Reality Emergency Tracheostomy Simulation: A Feasibility Study on Intensive Care Healthcare Professional Learning Outcomes.

Lay Summary:

This study is a test of a new, convenient way to train hospital staff on how to handle urgent, life-threatening emergencies involving a patient's breathing tube (tracheostomy). Since quick, flawless action is required when a tube gets blocked or comes out, consistent training is crucial, yet often difficult to deliver to busy Intensive Care Unit (ICU) staff due to resource limitations. The research evaluated a training program that uses Virtual Reality (VR) simulation delivered through portable headsets right in the clinical environment, allowing staff to train without leaving the hospital.



The training was tested on 28 doctors and other healthcare professionals working in the ICU. The results showed that the VR course is highly successful as a new education method. Staff reported feeling deeply immersed in the simulation and were highly motivated to learn, rating the system's usability as above average. There were no major differences in outcomes between doctors and allied health professionals, suggesting the training is effective across professional roles.

The authors conclude that this portable VR simulation is a safe and feasible method that has great potential to increase access to emergency training for all ICU personnel. By making high-quality training readily available, hospitals can ensure staff are better prepared to manage rare but catastrophic tracheostomy complications.

Summary for Healthcare Professionals:

This study evaluated the feasibility and learning outcomes of delivering a novel Virtual Reality (VR) emergency tracheostomy simulation (Trachosim® software) to 28 Intensive Care Unit (ICU) healthcare professionals. The rationale for the intervention addresses the critical challenge of limited access to traditional, resource-intensive simulation training necessary to manage potentially lethal tracheostomy complications.



The findings confirm the intervention's strong viability and efficacy in the affective and cognitive domains. Participants reported high levels of immersion and strong intrinsic motivation to learn. Furthermore, the System Usability Scale (SUS) score was above the acceptable threshold, indicating the VR hardware is practical for clinical settings. Analysis showed no statistically significant differences in outcomes between doctors and allied health professionals on measured parameters.

The authors conclude that this VR simulation demonstrates good potential as an appropriate educational intervention to increase simulation training accessibility within the clinical environment. Integrating remote VR technology is a feasible strategy to enhance workforce competency and preparedness for tracheostomy emergencies, supporting wider adoption of standardized training protocols across the ICU.

The Role of Ancient Greek Physicians in the Development of Tracheostomy: Pioneering Airway Interventions and Early Thoracic Surgery.

Lay Summary:

This study explores the long and complex history of the tracheostomy—the procedure to create a surgical airway—focusing specifically on its evolution among Ancient Greek physicians. While the earliest references to breathing tube interventions appear in Egyptian and Indian texts, this research details how Greek doctors debated and developed the fundamental ideas behind modern airway management. The study explains that during the influential time of Hippocrates, the procedure was heavily discouraged and largely rejected. This strong opposition was primarily due to the high and often fatal risk of severe bleeding from injuring major blood vessels in the neck, as surgeons lacked the necessary tools and anatomical knowledge to safely perform the operation. However, the paper highlights that this life-saving surgery remained a subject of medical discourse. Over time, later prominent physicians, including Asclepiades of Bithynia and Antyllus, began to refine the technique and surgical approach. Furthermore, Galen's anatomical studies significantly advanced the theoretical understanding of respiratory physiology and laid the groundwork for early concepts of artificial ventilation. By comparing these historical practices with modern surgery, the study concludes that it highlights the enduring principles of critical airway intervention and the long, continuous pursuit of safer surgical advancements.



Summary for Healthcare Professionals:

This review systematically explores the historical trajectory of tracheostomy and early thoracic surgery as conceived and executed by Ancient Greek physicians. The study establishes that despite its critical life-saving potential, the procedure faced strong opposition during the Hippocratic era due to the high, often fatal, risk of hemorrhage resulting from major vascular injury. The analysis identifies key contributions from later Greek and Roman physicians who moved beyond this opposition. Figures such as Asclepiades of Bithynia, Aretaeus, and Antyllus are noted for their subsequent efforts to refine the surgical technique and management of the airway. Additionally, Galen's work on anatomical study significantly advanced the understanding of respiratory physiology and laid the theoretical foundations for artificial ventilation. The authors conclude that this historical comparison provides valuable perspective on the continuity of medical knowledge and surgical principles. The research underscores the timeless clinical necessity of securing the airway in life-threatening obstruction and the enduring challenge of safely managing complex anatomy with limited instrumentation. These historical perspectives remain relevant by highlighting the foundational principles that inform contemporary thoracic and airway management practices.



