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Mechanical ventilation-associated complications and comorbidities in children admitted at pediatric intensive care unit: A cross-sectional retrospective study

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Abstract:

OBJECTIVES: Mechanical ventilation (MV) is frequently employed in acute care settings for severely ill children, but it may be associated with adverse events (AEs). This study investigated the AEs and comorbidities in children receiving invasive MV (IMV).

METHODS: This retrospective cross-sectional study assessed pediatric patients admitted to the pediatric intensive care unit from January 2021 to December 2023 and received IMV. Demographics, clinical findings, concurrent medical conditions, ventilator settings, complications, and outcomes were collected. The predictors of MV-related AEs were assessed using multivariate logistic regression.

RESULTS: One-quarter (24.1%) of the patients experienced at least one AE. Ventilator-associated pneumonia (VAP) was the most common consequence (13%), followed by postextubation stridor (7.9%) and air-leak syndrome (pneumothorax) (6%). Only 12.4% of cases had comorbidities and the death rate was 9.8%. The factors significantly associated with AEs included nonrespiratory causes for admission, prolonged MV duration, and the presence of comorbidities.

CONCLUSIONS: There is an elevated incidence of AEs, with VAP being the most frequent. Nonrespiratory causes for admission, prolonged MV, and preexisting comorbidities were the main predictors of AEs.

Keywords:

Children, comorbidities, complications, mechanical ventilation, pediatric intensive care unit

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Introduction

Mechanical ventilation (MV) is often used in the pediatric intensive care unit (PICU) for severely ill children. Despite respiratory disease being the primary indication for invasive MV (IMV), several nonrespiratory indications exist, including shock, neurological and neuromuscular disorders, congenital cardiac diseases, postoperative management, and pain alleviation.[1]

Regardless of widespread adoption of lung-protective ventilation strategies in pediatric patients, numerous unfavorable events associated with MV are observed, such as unplanned extubation (UE), aspiration-related trauma, atelectasis, ventilator-associated pneumonia (VAP),

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Box-ED section

What is already known on the study topic?

- Mechanical ventilation (MV) is frequently used in pediatric intensive care units (PICUs) for critically ill children
- MV is associated with significant complications, such as ventilator-associated pneumonia (VAP) and postextubation stridor, which may worsen the outcomes.

What is the conflict on the issue? Has it importance for readers?

- There is limited data on the local incidence and predictors of MV-associated complications in Egyptian PICUs
- Identifying these risk factors is essential for improving pediatric critical care practices and patient outcomes.

How is this study structured?

- This is a cross-sectional retrospective study conducted over 3 years at a tertiary PICU, analyzing the incidence, types, and predictors of MV-related adverse events (AEs) and comorbidities.

What does this study tell us?

- One-quarter of patients experienced AEs, with VAP being the most common complication
- Nonrespiratory causes for admission, prolonged MV duration, and preexisting comorbidities were the significant predictors of these events
- Findings highlight the need for targeted preventive strategies and quality improvement in PICU practices.

secretion-induced obstruction of the endotracheal tube (ETT), postextubation stridor, mucus plugging, neuromyopathy, air leak syndromes, extubation failure, and PICU delirium. To be recognized, certain occurrences need the direct involvement of a physician, nurse, or physiotherapist; hence, they are associated with treatment qualities.[2]

The incidence of these consequences in the PICU among pediatric patients is considerable, with rates ranging from 27 to 97 events per thousand patients per day, primarily due to hazardous invasive procedures that may lead to a detrimental outcome.[3]

The rationale for conducting similar studies remains valid, despite the fact that some previous studies have focused on the complications of ventilator usage in infants and adolescents, particularly in the context of VAP cases. This is due to the fact that each unit and country must have local data to compare their quality of care with that of other institutions.

This research was designed to demonstrate the prevalence, kinds, and determinants of MV-associated consequences and comorbidities in pediatric patients hospitalized in the PICU.

Methods

Study design and setting

Employing a retrospective cross-sectional design, this pragmatic observational study was conducted in the PICU of a university-affiliated tertiary care hospital, which has a capacity of 30 beds and 15 ventilators (comprising 5 AVEA and 10 Drager ventilators). Our PICU admits approximately 600 patients annually, with additional pediatric cases admitted to other specialized intensive care units within the hospital, including posttraumatic, postoperative, and toxicology units.

