Outcome Evaluation of Patients Requiring Tracheostomy in an Intensive Care Unit in Trinidad

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ABSTRACT

Objective: *To evaluate the outcome of patients who have undergone a tracheostomy in a multidisciplinary intensive care unit (ICU) and to determine the difference between an early and late tracheostomy.*
Design and Methods: *All patients who had tracheostomy in the ICU of The Eric Williams Medical Sciences Complex, Trinidad and Tobago, over a five-year period were retrospectively analysed. Data recorded included demographics, admission diagnoses, Glasgow Coma Score, Acute Physiology and Chronic Health Evaluation II score, Paediatric Index of Mortality II score, indication for endotracheal intubation and tracheostomy and the day it was performed, ICU and hospital length of stay and observed mortality. Predicted mortality was calculated. A comparison was made of patients who had tracheostomy before and after ten days following ICU admission. Validation of the prognostic models was done by Receiver Operating Curve (ROC) analysis.*
Results: *One thousand six-hundred and fourteen patients were admitted to ICU during the study period; 51 patients (3%) underwent tracheostomy, of which 48 were studied. The overall mortality was 19.1% and 40.6% in tracheostomised patients. Patients who had tracheostomy within ten days had a significantly lesser predicted mortality and shorter ICU length of stay than those who had it after ten days (*p *= 0.01). The observed mortality was also significantly less in early-tracheostomised patients (*p *< 0.02).*
Conclusions: *Tracheostomy should ideally be done within ten days following ICU admission when there is a clear need and indication for the procedure. Further delay may contribute adversely to the ICU morbidity and mortality.*

Evaluación de la Evolución Clínica de Pacientes que Necesitan Traqueotomía en una Unidad de Cuidados Intensivos en Trinidad

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RESUMEN

Objetivo: *Evaluar la evolución clínica de pacientes a los que se le ha practicado la traqueotomía en una unidad de cuidados intensivos (UCI) multidisciplinaria, y determinar la diferencia entre una traqueotomía temprana y una tardía.*
Diseño y Métodos: *Se analizaron retrospectivamente todos los pacientes que tuvieron traqueotomía en la UCI del Complejo de Ciencias Médicas Eric Williams de Trinidad y Tobago, por un período de más de cinco años. Los datos registrados incluían información demográfica, diagnósticos de ingreso, la Puntuación de la Escala de Coma de Glasgow, la Puntuación II para la Evolución de la Salud Crónica y la Fisiología Aguda, la Puntuación II del Índice Pediátrico de Mortalidad, la indicación de la entubación endotraqueal y la traqueotomía, así como el día en que fuera realizada, la UCI y el tiempo de hospitalización, y la mortalidad observada. Se calculó la mortalidad predicha. Se hizo una comparación de los pacientes que tuvieron traqueotomía antes y después de diez días luego de su ingreso a la UCI. Se realizó una validación de los modelos prognósticos mediante el análisis de la curva de las características operativas del receptor (ROC).*

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Resultados: *Mil seiscientos catorce pacientes fueron ingresados a la UCI durante el período bajo estudio; a 51 pacientes (3%) les fue practicada la traqueotomía, y de ellos 48 fueron estudiados. La mortalidad fue 19.1% en general y 40.6% en pacientes traqueotomizados. Los pacientes que tuvieron traqueotomía dentro de los diez días tuvieron una mortalidad predicha significativamente menor, y una estadía hospitalaria más corta que los que tuvieron la traqueotomía luego de los diez (*p = *0.01). La mortalidad observada fue también significativamente menor en los pacientes traqueotomizados tempranamente (*p < *0.02).*

Conclusiones: *La traqueotomía debe realizarse dentro de los diez días posteriores al ingreso a la UCI, cuando la necesidad y la indicación del procedimiento estén claras. Cualquier demora más allá de este límite, puede contribuir de manera adversa a la morbilidad y la mortalidad en la UCI.*

West Indian Med J 2009; 58 (2): 174

INTRODUCTION

Tracheostomy is performed in critically ill patients for various indications. One of the common indications is prolonged mechanical ventilation in an intensive care unit (ICU). Other than the routine endotracheal (translaryngeal) intubation, there are four different techniques for obtaining tracheal access in critically ill patients (1, 2). These include, standard tracheostomy, percutaneous tracheostomy, minitracheostomy and cricothyroidotomy

Currently, in the multidisciplinary ICU of The Eric Williams Medical Sciences Complex (EWMSC), Trinidad and Tobago, the patients requiring elective tracheostomy are referred to the Otorhinolaryngology (ENT) surgeon after an average period of fourteen days of translaryngeal endotracheal intubation. This may be sometimes extended in infants and children due to the expectation of weaning the paediatric patients off the ventilator without a tracheostomy. There is also a perception that the morbidity and mortality associated with tracheostomy in paediatric patients may be higher than that of the older age groups (3).

