# A Study of the Relationship Between APACHE II Scores and the Need for a Tracheostomy

K L McHenry, R L Byington, E L Verhovsek, S Keene

**Citation**

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**Abstract**

The purpose of this research was to determine if significant differences exist between the APACHE II scores of intubated mechanically ventilated patients who ultimately received a tracheostomy and those who did not. In addition to this inquiry, the study also investigated the possibility of a range of APACHE II scores, a particular age group, and the presence of chronic organ insufficiencies and their relationship to the tracheostomy result. Methodology was non-experimental, quantitative, and retrospective. It was observational in that the goal was to simply record and quantify the potential association between these variables. Data was obtained from patients at Bristol Regional Medical Center from January 1- August 31, 2011. Information was calculated using descriptive statistics and the t-test for independent samples. Participants included all intubated mechanically ventilated patients who were at least eighteen years of age with a documented APACHE II score in the allotted time frame. There were 468 total patients, 79 (16.9%) of which received a tracheostomy. The mean APACHE II score for patients who received a tracheostomy was 21.8354 as compared to the mean APACHE II score of 21.6735 for those who were extubated. There was no significant difference between the APACHE II scores of these groups. The tracheostomy group had the highest frequency of patients with APACHE II scores of less than 25 and a range of 20-29. 84.8% of tracheostomy patients had some form of chronic organ dysfunction. Respiratory failure was the most frequent admitting diagnosis for all 468 patients and respiratory insufficiency was the most prevalent co-morbidity for the tracheostomy patients. The age range that included more tracheostomy patients was 65-74. 40% of re-intubated patients eventually received a tracheostomy and 69.6% of tracheostomy patients had the procedure performed early (within the first seven days of intubation). The managerial team of this respiratory therapy department decided to stop calculating the APACHE II score on all intubated patients in an attempt to save time and staff resources.

## INTRODUCTION

The Intensive Care Unit (ICU) is a specialized area in most hospitals where patients with life threatening illnesses or injuries are admitted for constant attention and treatment by members of the interdisciplinary health care team. In addition to patients who require this intense care, select individuals that are at an increased risk for serious complications are sometimes placed in the ICU for close monitoring. The ICU should reflect the compelling nature of critical illness. One of the major roles of the ICU is to detect and treat life-threatening acute physiologic derangements (1). In the critically ill patient, respiratory compromise is common. Such compromise typically coincides with major and/or multi system organ failure. Respiratory interventions, such as placement of an advanced airway and mechanical ventilation (MV), are aggressive and often life-saving. MV constitutes one of the greatest personnel, resource, and financial commitments for most critical care units (2). Mechanically ventilated patients can be characterized as high-resource utilization patients and the ability to predict their duration of ventilation within the ICU would be helpful to physicians and respiratory care departments worldwide concerning resource allocation and critical care practice patterns (2).

A patient typically requires intubation and mechanical ventilation when the demands placed on their system are outweighed by their capabilities. If a patient is deemed a candidate for long term MV, whether due to failed attempts at discontinuation of ventilatory support or alternate reasons for the need of an advanced airway, the decision to perform a tracheostomy should be discussed. Tracheostomies are commonly performed surgical procedures within the adult ICU population. Persistent respiratory abnormalities usually do not reverse quickly therefore tracheostomy is the next step in their plan of care.

Tracheostomy as a result of respiratory failure is associated with significant cost and hospital reimbursement. The intent of disease management is to lower costs be educating and closely monitoring patients and reducing utilization of high-cost services (3). Performing a tracheostomy has the potential to decrease mechanical ventilation duration, decrease ICU and overall hospital length of stay, and increase survival rates of critically ill patients.

