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Clinical Outcomes of Early Versus Late Tracheostomy in Critically Ill Patients: A Retrospective Multicenter Study in Palestine

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Abstract: **Background**: Tracheostomy is a common procedure in critically ill patients requiring mechanical ventilation; yet, the optimum timing for its use is still debated. Data from Palestinian intensive care units is lacking. Elective tracheostomy is a type of tracheostomy that is planned in advance of time instead of being done in an emergency. Early tracheostomy (ET), which was performed during the first 10 days of intubation, and late tracheostomy (LT), performed beyond the tenth day of intubation. The study examines vital inquiries concerning the impact of ET, in contrast to LT, on mortality, duration of ventilation, lengths of ICU and hospital stay, and the occurrence of VAP in critically ill patients. This study aimed to assess the clinical outcomes of ET, versus LT, among mechanically ventilated patients in the Palestinians intensive care units (ICUs). **Method**: A multicenter retrospective study was performed at Ibn Sina Specialized Hospital and Specialized Arab Hospital in northern West Bank, Palestine. All adult patients requiring mechanical ventilation who underwent elective tracheostomy from January 2023 to December 2024 were included (n = 66). Demographic data, clinical severity (GCS, APACHE II), timing of tracheostomy, procedure type, and results were gathered utilizing a standardized data collection form. Continuous variables are presented as medians and interquartile ranges (IQRs); categorical variables were evaluated using chi-square tests. The Mann-Whitney U test was employed for non-parametric comparisons of continuous outcomes. **Results**: Out of 66 patients, 37 received ET and 29 received LT. ET was associated with to markedly reduced post-tracheostomy mechanical ventilation duration (median: 12.0 vs. 21.0 days, p = .022), total ventilation duration (median: 20.0 vs. 34.0 days, p < .001), length of ICU stay (median: 25.0 vs. 40.0 days, p < .001), and length of hospital stay (median: 34.0 vs. 45.0 days, p < .001). In patients with an APACHE II score of ≤ 20, early treatment significantly decreased the incidence of VAP (20.8% compared to 53.8%, p = .041). Overall mortality was lower in ET patients (29.7% vs. 55.2%); however, subgroup analysis by APACHE II score showed no significant differences, suggesting that baseline severity affected mortality outcomes. **Conclusion**: ET correlates with enhanced ventilatory and recovery outcomes, as well as a decreased incidence of VAP in lower-risk patients; nevertheless, its impact on mortality remains indeterminate. These findings offer information to inform ICU procedures and resource allocation in Palestine, underscoring the necessity for prospective, large-scale investigations to elucidate survival advantages.

Keywords: Early tracheostomy, ICU, mechanical ventilation, APACHE II, ventilator-associated pneumonia, critical care.

Introduction

Improvement in critical care medicine has resulted in reduced mortality rates, however an increasing number of patients with chronic critical illness demanding prolonged mechanical ventilation (PMV), which is a successful extubation after three spontaneous breathing tries or 14 days is PMV [1]. Tracheostomy is frequently used in 10–20% of intensive care unit (ICU) patients to treat PMV and assist in weaning [2]. It grants airway access, diminishes sedation, enhances communication, and aids in pulmonary toileting [3]. Notwithstanding certain complications such as infection, bleeding, or tracheal stenosis—tracheostomy is associated with decreased mechanical ventilation time, shortened length of ICU stay, and diminished healthcare expenses [4–6].

The term "early tracheostomy" (ET) has been defined inconsistently in the literature. Most studies and meta-analyses characterize ET as a procedure conducted within ten days of translaryngeal intubation [7], while Shaw *et al*. specify it as occurring within seven days [8]. Herritt *et al*. classified patients

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into three groups: very ET (<4 days), ET (4–10 days), and LT (>10 days) [7,9]. Previous study indicates that ET is better to LT in terms of length of ICU stay, duration of mechanical ventilation, and hospital expenses. Puentes *et al*. indicated that ET yields substantial advantages by diminishing postoperative morbidities, abbreviating ICU and hospital durations, and facilitating expedited patient rehabilitation while lowering healthcare expenditures [7,10].

Despite international studies indicating that early tracheostomy (ET) provides improved clinical results than late tracheostomy (LT), there is a lack of research has examined the timing of tracheostomy in Palestinian ICUs, where clinical practices vary significantly and formal timing guidelines are lacking. Certain hospitals in Palestine conduct extubation trials for patients anticipated to require extended ventilation; nevertheless, these practices lack support from locally sourced evidence. The scarcity of context-specific research is a significant gap, hindering the application of evidence-based timing strategies and the opportunity to enhance patient outcomes in this setting.