The study was reviewed and approved by the Ethics Committee at the Faculty of Medicine, Benha University (Approval no.: RC# 16-4-2023, Approval Date: April 16, 2023). This analysis was registered on ClinicalTrials.gov (NCT# 06368973).

Figure 1 illustrates the cohort flowchart of the pediatric patients recruited in our analysis and the sampling process to assess MV-associated adverse event (AE) and comorbidities during the study period.

Inclusion criteria encompassed pediatric patients aged between 29 days and 16 years who were admitted to the PICU and required IMV for a minimum of 24 h during the period from January 2021 to December 2023. Exclusion criteria were newborns (<29 days old), pediatric patients who received IMV for <24 h, children experiencing chronic respiratory failure or facing challenges in being discharged due to socioeconomic barriers, pediatric patients with insufficient data or transferred to a different hospital, and children requiring long-term IMV therapy (total duration of ventilation ≥21 days).[4]

Data collection

Medical files for all recruited pediatric patients were reviewed, and anonymous data were gathered, including age, sex, body mass index (BMI), and previous hospitalizations. Clinical data, including the primary diagnosis, reasons for admission, length of hospital stay, sedation duration, and initial pediatric index mortality score (PIM3), which is a simplified form that is composed of 8 variables assessed upon admission to an intensive care unit to predict mortality,[5] were recorded. These data played a crucial role in evaluating disease severity, predicting recovery, assessing PICU performance, determining clinically significant AEs attributable to IMV as the primary outcomes, and hospital mortality.

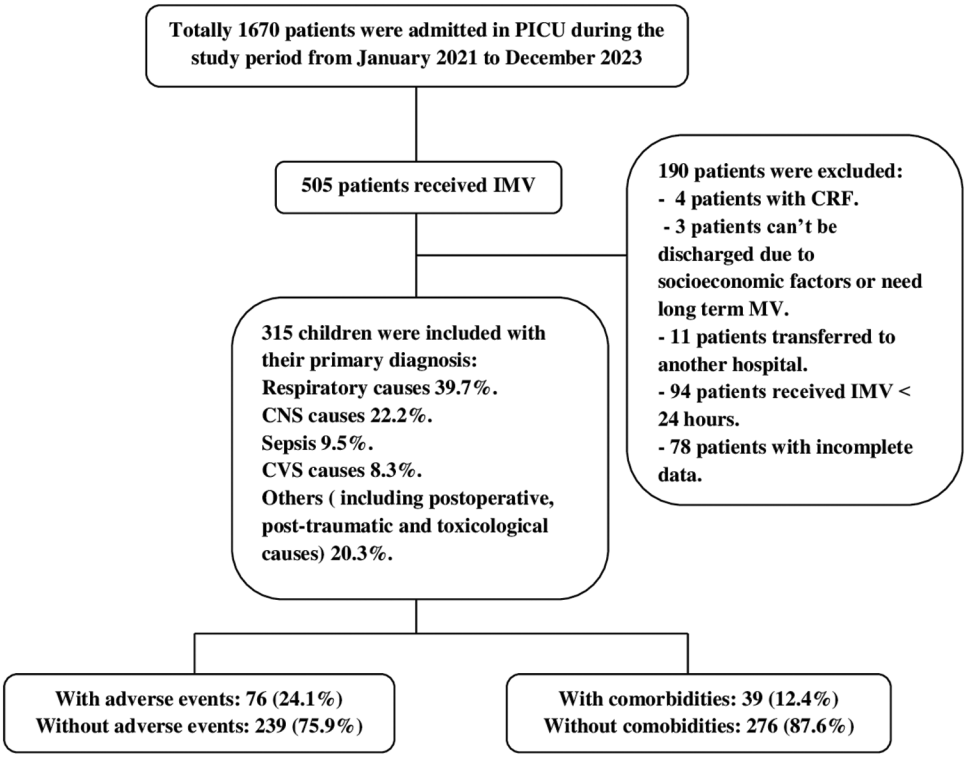

Figure 1: Cohort flowchart of the studied pediatric patients admitted to pediatric intensive care unit

Moreover, an analysis of ventilatory support characteristics was conducted. This included identifying the MV indications, determining the MV duration, the mode of ventilation used (either assist-control [AC] or synchronized intermittent mandatory ventilation [SIMV]), and average measuring parameters such as fraction of inspired oxygen (FiO_2), tidal volume (TV) that was calculated based on the actual body weight, positive end-expiratory pressure, and peak inspiratory pressure (PIP).

