

The Role of Early Tracheostomy in Critically Ill Neurosurgical Patients[†]

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Abstract

Objective: To determine the value of early tracheostomy (within 7 days) in ventilated neurosurgical patients. **Methods:** Retrospective review of intubated patients in the neurosurgical intensive care unit (NICU) who underwent elective open tracheostomies for prolonged ventilation. **Results:** Thirty patients over a 2-year period were analysed. There were 19 males and 11 females, mean age 53.9 ± 18.1 years (range 14 to 89), and mean Glasgow Coma Scale (GCS) score on admission 7.1 ± 3.8 (range 3 to 15). The underlying disease aetiology was cerebrovascular disease in 53% of patients, head trauma in 33% and tumour or infection in 13%. Tracheostomy was performed after a mean period of 8.5 ± 3.5 days (range 2 to 18), with patients requiring ventilation for a mean duration of 13.5 ± 6.3 days (range 3 to 31). Complications were minimal; 1 wound infection (3.3%) and 4 tube obstructions (13.3%). Patients who underwent elective early tracheostomy (Group 1 = within 7 days) had poorer GCS on admission (6.3 ± 2.9 versus 7.7 ± 4.3 in Group 2, $P = 0.271$). Tracheostomy was performed after a mean of 5.3 ± 1.7 days in Group 1 vs. 10.6 ± 2.7 days in Group 2. Group 1 patients had faster recovery from nosocomial pneumonia (12.3 ± 6.2 versus 17.9 ± 12.5 days, $P = 0.168$), shorter duration of ventilation (9.8 ± 5.9 versus 16.0 ± 5.4 days, $P = 0.007$), and reduced incidence of multibacterial tracheobronchial colonisation (42% versus 72%, $P = 0.098$). The most prevalent organisms were *Acinetobacter baumannii* (43.3%), *Pseudomonas* (40%), methicillin-resistant *Staphylococcus aureus* (MRSA) (33%), *Klebsiella* (30%) and *Staphylococcus aureus* (26.7%). **Conclusion:** Early tracheostomy in selected neurosurgical patients with poor GCS scores was associated with reduced incidence of tracheobronchial colonisation by multiple pathogens, improvement in chest infections, and rapid weaning from ventilatory support.

Ann Acad Med Singapore 2001; 30:234-8

Key words: Early tracheostomy, Nosocomial pneumonia, Poor GCS, Rapid weaning, Tracheobronchial colonisation

Introduction

In medical history, tracheostomy is one of the oldest operations performed. There are indications that the Egyptians first employed this procedure more than 3500 years ago when Asclepiades of Bithynia described it in the second century BC.^{1,2} Its primary indication then was for the emergency management of upper airway obstruction; however, its use was fraught with complications, so much so that during that time it was referred to as the scandal of surgery. The first successful tracheostomy was attributed to Antonio Musa Brasavola in 1548,³ but it was not until Chevalier Jackson's landmark article published in 1909 that tracheostomy was considered a safe procedure.⁴ He had standardised the technique, thereby reducing the operative mortality from 25% to 1%.

In the last two decades, advances in infection control and critical care have enabled more neurosurgical patients to

survive beyond the initial injury to become ventilator-dependent. The primary indication for tracheostomy has become to aid with pulmonary toilet and airway control in patients on prolonged mechanical ventilation. However, the exact timing of tracheostomy remains controversial.⁵⁻⁹ Issues revolve around the risks of prolonged endotracheal intubation versus the complications associated with tracheostomy. No clear consensus exists about how these factors should be weighed^{10,11} but individualisation of the decision is advocated on a case-by-case basis.^{9,12,13} Recently, the trend is towards early tracheostomy.^{12,14}

This is especially true for neurosurgical patients in whom poor Glasgow Coma Scale (GCS) scores mean that early endotracheal intubation for airway protection and control of ventilation is necessary. Unfortunately, nosocomial pneumonia commonly ensues¹⁵ in these neurologically obtunded patients because of glottic dysfunction, a poor

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[†] This paper was presented at the 34th Singapore-Malaysia Congress of Medicine and awarded 2nd Best Paper by the Chapter of Surgeons, Academy of Medicine of Singapore.

cough reflex and the inability to clear secretions effectively. The need for prolonged mechanical ventilation prolongs intensive care unit (ICU) stay and places considerable strain on hospital resources. Early tracheostomy in selected neurosurgical patients not only alleviates this, but also has a role in improving clinical outcome.