Tracheostomy is a critical procedure for patients on mechanical ventilation, especially those needing PMV, which can lead to complications including VAP, pressure ulcers, extended hospital stays, elevated mortality rates, increased healthcare expenses, and diminished quality of life [1,11,12]. Although ET is proposed to enhance outcomes compared to LT, the ideal timing is ambiguous, and no studies in Palestine have evaluated the comparative clinical effects of ET versus LT.

This study is required for providing regional evidence on early versus late tracheostomy in Palestine, where national protocols are lacking and ICU practices vary, in order to enhance patient outcomes and maximize critical care resources.

This multicenter study aimed to assess the clinical outcomes of ET, versus LT, among mechanically ventilated patients in the Palestinians intensive care units (ICUs). including mortality, duration of mechanical ventilation, lengths of ICU and hospital stay, and the incidence of ventilator-associated pneumonia.

Methods

This multicenter retrospective cohort study conducted in two tertiary ICUs in Palestine, and was aimed to assess the clinical outcomes of early versus late elective tracheostomy in mechanically ventilated patients admitted to the Intensive Care Unit (ICU) and Coronary Care Unit (CCU) at Ibn Sina Specialized Hospital (ISH) in Jenin and the Specialized Arab Hospital (SAH) in Nablus, northern West Bank, Palestine. Both hospitals are tertiary referral facilities accredited by the Joint Commission International (JCI), demonstrating compliance with globally recognized standards of patient care and clinical safety.

All adult patients (≥18 years) who underwent tracheostomy following endotracheal intubation between January 1, 2023, and December 31, 2024, at the two participating tertiary hospitals were retrospectively identified and included. As this study is a retrospective analysis of existing medical records, a convenience sampling approach was used, whereby all eligible patients meeting the predefined inclusion and exclusion criteria were selected to ensure sample completeness and data integrity, resulting in a total sample of 66 patients.

Inclusion and exclusion criteria

The study's referent population consisted of adult ICU patients needing prolonged mechanical ventilation and potential elective tracheostomy (who received planned non-emergency tracheostomy) candidates, the accessible population included adults admitted to the ICU of the study hospital during the study period, requiring a minimum of 48 hours of mechanical ventilation with full medical records; from this cohort, eligible participants were individuals aged ≥18 years who subsequently underwent a tracheostomy following their ICU admission.

Patients were excluded if they experienced multiple extubations or re-intubations during the same ICU admission to guarantee a consistent cohort and prevent confounding effects associated with frequent weaning failure. Underwent emergency tracheostomy, had chronic conditions (mentioned in result section) that could influence ventilator dependency or extubation outcomes or possible influence on extubation decisions resulting from diminished respiratory reserve and delayed weaning periods. Had multiple distinct ICU admissions during the same hospitalization, possessed incomplete or missing medical records, or were transferred from another hospital after prior prolonged mechanical ventilation.

Data Collection Procedure

After obtaining ethical approval from the Institutional Review Board (IRB) of An-Najah National University (Ref. No. Fgs/Med. Feb. 2025/74) and the Research Ethics Committees of ibn Sina Specialized Hospital and the Specialized Arab Hospital, approval was obtained for reviewing patient medical records.

Data Collection Sheet

The information was retrospectively extracted from electronic databases through a defined and validated data extraction form. The form has been developed through a comprehensive literature research and evaluated by a multidisciplinary panel including intensivists, anesthesiologists, critical care nurses, as well as academic professors to guarantee relevance, clarity, and content validity. Demographics (age, sex, hospital, admission source), clinical characteristics and severity (primary ICU diagnosis, comorbidities, Glasgow Coma Scale (GCS), APACHE II score, and reason for intubation), tracheostomy details (timing and procedure type), and clinical outcomes (mortality, duration of mechanical ventilation, length of ICU and hospital stay, and incidence of VAP

Patients were classified into two groups based on the time of tracheostomy: early tracheostomy (ET; ≤10 days post-intubation) and late tracheostomy (LT; >10 days). Illness severity was categorized based on the APACHE II score upon ICU admission, with scores of ≤20 identified as low-to-moderate risk and scores >20 identified as high risk [13–16].