Even after the decision to perform the tracheostomy in a patient, an additional delay is encountered before the procedure is done. This is due to staff shortage necessitating cross coverage of two tertiary hospitals by one group of ENT surgeons. The tracheostomy is therefore scheduled in accordance with their availability and workload. Until recently, in the study ICU, all tracheostomies were done surgically by ENT surgeons. Percutaneous tracheostomy was started only as late as September 2005 and is done by the anaesthetists providing patient care in the ICU. However, percutaneous tracheostomy is not commonly done because the kit is expensive and there may be a need for a bronchoscope for its safe use (4). There is no background data regarding the timing of tracheostomy in the ICUs in Trinidad and Tobago. Hence this study was undertaken to review and analyse the characteristics of ICU patients who had tracheostomies performed as an elective procedure.

SUBJECTS AND METHODS

Approval of the Ethics Committee of The University of the West Indies, St Augustine, was obtained prior to the study. This study was a retrospective analysis of the charts of all patients who had tracheostomy during a five-year period from January 2000 to December 2004 in the multidisciplinary ICU of the EWMSC. Approval was also sought from the Regional Health Authority for retrieval of the case notes. Case notes were collected from the Medical Records Department and no patient identifiers were recorded to maintain confidentiality.

Intensive Care Unit setting

The multidisciplinary ICU in the EWMSC is a 6–bed open unit, admitting both adult and paediatric patients from all medical and surgical specialties. Patients get admitted from the Priority Care Facility (Accident and Emergency Department) directly, from the operating rooms and also from the general wards. The unit adopts a 'mixed' ICU model with respect to medical staffing. A team of anaesthetic residents under the supervision of a consultant anaesthetist cares for the patient round the clock and there is daily input from the patient's primary doctors with regards to patient management. The nurse to patient ratio is predominantly 1:1. The study included paediatric and adult patients in whom tracheostomies were done as a formal elective surgical procedure.

We excluded patients in whom tracheostomies were done for emergency securing of the airway *eg*, surgical cricothyroidotomy in cases of failed intubation.

Patients admitted to the study-ICU with a tracheostomy already *in situ* (including those inserted at another institution) were also excluded.

The following data were recorded:

Initial data included relevant demographic data such as age and gender of the patients.

To assess the severity of illness of the ICU patients, two 'severity of illness' scoring systems were applied: The Acute Physiology and Chronic Health Evaluation II (APACHE II) score for adult patients (5) and Paediatric Index of Mortality 2 (PIM-2) score for paediatric patients (6). Glasgow Coma Score (GCS) was recorded for adult patients and its paediatric version was applied to children. Although GCS is part of the APACHE II scoring system, it was recorded separately to determine if tracheostomy was done for

an unconscious patient exclusively for the purpose of securing airway and/or ventilatory support.

Further clinical data with respect to tracheostomy included the indication for endotracheal intubation and tracheostomy. The timing of tracheostomy including the day it was done after ICU admission and initiation of mechanical ventilation was noted. Other clinical data recorded included duration of mechanical ventilation before and after tracheostomy, problems of weaning if any, length of ICU stay, hospital length of stay, hospital outcome and complications of tracheostomy.

For the purpose of analysis, the tracheostomised patients were divided into two groups:

Group 1. Tracheostomy performed on or before day-10 following admission to the study-ICU

Group 2. Tracheostomy performed after day-10 following admission to the study-ICU

All data were analysed descriptively. Chi-square analysis was used to compare categorical data and Mann Whitney-U test were used to analyse interval scale data with wide distribution. Receiver Operating Characteristic (ROC) curve analysis was done to validate the prognostic models used in the study. Statistical significance was fixed at the level of $p < 0.05$. Statistical package for Social Sciences (SPSS)-version 12 was used for data analysis.