The aim of this retrospective review was to report our experience with early tracheostomy in the neuro-intensive care setting, and its implications on multibacterial colonisation, nosocomial pneumonia, and the duration of ventilatory support.

Materials and Methods

Over a 2-year period from 1 January 1998 to 30 November 1999, a retrospective review was conducted of intubated patients in the neurosurgical intensive care unit (NICU) of our tertiary referral centre who underwent tracheostomy for anticipated prolonged mechanical ventilation as a result of their cerebral insult. These patients had poor neurological status (GCS less than 8) and active pneumonia with abundant secretions. Tracheostomy was indicated for pulmonary toilet and airway control. For the purposes of this study, only open tracheostomies performed by the neurosurgical team were studied and not bedside percutaneous dilational tracheostomies. This was to allow relative standardisation of the operative technique and hence, a more uniform evaluation of any complications. Informed consent was obtained from the nearest relative of each patient. According to local practice and the preferences of the neurosurgeons-in-charge, the patients were divided into two groups depending on the timing of tracheostomy. Group 1 patients were those in whom the neurosurgeon-in-charge preferred an early tracheostomy (within 7 days of ventilation), while Group 2 patients were those in whom this was performed later (after 7 days). All patients underwent a standardised regime of weaning off the ventilator once controlled ventilation for intracranial pressure control was no longer necessary. This involved the stepwise and gradual conversion from continuous mechanical ventilation (CMV) mode to synchronised intermittent mandatory ventilation (SIMV) mode, then pressure support (PS), irrespective of when the tracheostomy was to be performed. Patients were discharged from the NICU when no longer ventilator-dependent, and neurologically stable.

Data Collection

Demographic, clinical and treatment data were recorded. Each patients' casenotes were reviewed for the following: age, sex, disease aetiology, co-morbid illness, GCS on admission and at the time of tracheostomy, duration of endotracheal intubation and mechanical ventilation, days to resolution of chest infection, prevalence of tracheo-bronchial organisms, other sources of sepsis, procedural

complications and clinical outcome. Group 1 and Group 2 patients were then compared and analysed.

Statistical Analysis

Statistical analysis was performed with the Student's *t*-test for continuous variables and the Chi-square or Fisher's exact test for discrete variables using SPSS 7.5 for Windows. Results were expressed as mean $\pm$ SD (range).

Results

There were 30 patients over a 2-year period comprising 19 males and 11 females. The mean age of the patients was 53.9 ± 18.1 years (range 14 to 89), and the mean GCS was 7.1 ± 3.8 on admission (range 3 to 15). The underlying disease aetiology was cerebrovascular disease in 53% (7 patients with subarachnoid haemorrhage, 4 basal ganglia/thalamic haemorrhage, 3 cerebellar haemorrhage, 2 infarct), head trauma in 33% (9 patients with acute subdural haematoma, 1 diffuse axonal injury), and tumour/infection in 13% (2 patients with brain metastases, 2 intracranial infection) (Fig. 1).

Four out of 30 patients (13.3%) were on anticoagulation. Two patients were on ticlid and 1 patient on aspirin for previous strokes, and 1 patient was on warfarin for chronic atrial fibrillation prior to admission to the NICU. Tracheostomy was indicated for the latter patient's poor neurological recovery (GCS 4), despite emergency posterior fossa decompression craniotomy for a large cerebellar infarct. None of these patients had perioperative bleeding complications related to the tracheostomy. Two patients (6.7%) had distorted neck anatomy from a large goiter and previous neck irradiation and surgery. The mean time to elective tracheostomy was 8.5 ± 3.5 days (range 2 to 18), and all patients required ventilation for a mean duration of 13.5 ± 6.3 days (range 3 to 31).

