Practice Management Guidelines for Timing of Tracheostomy: The EAST Practice Management Guidelines Work Group

Michele Holevar, MD, J. C. Michael Dunham, MD, Robert Brautigan, MD, Thomas V. Clancy, MD, John J. Como, MD, James B. Ebert, MD, Margaret M. Griffen, MD, William S. Hoff, MD, Stanley J. Kurek, Jr., DO, Susan M. Talbert, MD, and Samuel A. Tisherman, MD

STATEMENT OF THE PROBLEM

The ideal time for performing a tracheostomy has not been clearly established. Periods ranging from 3 days to 3 weeks have been suggested in the literature. With current operative methods, it has been established that tracheostomy can be performed with a low rate of complications. In a review of 281 tracheostomies, as well as another 2,862 cases in the literature, Zeitouni and Kost[1] reported 0% mortality in their series and 0.3% mortality in the other series since 1973. The risks of prolonged endotracheal intubation—such as patient discomfort, necessitating increased sedation; sinusitis; inadvertent extubation; and laryngeal injury—have become increasingly apparent.

Selection of patients who might benefit from conversion of a translaryngeal tube to a tracheostomy tube is a complex medical decision. Furthermore, different subgroups may benefit from tracheostomy at different times in their hospital course. Management of patients with a single organ failure (head injury or respiratory failure) may differ from that of the multiple injury trauma patient. With the lack of clear guidelines for selecting patients for tracheostomy, considerable variability exists in the timing of the procedure, with local practice preferences guiding care, rather than patient considerations.

We initiated our review by converting the need for information about optimal timing of tracheostomy into several answerable questions:

1. Does performance of an "early" tracheostomy provide a survival benefit for the recipients?
2. What patient populations benefit from an "early" tracheostomy?
3. Does "early" tracheostomy reduce the number of days on mechanical ventilation and intensive care unit length of stay (ICU LOS)?
4. Does "early" tracheostomy influence the rate of ventilator-associated pneumonia?

PROCESS

Identification of References

A computerized search was undertaken using Medline with citations published between the years of 1966 and 2004. By using the search words "tracheostomy" and "timing" and by limiting the search to citations dealing with human subjects and published in the English language, we identified 87 articles. From this initial search, case reports, review articles, editorials, letters to the editor, and pediatric series were excluded before formal review. Additional references, selected by the individual subcommittee members, were then included to compile the master reference list of 24 citations.

Articles were distributed among the subcommittee members for formal review. A data sheet was completed for each article that was reviewed, which summarized the purpose of the study, hypothesis, methods, main results, and conclusions. The reviewers classified each reference by the methodology established by the Agency for Health Care Policy and Research of the U.S. Department of Health and Human Services.

Quality of the References

Class I: Prospective randomized controlled trials (PRCT) (7 references).

Class II: Clinical studies in which the data were collected prospectively, and retrospective analyses that were based on clearly reliable data. Types of studies classified as such included observational studies, cohort studies, prevalence studies, and case-control studies (5 references).

Class III: Studies based on retrospectively collected data. Evidence used in this class included clinical series and database or registry review (12 references).

An evidentiary table was constructed using the remaining 24 references (Table 1). Additionally, a meta-analysis,

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From the Chicago Medical School/Rosalind Franklin University (M.H.), Chicago, Illinois; Northeastern Universities School of Medicine (J.C.M.D.), Rootstown, Ohio; University of Connecticut School of Medicine (R.B.), Farmington, Connecticut; New Hanover Regional Medical Center (T.V.C.), Wilmington, North Carolina; MetroHealth Medical Center (J.J.C.), Cleveland, Ohio; Elmhurst Memorial Health Center (J.B.E.), Elmhurst, Illinois; University of Florida-Jacksonville (M.M.G.), Jacksonville, Florida; University of Tennessee Medical Center at Knoxville (S.J.K.), Knoxville, Tennessee; St. Luke's Roosevelt Hospital (S.M.T.), New York, New York; and University of Pittsburgh (S.A.T.), Pittsburgh, Pennsylvania.
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Address for correspondence: Michel Holevar, MD, 1500 South California Avenue, F938, Chicago, IL 60612; email: michellehmail-career@yahoo.com.