Early versus Late Tracheostomy in Critically Injured Burn Survivors: A National, Multi-Database Analysis.

Lay Summary:

This large-scale study investigated whether the timing of a tracheostomy—a surgical breathing tube in the neck—affects the recovery and outcomes for patients who survive severe burns. This procedure is often needed for those with inhalational injuries or prolonged reliance on mechanical ventilation. Researchers analyzed national data from over 9,100 burn patients who underwent a tracheostomy, comparing those who received it early (≤ 10 days after admission) to those who received it late (> 10 days).



The most critical finding was that the timing of the procedure made no difference to the patient's chance of survival; the overall mortality rate was comparable between the early and late groups. However, there were significant benefits related to recovery speed and efficiency. Patients who received an early tracheostomy experienced a marked reduction in the time spent on life support and in the hospital. Specifically, the early group spent an average of 6.2 fewer days on the ventilator, 9.0 fewer days in the ICU, and 12.1 fewer days in the hospital overall. Early intervention also increased the likelihood of being discharged to a rehabilitation or long-term acute care facility. The study concludes that performing the tracheostomy early is a valuable strategy for accelerating functional recovery and freeing up critical hospital resources without compromising the patient's survival.



Summary for Healthcare Professionals:

This multi-database retrospective cohort study analyzed 9,173 burn encounters to evaluate the impact of tracheostomy timing—early (≤ 10 days) versus late (> 10 days) relative to admission—on clinical outcomes in burn survivors. The analysis utilized propensity-score matching to control for patient heterogeneity, including age, sex, and Total Body Surface Area (TBSA) of burns. The primary finding was that tracheostomy timing did not significantly affect overall mortality or the incidence of Ventilator-Associated Pneumonia (VAP). However, the study demonstrated that early tracheostomy was significantly associated with reduced resource utilization. Patients in the early cohort experienced a shorter duration of mechanical ventilation (Weighted Mean Difference [WMD]: -6.2 days), a reduced ICU length of stay (WMD: -9.0 days), and a shorter total hospital length of stay (WMD: -12.1 days). Furthermore, early tracheostomy was associated with an increased likelihood of discharge to an inpatient rehabilitation or long-term acute care facility (LTAC). The authors conclude that while early tracheostomy does not confer a survival advantage in this high-risk population, it is a beneficial strategy for accelerating weaning and functional recovery, providing clear resource benefits for critical care systems.

Deployable machine learning-based decision support system for tracheostomy in acute burn patients.

Lay Summary:

This study focused on creating an advanced Artificial Intelligence (AI) tool to help medical teams quickly and accurately predict which severely injured burn patients will require a tracheostomy (a breathing tube in the neck). Airway obstruction is a life-threatening emergency in burn patients, and the decision regarding the indication and timing of a tracheostomy can be challenging and controversial. To create this predictive system, researchers analyzed a large dataset of over 1,000 burn patients and used Machine Learning (ML) to identify the strongest risk factors.



The key finding was the development of an extremely accurate prediction model (XGBoost classifier), which achieved a predictive accuracy (AUROC) greater than 95% in external tests. The model successfully identified six basic clinical features as the most important predictors, including the patient's age, the timing of their admission after injury, the size of the burn injury (total and head/face/neck), and the presence of inhalation injury. These are all factors easily obtained in a clinical setting. The entire prediction system, which includes a simplified calculator and an online tool, is designed to be deployable and reliable across different hospitals and in resource-limited environments. The study concludes that this AI system offers a new, standardized way to provide accurate, real-time risk assessment, helping clinicians make better-informed decisions about airway management and improving patient outcomes.