Patients that are at a higher risk for prolonged mechanical ventilation and eventually a tracheostomy are not well defined. The ability to predict this need and provide the appropriate intervention could have a direct impact on patient outcome and medical care costs. If those practicing critical care medicine could target which patients would benefit from a tracheostomy by using a prognostic device, such as the APACHE II scoring system, along with sound clinical judgment, we could provide the patient and his or her family with a simplified decision making process. Higher APACHE II scores are associated with longer intubation times (4) and longer intubation probability is an absolute indication for an alternate advanced airway. An accurate and reliable APACHE II score has the ability to characterize ICU patients based on their severity of illness and potentially predict their clinical outcome. Critical care medicine constantly changes and the interventions often performed in this healthcare environment could benefit from a predictive prognostic device aiding in the decision making process.

While much has been written about the APACHE II score and tracheostomies, little research has investigated the possibility of a relationship between the score and its predictive power for tracheostomy patients. The purpose of the study was to determine if significant differences exists between the APACHE II scores of intubated mechanically ventilated patients who received a tracheostomy and those who did not. Further, it examined which demographic variables had the greatest effect on the tracheostomy result. This study is significant because of the growing number of patients that require long term mechanical ventilation. As many as 10% of patients requiring at least three days of MV will eventually receive a tracheostomy (4). With such a remarkable part of the ICU population being susceptible to tracheostomy, it is necessary to determine if a relationship exists between severity of illness, as represented by the APACHE II score, and the prediction of need for a tracheostomy. Another important factor that led to this inquiry was the potential impact tracheostomy patients have on overall health care expenditures. These patients have a high consumption of resources mostly due to their longer length of stays in hospitals/rehabilitative facilities and increased in-patient survival rates.

Research questions are as follows:

Will there be significant differences between the APACHE II score of intubated and mechanically ventilated patients who received a tracheostomy and patients without the need of a tracheostomy?
Will there be a range of APACHE II scores in this patient population that prove to have a higher incidence of receiving a tracheostomy?
Will an association be present between select physiologic variables (age, presence of co-morbidities) within the APACHE II and the need for a tracheostomy?

Hypotheses are as follows:

1. An APACHE II score of twenty five or greater (>25) will result in a higher incidence of a patient receiving a tracheostomy than an APCHE II score less than twenty five (<25).
2. An APACHE II score range of 20-29 will yield a higher frequency of patients that receive a tracheostomy than any other age group.
3. A patient with one or more chronic organ insufficiencies or an immunocompromised system will result in a higher rate of tracheostomy as compared to a patient with no chronic organ insufficiency/immunocompromised system.
4. The age group of 18-44 will yield a higher prevalence of tracheostomy than that of any other age groups.

## METHODS

This study was delimited to intubated mechanically intubated patients who received a tracheostomy from January 1- August 31 in the year 2011 at Bristol Regional Medical Center (BRMC) located in Bristol, Tennessee. BRMC is a 348 bed non-profit community hospital with a 38 bed Intensive Care Unit (ICU). Participants in the study also had a documented APACHE II score based on values obtained during the first twenty four hours of admission to the ICU or intubation. It was assumed that all APACHE II scores were recorded for patients who received a tracheostomy and were done so within the twenty four hours of intubation and that appropriate (worst) values were chosen to calculate the score. It was also assumed the individuals who performed the calculation were trained to do so and documented the score on the correct patient.

The participants in this study were patients who were admitted to any of the four intensive care units (Surgical,

Cardiovascular, Medical, or Neurological) within BRMC. Patients with current tracheostomies were excluded. Persons intubated for less than twenty four hours and for which an APCHE II score was not calculated were also excluded. Because the study was retrospective in nature, it focused on efforts to improve quality at the participating facility, and no patient identifiers were collected, informed consent from each patient was unnecessary. Diagnoses for participants included respiratory failure, cardiovascular failure, trauma, neurologic deficiency, or was classified as other. Chronic organ insufficiency or co-morbidities were categorized into related organ systems: liver, cardiovascular, renal or immune-depressed based on the criteria located within the APACHE II scoring system. Patients could have more than one admitting diagnosis and co-morbidity. All information was gathered by the primary researcher from the Ventilator Q/A Sheet located in the Respiratory Therapy department at BRMC. Participants were not identified by gender or race as to not easily discern from the information recorded for patients included in this study. The technique for tracheostomy (surgical or percutaneous) was of no interest in this study and was therefore not documented. Information was gathered after Wellmont's IRB approved and determined this study was exempt on November 15, 2012.