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TABLE 1. Evidentiary Table

First Author	Year	Reference	Data Class	Conclusions/Comments
Sugarman HJ	1997	Multicenter, randomized, prospective trial of early tracheostomy. J Trauma. 1997;43;741–747	I	This study failed to find any significant benefit to early (days 3 - 5) tracheostomy with regard to the ICU LOS, frequency of pneumonia, or mortality rate. The early tracheostomy group, however, had significantly higher Apache III scores, which may have affected the results of the study.
Rodriguez JL	1990	Early tracheostomy for primary airway management in the surgical critical care setting. Surgery. 1990;108;655	I	Early tracheostomy shortens days on the ventilator as well as ICU & hospital LOS and should be considered for patients in the ICU at risk for more than 7 d of intubation.
Dunham M	1984	Prolonged tracheal intubation in the trauma patient J Trauma. 1984;24;120	I	Patients can undergo translaryngeal intubation for up to 2 wk without significantly increasing complications relative to transtracheal intubation.
Saffle, JR	2002	Early Tracheostomy Does Not Improve Outcome in Burn Patients. Journal of Burn Care and Rehabilitation. 2002; 6;431–8	I	Early tracheostomy in the burn patient does not improve outcomes nor result in early extubation.
Bouderka MA	2004	Early tracheostomy versus prolonged endotracheal intubation in severe head injury. J Trauma. 2004;57;251	I	In severe head injury, early tracheostomy decreases total days of mechanical ventilation.
Barquist E	2004	A randomized prospective study of early vs late tracheostomy in trauma patients www.aast.org/04abstracts	I	Performance of tracheostomy at day 8 did not reduce the number of days of mechanical ventilation, frequency of pneumonia or ICU length of stay compared to patients with tracheostomy performed >28 d.
Rumbak MJ	2004	A prospective, randomized study comparing early percutaneous dilational tracheotomy to prolonged translaryngeal intubation (delayed tracheotomy) in critically ill medical patients. Critical Care Med. 2004; 32;1689	I	The benefits of early tracheotomy outweigh the risks of prolonged translaryngeal intubation.
El-Naggar M	1976	Factors influencing choice between tracheostomy and prolonged translaryngeal. Anasthesia & Analgesia. 1976; 55;195–201	II	Predictors of serious airway lesions and mortality difficult to determine. The types of tubes used and the inclusion criteria for this study make the findings difficult to understand.
Blot F	1995	Early Tracheostomy in Neutropenic, Mechanically Ventilated Patients: Rationale and Results of a Pilot Study. Support Care Cancer. 1995;3;291–296	II	Trend toward increased survival in neutropenic patients who undergo early tracheostomy. Class I study in progress.
Arabi Y	2004	Early tracheostomy in intensive care trauma patients improves resource utilization: a cohort study and literature review. Critical Care. 2004;8;R346;	II	Early tracheostomy (within 7 d of admission) in trauma ICU patients is associated with shorter duration of mechanical ventilation and ICU LOS. There is no difference in mortality.
Claridge JA	2002	Can we predict who needs a tracheostomy at admission? www.aast.org/02abstracts	II	Age, ARDS and pneumonia predicted the need for tracheostomy. Early tracheostomy (</= 7 d) was associated with decreased ventilator dependence.
Brook AD	2000	Early versus late tracheostomy in patients who require prolonged mechanical ventilation. American Journal of Critical Care. 2000;9;352–359	II	The authors conclude that early tracheostomy is associated with shorter duration of mechanical ventilation, shorter intensive care unit lengths of stay, and lower hospital costs than is late tracheostomy among patients in a medical intensive care unit.
Armstrong PA	1998	Reduced use of resources by early tracheostomy in ventilator-dependent patients with blunt trauma. Surgery. 1998;124;763–767	III	The authors conclude that tracheostomy within the first 6 d of hospitalization resulted in significantly lowered use of resources with no adverse effect on outcome.
Kluger Y	1996	Early tracheostomy in trauma patients. European Journal of Emergency Medicine. 1996;3;95–101	III	The authors conclude that early tracheostomy may decrease pulmonary septic complications in trauma patients.
Koh WY	1997	Tracheostomy in a neuro-intensive care setting: indications and timing. Anesthesia and Intensive Care.1997;25;365-368	III	Although the authors conclude that elective tracheostomy for selected patients with poor neurological status and nosocomial pneumonia resulted in shortened intensive care unit length of stay and rapid weaning from ventilator support, this conclusion is not supported by the data, as the mean length of intubation prior to tracheostomy is nearly identical.
Qureshi AI	2000	Prediction and timing of tracheostomy in patients with infratentorial lesions requiring mechanical ventilatory support. Critical Care Medicine. 2000;28;1383–1387	III	Patients with infratentorial lesions should have tracheostomy performed after 8 d because the probability of successful extubation and potential death is approximately 5%. Early tracheostomy should be considered in those patients with a GCS <7 and evidence of brainstem dysfunction at the time of intubation.