The patients in Groups 1 ($n = 12$) and 2 ($n = 18$) were compared and analysed (Table I). There was no significant difference in age (54.1 versus 53.8 years) between these two groups. Group 1 patients had poorer GCS scores on admission compared to Group 2 (6.3 ± 2.9 versus 7.7 ± 4.3 , $P = 0.271$) and at the time of tracheostomy, (5.8 ± 1.8 versus 6.8 ± 2.1 , $P = 0.162$). Tracheostomy was performed after a mean of 5.3 ± 1.7 days in Group 1 compared to 10.6 ± 2.7 days in Group 2. Group 1 patients also had a statistically significant reduction in days of ventilator requirements compared to Group 2 (9.8 ± 5.9 versus 16.0 ± 5.4 days, $P = 0.007$).

Group 1 patients with chest infections had faster mean recovery time compared to Group 2 (12.3 ± 6.2 versus 17.9 ± 12.5 days, $P = 0.168$). Clinical endpoints for judging improvement of nosocomial pneumonia were resolution of mucopurulent tracheobronchial secretions and absence of

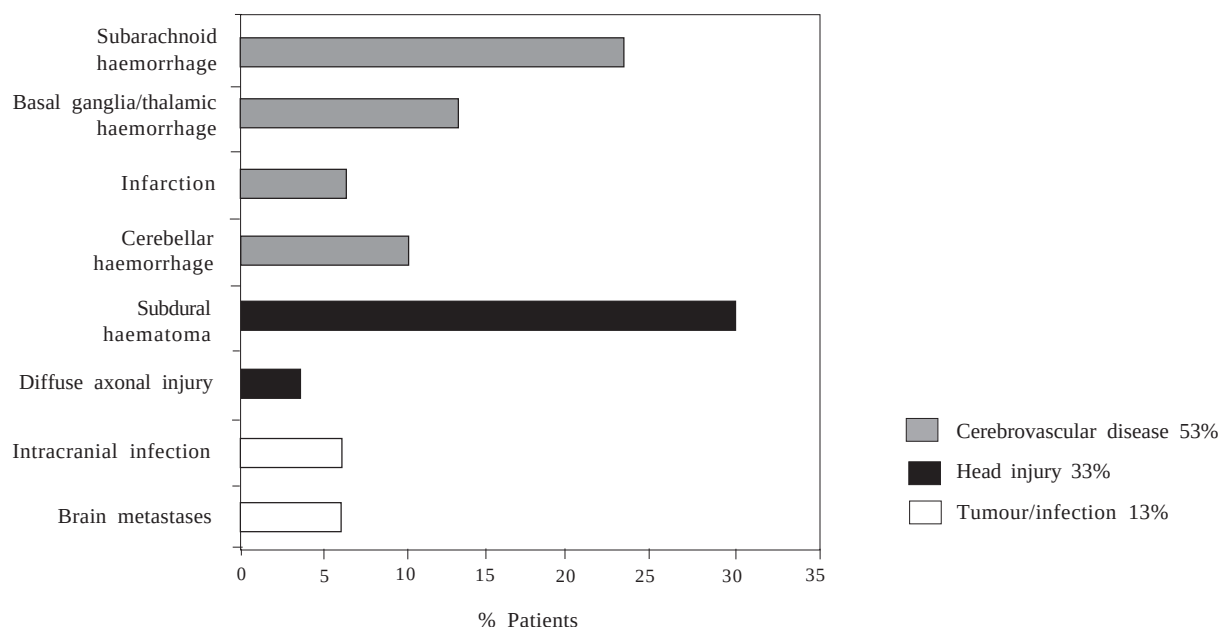


Fig. 1. Underlying disease aetiology of patients studied.

TABLE I: COMPARISON OF PATIENTS WHO UNDERWENT EARLY TRACHEOSTOMY (GROUP 1 ≤ 7 DAYS) VERSUS LATE TRACHEOSTOMY (GROUP 2 > 7 DAYS)