Results

During the five-year study period 1614 patients were admitted to the study-ICU. The overall hospital mortality was 19.1%. Table 1 shows the patient turnover in the study-ICU

Table 1: Admissions to the ICU during the study period

Year	Number of admissions	Number of tracheostomies	Overall mortality (%)
2000	432	4	17.8
2001	362	10	19.6
2002	298	12	19.1
2003	197	15	17.8
2004	325	10	20.9
Total	**1614**	**51**	**19.1**

and the observed hospital mortality in these patients during the five years. The mortality in tracheostomised patients was 40.6%.

Fifty-one (3%) patients had tracheostomies performed during the five-year period but three were excluded because the tracheostomies were done as emergencies. An average of ten tracheostomies were done per year, all of which were done by the ENT surgeons by the standard surgical approach.

During the study period, paediatric patients accounted for 62.5% and adult patients for 37.5% of the total ICU admissions and more males (68.8%) were admitted. The age range of patients was from one-day to 76 years with a median age of 12 years (5.5 – 45.5 Interquartile range, IQR). The mean Glasgow Coma Score was 7.7 ± 4.6 (Standard Deviation, SD). The mean APACHE II score was 10.5 ± 10.5 (SD) for the adult patients. (Fig. 1, 2) show the indications

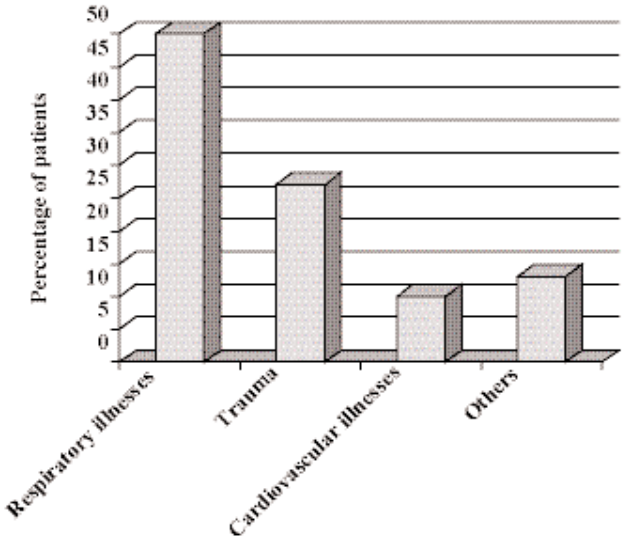

Fig. 1: Indications for endotracheal intubation
Other: Post-cardiac arrest, anaphylactic reactions, elective postoperative admissions.

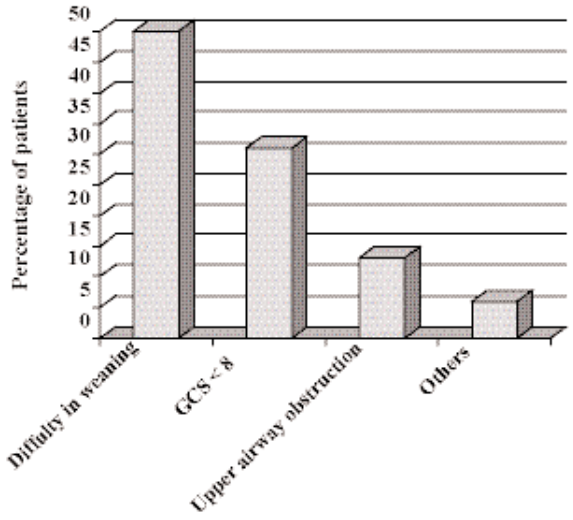

Fig. 2: Indications for tracheostomy
Others: Tracheal toileting, post-thyroidectomy complication, polymyositis.

for endotracheal intubation (translaryngeal) and tracheostomy respectively. Pneumonia was the most common respiratory pathology, cardiogenic shock and pulmonary oedema due to ischaemic heart disease was the most common cardiac pathology while head injury was the most common trauma requiring ICU admission. The median duration of mechanical ventilation was 17.5 days (13.3 – 24.5 IQR).

The patients had tracheostomy done ranging from three days following ICU admission to 33 days. The median day of tracheostomy was 13 (9 – 15.8 IQR).

Table 2 shows the comparison of parameters between patients who had tracheostomy before and after ten days following admission. ICU length of stay ranged from four days to 73 days with a median value of 20.5 days (15.3 – 29.8 IQR). Hospital length of stay ranged from seven days to 166 days with a median value of 46.5 days (20 – 99.3 IQR). The ICU length of stay for patients in whom tracheostomy was done within ten days was significantly shorter than those who had the tracheostomy after 10 days (p = 0.01 by Mann Whitney-U test).

