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The Use of Stroke-Related Early Tracheostomy Score (SET) as a Predictor for the Need for Tracheostomy in Stroke Patients Admitted to ICU

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Abstract

Background: Stroke patients who are in the intensive care units (ICUs) experience problems because they tend to have a long time of weaning time, and they have a continued high occurrence of extubation failure, and a high probability of the need to be placed on a tracheostomy. A proposed tool to describe predictive scores to assist the choice of early tracheostomy in neurocritical care is the Stroke-Related Early Tracheostomy (SET) score, which has not been externally validated.

Objectives: To determine the accuracy of predicting the requirement of tracheostomy, prolonged ICU stay, and 28-day mortality among stroke patients under ventilation using the SET score.

Methods: In this prospective observational study, 114 stroke patients who were on mechanical ventilation were admitted to the two tertiary intensive care units in the United Arab Emirates. The SETs were done in less than 24 hours after admission. ROC curve analysis and logistic regression were conducted as statistical analyses used to examine predictive validity.

Results: 78.9% of patients were under tracheostomy. The SET score presented ideal predictive ability of the tracheostomy requirement (AUC = 0.897), with the best cutoff value of 8 (sensitivity: 82.22 percent, specificity: 91.67 percent). It was also a moderate predictor of prolonged stay in ICU (AUC = 0.767) but not good at discriminating mortality (AUC = 0.516).

Conclusion: SET score is a dependable aspect of predicting the requirement for tracheostomy amongst stroke patients. The use of early may help in better management of the airway and ICU resource planning.

Keywords: Stroke; Tracheostomy; Intensive Care Units; Mechanical Ventilation; Prognostic Score; Neurologic Critical Care

Introduction

Stroke is among the leading causes of morbidity and death worldwide, especially in severely ill patients who are under mechanical ventilation [1]. In this group of patients, those with long-term ventilation have a higher chance of developing unfavorable events, such as elevated levels of mortality, inadequate neurological recovery, and airway-related complications [2]. Tracheostomy (TT) may be required in this group, particularly when the duration of weaning off mechanical ventilation is protracted or the patient fails at weaning, or when there is failure to pass the tube out of the airway because of a deficit in the awareness of consciousness or inability to protect the airways [3]. Patients with stroke, especially those affecting the brainstem, are more likely to experience deficient airway reflexes, low Glasgow Coma Scale (GCS) rankings, and dysphagia that complicate the process of extubation, thus making it more beneficial to use the early application of tracheostomy [4].

Moreover, research has undoubtedly shown high rates of tracheostomy in stroke patients compared to the overall ICU population, where the prevalence of tracheostomy occurs in neurocritical care cohorts at rates of 15% to 46.8% [5-7] Although the traditional way of practice settles on thinking of the use of tracheostomy between the range of 7 to 14 days of staying on intubation, the interest in then doing it before this period has grown [8]. The interest is fueled by the fact that early tracheostomy has evidence that it can decrease the time spent under ventilation, the length of ICU stays, and the demand of sedatives, as well as lesser cases of ventilator-associated pneumonia (VAP), which entails a lessening of the complications that appear because of the extended stay in the endotracheal passage, including oropharyngeal injury, causing development of tracheomalacia and vocal cord impairment [9].

Nevertheless, despite these possible advantages, there is no consensus on the optimal timing of tracheostomy in ventilated stroke patients. Clinical guidelines are not universal, and no universally accepted decision-making algorithm exists to determine which patients would benefit the most using early intervention. The situation is especially vague under neurocritical care conditions, where decisions have to be made that weigh the risk of procedural complications against the possibilities of better outcomes.

SET score

To fill this gap, clinical scoring systems have been devised to help identify the patients who are most likely to benefit the early tracheostomy. The Stroke-Related Early Tracheostomy (SET) score is one of them, having been launched in the setting of the SETPOINT (Stroke-related Early Tracheostomy versus Prolonged Orotracheal Intubation in Neurocritical Care) pilot trial (see Appendix A). The purpose of the SET score was to offer an objective and evaluable strategy for determining the probability of whether a patient experiencing stroke ventilated would necessitate the insertion of a tracheostomy. It is based on a fusion of clinical and radiological predictors that were employed in the TRACH score, which is a variant of the score designed to be applied to patients with supratentorial spontaneous intracerebral hemorrhage [10].