Research Process

Following the obtaining of institutional approval, the researcher performed an on-site review of patient records at both target hospitals. The data method of extraction adhered to a specified protocol to ensure accuracy and accuracy. All patient information was anonymised, encoded, and securely stored to ensure confidentiality. Cooperation with hospital managers provided comprehensive access to medical databases and enabled efficient data collecting at both locations.

Statistical Analysis

Data were encoded in Excel and analyzed utilizing (SPSS v25). All statistical tests were two-tailed. The Shapiro-Wilk test was employed to evaluate normality, revealing non-normal distributions. Continuous variables were expressed as medians and interquartile ranges (IQRs), with between-group comparisons conducted using the Mann-Whitney U test. Categorical variables, such as mortality and VAP, were examined using the Chi-square test. Statistical significance was established at $p < 0.05$.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of An-Najah National University and the ethics committees of both cooperating hospitals. All methods complied with institutional research protocols and the principles of the Declaration of Helsinki. Patient identifiers were eliminated throughout data processing, and no personally identifying information was gathered. All anonymised data were safely stored with limited access.

Results

Demographic and Clinical Characteristics

The study included a total of 66 critically ill patients. The average age was 54.06 ± 19.89 years, with the majority of males (74.2%). The majority of patients were admitted from the emergency department (89.4%), whilst 10.6% had been transferred from hospital wards. According to the timing of tracheostomy, 37 patients (56.1%) received (ET) and 29 patients (43.9%) had (LT).

Overall, there were no significant differences between the ET and LT groups with regard to comorbidities, APACHE II scores, discharge destination, or primary ICU diagnosis. The only significant difference observed in univariate analysis was gender, with a higher proportion of males in the ET group. Notably, despite comparable critical illness scores, early tracheostomy was associated with improved ventilatory and recovery outcomes.

Table 1 summarizes the differences of demographic and clinical variables in both the ET and LT groups. The only statistically significant difference among the two groups was gender, with a greater percentage of men in the ET group (83.8%) than in the LT group (62.1%) ($\chi^2(1, N = 66) = 4.009$, $p = .045$). The mean age in the LT group (56.97 ± 19.95 years) was marginally higher than that in the ET group (51.78 ± 19.81 years), but the difference was not statistically significant ($p = .402$).

Upon ICU admission, clinical severity assessed by GCS and APACHE II scores showed no significant differences between the groups ($p > .05$). The mean GCS was 7.03 ± 3.42 in the ET group and 8.52 ± 4.12 in the LT group, while the mean APACHE II scores were 20.38 ± 7.99 and 22.17 ± 7.48, respectively.

The majority of ICU diagnoses were similar across groups, with traumatic brain injury (TBI) occurring more frequently in the ET group (37.8%) compared to the LT group (13.8%). In contrast, gastrointestinal and pulmonary problems were more common in LT, although these differences were not statistical significance ($p > .05$). Comorbidities, such as cardiovascular disease (60.6%), pulmonary illnesses (10.6%), and neurological diseases (16.7%), occurred evenly between the two groups.

According to APACHE II risk categorization, 64.9% of ET patients were categorized as low-to-moderate risk, in contrast to 44.8% of LT patients ($p = .513$).

Table (1): Demographic and clinical characteristics of the study participants (N = 66).

Variable	N	%	Early Tracheostomy (n=37)		Late Tracheostomy (n=29)		P-value
			N	%	N	%	
Gender							
Male	49	74.2	31	83.8	18	62.1	**.045**
Female	17	25.8	6	16.2	11	37.9	
Primary ICU Diagnosis							
Stroke/neurological disorder	15	22.7	9	24.3	6	20.7	.122
Cardiac disorder	19	28.8	9	24.3	10	34.5	
GI disorder	3	4.5	-	-	3	10.3	
Pulmonary disorder	3	4.5	1	2.7	2	6.9	
Trauma	8	12.1	4	10.8	4	13.8	
Traumatic Brain Injury	18	27.3	14	37.8	4	13.8	
Comorbidities							
Preexisting Pulmonary Disease (COPD, Asthma, IPF)	7	10.6	4	10.8	3	10.3	.500
Preexisting Neurological Disease (CVA, Alzheimer, Dementia, Parkinson)	11	16.7	5	13.5	6	20.7	
Preexisting Cardiovascular Disease (HTN)	40	60.6	22	59.5	18	62.1	
Others	32	48.5	20	54.1	12	41.4	
Free	20	30.3	11	29.7	9	31	
Procedure Type							
Surgical	54	81.8	29	78.4	25	86.2	.413
Percutaneous	12	18.2	8	21.6	4	13.8	
APACHE II Score at Presentation to the ICU							
Low-moderate Risk	37	56.1	24	64.9	13	44.8	.513
High Risk	29	43.9	13	35.1	16	55.2	
Discharge Destination							
Home	15	38.5	10	38.5	5	38.5	.633
Rehabilitation Center	24	61.5	16	61.5	8	61.5	
Variable	**M**	**SD**	**M**	**SD**	**M**	**SD**	
Age	54.06	19.89	51.78	19.81	56.97	19.95	.402
GCS at ICU Admission	7.68	3.79	7.03	3.42	8.52	4.12	.244
APACHE II Score at ICU Admission	21.17	7.77	20.38	7.99	22.17	7.48	.215