Summary for Healthcare Professionals:

This retrospective cohort study reports the development and external validation of a deployable Machine Learning (ML)-based decision support system for predicting the necessity and timing of tracheostomy in acute burn patients. The model addresses the high mortality and clinical uncertainty associated with airway management in this population.



The methodology involved developing a model based on 1,011 patients, using the eXtreme Gradient Boosting (XGB) classifier as the optimal ML algorithm. The model demonstrated strong predictive ability (AUROC 0.973 in training and >0.95 in cross-temporal and cross-institutional validation). The final predictive formula is based on six key clinical features: age, time from injury to admission, burn index (total body), burn index (head/face/neck), and the severity of inhalation injury. These features are readily available without reliance on expensive or specialized testing.

The system includes practical tools—an AI-based nomogram, an online calculator, and an abbreviated scale (BETS score)—to facilitate real-time clinical use and reduce subjective decision-making. The authors conclude that the developed ML-based system exhibits strong predictive performance and generalizability. Its deployment offers a standardized, quantified guidance for determining the indication and timing of tracheostomy, which is essential for optimizing care protocols and reducing regional disparities in burn critical care.

Outcomes of Virtually Assisted Personalized Tracheostomy Tubes for Congenital Airway Anomalies.

Lay Summary:

This study describes an innovative approach to treating children with complex congenital airway problems who require a breathing tube (tracheostomy). Many standard tracheostomy tubes do not fit these children's unique airways well, leading to ongoing issues like breathing difficulty, chronic injury, and lengthy hospital stays.



The solution is the virtually assisted personalized tracheostomy tube (vapTT), which uses advanced computer modeling of the child's airway (based on a CT scan) to design a custom-shaped tube. The paper reports on three children who received these custom tubes. The results were highly successful: all three patients experienced a complete resolution of their tube-related obstruction, ulceration, and granulation tissue. This clinical improvement allowed the children to significantly reduce their reliance on breathing support and urgent airway procedures. In a dramatic outcome, one patient who had been hospitalized for three years was safely discharged home, stabilized on a suitable ventilator.

The study concludes that this personalized manufacturing technology is a feasible and safe solution. It offers a critical and successful intervention for a small, highly vulnerable population whose complex anatomy cannot be safely managed with conventional medical devices.

Summary for Healthcare Professionals:

This case series assesses the feasibility and clinical outcomes of implementing the virtually assisted personalized tracheostomy tube (vapTT) in pediatric patients with complex Congenital Airway Anomalies (CAAs). The rationale addresses the limitations of conventional tracheostomy tubes (TTs) in managing patients with unique anatomical challenges, who often experience persistent respiratory failure and local iatrogenic injury.



The methodology involved designing shape-customized TTs based on 3D virtual modeling derived from high-resolution CT scans. The cohort included three patients with CAAs who had failed multiple conventional TT strategies.

Clinical results confirmed the procedure's efficacy: all three patients demonstrated complete resolution of TT-related obstruction and mucosal ulceration/granulation. Furthermore, the vapTT facilitated the de-escalation of respiratory support and significantly reduced the incidence of clinical events requiring urgent tracheoscopy. Notably, one patient was successfully transitioned to home care after a three-year index hospitalization. The authors conclude that the vapTT is a feasible and effective personalized medical device solution. This technology offers a critical pathway for the long-term management of respiratory failure in pediatric patients who are refractory to standard-of-care tracheostomy methods.

Scientific abstracts and references



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Virtual Reality Emergency Tracheostomy Simulation: A Feasibility Study on Intensive Care Healthcare Professional Learning Outcomes.