(continued)

TABLE 1. Evidentiary Table (continued)

First Author	Year	Reference	Data Class	Conclusions/Comments
Major KM	2003	Objective indications for early tracheostomy after blunt head trauma. American Journal of Surgery. 2003; 186;615	III	Calculating the GCS & SAPS can aid in identifying those patients who will ultimately require a tracheostomy for prolonged airway protection after blunt trauma.
Gurkin SA	2002	Indications for tracheostomy in patients with traumatic brain injury. American Surgery. 2002;68;324	III	Patients with TBI presenting with a GCS </=8, an ISS >/= 25, and ventilator days > 7 are more likely to require a tracheostomy.
Teoh WH	2001	The role of early tracheostomy in critically ill neurosurgical patients. Ann Acad Med Singapore. 2001;20;234	III	Early tracheostomy in neurosurgical patients may lead to decreased length of ventilation.
Lanza DC	1990	Predictive value of the Glasgow Coma Scale for tracheotomy in head-injured patients. Ann Otol Rhinol Laryngol. 1990;99;38	III	Patients with significant intracranial injury who did not undergo craniotomy and had a GCS ≤ 7 require prolonged intubation and subsequent tracheostomy in 95% of the cases.
Enfors B	1967	Tracheostomy in general surgery. Indications & results. Acta Chir Scan. 1967;133;217	III	Early tracheostomy (<48 h) is beneficial in brain injury.
Van Boerum DH	1999	Timing of tracheostomy correlated with costs and resource utilization in critically ill patients. www.aast.org/99abstracts	III	For patient requiring tracheostomy, early tracheostomy was associated with lower total costs, shorter duration of mechanical ventilation, and shorter hospital LOS.
Lesnik I	1992	The role of early tracheostomy in blunt, multiple organ trauma. American Surgery. 1992;58;346	III	Early tracheostomy helps in early weaning from the ventilator and reduces the incidence of nosocomial pneumonia.
Kluger Y	1996	Early tracheostomy in trauma patients. European Journal of Emergency Medicine. 1996;3;95	III	Early tracheostomy may decrease pulmonary septic complications in trauma patients.

including the seven class I articles, was done by the Vice Chairman of the Committee, Michael Dunham. Recommendations were based on studies that were included in the evidentiary tables.

RECOMMENDATIONS

Level I

There is no mortality difference between patients receiving early tracheostomy (3–7 days) and late tracheostomy or extended endotracheal intubation.

Level II

Early tracheostomy decreases the total days of mechanical ventilation and ICU LOS in patients with head injuries. Therefore, it is recommended that patients with a severe head injury receive an early tracheostomy.

Level III

Early tracheostomy may decrease the total days of mechanical ventilation and ICU LOS in trauma patients without head injuries. Early tracheostomy may decrease the rate of pneumonia in trauma patients. Therefore, it is recommended that early tracheostomy should be considered in all trauma patients who are anticipated to require mechanical ventilation for >7 days, such as those with neurologic impairment or prolonged respiratory failure.

SCIENTIFIC FOUNDATIONS

The optimal timing for tracheostomy has been controversial. Laryngeal complications were common before the widespread use of endotracheal tubes with low-pressure, high-volume cuffs. With modern endotracheal tubes, it has been established that patients can be safely intubated for at least 14 days.[2] In a prospective, randomized, controlled trial of 74 trauma patients who received a tracheostomy at either 3 days or 14 days, there was no significant difference in the incidence of major laryngotracheal pathology between the early and late tracheostomy groups. Significantly, because the perfusion pressure of the tracheal mucosal capillaries was ~20–30 mm Hg, the authors were careful to limit cuff pressures to 25 mm Hg whenever possible.