In this study, we assessed the complications during IMV in pediatric patients, including UE, lung atelectasis, and VAP, the latter typically diagnosed through integrating imaging, clinical, and laboratory findings: (1) persistent or newly detected radiographic infiltrates; (2) signs of infection such as fever, purulent sputum, leukocytosis, increased minute ventilation, arterial oxygenation decline, and/or increased vasopressor infusion to maintain blood pressure; and (3) positive microbiological cultures.[6] Other complications included aspiration events, air leak syndromes, ETT obstruction, and extubation failure (subglottic stenosis and other causes). Additionally, PICU-acquired neuromyopathy, a diffuse neuromuscular disorder observed in critically ill pediatric patients, was identified. This condition was manifested as generalized symmetrical weakness (more pronounced proximally than distally), delayed weaning from MV, and hypo-/areflexia, following the exclusion of alternative etiologies. Diagnosis was primarily based on the clinical assessment.[7] Furthermore, PICU delirium, defined as an acute confusional state accompanied by cognitive changes, was documented. Delirium was categorized into three motor subtypes: Hypoactive, hyperactive, and mixed.[8-10] Delirium diagnosis relied on sedation-agitation level assessment, psychometric evaluation, and caregivers' judgments.[11]

Furthermore, we assessed the associated comorbidities, such as cardiovascular system (CVS) insufficiency, multiple organ failure (MOF), the occurrence of acute kidney injury (AKI), acute respiratory distress syndrome (ARDS), gastrointestinal tract (GIT) bleeding, and thrombophlebitis.

Sample size estimation

Referring to findings from the prior literature, the study's power was estimated using online software for the sample size calculation through UCSF-CTSI Grant Numbers UL1 TR000004 and UL1 TR001872. Considering a 95% confidence level (Z-score = 1.96) and a ±5% desired precision of the estimate, based on Konca *et al*.'s study[12] that reported the AEs prevalence associated with MV in critically ill children to be 24.1%, sample size calculation necessitated the inclusion of 299 subjects according to the formula reported by Hulley *et al*.[13]

Statistical analysis

Encountered data were analyzed using the SPSS software version 28 (IBM, Armonk, New York, United States).

The Kolmogorov–Smirnov test evaluated the normalcy of quantitative data. Normally distributed data were presented as means with standard deviations, while nonnormally distributed ones were expressed as medians with interquartile ranges. Categorical data were expressed as numerical values and percentage. A *t*-test or Mann–Whitney U-test was used independently to compare the AEs, based on the data distribution. The comparison of categorical data was performed using the Chi-square test or Fisher's exact test. The probability of these consequences was predicted through multivariable regression analysis, producing odds ratios (OR) with a 95% confidence interval (CI). All tests were bilateral, with an established $P < 0.05$ being significant.

Results

Baseline characteristics of the pediatric patients with their main indications of admissions are presented in Table 1 and Figure 1.

Regarding MV parameters, the most common ventilator mode used is AC, followed by SIMV, and the mean airway pressure is 10.3 ± 1.4 cm H2O. Detailed ventilation settings are shown in Table 1.

The majority of patients (24.1%) experienced at least one AE, with VAP being the most common. Postextubation stridor was noted in 7.5%, and air leak syndromes, mainly pneumothorax, were seen in 6%. Less common AEs included atelectasis, trauma by aspiration, neuromyopathy, and PICU delirium, as illustrated in Table 2 and Figure 2.

Table 1: General characteristics of the studied patients

General characteristics	Total (*n* = 315)
Age (months), median (IQR)	32 (8–60)
Sex, *n* (%)	
Males	157 (49.8)
Females	158 (50.2)
Weight (kg), median (IQR)	13.9 (8.5–20.4)
BMI, mean±SD	21.2±2.2
Primary diagnosis, *n* (%)	
Respiratory disease	125 (39.7)
Sepsis	30 (9.5)
CNS causes	70 (22.2)
CVS diseases	26 (8.3)
Others	64 (20.3)
FiO_2 (%), mean±SD	33±6
PIP (cmH_2O), mean±SD	17±1
PEEP (cmH_2O), median (IQR)	6 (5–6)
TV (mL/kg), median (IQR)	6 (6–7)
Duration of MV therapy (days), median (IQR)	2 (1–3)
Length of hospital stay (days), median (IQR)	6 (5–8)
PIM3 score, median (IQR)	0.96 (0.89–1.4)
Sedation time (h), median (IQR)	27 (21–48)

SD: Standard deviation, IQR: Interquartile range, CNS: Central nervous system, CVS: Cardiovascular system, FiO_2: Fraction of inspired oxygen, PEEP: Positive end-expiratory pressure, PIP: Peak inspiratory pressure, TV: Tidal volume, MV: Mechanical ventilation, PIM3: Pediatric index of mortality 3, BMI: Body mass index

Our analysis showed that 12.4% of the patients had at least one comorbidity, with a hospital mortality rate of 9.8%, involving 31 patients with various medical conditions.