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INTRODUCTION: The ability to manage tracheostomy emergencies is vital within the intensive care unit (ICU); however, due to clinical pressures, access to teaching and training is often limited. Simulation training using portable virtual reality (VR) headsets may provide increased access to this training without significant time away from clinical duties. This study aims to evaluate whether the management of a tracheostomy emergency can be effectively delivered through VR simulation within a clinical environment. The study used Trachosim® software produced by Goggleminds®. **METHODS:** This study recruited 28 clinical professionals working within the ICU and utilised a single-group post-test observation design. All participants were asked to complete a validated survey, the Immersive Technology Evaluation Measure (ITEM), using an online questionnaire to assess different aspects of the utility of the educational intervention. The study used descriptive statistics to assess overall data and used the Mann-Whitney U test to compare doctors to allied health professionals. **RESULTS:** The simulation showed high levels of immersion, strong intrinsic motivation, and a high quality of debrief. The cognitive load was deemed moderate, and the system usability was above the acceptable threshold. There were no statistically significant differences between doctors and allied health professionals. **CONCLUSION:** This study showed that Trachosim® has good potential for increasing and improving training around tracheostomy emergencies within the ICU. The results suggest that VR is an appropriate teaching intervention to increase simulation training accessibility within a clinical environment. Further work should be done to compare VR intervention to alternative teaching modalities, as well as long-term outcomes such as knowledge and skill retention and improved patient outcomes.

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The Role of Ancient Greek Physicians in the Development of Tracheostomy: Pioneering Airway Interventions and Early Thoracic Surgery.

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Tracheostomy, a critical airway intervention, has a long and complex history that dates back to antiquity. While the earliest references to the procedure appear in Egyptian and Indian medical texts, its development within ancient Greek medicine remains a subject of historical debate. This study explores the evolution of tracheostomy in ancient Greece, analyzing its theoretical foundations, historical accounts, and surgical advancements. Despite Hippocratic opposition, which largely discouraged invasive airway procedures due to the risk of fatal complications, later physicians such as Asclepiades, Aretaeus, and Antyllus made significant contributions to refining airway management techniques. The anatomical studies of Galen further advanced the understanding of respiratory physiology, including early concepts of artificial ventilation. Additionally, this study examines archaeological evidence, such as a marble relief discovered in Abdera, which may depict an early attempt at tracheostomy, providing valuable insight into the practical application of airway interventions in antiquity. By comparing ancient Greek surgical techniques with modern tracheostomy practices, this research highlights the continuity of medical knowledge and innovation. It underlines the role of ancient Greek physicians in shaping the principles of thoracic surgery, offering a broader understanding of how early medical practices have influenced contemporary airway management. The findings contribute to the historical perspective on tracheostomy, emphasizing the timeless pursuit of life-saving surgical advancements and the evolving relationship between theoretical medical knowledge and practical surgical application.

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Early versus Late Tracheostomy in Critically Injured Burn Survivors: A National, Multi-Database Analysis.

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Tracheostomy is indicated in critically ill patients when prolonged mechanical ventilation is anticipated. We leveraged national data to evaluate tracheostomy timing in burn patients, hypothesizing that early tracheostomy would be associated with reduced length of stay (LOS) and ventilator-associated pneumonia (VAP). Surviving burn encounters undergoing tracheostomy in three national databases-Nationwide Inpatient Sample (NIS), 2016-2021, National Trauma Data Bank (NTDB), 2007-2014, and Burn Care Quality Platform (BCQP), 2015-2022-were stratified by tracheostomy timing relative to admission: early: ≤ 10 days versus late: > 10 days. Early tracheostomy encounters were propensity-score-matched with late tracheostomy encounters on age, sex, and total body surface area (TBSA) of burns to evaluate the impact of tracheostomy timing on LOS, ICU LOS, ventilator days, VAP, discharge to inpatient rehabilitation, and discharge to long term acute care (LTAC). 9,173 burn encounters underwent tracheostomy (6,255 in NIS, 1,332 in NTDB, and 1,586 in BCQP) of which 51.1% were early. Within matched cohorts, early tracheostomy was associated with shorter LOS, reported as Average Treatment Effect, in days [95% CI]: NIS: -22.9 [-32.8- -13.1], $p<0.01$; NTDB: -12.7 [-18.7- -6.8], $p<0.01$; BCQP: -7.0 [-12.5- -1.5], $p<0.01$. Early tracheostomy was associated with shorter ICU LOS and fewer ventilator days in NTDB and BCQP ($p<0.04$). Early tracheostomy was not associated with discharge to inpatient rehabilitation or VAP. Early tracheostomy decreased discharge to LTAC in NTDB and BCQP ($p\leq 0.02$). Our multi-database analysis supports early tracheostomy in critically injured burn patients requiring prolonged mechanical ventilation.