The development of the SET score involved the creation of an in-house screening test using retrospective risk factor analysis of tracheostomy complications in stroke patients. It comprises variables divided into these three domains: (1) neurological functioning (maximum 10 points), (2) neurological lesion properties (maximum 22 points), and (3) overall organ functioning and operations (maximum 16 points). Individual components are measured based on the most extreme physiological values after the initial 24 hours in the ICU, which suggests that there is an opportunity to predict whether a patient requires a tracheostomy early in their hospital stay. The maximum scorable points are 3 to 37 according to the configuration of variables. Remarkably, neurological lesion components are mutually exclusive, ensuring internal consistency and clinical validity of some of its items [5].

The accuracy of the SET score has been tested in several studies. It has been observed to perform moderately well in the prediction of length of stay in ICUs, the mechanical ventilating time, and tracheostomy requirement in patients with stroke. It was proposed to use a cutoff of 10 to predict early tracheostomy with a good sensitivity and specificity. Notably, early tracheostomy has been linked to better early outcomes, including diminished sedation needs in the short term as well as lower ICU life, but it seems not to make a significant impact on long-term mortality rates [5].

The feasibility and safety of early tracheostomy in neurocritical patients were demonstrated in the SETPOINT pilot trial. Patients in this study were randomized to receive early or late tracheostomy based on their SET scores > 10, which could either be performed in the first 3 days after intubation or during days 7 and 14 of intubation, respectively, should extubation not be possible. The consequences were fewer ICU deaths and less sedative use in the early tracheostomy group, but no change in long-term functional outcomes. The resulting score (SET) was subsequently, by the same authors, internally validated using a different independent, monocentric cohort. A cutoff score of 8 was determined to be optimal in the prediction of long ICU stays with a positive predictive value of 0.748 ($p < 0.001$) in that validation [3, 5].

The findings support the potential applicability of the SET score as a clinically useful instrument to direct the time of tracheostomy in motor strokes necessitating mechanical ventilation. Nonetheless, or even in clinical practice, the SET score needs additional external validation using different patient groups and in varying healthcare settings.

Study Objectives

This study mainly aims to provide an external validation of the SET score to predict the need for tracheostomy in ventilated stroke patients admitted to the ICU. In evaluating the predictive value, sensitivity, and specificity of the SET score in a new patient cohort, this study will secure its amenability in everyday neurocritical care practice.

Secondary objectives will be to analyze the capacity of the SET score to foretell ICU length of stay and 28-day death, and thus give a wider picture of the clinical importance of the score. This study tries to provide evidence-based guidelines on airway management among this high-risk population by searching for a robust cut-off point and correlating outcomes.

Study Design

This is a prospective observational study in a cohort of two tertiary healthcare facilities, Kuwait Hospital, Dubai, and Al Qassimi Hospital within the Emirates Health Services, United Arab Emirates. The participant group in the study consists of stroke-affected adults who have been subjected to mechanical ventilation when admitted to the ICU. Timing and the decision of performing tracheostomy were made according to the available standard-of-care practices and were unavailable to be determined based on SET score calculations, which were compared with retrospective predictive analysis.

Methodology

Study Design and Setting

This prospective observational cohort study was conducted in two tertiary-care centers in the United Arab Emirates: Kuwait Hospital Dubai and Al Qassimi Hospital, both of which operate under the Emirates Health Services. The study aimed to evaluate the predictive accuracy of the Stroke-Related Early Tracheostomy (SET) score in determining the need for tracheostomy among stroke patients admitted to the intensive care unit (ICU) and requiring mechanical ventilation.

Study Population

ICU patients with confirmed stroke (>18 years of age) admitted to the ICU with the need for invasive mechanical ventilation were enrolled consecutively. Stroke diagnosis was comprised of ischemic stroke, intracerebral haemorrhage, subarachnoid haemorrhage, or cerebellar infarction/haemorrhage, which was diagnosed using neuroimaging and clinical examination.