Several variables demonstrated significant associations with the occurrence of AEs. The percentage of females was higher in the AEs group, which was statistically significant (60.5% vs. 46.9%, $P = 0.038$). The indication of admission significantly differed according to the occurrence of AEs ($P < 0.001$), with respiratory diseases being higher in the group without AEs (46.9%) compared to those with AEs (17.1%). In contrast, sepsis was higher in the group with AEs (23.7%) than in those without (5%) [Table 3].

Additionally, length of hospital stay (median 10 days vs. 6 days, $P < 0.001$), FiO2 (mean 37% vs. 32%, $P < 0.001$), PIP (mean 18 vs. 17 cm H2O, $P < 0.001$), TV (median 7 vs. 6 ml/kg, $P < 0.001$), duration of IMV (median 5 vs. 2 days, $P < 0.001$), PIM3 score (median 1.05 vs. 0.95, $P < 0.001$), and sedation time (median 59 vs. 24 h, $P < 0.001$) were all significantly higher in patients with AEs. The presence of comorbidities, including CVS insufficiency, ARDS, MOF, GIT bleeding, thrombophlebitis, and recurrent admission, were also notably associated with AEs. Hospital mortality was considerably higher in the AEs group (15.8% vs. 7.9%, $P = 0.046$). In contrast, age, weight, BMI, CVS diseases, and AKI were not significantly associated with AEs [Table 3].

Variables demonstrating a statistical significance (P values < 0.05) in the previous analyses were initially subjected to univariate analysis, followed by inclusion in a multivariate logistic regression model, revealing that the nonrespiratory causes of admission were significantly associated with about three times increased risk of MV consequences (OR = 2.784, 95% CI = 1.255–6.175, $P = 0.012$). In addition, a 1-day increase in MV duration was significantly associated with about 1.5 times increased risk of MV-related complications (OR = 1.566, 95% CI = 1.141–2.149, $P = 0.005$). Moreover, the presence of comorbidities was significantly associated with about four times increased risk of these events (OR = 4.472, 95% CI = 1.708–11.712, $P = 0.002$) [Table 4].

Discussion

While MV has revolutionized pediatric critical care management, its life-saving benefits are counterbalanced by substantial risks of its AEs and comorbidites, understudied aspects in Egyptian PICUs, despite global clinical reliance.

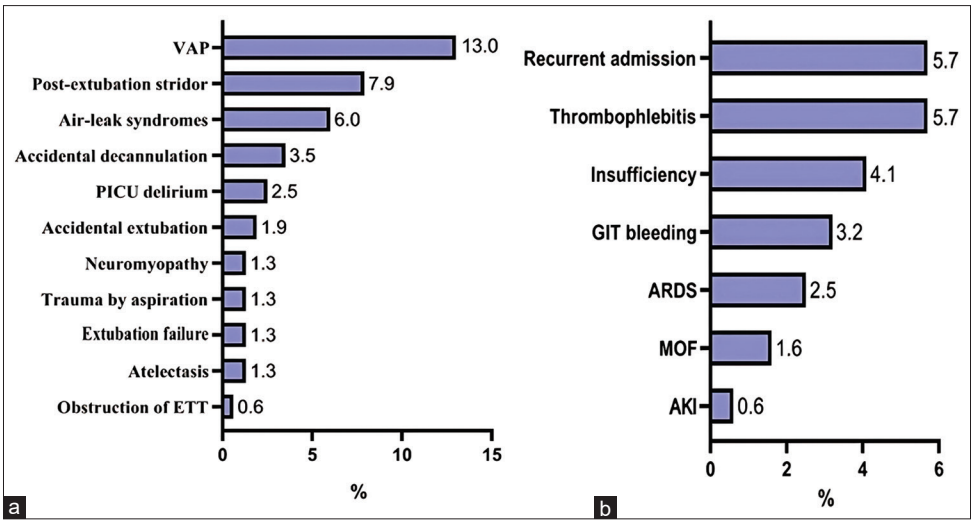

Figure 2: Mechanical ventilation-associated adverse events and comorbidities in the studied patients: (a): Percentages of mechanical ventilation-associated adverse events and (b): Percentages of comorbidities in the studied patients