There have been many advantages attributed to converting a translaryngeal endotracheal tube to a tracheostomy tube in the critically ill or injured patient, although not all of them are supported in the literature. Among them are improved patient comfort; facilitation of nursing care, such as airway suction and oral hygiene; and psychologic benefit. These statements have never been tested with a large-scale prospective, randomized study. Astrachan et al.[3] surveyed 60 critical care nurses, the majority of whom felt that tracheostomy simplified airway care. They also thought that patients were more comfortable and, therefore, required less sedation and restraints. Unfortunately, there are no data available from either patients or their families on the preferred method of airway support.

A common perception among critical care providers is that early tracheostomy may reduce the necessity for mechanical ventilation. One possible mechanism is that mobilization of the patient might allow improved pulmonary toilet and functional residual capacity as well as avoidance of oversedation. Decreased airflow resistance and reduced dead space after tracheostomy may also contribute to accelerate weaning. In a study of 20 patients, Davis et al.[4] found decreased work of breathing per minute (8.9 ± 2.9 J/min vs. 6.6 ± 1.4 J/min, $p < 0.04$) and airway resistance (9.4 ± 4.1 cm $H_2O \cdot L^{-1} \cdot s^{-1}$ vs. 6.3 ± 4.5 cm $H_2O \cdot L^{-1} \cdot s^{-1}$, $p < 0.07$) after conversion of a translaryngeal tube to tracheostomy.

A number of retrospective and a few prospective outcome studies have examined the effect of tracheostomy on weaning from mechanical ventilation. These studies have compared patients undergoing "early" tracheostomy to patients either continuing with translaryngeal intubation or undergoing "late" tracheostomy. There is a great deal of variability in the definition of "early" tracheostomy, varying from 2 to 10 days from the time of initial intubation. Furthermore, some of these studies have used quasirandomization methods (even/odd admission day and even/odd medical record number) or assigned patients to groups based on physician preference.

Rodriguez et al. prospectively randomized (by day of admission) 106 multiple trauma patients to receive either an early tracheostomy (within 7 days) or late tracheostomy (greater than 7 days). They found a reduction in duration of mechanical ventilation favoring the early tracheostomy group (12 days vs. 32 days, $p < 0.05$). Not surprisingly, ICU LOS was also reduced (16 days vs. 37 days, $p < 0.05$), as was overall hospital LOS (34 days vs. 51 days, $p < 0.05$). Their conclusion was that early tracheostomy shortens days on the ventilator as well as ICU and hospital LOS. They advised considering tracheostomy for patients in the ICU who are at risk for >7 days of intubation.[5]

In a cohort study of 136 trauma ICU patients who were entered prospectively into an ICU database, Arabi et al.[6] found that the duration of mechanical ventilation was significantly shorter (9.6 days vs. 18.7 days, $p < 0.0001$) when tracheostomy was performed within 7 days, as was ICU LOS (10.9 days vs. 21 days, $p < 0.0001$). These results were supported by the review conducted by Van Boerum et al. on 94 trauma patients who required tracheostomies. In this study, tracheostomy within 7 days of intubation resulted in a significant reduction in ventilator days (9.6 days vs. 18.7 days, $p < 0.0001$) and a reduction in ICU LOS (10.9 days vs. 21 days).[7]

Lesnik et al. retrospectively reviewed 101 blunt trauma patients who underwent tracheostomy. Patients who underwent tracheostomy within 4 days of injury had significantly fewer days of mechanical ventilation compared with those who underwent tracheostomy at 5 or more days (6.0 vs. 20.6, $p < 0.001$). The selection criteria for performing early tracheostomy were not given.[8]

In a prospective, randomized trial of 62 patients with isolated head injury, Bouderka et al. randomized patients on the fifth day to receive either a tracheostomy or a prolonged translaryngeal intubation. The total ventilation days were significantly less in the early tracheostomy group (14.5 days vs. 17.5 days, $p < 0.02$).[9]