Inclusion Criteria

- Age ≥18 years.
- Radiologically confirmed stroke diagnosis.
- Requirement for invasive mechanical ventilation.

Exclusion Criteria

- Patients younger than 18 years.
- Patients with stroke who did not require mechanical ventilation.
- Patients with incomplete data or missing outcome variables.

Data Collection

Registration of clinical and demographic data at admission to the ICU and during the stays at the hospital was supported by standardized electronic case report forms. The variables obtained were:

- Demographics (age, sex).
- Type and location of a stroke.
- Comorbidities (e.g., hypertension, diabetes mellitus, ischemic heart disease, chronic kidney disease).
- Acute Physiology and Chronic Health Evaluation II (APACHE II) points.
- Components of SET scores that are calculated within the 24 hours of ICU admission.
- ICU length of stay (LOS), requirement of tracheostomy, and 28-day mortality.

The evaluation of the SET score was performed retrospectively and used the most severe physiologic and neural values within 24 hours after ICU transfer. There are three categories of the score:

1. ***Neurological function*** (maximum 10 points).
2. ***Neurological lesion characteristics*** (maximum 22 points).
3. ***General organ function/procedures*** (maximum 16 points).

Outcomes

Primary Outcome

- The predictive value of the SET score in determining the need for tracheostomy during ICU admission.

Secondary Outcomes

- Predictive value of the SET score for:
- Prolonged ICU length of stay (>10 days).
- 28-day all-cause mortality.

Ethical Considerations

International ethical standards guided the review of the study protocol that was approved by the local institutional ethics committees. The procedures were conducted by the principles of patient confidentiality and the Declaration of Helsinki. Since it was a non-interventional study, informed consent was not required.

Statistical Analysis

The statistical analysis was conducted by SPSS version 25. Continuous variables were described as means and standard deviations (SD) or medians and interquartile range IQR), whereas categorical variables were presented as frequencies and percentages. The group comparisons of the patient groups subjected to tracheostomy and non-tracheostomy were done by:

- T-test or Mann-Whitney U test.
- Chi-square test or Fisher's exact test in categorical variables.

To measure the discriminative performance of the SET score concerning the primary and secondary outcomes, the Receiver Operating Characteristic (ROC) curve was analysed. Area under the curve (AUC), sensitivity, specificity, and optimal cutoff points were computed. Logistic regressions were used to examine relationships between SET score and binary outcomes, and the results were expressed as odds ratios (OR) along with 95 percent confidence intervals (CI). This limited them to a p-value lower than 0.05 as being statistically significant.

Results

Description of patients' characteristics

This is a prospective study that enrolled 114 patients who were mechanically ventilated and had with confirmed cerebral stroke. A majority of the patients were male (n = 83, 72.8%), and females were 27.2% (n = 31). The age of the participants ranged between 22 and 90 years, with a mean age of 53.38 +/-16.56 and the median age 51 years. The most common types of strokes were middle cerebral artery (MCA) infarction (39.5%), basal ganglia haemorrhage (23.7%), cerebral haemorrhage (19.3%), subarachnoid haemorrhage (10.5%), and cerebellar infarction or haemorrhage (7.0%).

The cases of comorbid conditions were common. Among the patients, hypertension (61.4%), diabetes mellitus (36.8%), ischemic heart disease (21.9%), and chronic kidney disease (7.9%) were found. The mean Acute Physiology and Chronic Health Evaluation II (APACHE II) score at the time of ICU admission was 17.23 (SD=8.54) compared to the mean Sequential Organ Failure Assessment (SET) score, which was calculated during the first 24 hours of ICU stay and was 12.99 (SD=7.35).

The average ICU length of stay (LOS) in all patients was 25.24 standard deviation of 30.14 days, and the median length was 15.5 days. Among these 114 patients, 90 (78.9 %) were subjected to tracheostomy as part of their ICU stay. The patients who received tracheostomy and those who did not received the same care showed statistically significant differences in the prevalence of hypertension, APACHE II and SET scores, and the ICU stay (the p-value of all comparisons was <0.001) as shown in Table 1. The discriminatory power of the SET score in prediction of prolonged ICU stay was 0.767. The SET score with the optimal cutoff had sensitivity of 73.85 % and specificity of 72.09 % at a cutoff level of 11 (see Figure 1).