Table 2: Adverse events, comorbidities, and mortality in the studied patients

Adverse events, comorbidities, and outcome	*n* (%)
Adverse events	
Occurrence of any adverse event	76 (24.1)
Atelectasis	4 (1.3)
Accidental extubation	6 (1.9)
VAP	41 (13)
Extubation failure	4 (1.3)
Trauma by aspiration	4 (1.3)
Obstruction of ETT	2 (0.6)
Postextubation stridor	25 (7.9)
Air-leak syndromes	19 (6)
Neuromyopathy	4 (1.3)
PICU delirium	8 (2.5)
Accidental decannulation	11 (3.5)
Time of occurrence	
Morning	22 (28.9)
Night	54 (71.1)
Comorbidities	
Presence of any comorbidity	39 (12.4)
CVS insufficiency	13 (4.1)
ARDS	8 (2.5)
AKI	2 (0.6)
MOF	5 (1.6)
GIT bleeding	10 (3.2)
Thrombophlebitis	18 (5.7)
Recurrent admission	18 (5.7)
Outcome	
Hospital mortality	31 (9.8)

VAP: Ventilator-associated pneumonia, ETT: Endotracheal tube, PICU: Pediatric intensive care unit, CVS: Cardiovascular system, ARDS: Acute respiratory distress syndrome, AKI: Acute kidney injury, MOF: Multiple organ failure, GIT: Gastrointestinal tract

In this study, among the total patients, 24.1% experienced at least one AE, a rate higher than reported in Martins *et al*.[3] (21.6%) and lower than the studies by Kendirli *et al*.[14] (42.8%) and Meligy *et al*.[15] (39.9% or 29.5 AEs per 1000 days of MV). Variations in prevalence could stem from differences in event selection by authors, reflecting diverse safety cultures and surveillance parameters across services.

A previous study that was conducted in a developing country revealed a complication prevalence rate of 9.2%, whereas our results documented a substantially higher rate of 24.1%.[16] The extant literature demonstrates peak incidence rates of 42.8%.[14] Complications have been linked to prolonged IMV, and research suggests that these complications notably decrease when patients are under the care of clinicians experienced in respiratory support with MV.[14,17]

In the current study, VAP was the most prevalent MV-associated AE that occurred in 13% of cases, followed by postextubation stridor that was seen in 7.9%, while pneumothorax manifested in 6% of patients. Correspondingly, Anitha *et al*.[18] reported that out of 111 children, VAP was the predominant event in 21.1%, followed by stridor in 15.7%.

However, the prevalent AE identified in Martins *et al*.'s[3] research was postextubation stridor, accounting for 25.9% of incidents. Similarly, Dave *et al*.[19] noted that stridor was the primary problem experienced in 15.7% of children. The primary contributing factors to stridor across these studies were extended MV duration, intubation-related trauma, and younger age groups, particularly children under 4 years old.

A Mexican contemporary study reported the most common pulmonary incidents with the following prevalence: Atelectasis (35%), followed by pneumonia (27.5%), pneumothorax, bronchopulmonary dysplasia, pneumomediastinum (15% each), and pulmonary hemorrhage (2.5%).[20]

Table 3: General characteristics, comorbidities, and mortality according to the occurrence of ventilator-associated adverse events