Intubation-Related Information

In patients who received ET, the most common reason for intubation declined of the level of consciousness (78.4%), whereas in the LT group, this reason represented 44.8% of instances (Table 2). A significant relationship was identified between the reason for intubation and the timing of tracheostomy ($\chi^2(4, N = 66) = 11.799$, $p = .019$), indicating that diminished level of consciousness was the main factor driving ET, Table (2).

Table (2): Intubation-related characteristics by tracheostomy timing.

Variable	n	%	Early Tracheostomy (n=37)		Late Tracheostomy (n=29)		P-value
			N	%	N	%	
Reason for Intubation							
Decreased Level of Consciousness	42	63.6	29	78.4	13	44.8	**.019**
Acute Respiratory Distress	8	12.1	1	2.7	7	24.1	
Cardiac arrest	10	15.2	5	13.5	5	17.2	
Respiratory Failure	4	6.1	2	5.4	2	6.9	
Surgical Operation	2	3.0	-	-	2	6.9	

Mortality

A statistically significant relationship was identified between mortality and the date of tracheostomy, regardless of APACHE II values ($\chi^2(1, N = 66) = 4.354$, $p = .033$). Mortality in the ET group was 29.7%, whereas in the LT group it was 55.2%. For more details regarding to when categorized by illness severity, patients results were described in table (3).

Table (3): Mortality among Tracheostomy Groups.

Mortality	N	%	Early Tracheostomy (n=37)		Late Tracheostomy (n=29)		P-value
			N	%	n	%	
APACHE II score ≤ 20							
Alive	31	83.8	21	87.5	10	76.9	.405
Dead	6	16.2	3	12.5	3	23.1	
APACHE II score > 20							
Alive	8	27.6	5	38.5	3	18.8	.238
Dead	21	72.4	8	61.5	13	81.3	

Duration of Mechanical Ventilation

The Mann–Whitney U test indicated that the ET group had significantly reduced mechanical ventilation durations compared to the LT group, both post-tracheostomy (median = 12.0 days vs. 21.0 days; $U = 359.500$, $p = .022$) and for total ventilation duration (median = 20.0 days vs. 34.0 days; $U = 171.000$, $p < .001$). And according when categorized by APACHE II scores, patient's results was shown in Table (4).

Table (4): Duration of mechanical ventilation among tracheostomy groups.

Variable	M	IQR	Early Tracheostomy (n=37)		Late Tracheostomy (n=29)		P-value
			M	IQR	M	IQR	
APACHE II score ≤ 20							
Duration of MV (Days) Post-tracheostomy	14.00	11.50	11.50	8.50	21.00	17.50	.016
Total Duration of MV (Days)	23.00	16.50	18.50	8.75	34.00	18.00	.000
APACHE II score > 20							
Duration of MV (Days) Post-tracheostomy	16.00	19.50	16.00	23.50	19.00	19.25	.236
Total Duration of MV (Days)	27.00	21.00	21.00	22.00	34.00	17.25	.009

Length of ICU and hospital stay

The ET group showed significantly fewer ICU and hospital duration in comparison to the LT group. The median ICU duration was 25.0 days (IQR: 13.0) for ET and 40.0 days (IQR: 22.5) for LT ($U = 202.000$, $p < .001$). The median duration of hospitalization was 34.0 days (IQR: 17.0) for ET and 45.0 days (IQR: 25.5) for LT ($U = 269.500$, $p < .001$). For the results of patients with APACHE II scores were described in Table (5).

Table (5): Length of ICU and hospital stay among tracheostomy groups.

