Review Article

Tracheostomy in special groups of critically ill patients: Who, when, and where?

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Abstract

Tracheostomy is one of the most common procedures undertaken in critically ill patients. It offers many theoretical advantages over translaryngeal intubation. Recent evidence in a heterogeneous group of critically ill patients, however, has not demonstrated a benefit for tracheostomy, in terms of mortality, length of stay in Intensive Care Unit (ICU), or incidence of ventilator-associated pneumonia. It may be a beneficial intervention in articular subsets of ICU patients. In this article, we will focus on the evidence for the timing of tracheostomy and its effect on various subgroups of patients in critical care.

Keywords: Complications, mechanical ventilation, percutaneous tracheostomy, surgical tracheostomy, tracheostomy, translaryngeal intubation, ventilator-associated pneumonia

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Introduction

Tracheostomy may facilitate weaning from mechanical ventilation and is one of the most common surgical procedures performed in the Intensive Care Unit (ICU). Tracheostomy is performed in 9% and 10% of all mechanically ventilated patients in the United States and the United Kingdom, respectively.[1-4] Mortality due to tracheostomy is rare and periprocedural complications requiring fluid or blood replacement occurring in 7% of all cases.[5] Timing of tracheostomy is controversial with single center trials showing benefit of early tracheostomy compared with larger multicenter studies failing to replicate such favorable outcomes.[5-9] This article will focus on the current evidence around the timing of tracheostomy and its impact on different patient subpopulations.

Advantages of Tracheostomy to Conventional Intubation

Sedation and mobilization

Multiple single center prospective and retrospective studies have shown an association of early tracheostomy with decreased use of sedation facilitating early weaning from mechanical ventilation.[10,11] Tracheostomy may reduce translaryngeal stimulation facilitating patient comfort, encourage patient autonomy, communication and has been associated with improved mobility and decreased length of intensive care stay.[12,13]

Weaning from the ventilation

Good quality single center studies[7] and larger methodologically less rigorous studies have suggested

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a reduction in the duration of mechanical ventilation, nosocomial pneumonia, and hospital length of stay (LOS) in patients undergoing early tracheostomy.[14] Several multicenter randomized controlled trials and meta-analysis in mixed intensive care populations, however, failed to show a statistically significant reduction in the duration of mechanical ventilation.[5]

Work of breathing

In patients with failed extubations, tracheostomy can reduce expiratory resistance to airflow and improve lung mechanics.[15] In this cohort of patients, a reduction in work of breathing may facilitate liberation from the ventilator.[15,16]

Secretion clearance and mucociliary function

Translaryngeal intubation is associated with a high incidence of nosocomial sinusitis in critically ill patients. Over 90% of translaryngeal intubated patients have opacified sinuses by day 7, which improves following extubation or tracheostomy. This clinical significance of this is yet to be determined.[17]

Complications of Prolonged Translaryngeal Intubation

Laryngotracheomalacia is a rare complication following prolonged intubation in the critical care unit due to the use of a high-volume low-pressure cuff. Prolonged translaryngeal intubation is associated with lip and vocal cord pressure ulceration (in > 90% patients on autopsy)[18] and vocal cord dysfunction postextubation. This can be minimized through the use of a tracheostomy. Tracheal stenosis, defined as a 10% reduction in the internal tracheal diameter, is more common with tracheostomy [Figure 1].[19]

Percutaneous versus Surgical Tracheostomy

The percutaneous approach offers several advantages over surgical tracheostomy and is the preferred choice in over 97% of the UK ICUs.[2] Most notably, these include the speed of insertion, comparable complication rates, and a smaller wound size improving cosmetic outcome and minimizing the incidence of infection. A bedside tracheostomy avoids deterioration of the patients associated with intrahospital transfer.[20]

This has been demonstrated through several meta-analyses and has led to percutaneous tracheostomies being the predominant method of choice for tracheostomies in the ICU.[3] Studies have revealed that 70–97% of all tracheostomies are performed in the ICU by the intensivists and favored technique being

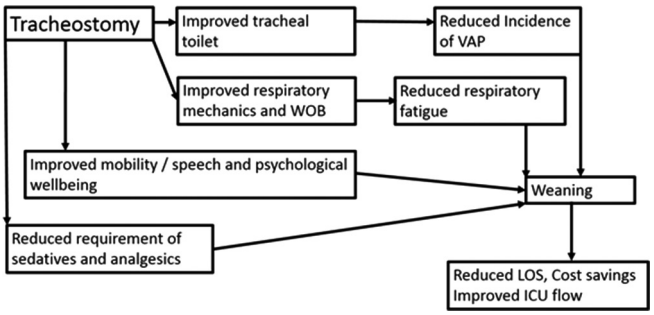

Figure 1: Theoretical advantages of tracheostomy in Intensive Care Unit

single stage dilatation technique.[3] The potential benefit of percutaneous tracheostomy was analyzed by Freeman *et al.*,[20] who performed a meta-analysis comparing the surgical versus percutaneous approach. They pooled data from 5 prospective randomized controlled trials which included 236 patients in total. They found that the percutaneous method reduced the operative time, perioperative bleeding, stomal infection, and postoperative complications. There was no significant difference in mortality.[20] In addition to the above advantages, percutaneous tracheostomies are more cost effective. An economic analysis comparing percutaneous and surgical tracheostomies found that percutaneous technique reduced the cost by one-third in the United States hospitals.[21] This evidence has been reflected in the recently published national guidelines suggesting percutaneous tracheostomy as the standard method for tracheostomy in intensive care patients.[22]

Timing of the Tracheostomy in Unselected Intensive Care Patients

There has been numerous single[7,14] and multicenter trials,[5] meta-analysis,[23,24] and retrospective studies[25] investigating early (<5 days) versus late (>7–10 days) tracheostomy in critically ill patients. The well-conducted single center trials showed a reduction in the ICU and hospital LOS, reduced requirement for sedation in ventilated, early weaning from the ventilator and reduced usage of sedation in the early tracheostomy group.[26] While it showed a reduction in the quality indicators of ICU, they failed to show a mortality benefit.