Variables	***No Tracheostomy***	***Tracheostomy***	***All patients***	***P-value***
	(n=24)	***(n=90)***	***(n=114)***	
Age, mean (SD)				
	47.67 (16.10)	54.91(16.44)	53.39(16.56)	0.06
Sex, n (%)				
	14(58.3%)	69 (76.7%)	83(72.8)	0.119
Comorbidities				
DM, n (%)	11(45.8%)	31(34.4%)	42(36.8)	0.345
HT, n (%)	10(41.7%)	60(66.7%)	70(61.4)	0.034
IHD, n (%)	12(50.0%)	13(14.4%)	25(21.9)	0.001
CKD, n (%)	3(12.5%)	6(6.7%)	9(7.9)	0.395
Type of stroke				
Basal Ganglia Hemorrhage, n (%)	3(12.5%)	24(26.7%)	27(23.7)	0.237
Subarachnoid hemorrhage, n (%)	3(12.5%)	9(10.0%)	12(10.5)	0.984
Cerebellar infarction/Hemorrhage, n (%)	0(0.0%)	8(8.9%)	8(7.0)	0.286
Middle Cerebral Artery Infarction n (%)	14(58.3%)	31(34.4%)	45(39.5)	0.058
Cerebral hemorrhage n (%)	4(16.7%)	18(20.0%)	22(19.3)	0.942

APACHE II Score, mean (SD)				
	5.17(0.56)	20.48(6.50)	17.23(8.54)	0.001
SET Score within 24 hrs. of admission, mean (SD)				
	5.50(2.17)	14.98(6.39)	12.99(7.35)	0.001
Total ICU Days, mean (SD)				
	5.25(1.51)	30.95(31.97) [a]	25.24(30.14)	0.001
Death, n (%)				
	5(20.8)	21(23.3)	26(22.8)	0.795
Six cases are still in ICU, APACHE II = Acute Physiology and Chronic Health Evaluation, SET = Stroke-related early tracheostomy.				

Table 1: Clinical characteristics of cerebral stroke patients.

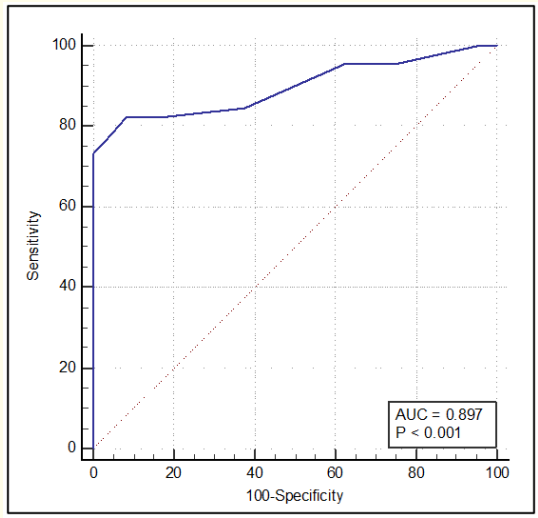

Figure 1: ROC curve showing the discriminative power of the SET-score for predicting the need for tracheostomy in ICU cerebral stroke patients.

SET-score for predicting prolonged ICU stay in cerebral stroke patients

Further analysis was done to clarify the discriminating power of the SET score in terms of clinically relevant endpoints. Regarding the prolonged intensive care unit (ICU) stay (>10 days), the SET score had a modestly good predictive performance with an area under the receiver operating characteristic (ROC) curve (AUC) of 0.767 (Table 2 and Figure 2). An optimal cutoff value of 11 was found to be able to achieve a sensitivity of 73.85%, specificity of 72.09%, therefore, depicting a reasonable discrimination between a probable and improbable patient who may require extended ICU stay.

	AUC (95% CL)	*Optimal cutoff point*	*Sensitivity (%)*	*Specificity (%)*
Tracheostomy	0.897 (0.826 to 0.946)	8	82.22	91.67
Long ICU stay > 10 days	0.767 (0.676 to 0.843)	11	73.85	72.09
Death	0.516 (0.427 to 0.648)	16	76.92	34.09
AUC=Area under the curve, 95%CI=95% confidence interval.				