Table 2: Comparison between patients who had tracheostomy before and after 10 days

Variable	Tracheostomy ? 10 days	Tracheostomy < 10 days	Significance
Age (years) (Median, IQR)	13 (8.5 – 46.5)	9 (1 – 25)	NS
GCS (Mean ± SEM)	8.0 ± 0.9	7.4 ± 1.8	NS
Duration of mechanical ventilation (days) (Mean ± SEM)	22.8 ± 3.3	14.7 ± 2.2	NS
ICU length of stay (days) (Mean ± SEM)	27.5 ± 2.9	18.0 ± 2.8	p = 0.01*
Hospital length of stay (days) (Mean ± SEM)	68.6 ± 9.3	39.5 ± 18.3	NS
Observed mortality (%)	52.4	18.2	p < 0.02†
Predicted mortality (%) (Mean ± SEM)	31.0 ± 4.4	17.2 ± 2.4	p = 0.01*

GCS = Glasgow Coma Score, SEM = Standard error of Mean, IQR = Interquartile range
NS = Not statistically significant
* by Mann Whitney U test
† by chi-square analysis

Predicted mortality of all patients was calculated using the logistic regression equations published with the scoring systems. The overall median predicted mortality was 26% (15 – 32.2 IQR). The mean predicted mortality for patients in whom tracheostomy was done within ten days following ICU admission was significantly less than those who had the tracheostomy after ten days (p = 0.011 by Mann Whitney-U test).

There was a statistically significant difference in the observed mortality between the patients who had tracheostomy before and after 10 days following ICU admission (Table 2). A chi-square analysis confirmed that there was a significantly less mortality in the early-tracheostomy group ($?^2$ = 4.53, df = 1, p < 0.02).

There were three cases of ventilator associated pneumonia, there were no documented cases of tracheal stenosis at the time of decannulation and no other complications were documented due to tracheostomy *in-situ*. One paediatric patient had cardiac surgery and had an extended period of ventilation secondary to complications of the surgery. Table 3 shows the comparison between survivors and non-survivors within the tracheostomised patients.

Table 3: Comparison between survivors and non-survivors

Variable (Mean ± SEM)	Survivors	Non-survivors	Significance
Day of tracheostomy	12.5 ± 1.6	14.2 ± 1.4	NS
ICU length of stay (days)	24.3 ± 2.6	25.5 ± 4.6	NS
Hospital length of stay (days)	74.6 ± 12.2	42.8 ± 10.3	P < 0.01*
GCS	7.9 ± 1.1	7.9 ± 1.3	NS
Predicted mortality (%)	20.4 ± 4.3	37.3 ± 4.9	P < 0.05*

GCS = Glasgow Coma Score
SEM = Standard error of Mean
NS = Not statistically significant
* by Mann Whitney U test

A Receiver Operator Characteristic Curve analysis was done to validate the prognostic scoring systems used in the study. The discriminating ability of the scoring systems between survivors and non-survivors was good as shown by the area under the curve of 0.81 (0.65, 0.97, 95% Confidence Intervals) with statistical significance (p = 0.004) [Fig. 3].

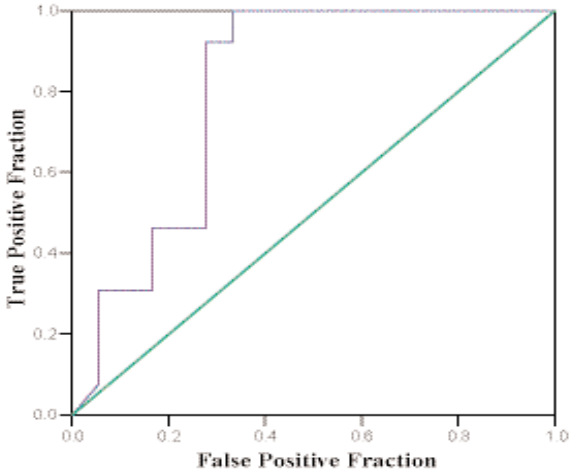

Fig. 3: Receiver Operator Characteristic (ROC) Curve analysis for validating the prognostic scoring systems.

DISCUSSION

The major finding of the present study is that if the tracheostomy is done within ten days following admission, there was favourable outcome of ICU patients.