The scientific method was used to study aspects of the relationship between patients who received a tracheostomy in the course of their care at this medical facility and APACHE II scores. Deductive reasoning was used to form conclusions from the study's data. The analysis was retrospective and observational in nature. No experimental testing or randomization occurred. Descriptive statistics were used and differences were evaluated using the t-test for independent samples. Laboratory and clinical data were collected by staff Registered Respiratory Therapists working in the ICU. The APACHE II calculator was used and the score was documented in the RT supervisor's Communication Book. The mean APACHE II scores were recorded as well as average number of days of intubation prior to tracheostomy. Worst values were obtained for temperature, mean arterial pressure (MAP), heart rate, respiratory rate, PaO2 and/or A/a gradient, serum HCO3, arterial pH, serum sodium, serum potassium, serum creatinine, hematocrit and WBC. The presence of acute renal failure, the Glasgow Coma Score (without sedation), presence of chronic organ insufficiency, and the patient's age were also noted. Surgical status was also obtained and documented. The APACHE II score resulted in a severity of illness classification and the predicted death percentage of each patient. Additionally, the following data was collected on each patient: admitting diagnosis, past medical history, list of any respiratory related home treatment regimens, whether or not re-intubation occurred, whether or not the patient expired, and date of the tracheostomy.

IBM SPSS Statistics Standard version 20 was used for data analysis. The collective mean APACHE II score was obtained by using the measures of central tendency option of SPSS. The collective standard deviation was found using the dispersion computation option. Differences among groups (group 1= no tracheostomy, group 2= tracheostomy) were analyzed using the t-test for independent samples. Additional parameters were examined including patient age, admitting diagnosis, co-morbidities (particularly those of pulmonary origin), whether the patient underwent one or more re-intubations prior to tracheostomy during the same hospital stay, whether the patient expired while in the hospital, and whether the patient had a respiratory treatment regimen at home (consisting of oxygen therapy, bronchodilator therapy, and Cpap or BiPap therapy). Specific APACHE II score ranges were examined to determine if a higher or lower group of scores resulted in a greater probability of receiving a tracheostomy.

Several variables were present in this study. The independent variable was the APACHE II score. The dependent variable was the patient receiving a tracheostomy as indicated by a yes answer on the data collection sheet. The APACHE II score should ideally be independent from treatment therefore control variables proved to be anything that influenced the physiologic parameters monitored, including:

--Heating/cooling blankets affecting temperature

--Intravenous drips affecting heart rate, blood pressure, and/or mean arterial pressure

--Ventilator settings affecting blood pH, PaCO2, and A/a gradient

--Medicines that affect electrolyte values including sodium (Na+) and potassium (K+)

--Antibiotics that affect white blood cell (WBC) counts

--Presence of dialysis, which can affect creatinine levels

--Administering blood products, which affects hemoglobin (Hg) and hematocrit (Hct)

--Medicines that can affect level of consciousness (LOC) and Glasgow Coma Scale (GCS)

Extraneous variables to this study include the patient's admitting diagnosis, reason for intubation, or the physician's particular views (conservative vs. aggressive) on treatment options.

## RESULTS

The total number of participants in the study was 468, 79 (16.9%) received a tracheostomy during their stay in the ICU. March, 2011 had the highest frequency of intubated patients and April, 2011 had the greatest number of tracheostomies performed. Patients who received a tracheostomy (group 2) had a mean APACHE II score of 21.8354 and patients who did not receive a tracheostomy (group 1) had a mean APACHE II score of 21.6735 resulting in a mean difference of -.16192. Leven's test for equality of variance was considered and the obtained t value, assuming equal variances, (-.167) was less than the critical t value (-.199) and the p value (.867) was greater than 0.05. Based on these findings, there are no significant differences between the APACHE II scores of patients who received a tracheostomy and those who did not.