Table 2: Results of the discriminating power of the Receiver Operating Characteristic (ROC) analysis in predicting tracheostomy, long ICU stay (>10 days), and survival in cerebral stroke patients.

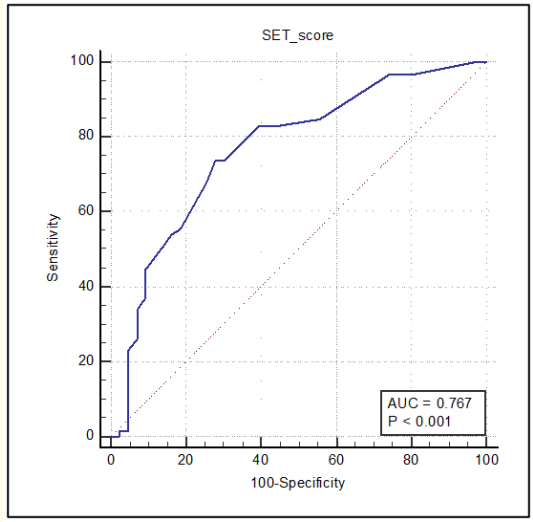

Figure 2: ROC curve showing the discriminative power of the SET-score for predicting prolonged ICU stay (> 10 days) in cerebral stroke patients.

SET-score for predicting survival in cerebral stroke patients admitted to ICU

Comparatively, the SET score showed limited predictive value to 28-day death, as reflected in Table 2 as well as in Figure 3. The ROC analysis yielded a limited AUC of 0.516, indicating low capability of differentiating survivors and non-survivors. The model had a sensitivity of 76.92 when a cutoff of 16 was used, but had a low score of specificity at 34.09, indicating a high false positive rate in assessing mortality.

SET-score for predicting the need for tracheostomy in cerebral stroke patients admitted to ICU

It is important to note that the SET score has good performance in predicting tracheostomy requirement among stroke patients who were under tracheostomy in Table 2. The ROC curve analysis indicated a very good discriminatory ability with AUC of 0.897. The best classification score of 8 showed a sensitivity of 82.22 and specificity of 91.67 to indicate that the treatment efficacy of SET score is high in identifying patients who will be likely candidates of tracheostomy during their stay in the ICU.

All in all, the results support the use of SET score as an accurate instrument to predict stroke patients who are more likely to need tracheostomy and the set score has modest applicability in determining ICU stay and minimal applicability in forecasting mortality.

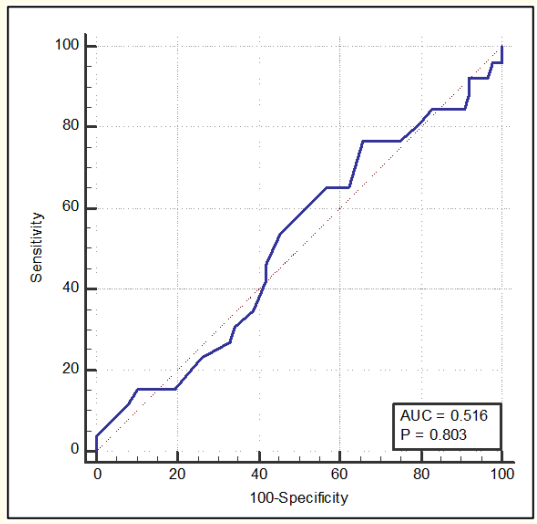

Figure 3: ROC curve showing the discriminative power of SET-score for predicting death in cerebral stroke patients with tracheostomy.

Discussion

The role of optimal timing of tracheostomy in critically ill stroke patients is currently debatable within neurocritical care. There have been many studies aimed at determining the clinical benefits of early tracheostomy, especially regarding ICU length of stay (LOS), days on ventilators, mortality, and ventilator-related pneumonia (VAP). The results of the literature have been contradictory, as has been methodological disparity as much as some what population.