The timing of tracheostomy in critically ill patients has been the subject of interest in recent times with many studies advocating performing early tracheostomy in the critically ill, once mechanical ventilatory support is anticipated to exceed

seven days (7–10). Notably, the only consensus statement made on the timing of the conversion of translaryngeal endotracheal intubation to tracheostomy was by The American College of Chest Physicians [11].

The recommendations from the consensus group were as follows:

- For anticipated need of the artificial airway up to 10 days, the translaryngeal route is preferred.
- For anticipated need of the artificial airway for > 21 days, tracheostomy is preferred.
- When the time anticipated for the maintenance of an artificial airway is not clear, daily assessment is required to determine whether conversion to tracheotomy is indicated.
- The decision to convert to tracheotomy should be made as early as possible in the course of management to minimise the duration of translaryngeal intubation.

After the consensus statement, many retrospective and prospective studies were done on medical, trauma and neurosurgical patients to determine the effect of early (<10 ten days) tracheostomy *versus* late (>10 ten days) tracheostomy (7–10). Earlier tracheostomy was found to be beneficial in patients who are anticipated to have no improvement in their neurological state [Glasgow Coma Score < 8] and with anticipated difficulty in weaning from mechanical ventilation. The benefits included shorter duration of mechanical ventilation, shorter ICU length of stay and lower incidence of ventilator associated pneumonia. The present study also found that there was a statistically significant lesser mortality and decreased ICU length of stay in patients who had an early tracheostomy, similar to the findings of other published studies.

Currently in the ICU setting, there is an increasing trend for percutaneous tracheostomy procedures, which may allow a bedside performance of the procedure without having to subject the patient to the hazards of transport (12). The complications of general anaesthesia could also be avoided because percutaneous tracheostomy could be done under local anaesthesia. In a meta-analysis comparing the standard tracheostomy and percutaneous tracheostomy, it was found that there was a five-fold difference in complication rate between standard tracheostomy *versus* percutaneous tracheostomy (13). The complications were less severe in the percutaneous tracheostomy group and it was concluded that it was a safer technique in a patient with a normal neck. Another study also found that even though there were minor differences in the complication rate between the various commercially available percutaneous sets, they were equally reliable (14). In our situation, this procedure was started only recently and a scientific evaluation and comparison cannot be done because the numbers are too small. Additionally, there is controversy on the role of percutaneous tracheostomy in paediatric patients and hence tracheostomy would often have to be done in the operating theatre. Since percutaneous tracheostomy is done only in adult patients and the study-ICU was predominantly admitting paediatric patients (63%) during the study period, this precluded any reasonable comparison due to skewing of data.

Klotz and Hengerer showed that it was safe to perform tracheostomy on paediatric patients in the ICU, once patients were selected appropriately (3). In our situation, the ENT surgeons always prefer to do the tracheostomy in an operating theatre setting rather than in ICU. There were no documented early or late complications attributable to the standard surgical tracheostomy in this study, which may defend this choice.

The scoring systems used in the study not only give an idea about the severity of illness of the patient but also predict patient outcomes in an ICU (15). The severity of illness and predicted mortality in patients who had an earlier tracheostomy was less than those who had it later. Although this may partly explain the lower mortality in this group of patients, the study clearly showed a lower morbidity in these patients as shown by a reduced length of stay. Every prognostic model has to be validated to the case mix studied to make it reliable with respect to its prognosticating ability. In the present study, the scoring systems performed reasonably well in the case mix as shown by the area under the Receiver Operating Characteristic (ROC) curve (0.81).

There were some limitations to the present study which are common to a retrospective analysis. Firstly, the initial sample size itself was small which would have affected the statistical analysis of the possible associations. However, during the study period, the study-ICU predominantly served the paediatric population of the country and as mentioned earlier, tracheostomy is not performed as commonly in children as compared to adults. This was the main reason for the small sample size. Because of the multidisciplinary nature of the study-ICU (both paediatric and adult patients), case-mix variability may affect the performance of a prognostic scoring system. Although the present study showed a good performance of the prognostic models, it may be difficult to make discrete conclusions because of the small sample size. Nevertheless, in conclusion, the study found that the delay in performing surgical tracheostomy in the ICU patients may adversely affect outcome. Hence tracheostomy in ICU patients should be ideally done within ten days following admission when there is a clear need and indication for the procedure.

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