All these well-controlled single center trials point toward cost savings without affecting the patient mortality. Unfortunately, these benefits were not translated in well-conducted multicenter trials[5] and meta-analysis[24] of the published data. These well-controlled randomized multicenter trials could be criticized for the heterogeneity of the patients recruited. For example, in the study by Young *et al.*,[5] each center contributed 2–3 patients per year, probably an underestimate of the total number of

tracheostomies performed. Furthermore, this study did not report on the subgroups of patients who may have benefited from an early tracheostomy.

Tracheostomy in Cardiac Intensive Care

Ventilatory dependence after cardiovascular surgery is common, partly due to an improvement in the provision of services in patients with comorbidities.[6] One study found, of 12,777 patients undergoing cardiovascular surgery, 704 (5.5%) developed ventilator dependence, and defined as intubation for over 72 h. Of those, the survival at 30 days and 2 years were 74% and 26%, respectively, compared to 84% and 58% in patients who did not develop ventilator dependence.[27] Another study found that only 31% of cardiac surgery patients ventilated for over 3 days were successfully weaned by day 10.[28] The results from well-conducted prospective randomized controlled trials and retrospective studies are conflicting in patients in cardiac intensive care.[29,30] In these studies, there were no differences in the duration of critical care stay, mortality rates up to 90 days, and ventilator-associated pneumonia (VAP). In the early percutaneous tracheostomy group, there was reduced usage of sedation, delirium, unscheduled extubations, early mobilization with associated patient comfort, and ease of administering nursing care.[31] In this cohort of patients where establishment of early nutrition is of paramount importance, tracheostomy was associated with early resumption of oral nutrition.[6] Some investigators believe that early tracheostomy within 48 h is associated with deep-seated mediastinitis in patients following median sternotomy.[32,33] However, large studies have shown that a retrospective analysis of 5095 patients who underwent tracheostomy over 6 days after cardiac surgery found no link to mediastinitis and sternal wound infection.[33]

Tracheostomy in Neurocritical Care

Small prospective and large retrospective studies in patients with brain injuries have shown that early tracheostomy reduced the duration of mechanical ventilation by reduced usage of sedation. This translated to a reduction in the LOS in critical care and hospital after stroke and traumatic brain injury.[34-38] Despite these improvements after tracheostomy, there was no significant difference in long-term mortality, attributable to the diffuse nature of brain injury. Patients with brain injury are at a higher risk to develop VAP (in mechanically ventilated patients after traumatic brain injury up to 60%), and it is associated with significant morbidity[39] and mortality. While it is controversial, tracheostomy may reduce the secondary insults associated with a reduction in the incidence of VAP and unscheduled extubations after a brain injury.

Tracheostomy is a safe and well-tolerated procedure in patients with brain injury, but caution should be exercised to reduce the incidence of periprocedural secondary neurological insults. When performed in an appropriate setting, there was no evidence of periprocedural insults during percutaneous tracheostomy in patients with brain injury.[40]

Tracheostomy in Trauma Patients

Incidence of tracheostomy in patients with polytrauma is high (over 40%).[41] Risk factors for tracheostomy in this cohort are age over 55, pulmonary contusions, multiple rib fractures, presence of head injury, low Glasgow coma score at admission, high abbreviated injury scale scores (>75), and craniotomy.[41] Early tracheostomy (< day 7) in critically ill patients following polytrauma has been associated with shorter duration of mechanical ventilation (9.6 vs. 18.7 days $P < 0.0001$), ICU LOS (10.9 vs. 21.0 days; $P < 0.0001$) and VAP without affecting ICU or hospital mortality and morbidity.[42-45] Adopting a standardized protocol of early consideration of tracheostomy may reduce time on the ventilator, VAPs, and ICU LOS.

Tracheostomy in Burns

The surface area, depth, and location of the burn (particularly head and neck burns) are the main factors determining the need for early tracheostomy in patients with burns. It is performed in patients with total surface body area burns of over 60% because of the requirement for multiple trips to the theater. It is also performed in patients with head or neck burns and associated inhalation injury.[46] In a small randomized control trial of 44 burns patients of early (next operative day) versus late tracheostomy (if needed on day 14), there were no significant differences in the incidence of VAP, LOS, or mortality.[47] Despite these results, early tracheostomy may confer a microbiological advantage in burns patients. In pediatric patients with burns that early tracheostomy conferred a microbiological benefit to burned children.[48]

Conclusion

There is insufficient evidence to support an either early or late tracheostomy in routine clinical practice. Large national retrospective national registries have shown a significant linear increase in hospital costs and LOS with time to tracheostomy. Timing of tracheostomy

should be personalized for the patient after taking into account the risks and benefits of this procedure. We believe that a bedside percutaneous tracheostomy is safe and economically feasible alternative to formal theater tracheostomy. Well-conducted randomized controlled trials with the relevant subgroups of patients are needed.

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Conflicts of interest

There are no conflicts of interest.

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