The APACHE II score range of 15-24 had the greatest number of total patients followed by 25-34. An APACHE II score of less than 25 had the highest frequency of patients receiving a tracheostomy (f = 48) as compared to those with an APACHE II score of equal to or greater than 25 (f = 31). The APACHE II score range of 20-29 (42 or 53.2%) yielded the most tracheostomy patients followed by the 0-19 range. 67 (84.8%) of the tracheostomy patients had a history of one or more chronic organ insufficiencies/immune-depression compared to the 12 (15.2%) who had no medical history of organ dysfunction. Respiratory insufficiency was the most prevalent co-morbidity representing 46.8% of the participants followed closely by cardiovascular insufficiency (35.7%). The age group 55-64 had the greatest number of total participants (119) followed by patients older than 74 years of age (106). Within the tracheostomy group, the age range of 65-74 had the highest frequency of patients (26 or 32.9%) followed by the age group of 55-64 (19 or 24.1%).

In addition to the findings already presented, further information was obtained concerning the study participants. For instance, respiratory failure had the highest frequency of admitting diagnosis or reason for intubation (211 or 45%). Also, 84 (17.9%) of the participants expired while in the ICU. 35 of the patients required one or more re-intubations, 14 of which (40%) eventually received a tracheostomy within their hospital stay. Lastly, 55 (69.6% of the tracheostomy patients had the procedure performed within the first seven days (early group) whereas 24 (30.4%) received their tracheostomy between days 8-15 (late group).

## DISCUSSION

The data demonstrates no clear relationship between APACHE II scores and the need for a tracheostomy within this patient population. The average scores of each group were statistically similar. The results were not as initially predicted. In theory, the higher the APACHE II score, the sicker the patient and the longer one would expect them to require life sustaining measures including mechanical ventilation. It is likely the longer a person requires MV they will then, in turn, receive a tracheostomy since the length of intubation has its limits. These results differ from those of Kollef, Ahren, and Shannon who found their tracheostomy patients to have higher APACHE II scores (5).

The comparable scores may be due to relatively normal physiologic measurements within the APACHE II system resulting in an overall low numerical value for the tracheostomy group. The clinical and/or laboratory measurements (temperature, heart rate, respiratory rate, serum sodium, potassium, creatinine, hematocrit, etc.) may have been unremarkable and the reason for a tracheostomy could be attributed to a decreased level of consciousness (as represented by the Glasgow Coma Scale) and the need for prolonged airway protection but not necessarily MV. Another explanation could be a history of organ impairment (as denoted by the chronic organ insufficiency parameter) causing increased weakness and a longer weaning period resulting in a tracheostomy. The tracheostomy may have also been influenced by varying physician discretion unrelated to the APACHE II score. The variables within the APACHE II system could have also unknowingly been recorded after treatment had been initiated (medicine, fluids, etc.).

A particular range of APACHE II scores resulted in more tracheostomies performed, specifically 20-29 and less than 25. This is an important finding because as APACHE II scores rise, so does the risk of mortality. A patient with a high score may be too critically ill and possibly expire before the decision to perform a tracheostomy can be made; a score that is low may represent a non-acutely ill patient who has been intubated due to some extraneous

circumstances and only requires short term life support. The APACHE II score range of 20-29 coincides with a death rate of 40-55% and in my opinion, low enough to still benefit from life saving measures and a tracheostomy if needed. It was correctly assumed that the range of 20-29 would afford more tracheostomies but incorrect in that a score of greater than or equal to 25 would bear a greater number of these patients. Several studies have shown that tracheostomy patients have higher in-patient survival rates including that of Combes and colleagues (6) and Engoren, Arslanian-Engoren, and Fenn-Buderer (7). This may correspond with a lower APACHE II score.

The expectation that the tracheostomy group would have a greater number of patients that suffered from a history of chronic organ dysfunction and/or an immune-compromised system was accurate. However, the presumption that the age group of 18-44 would result in more tracheostomies than any other age group was wrong. Age and medical history play vital roles in the overall APACHE II score. One could assume that a patient with an underlying chronic disease process (especially that of respiratory related origin) may have a more difficult time recovering from an acute illness or exacerbation (this being the basis for my initial hypothesis). A relatively young age group was chosen for the tracheostomies because this range of patients could potentially reap the greatest long-term benefits of the procedure. In reality, the age range of 65-74 actually had the greater number of tracheostomies performed. This may be due to the baby boom generation being such a great part of the patient population in this study.