Results in the Medical Intensive Care Unit (MICU) population mirror those in the trauma patient population. In a prospective, randomized, controlled trial of 120 MICU patients who were projected to require mechanical ventilation for more than 14 days, patients received either early percutaneous tracheostomy within 48 hours of intubation or late tracheostomy at days 14–16. Early tracheostomy was associated with reduced duration of mechanical ventilation (7.6 days vs. 17.4 days, $p < 0.001$) and decreased ICU LOS (4.8 days vs. 16.2 days, $p < 0.001$).[10]

Brook et al. added financial information to the clinical data in their retrospective cohort study of 90 MICU patients who underwent either early (< 10 days, mean 5.9 days) or late (> 10 days, mean 16.7 days) tracheostomy. Both duration of mechanical ventilation (28.3 days vs. 34.4 days, $p = 0.005$) and ICU LOS (15.6 days vs. 29.3 days, $p < 0.001$) were reduced, which was reflected in a lower cost of hospitalization ($86,189 vs. $124,649, $p = 0.001$) for the patients who received tracheostomy within 10 days.[11]

Therefore, it seems that tracheostomy that is performed earlier rather than later will reduce days of mechanical ventilation and, therefore, ICU LOS and overall cost. Whether early tracheostomy affects the frequency of pneumonia is less well elucidated. The studies that report frequency of pneumonia use the Center for Disease Control criteria, which are notoriously inaccurate in intubated ICU patients.

In the PRCT of multiple trauma patients by Rodriguez,[7] early tracheostomy resulted in a statistically significant lower incidence of pneumonia (78% vs. 96%, $p < 0.05$). In the study of PRCT of 120 MICU patients by Rumbak et al.,[10] early tracheostomy was again associated with a lower rate of pneumonia (5% vs. 25%, $p < 0.05$). This conclusion was supported by retrospective reviews by Lesnik et al.,[8] who also demonstrated a reduced incidence of pneumonia after early tracheostomy (19% vs. 59%, $p < 0.001$), and Kluger et al.[12] (14% Early, 23% Intermediate, and 43% Late, $p = 0.0034$). Although Sugerman et al.[13] failed to find a difference in mortality in their PRCT of trauma and ICU patients, a difference in Apache scores between the tracheostomy and nontracheostomy groups may account for this finding. In a PRCT of 74 trauma patients who received either an early or late tracheostomy, Dunham and LaMonica also failed to find a difference in pulmonary septic complications. In their study, however, all types of respiratory sepsis (tracheitis, pneumonia, lung abscess, and peristomal infection) were combined for analysis, which may explain their differing results.[2]

Unfortunately, early tracheostomy has not been found to provide a survival benefit for its recipients. Of six prospective, randomized, controlled trials,[5,10,11,13–15] only one has demonstrated a reduction of mortality. In a study of 120 MICU patients who were projected to need ventilation beyond 14 days, patients who were randomized to early percutaneous tracheostomy within 48 hours had a lower mortality rate than those receiving delayed tracheostomy at days 14–16 (31.7% vs. 61.7%, $p < 0.05$).[10] Therefore, although early tracheostomy may reduce ventilator days and pneumonia rates, an effect on mortality remains to be seen.

FUTURE INVESTIGATIONS

Future investigations should be performed in a prospective, randomized manner with a sufficient number of patients to enable clinicians to draw valid, concrete conclusions as to the optimal methods of evaluating these patients. Prospective randomization will decrease the baseline differences between the groups and allow more concrete conclusions to be drawn.

Quasirandomization methods (e.g., hospital record number and even-odd days) should be avoided. Consensus as to what constitutes "early" versus "late" tracheostomy should be established, so that various studies can be compared. Because blinding is unrealistic, systematic weaning protocols should be used to reduce the effect of different approaches toward weaning. It remains unclear as to which patients will need prolonged ventilation. Multi-institutional studies of sufficient sample sizes of specific patient populations, such as the head injured, should identify objective criteria to aid the individual physician in determining which subgroups of patients are likely to require prolonged ventilation and might subsequently benefit from an early tracheostomy. Given the current condition of shrinking resources, future studies should also routinely include cost-effectiveness analysis.

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