	Group 1 n = 12 (mean $\pm$ SD)	Group 2 n = 18 (mean $\pm$ SD)	P value
Age (y)	54.1 $\pm$ 19.6	53.8 $\pm$ 17.7	0.972
GCS on admission	6.3 $\pm$ 2.9	7.7 $\pm$ 4.3	0.271
GCS at tracheostomy	5.8 $\pm$ 1.8	6.8 $\pm$ 2.1	0.162
Days before tracheostomy	5.3 $\pm$ 1.7	10.6 $\pm$ 2.7	0.000
Days on ventilator	9.75 $\pm$ 5.88	16.0 $\pm$ 5.37	0.007
Days to chest improvement	12.3 $\pm$ 6.2	17.9 $\pm$ 12.5	0.168
% of multibacterial colonisation	42%	72%	0.098

GCS: Glasgow Coma Scale

crepitations or rhonchi. Objective assessment involved chest radiographic improvement in consolidation or pulmonary infiltrates, and the normalisation of leukocytosis in patients with no other foci of infection apart from the chest. However, 18 (60%) patients had confounding sources of sepsis (some from more than one source). Three patients (10%) had sinusitis, 6 (20%) had cerebritis or intracranial infection, 10 (33%) had deep vein thrombosis, 12 (40%) had urinary tract infections, 3 (10%) had wound infections (bone flap infection, groin haematoma, and abdominal wound infection). All patients received appropriate antibiotic therapy as guided by cultures and sensitivities.

Multibacterial colonisation, defined as more than 2 pathogens, occurred in 42% of Group 1 patients compared to 72% of Group 2 patients ($P = 0.098$). The most prevalent organisms cultured on tracheal aspirates were *Acinetobacter*

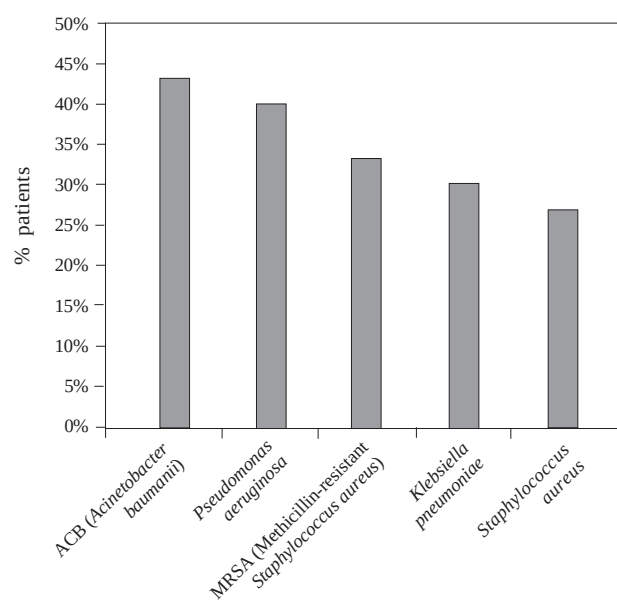


Fig. 2. Most prevalent organisms cultured.

baumannii (43.3%), *Pseudomonas* (40%), Methicillin-resistant *Staphylococcus aureus* (33%), *Klebsiella* (30%) and *Staphylococcus aureus* (26.7%) (Fig. 2).

Procedure-related complications were minimal. There was 1 stoma wound infection (3.3%), and 4 tube obstructions (13.3%) from mucus plugging, blood clot or the tip abutting against the wall of the trachea. There was no incidence of pneumothorax, subcutaneous emphysema, tube dislodgement or tracheoinnominate fistula.

Tracheostomy tubes were successfully removed in 60%

(18/30) of patients after a mean duration of 34.3 ± 23.9 days (range 9 to 98), while 23.3% (7/30) eventually died with the tube *in situ*, and the remaining 16.7% (5/30) were discharged from hospital or transferred to a rehabilitation facility with the tracheostomy.

Discussion

An early tracheostomy raises the concern of performing an unnecessary procedure on a patient with the potential for rapid neurologic recovery. In most cases, the decision is clear and easily made, but there are clinical situations where the decision of when to perform a tracheostomy is less well defined and, unfortunately, the scientific evidence is lacking.