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Deployable machine learning-based decision support system for tracheostomy in acute burn patients.

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BACKGROUND: Airway obstruction is a common emergency in acute burns with high mortality. Tracheostomy is the most effective method to keep patency of airway and start mechanical ventilation. However, the indication of tracheostomy is challenging and controversial. We aimed to develop and validate a deployable machine learning (ML)-based decision support system to predict the necessity of tracheostomy for acute burn patients. **METHODS:** We enrolled 1011 burn patients from Southwest Hospital (2018-20) for model development and feature selection. The final model was validated on an independent internal cross-temporal cohort (2021, n = 274) and an external cross-institutional cohort (Second Affiliated Hospital of Zhejiang University School of Medicine 2020-21, n = 376). To improve the model's deployment and interpretability, an ML-based nomogram, an online calculator, and an abbreviated scale were constructed and validated.

RESULTS: The optimal model was the eXtreme Gradient Boosting classifier (XGB), which achieved an AUROC of 0.973 and AUPRC of 0.879 in training dataset, and AUROCs of greater than 0.95 in both cross-temporal and cross-institutional validation. Moreover, it kept stable discriminatory ability in validation subgroups stratified by sex, age, burn area, and inhalation injury (AUROC ranging 0.903-0.990). The analysis of calibration curve, decision curve, and score distribution proved the feasibility and reliability of the ML-based nomogram, abbreviated scale (BETS), and online calculator. **CONCLUSIONS:** The developed system has strong predictive ability and generalizability in cross-temporal and cross-institutional evaluations. The nomogram, online calculator, and abbreviated scale based on ML show comparable prediction performance and can be deployed in broader application scenarios, especially in resource-limited clinical environments.

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Outcomes of Virtually Assisted Personalized Tracheostomy Tubes for Congenital Airway Anomalies.

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OBJECTIVE(S): To measure clinical outcomes and respiratory trajectories after the placement of virtually assisted personalized tracheostomy tubes (vapTT) designed for patients with congenital airway anomalies (CAA). **METHODS:** Retrospective review was performed of vapTT candidates, which included patients with CAA experiencing recurrent respiratory failure due to ongoing TT obstruction despite exhaustion of commercially available TT. VapTT design used a previously reported protocol for virtual modeling from CT images correlated with endoscopy findings. Outcomes obtained from medical records included the presence of TT-related granulation/ulceration, symptomatic tracheoscopy frequency, progression of inpatient care, ventilatory parameters, and serum bicarbonate levels. **RESULTS:** Six patients were included. CAA pathology included tracheal cartilaginous sleeve, tortuosity, and stenosis in the setting of conditions such as craniosynostosis syndromes, skeletal dysplasia, and long-gap esophageal atresia with scoliosis. Three patients were hospitalized for greater than 5 months at the time of vapTT implementation; all three demonstrated improvement in acute obstructive events, resolution of granulation on tracheoscopy, significant improvement in serum bicarbonate ($p < 0.005$), and progression of care to discharge. Of the three outpatients undergoing vapTT implementation, one patient experienced resolution of recurrent tracheitis and one had resolution of acutely symptomatic airway events. For the group, there was a significant decrease in compiled serum bicarbonate levels after vapTT implementation (3.6, 95% CI: 2.85-4.31, $p < 0.001$). **CONCLUSIONS:** VapTT is a feasible option when airway obstruction cannot be overcome with standard TTs in children with CAA. Our early experience with vapTT demonstrated improved respiratory function without significant adverse events. Future studies are required to investigate long-term outcomes of vapTT.

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