Variable	M	IQR	Early Tracheostomy (n=37)		Late Tracheostomy (n=29)		P-value
			M	IQR	M	IQR	
APACHE II score ≤ 20							
Length of ICU Stay (Days)	27.00	20.50	24.00	9.75	42.00	24.50	.000
Total Length of Hospital Stay (Days)	40.00	19.00	34.00	16.50	52.00	21.50	.002
APACHE II score > 20							
Length of ICU Stay (Days)	31.00	19.50	27.00	19.00	38.50	20.25	.037
Total Length of Hospital Stay (Days)	36.00	20.00	31.00	16.50	42.50	27.75	.035

Ventilator-associated pneumonia (VAP)

The incidence of VAP was lower in ET patients (21.6%) than in LT patients (41.4%), however this difference was not statistically significant ($\chi^2(1, N = 66) = 3.005$, $p = .083$), Table (6).

Table (6): Ventilator-associated pneumonia (VAP) among tracheostomy groups.

VAP	N	%	Early Tracheostomy (n=37)		Late Tracheostomy (n=29)		P-value
APACHE II score ≤ 20							
Yes	12	32.4	5	20.8	7	53.8	.041
No	25	67.6	19	79.2	6	46.2	
APACHE II score > 20							
Yes	8	27.6	3	23.1	5	31.3	.474
No	21	72.4	10	76.9	11	68.8	

Discussion

This study assessed the clinical effects of early versus late tracheostomy in mechanically ventilated patients in Palestinian ICUs. The findings demonstrated that ET is consistently correlated with decreased durations of mechanical ventilation, length of ICU and hospital stay, and instances of VAP, irrespective of baseline severity; however, variations in patient comorbidities and primary diagnoses affected the degree of the benefits. In addition, this directly addresses that ET benefits exist regardless of baseline severity (critical illness scoring). These differences likely reflect the varying impact of underlying disease severity on weaning and recovery, which modulate the degree of benefit from ET.

These findings correspond with previous worldwide studies indicating that ET accelerates weaning, decreases sedative needs, and facilitates earlier ICU discharge [6,17–20]. Sarwar *et*

al. (2024) indicated that ET patients experienced markedly reduced length of ICU stay and ventilation durations in comparison to LT patients [21]. Likewise, Rifki *et al*. (2024) identified a significant association between ET and reduced VAP rates [20]. The diminished occurrence of VAP in ET patients can be attributed to a reduced duration of endotracheal intubation, enhanced pulmonary hygiene, and decreased bacterial colonization, with the most significant advantages noted in patients with lower baseline conditions. Nonetheless, even among critically ill patients, ET provided measurable improvements in ventilator duration and length of ICU stay, indicating systemic benefits that beyond individual patient scores [22,23]. Regardless of APACHE II score, ET consistently reduced ventilator duration and ICU stay, demonstrating that the benefits of ET extend across all levels of critical illness.

The reported decrease in mechanical ventilation duration in ET patients might come from improved airway access, reduced sedation requirements, and the prompt commencement of physiotherapy and rehabilitation, all of which provide enhanced comfort, diminished problems, and expedited recovery [4,5]. Significantly, these advantages facilitate earlier hospital discharge, thereby decreasing mortality indirectly by reducing exposure to ICU-related problems such as VAP, pressure ulcers, and hospital-acquired infections.

Overall, mortality rates did not show significant variations between the ET and LT groups, aligning with the majority of existing evidence [24–26]. Moussa *et al*. (2020) found no statistically significant difference in short-term death rates; however, a pattern indicating reduced long-term mortality was noted in lower-risk patients undergoing ET [7]. The data indicate that although baseline illness severity influences direct mortality outcomes, ET offers indirect survival advantages via earlier discharge, decreased complication rates, and enhanced patient rehabilitation pathways. Although ET may not significantly reduce direct short-term mortality, its role in facilitating earlier hospital discharge and minimizing ICU-related complications such as VAP and pressure ulcers provides meaningful indirect survival benefits.

APACHE II continues to be a dependable predictor of ICU mortality and weaning outcomes, and our results confirm its effectiveness in selecting patients who are most likely to benefit from ET. Nonetheless, patients with elevated APACHE II scores still exhibited reduced durations of breathing and ICU admissions, so underscoring the overall benefit of ET across various illness conditions [7,27,28].

This is the first study in Palestine to assess the timing of tracheostomy and its clinical consequences from a local perspective. The findings are especially significant given that Palestinian ICUs do not possess defined national protocols for the scheduling of tracheostomy procedures. Current approaches differ among institutions; some prioritize early treatments based on physician discretion, whereas others postpone tracheostomy due to resource constraints, insufficient specialist personnel, or cultural reservations over intrusive interventions. Implementing evidence-based timing rules could thereby facilitate patient recovery, decrease ICU occupancy, and boost cost efficiency in Palestinian healthcare environments.