Merola et al. (2024) in a prior study had concluded that early tracheostomy, which was defined as performed within 10 days of intubation, did not show any significant mortality benefit and reduced ICU LOS, mechanical ventilation duration, and VAP [11]. Nevertheless, it was linked with a decreasing sedation demand and a higher amount of homicide interventions. Likewise, a meta-analysis by Kevin Chorath et al. (2021) backed up the opinion that early tracheostomy in a general ICU context resulted in lower VAP and fewer ICU and ventilation days, but not a consequent mortality reduction [12].

A Bayesian meta-analysis published by Quinn et al. (2022) indicated that early tracheostomy probably has some beneficial effect on multiple clinical outcomes, such as ICU complications and ventilator burden [13]. It is important to note that Shen et al. (2022) concentrated on the specific group of patients, ventilated stroke, and early tracheostomy lowered ICU LOS, total LOS, and VAP incidence, indicating more positive outcomes of the treatment in this cohort of patients [14]. Similar outcomes were obtained by Qiu et al. (2023), who noted similar decreases in the length of stay and complications after early tracheostomy in stroke populations [15].

However, the findings fall in line with a number of studies. It was discovered that the patients subjected to tracheostomy had very much higher SET score, APACHE II, and prolonged stays in the ICU, supporting the clinical burden driven by such patients [16]. The SET score showed very good discriminatory ability to predict the necessity of tracheostomy (AUC = 0.897), with a best cut-off point of 8 that could achieve sensitivity of 82.22% and specificity of 91.67%. This is evidence of its usefulness as an early decision-making tool in the neurocritical environment [5-7].

Similarly, the findings differed when the mortality outcomes were investigated. The SET score had a dismal discriminatory ability to estimate death (AUC = 0.516) even on a more stringent cutoff of 16. As per Premraj et al. (2023), they did not find significant differences between the timing of tracheostomy and mortality, neurological improvement, and ICU/hospital LOS in critically ill stroke patients [17]. The study cohort showed that despite the fact that high SET and APACHE II scores were a risk factor for tracheostomy and ICU length of stay, they did not correlate with better mortality prediction.

Different researchers have examined the performance of SET scores in other neurocritical circumstances. In an independent study, Lei and colleagues (2021) indicated that the SET score showed good predictive value for ICU stay, mechanical ventilation duration, and the need for tracheostomy, which was partly consistent with our results [10]. The SET score is also reliable in predicting the neuro-ICU LOS and ventilation days, which was reported by Likar et al. (2024) as having an accurate value of LOS and ventilation time with positive predictive value. As even more proof that we chose the correct cutoff, a set score of 8 was also stated as the best cutoff in their analysis [18].

The evidence supporting early tracheostomy is also supported by the data produced by the SETPOINT and SETPOINT2 trials. The first pilot investigation confirmed the viability and safety of such a procedure by doing it in severely stroke patients [19]. Afterwards, a large multicenter randomized trial (SETPOINT2) compared early (median 4 days) with standard (median 11 days) tracheostomy. Although the procedure was more commonly applied in the first cohort (95% vs. 67%), no significant difference was recorded in the percentage survival of patients without major disability at 6 months, ICU stay or length of ventilator support [5]. These results emphasize that the relationship between timing of tracheostomy and clinical outcomes is a sophisticated matter, and that although early tracheostomy can have short-term effects on perioperative parameters like sedation and ventilator-associated pneumonia, there are currently no indications that this intervention helps improve long-term functional outcomes.

Moreover, the findings were confirmed by the results of Lei et al. (2021), who showed that the SET score has greater predictive values for both ventilation over 5 days (AUC = 0.915) and tracheostomy requirement (AUC = 0.919) at a threshold of 13.5. Their findings indicated that SET is superior to the APACHE II scale in this respect and reinforce the specificity of the instrument's use in neurocritical patients [10]. The highest clinically effective cutoff in our cohort was 8, indicating that there is a necessity to validate the thresholds in the context and individually.