In our practice, translaryngeal intubation is usually maintained for the initial 5 to 7 days, during which the patients' response to treatment of the cerebral insult is assessed.^{12,16} A tracheostomy is often performed if the patient remains neurologically obtunded after the initial 5 to 7 days, or if he is likely to survive the acute course, but may have a poor long-term prognosis in terms of severity of disability. In this situation, the tracheostomy simplifies care and accelerates the transfer from ICU to a step-down intermediate care unit. Tracheostomy is generally not performed in patients who have the potential for rapid neurologic recovery with anticipated extubation within 24 to 72 hours, or in those who have such severe cerebral insults that the prognosis is hopeless. We were fortunate that in our unit, there were some neurosurgeons who favoured an early tracheostomy (within 7 days) and those who preferred to wait (beyond 7 days). This then formed the basis for our patient group analysis.

There are several arguments for performing tracheostomy early. First, there are reports of laryngeal and subglottic stenosis in patients with prolonged translaryngeal intubation. In a prospective study of 200 intubated patients, Whited¹⁷ found that patients intubated for 2 to 5 days had a 6% incidence of transient laryngeal injury, those intubated for 6 to 10 days had a 5% incidence of chronic irreversible laryngeal stenosis, and those intubated for 11 to 24 days had a 12% incidence of extensive laryngeal stenosis.

Second, we know that patients with traumatic head injury and medically-related coma are at particularly high risk of ventilator-associated pneumonia.¹⁸⁻²¹ They are likely to aspirate oropharyngeal secretions shortly after brain injury, during resuscitation, and as a consequence of intubation. Impaired levels of consciousness generally favour continuous and silent aspiration, which leads to the subsequent development of pneumonia.²² In addition, it has also been postulated that a compromise of local airway immune defense mechanisms occurs very early during their illness, which allows microorganisms to adhere and

persist at mucosal surfaces.¹⁵ Longer periods of intubation and greater difficulties with control of airway secretions have been found to contribute to an increased incidence of airway colonisation with nosocomial pathogens in tracheostomised patients.^{23,24} This was reflected in our results where the incidence of multibacterial colonisation was lower in Group 1 patients (42% vs. 72%), although this did not reach statistical significance.

Third, our data also suggest a faster recovery of chest infections in the group of patients who underwent early tracheostomy, although no previously reported study has convincingly demonstrated this.^{6,11,13,25} Many critical care experts consider tracheostomy to be the most effective airway for the removal of respiratory secretions.²⁶ Although this view has yet to be confirmed by objective evidence, surveys of critical care nurses have demonstrated that 90% of respondents agree with this impression.²⁷ Upon subjective questioning, we found that 80% of our neuro-intensive care nurses concurred with the view that tracheostomy tubes facilitated easier suctioning of secretions.

Other potential advantages of early tracheostomy over translaryngeal intubation include the reduction of dead space volume which could aid in the weaning process^{9,28,29} and indeed patients in our study had reduced days of mechanical ventilation when an early tracheostomy was performed. Tracheostomy tubes are also more securely fixed in the airway than translaryngeal endotracheal tubes, decreasing the incidence of accidental extubation of critically ill patients. In addition, should decannulation occur, tracheostomy tubes with mature tracts are more quickly and safely replaced in the absence of immediate personnel with expert intubation skills. This is an important consideration in terms of nursing neurosurgical patients in the general wards later after they have survived the initial injury.

Conclusion

We conclude that early tracheostomy, when performed in selected neurosurgical patients with poor GCS scores, enables rapid weaning from ventilatory support. Additionally, early tracheostomy may have a beneficial role in decreasing the incidence of tracheobronchial colonisation and hasten the recovery of nosocomial pneumonia.

REFERENCES

1. Alberti P W. Tracheostomy versus intubation: A 19th century controversy. *Ann Otol Rhinol Laryngol* 1984; 93:333-7.
2. Garrison F H. *History of Medicine*. Philadelphia: WB Saunders, 1917:91.
3. Eavey R D. The evolution of tracheotomy. In: Myers E N, Stool S E, Johnson J T, editors: *Tracheotomy*. New York: Churchill Livingstone, 1985:1.