Strengths, Limitations and future Research

This study has many significant strengths. Provides the first research in Palestine concerning the timing of tracheostomy, offering context-specific evidence for ICUs that presently lack standardized standards. The multicenter methodology increases representativeness, while the utilization of real-world clinical data and uniform criteria of early versus late tracheostomy enhance the reliability and applicability of the results. The integration of APACHE II scores for a more precise evaluation of patient severity, while the assessment of other clinical outcomes such as ventilator duration, ICU length of stay, and VAP incidence provided a thorough insight into the advantages of early tracheostomy.

On the other hands, this research includes several limitations. The limited sample size (n = 66) could limit statistical power and may amplify associations. Furthermore, certain observed outcomes such as the reported mortality benefit of ET must be considered with caution, as they arise from analyses not precisely structured to determine causal relationships. Data were sourced from existing medical records, which may exhibit partial or inconsistent documentation. The investigation was performed in only two tertiary institutions in the northern West Bank, which may restrict generalizability due to significant discrepancies in ICU practices among Palestinian healthcare environments. The lack of long-term follow-up limits the capacity to evaluate prolonged clinical outcomes associated with tracheostomy timing.

The retrospective, non-randomized method limits causal inference and increases the potential for selection bias. Future prospective, multicenter research with larger cohorts are required to validate these findings and produce additional definitive evidence.

Recommendations and Clinical Implications

This multicenter retrospective study demonstrates that early tracheostomy (ET) may enhance clinical outcomes in critically patients need mechanical ventilation by lowering ventilator duration, length of ICU and hospital stay, and the occurrence of VAP. Nonetheless, due to the retrospective methodology, restricted sample size, and absence of randomization, these results must be considered with care. ICU teams in Palestine have to evaluate tracheostomy timing on an individual basis, taking into account patient severity, primary diagnoses, and ventilatory needs, while nurses are essential in early evaluation, airway management, and problem prevention. The findings emphasize the necessity of incorporating knowledge regarding tracheostomy timing and ventilator management into nursing education to improve critical care competencies. At the policy level, these findings establish a basis for formulating standardized national guidelines to optimize tracheostomy scheduling, boost resource usage, and improve patient flow in resource-constrained ICUs. The study underscores the necessity for additional prospective, multicenter research to corroborate these findings, enhance the evidence base, and inform future critical care practices and policies in Palestine. The findings indicate that implementing ET in Palestinian ICUs could enhance patient flow by lowering ventilator use and length of ICU stay, therefore saving healthcare costs. Given restricted ICU capacity, the use of evidence-based timing protocols may improve patient outcomes and optimize resource utilization.

Conclusion

The ET improves ventilatory outcomes, shortens length of ICU and hospital stay, and reduces VAP incidence for low risk patients suggests system-level optimization in the Palestinian ICU, where national protocols for ET timing may be lacking and critical care resources are limited. Although there are few studies in low- and middle-income countries (LMICs), research in Malawi found that patients receiving tracheostomies had lower mortality rates than those without, demonstrating the value of airway optimization even in resource-limited ICUs [29]. Research indicates that ET (defined as ≤6 days) is linked to lower hospital

mortality compared to later tracheostomy [30]. Large meta-analyses from randomized controlled studies show that ET shortens ICU stay and mechanical ventilation duration [31]. In Palestinian ICUs, reducing ventilator days and occupancy could free up essential beds and reduce expenses. Integrating ET to local ICU protocols, especially for patients with lower severity (APACHE II scores), may improve clinical outcomes and health system efficiency. Our findings could inform national recommendations and improve resource allocation and patient care in Palestinian hospitals due to resource constraints and varied practices. To determine the best time for ET in the Palestinian setting and assess its effects on long-term results and cost-effectiveness, future research should focus on multicenter prospective studies with bigger sample sizes.

Disclosure statement

- **Ethics approval and consent to participate:** Ethical approval was obtained from the Institutional Review Board of An-Najah National University and the ethics committees of both cooperating hospitals. All methods complied with institutional research protocols and the principles of the Declaration of Helsinki. Patient identifiers were eliminated throughout data processing, and no personally identifying information was gathered. All anonymised data were safely stored with limited access.
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