	Adverse event		*P*
	Yes (*n*=76)	No (*n*=239)	
Age (months), median (IQR)	32 (10–57)	32 (8–61)	0.905
Sex, *n* (%)			
Males	30 (39.5)	127 (53.1)	0.038*
Females	46 (60.5)	112 (46.9)	
Weight (kg), median (IQR)	13.5 (9.5–19.5)	13.9 (7.9–20.4)	0.725
BMI, mean±SD	21±1.7	21.3±2.4	0.403
Indications of admission, *n* (%)			
Respiratory disease	13 (17.1)	112 (46.9)	<0.001*
Sepsis	18 (23.7)	12 (5)	
CNS causes	18 (23.7)	52 (21.8)	
CVS diseases	6 (7.9)	20 (8.4)	
Others	21 (27.6)	43 (18)	
Length of hospital stay (days), median (IQR)	10 (7–14)	6 (5–7)	<0.001*
FiO_2 (%), mean±SD	37±7	32±5	<0.001*
PIP (cmH_2O), mean±SD	18±2	17±1	<0.001*
PEEP (cmH_2O), median (IQR)	6 (5–6)	6 (5–6)	0.969
TV (mL/kg), median (IQR)	7 (6–8)	6 (6–7)	<0.001*
Duration of MV (days), median (IQR)	5 (3–8)	2 (1–3)	<0.001*
PIM3 score, median (IQR)	1.05 (0.96–2.25)	0.95 (0.89–1.1)	<0.001*
Sedation time (h), median (IQR)	59 (36–88)	24 (19–45)	<0.001*
Comorbidities, *n* (%)			
Presence of any comorbidity	26 (34.2)	13 (5.4)	<0.001*
CVS insufficiency	11 (14.5)	2 (0.8)	<0.001*
ARDS	8 (10.5)	0	<0.001*
AKI	2 (2.6)	0	0.058
MOF	4 (5.3)	1 (0.4)	0.013*
GIT bleeding	8 (10.5)	2 (0.8)	<0.001*
Thrombophlebitis	14 (18.4)	4 (1.7)	<0.001*
Recurrent admission	10 (13.2)	8 (3.3)	0.001*
Outcome			
Hospital mortality	12 (15.8)	19 (7.9)	0.046*

*Significant at *P*<0.05. SD: Standard deviation, IQR: Interquartile range, BMI: Body mass index, CNS: Central nervous system, CVS: Cardiovascular system, FiO_2: Fraction of inspired oxygen, PEEP: Positive end-expiratory pressure, PIP: Peak inspiratory pressure, MV: Mechanical ventilation, TV: Tidal volume, PIM3: Pediatric index of mortality 3, ARDS: Acute respiratory distress syndrome, AKI: Acute kidney injury, MOF: Multiple organ failure, GIT: Gastrointestinal tract

Table 4: Univariate and multivariate logistic regression analysis to predict mechanical ventilation-associated adverse events

	Univariate		Multivariate	
	OR (95% CI)	*P*	OR (95% CI)	*P*
Female gender	1.739 (1.028–2.941)	0.039*	1.507 (0.753–3.017)	0.246
Nonrespiratory causes for admission	4.274 (2.234–8.177)	<0.001*	2.784 (1.255–6.175)	0.012*
FiO_2 (%)	1.173 (1.118–1.231)	<0.001*	1.067 (0.973–1.171)	0.169
PIP (cmH_2O)	1.741 (1.42–2.135)	<0.001*	1.037 (0.705–1.525)	0.854
TV (mL/kg)	3.695 (2.554–5.347)	<0.001*	0.78 (0.388–1.569)	0.486
Duration of MV therapy (days)	1.824 (1.548–2.15)	<0.001*	1.566 (1.141–2.149)	0.005*
PIM3 score	1.458 (1.241–1.714)	<0.001*	0.977 (0.728–1.313)	0.879
Sedation time (h)	1.047 (1.035–1.06)	<0.001*	1.006 (0.984–1.028)	0.616
Comorbidity	9.04 (4.344–18.812)	<0.001*	4.472 (1.708–11.712)	0.002*

*Significant at *P*<0.05. OR: Odds ratio, CI: Confidence interval, PIP: Peak inspiratory pressure, FiO_2: Fraction of inspired oxygen, TV: Tidal volume, MV: Mechanical ventilation, PIM3: Pediatric index of mortality 3

In Principi *et al*.'s study,[21] complications related to MV affected 40% of patients (60 out of the total sample of 85), with atelectasis occurring in 16.7% and postextubation stridor in 13.3% of cases. However, VAP was reported in only 1.9% of the patients. This may be due to the smaller sample size they used. Kendirli *et al*.[14] documented the occurrence rates of complications as 26.3% for atelectasis, 17.5% for VAP, 13.1% for pneumothorax, 5.4% for

bleeding, 4.3% for tracheal edema, and 2.1% for chronic lung disease.