4. Jackson C. Tracheostomy. *Laryngoscope* 1909; 19:285.
5. Heffner J E. Timing tracheostomy: calendar watching or individualization of care? *Chest* 1988; 114:361-3.
6. Heffner J E. Timing of tracheostomy in ventilator-dependent patients. *Clin Chest Med* 1991; 12:611-25.
7. Heffner J E. Timing of tracheostomy in mechanically ventilated patients. *Am Rev Respir Dis* 1993; 147:768-71.
8. Marsh H M, Gillespie D J, Baumgartner A E. Timing of tracheostomy in the critically ill patient. *Chest* 1989; 96:190-2.
9. Plummer A L, Gracey D R. Consensus conference on artificial airways in patients receiving mechanical ventilation. *Chest* 1989; 96:178-80.
10. Bishop M J. The timing of tracheostomy: An evolving consensus. *Chest* 1989; 96:712-3.
11. Sugerman H J, Wolfe L, Pasquale M D, Rogers F B, O'Malley K F, Knudson M, et al. Multicenter, randomized, prospective trial of early tracheostomy. *J Trauma* 1997; 43:741-7.
12. Heffner J E. Medical indications for tracheostomy. *Chest* 1989; 96:186-90.
13. Kollef M H, Ahrens T S, Shannon W. Clinical predictors and outcomes for patients requiring tracheostomy in the intensive care unit. *Crit Care Med* 1999; 27:1714-20.
14. Kane T D, Rodriguez J L, Luchette F A. Early versus late tracheostomy in the trauma patient. *Respir Care Clin N Am* 1997; 3:1-20.
15. Ewig S, Torres A, El-Ebiary M, Fàbregas N, Hernández C, González J, et al. Bacterial colonization patterns in mechanically ventilated patients with traumatic and medical head injury. *Am J Respir Crit Care Med* 1999; 159:188-98.
16. Koh W Y, Lew T W, Chin N M, Wong M F. Tracheostomy in a neuro-intensive care setting: indications and timing. *Anaesth Intensive Care* 1997; 25:365-8.
17. Whited R E. A prospective study of laryngotracheal sequelae in long-term intubation. *Laryngoscope* 1984; 94:367-77.
18. Hsieh A, Bishop M J, Kubilis P S, Nellwell D W, Pierson D J. Pneumonia following closed head injury. *Am Rev Respir Dis* 1992; 146:290-4.
19. Langer M, Cigada M, Mandelli M, Mosconi P, Tognoni G, ICUGIC. Early onset pneumonia: a multicenter study in intensive care units. *Intensive Care Med* 1987; 13:342-6.
20. Rello J, Ausina V, Ricart M, Puzo C, Net A, Prats G. Nosocomial pneumonia in critically ill comatose patients: need for a differential therapeutic approach. *Eur Respir J* 1992; 5:1249-53.
21. Rodriguez J L, Gibbons K J, Bitzer L G, Dechert R E, Steinberg S M, Flint L M. Pneumonia: incidence, risk factors and outcome in injured patients. *J Trauma* 1991; 31:907-14.
22. Rello J, Ausina V, Castella J, Net A, Prats G. Nosocomial respiratory tract infections in multiple trauma patients: influence of level of consciousness with implications for therapy. *Chest* 1992; 102:525-9.
23. Cross A S, Roup B. Role of respiratory assistance devices in endemic nosocomial pneumonia. *Am J Med* 1981; 70:681-5.
24. Niederman M S, Merrill W W, Ferranti R D. Nutritional status and bacterial binding in the lower respiratory tract in patients with chronic tracheostomy. *Ann Intern Med* 1984; 100:795-800.
25. Dunham M C, LaMonica C. Prolonged tracheal intubation in the trauma patient. *J Trauma* 1984; 24:120-4.
26. Stock M C, Woodward C G, Shapiro B A. Perioperative complications of elective tracheostomy in critically ill patients. *Crit Care Med* 1986; 14:861-3.
27. Astrachan D J, Krichner JC, Goodwin WJ Jr. Prolonged intubation vs tracheostomy; complications, practical and psychological considerations. *Laryngoscope* 1988; 98:1165-9.
28. Berlauk J F. Prolonged endotracheal intubation vs tracheostomy. *Crit Care Med* 1986; 14:742-5.
29. Diehl J L, El Atrous S, Touchard D, Lemaire F, Brochard L. Changes in the work of breathing induced by tracheotomy in ventilator-dependent patients. *Am J Respir Crit Care Med* 1999; 159:383-8.