According to the collected data, it is possible to support the works created by Guillotte and colleagues (2023), who concluded that a GCS motor score of 5 or below was a robust indicator of either tracheostomy or successful extubation on postoperative Day-5 after decompressive craniectomy [20]. Collectively, these findings recommend the application of well-defined clinical protocols like SET in the neurological boundary decision-making across the neurocritical care spectrum. In more complex surgical contexts, such as emergency decompressive craniectomy, Kumar et al. (2022) reported that immediate tracheostomy yielded shorter ventilation duration and ICU stay with acceptable outcomes [21]. Similarly, Ding et al. (2020) found that early tracheostomy in brainstem haemorrhage patients improved 30-day prognosis and reduced ICU stay, even in the absence of standardized scoring systems, emphasizing the broader relevance of early intervention in high-risk neurologic populations [22].

The results of the current research support the emerging body of evidence regarding using the SET score in the neurocritical care setting. As an implemented systematic measure, the tool may assist expeditious evidence-based decision-making regarding tracheostomy placement, especially when combined with clinical intuition and other prognostic factors. Future validation using larger, multicentre cohorts is needed to help optimize current cutoff values and to consider possible improvements, with a view toward including covariates that might enhance the predictive accuracy of the score, including, possibly, body mass index, race, and microbiological profile.

Conclusion

This research supports the clinical applicability of the Stroke-Related Early Tracheostomy (SET) score regarding its use as a predictive measure in determining stroke patients who are at a high risk of having a tracheostomy over the course of their time in the ICU. The results of the study show that the SET score has a perfect discriminative power of determining the need of tracheostomy and an optimal cut-off of 8 indicated a high level of sensitivity and specificity. The score was also found to be moderately accurate on prediction of long ICU LOS, but poor in prediction of mortality.

The findings correspond with current literature and validate the usefulness of the SET score as an evidenced-based early decision support tool in airway management in the neurocritical care setting. Using a standardized scoring system could prompt clinicians to use better weaning interventions, lessen ventilator-related complications, and utilize ICU resources effectively.

Multicentric studies with validation in various populations are needed to improve cut-offs of the SET score and examine the possibility of combining with other prognostic markers. However, we believe that our data justify the inclusion of the SET score in the standard protocol of neurocritical care aimed at making decisions about the timely implementation of tracheotomy.

Recommendations

Early assessment stroke units should consistently use the SET Score to assess ventilated stroke patients in neurocritical care facilities and make decisions about tracheostomy in due time. It is suggested that a cutoff score of 8 be used in the prediction of the need for tracheostomy, although additional multicenter research is required to support this level. SET score must support clinical judgment and should help in making individual decisions dependent on patient trajectory, neurological recovery potential and overall prognosis. In future studies, the combination of the SET-score with other clinical indices to increase the predictive power should be studied. Its application and decryption ought to be trained on clinicians.

Budget and finance

No funding needed.

Conflict of interest

No conflict of interest.

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Appendix

A: SET Score Table – Stroke-Related Early Tracheostomy.

Area of Assessment	***Situation***	***Points***
Neurological function	Dysphagia	4
Neurological function	Observed aspiration	3
Neurological function	GCS on admission <10	3
Neurological lesion	Brainstem	4
Neurological lesion	Space-occupying cerebellar	3
Neurological lesion	Ischemic infarct >2/3 MCA territory	4
Neurological lesion	ICH volume >25 ml	4
Neurological lesion	Diffuse lesion	3

Neurological lesion	Hydrocephalus	4
General organ function/procedure	(Neuro)surgical intervention	2
General organ function/procedure	Additional respiratory disease	3
General organ function/procedure	$PaO_2/FiO_2 < 150$	2
General organ function/procedure	APS (of APACHE II) > 20	4
General organ function/procedure	LIS > 1	2
General organ function/procedure	Sepsis	3

The Heidelberg NICU in-house scoring tool was originally used to estimate at least 2 weeks of ventilatory support if the score sums to >10. SET = stroke-related early tracheostomy, GCS = Glasgow Coma Scale, MCA = middle cerebral artery, ICH = intracerebral hemorrhage, PaO_2 = arterial partial pressure of oxygen, FiO_2 = fractional inspired oxygen, APS = acute physiology score, APACHE II = Acute Physiology and Chronic Health Evaluation II [43], LIS = lung injury score.

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