The study found that 40% of re-intubated patients eventually received a tracheostomy and approximately 70% of tracheostomies were done within the first seven days of intubation. One could conclude that these patients' underlying problem or reason for intubation was not completely resolved prior to discontinuation of life support and resulted in extubation failure. The re-intubations may have also been a result of unanticipated or self-extubations. One or more re-intubations are typically a good indicator of a prolonged need for mechanical ventilation or airway protection; the relatively high percentage of patients who received a tracheostomy within this group was not surprising. This number could also be a reflection of an aggressive physician in regard to the extubation decision making process.

Though specific data was not collected on which type (percutaneous or surgical) of tracheostomy was performed in this patient population, the majority of tracheostomies done at this facility are performed percutaneous at the bedside by the Critical Care Team. It was interesting that such an overwhelming percentage received their tracheostomy "early" in the overall course of their treatment. This may be a result of the extensive research done on early versus late tracheostomy and the multiple benefits of the ladder. Less ventilator days as well as a decreased length of stay in the Intensive Care Unit are just a few examples of the advantages of an early tracheostomy. These results could be due to the fact this facility has an ICU step down floor and close access to a long term rehabilitation facility that accepts ventilator patients. BRMC is also a teaching facility and the medical students/residents get the opportunity to practice this procedure unlike some of their other rotations.

The results of this research further support the decision made by the leadership of the respiratory therapy department at Bristol Regional Medical Center to stop calculating the APACHE II score on all intubated mechanically ventilated patients since there appears to be no clear link between the score and the prediction of need for tracheostomy in this patient population. The staff will continue to gauge its severity of illness and ventilator discontinuation based on best practices for the field of Respiratory Care. The research could be improved by collecting data from a larger population and from patients from different hospitals. The facilities' practices may differ from that of others in the country and therefore this study's findings may not represent the greater population and transferability is difficult. A weakness of this research is that the data was obtained and entered into the software manually which is more prone to human error than data extracted from a computer system or some form of electronic medical record. Reliability and uniformity of the raters calculating the score may also be a flaw of the research.

This information generated a few questions and may actually serve as topics of future research. First, do RT protocols affect the tracheostomy outcome? Respiratory therapists could potentially play an important role in the decision making process through their knowledge base and hands-on approach to patient care. RT's are an essential part of the current health care system because of the prevalence and seriousness of pulmonary disease (3). Secondly, a broader study concerning re-intubations and tracheostomies would be of interest considering the incidental results of this

research. Re-intubation carries a higher risk for nosocomial pneumonia and mortality (8). Additionally, studies regarding how long until transfer out of the ICU, once a tracheostomy has been performed, and the length of weaning after tracheostomy in differing sites (ICU, step-down units/floors, and rehabilitation facilities) may prove to be significant. Lastly, can APACHE II scores predict the need for other invasive procedures within the critical care environment, such as intubation?

Though the study did not find a relationship linking this severity of illness score and tracheostomy, it proved beneficial to the hospital's respiratory care department in that they no longer calculate the score on every intubated patient that is placed on mechanical ventilation. If the information is not telling practitioners something they cannot already conclude on their own through patient assessment and evaluation, it is of no value, and its elimination results in savings of valuable time and resources. There may not have been a statistical difference between the two groups studied but the research has practical significance for one particular department.

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## Author Information

**Kristen L. McHenry, MS, RRT-ACCS**
East Tennessee State University

**Randy L. Byington, Ed.D, MT (ASCP)**
East Tennessee State University

**Ester L. Verhovsek, Ed.D, MT (ASCP)**
East Tennessee State University

**Shane Keene, DHSc, RRT-NPS, CPFT, RPSGT, RST**
University of Cincinnati