The incidence of VAP has decreased with the implementation of bundled strategies, including hand hygiene, scheduled oral care, raising the head of the bed, and replacement of contaminated circuits.[22] Furthermore, the occurrence of pneumothorax seems to diminish with the use of lung-protective breathing strategies.[23]

Accidental extubation emerged at a frequency of 0.11–2.27 events per 100 intubation days.[24] UE occurred in 1.9% of the studied patients, reflecting a wide variation in frequency across different studies in the literature. In the study done by Lucas da Silva and Fonseca,[25] UE was the most common incident, accounting for 31.9%. Martins *et al*.[3] reported UE in 16.9% of cases, while Principi *et al*.[21] and Dave *et al*.[19] detected a rate of 3.3% and 3.4%, respectively.

Risk factors contributing to UE risk can be categorized as either patient-related, process-related, or unit-related. Patient-related determinants encompass the patient's consciousness level (such as restlessness, agitation, or the necessity for physical restraints), and process-related risks pertain to clinical interventions requiring meticulous attention from the healthcare team, including procedures, handling critically ill patients, and ensuring proper fixation of the ETT.[25] Conversely, unit-related factors were linked to staffing dynamics, workload, and potential overload in nursing assignments.[24]

A multicenter study demonstrated that substantial reductions in the incidence of UE are attainable through the implementation of improved quality assurance measures.[26]

It is observed that the extubation failure rate in our study is 1.3% due to other causes rather than postextubation stridor. It has been linked to various causes, including age ≤ 2 years, syndromes, prematurity, dysgenesis conditions, chronic respiratory diseases, neurosurgical procedures, and congenital heart disorders.[27]

Regarding the timing of AEs, the majority occurred at night, accounting for 71.1%. In our analysis, it is demonstrated that 12.4% of the studied patients had at least one comorbid disorder. Concerning the patients' hospital mortality rate, 9.8% was observed. Contrariwise, the literature documented higher mortality rates among mechanically ventilated children that reached up to 63%. Shaukat *et al*.[28] reported a 63% mortality rate in developing countries, contrasting starkly with rates below 2% in PICUs in developed countries. The wide range in ventilated children's mortality rates stems from factors such as healthcare access, technological advancements, skilled PICU staff, and specialized pediatric surgical care. Providing care for these patients requires a profound understanding of their conditions, demanding vigilant follow-up and expert disease management.

Comorbidities were seen in 24.3% of the participants in the study conducted by Anitha *et al*.[18] Cerebral palsy and hypoxic-ischemic encephalopathy sequelae were the most prevalent comorbidity. In their research, Volakli *et al*.[29] identified a comorbidity rate of 41.3%.

Numerous factors were significantly linked to AEs. Females had a higher occurrence. Indications of admission differed notably: Respiratory diseases were lower in the AE group (17.1%) than in the group without (46.9%), while sepsis was higher (23.7% vs. 5%). Patients with AEs exhibited longer hospital stays; higher FiO_2, PIP, and TV; longer MV duration; higher PIM3 scores; and longer sedation times. Comorbid conditions such as CVS insufficiency, ARDS, MOF, GIT bleeding, thrombophlebitis, and recurrent admissions were also significantly associated with AEs. Hospital mortality rate was notably higher in the AE group.

Comparably, Anitha *et al*.[18] indicated that the majority of problems (68.4%) arose in the cohort requiring extended ventilator support (>72 h), with all instances of VAP recorded in the >72-hour group.

Numerous results showed that longer duration of hospital stay was a risk factor for AEs.[3,15,20] Consequently, the significance of minimizing hospital stays for these individuals is clear.

The current investigation demonstrated that nonrespiratory admission reasons were substantially linked to an almost 3-fold increase in the probability of MV-related consequences, as shown by multivariate logistic regression analysis. Additionally, a 1-day increase in MV duration was substantially correlated with an approximately 1.5-fold increase in the likelihood of MV AEs. Furthermore, the existence of comorbidities was substantially correlated with an almost four times increased risk of AEs related to MV.

Similar to our results, a recent investigation conducted by Durak and Guvenc[30] revealed a significant correlation between extended MV duration (>3 days) and complications related to IMV. Another study, using multivariate analysis, demonstrated a heightened occurrence of AEs linked to a hospital stay lasting 7 days or longer.[3]

Consistently, the multivariate logistic regression analysis in Konca *et al*.'s[12] showed that comorbidities (OR: 10.527,

95% CI: 3.576–30.994, $P < 0.001$) were significantly related to the complications.

AEs are acknowledged as injuries sustained by patients that arise directly from therapeutic or interventional procedures administered, rather than being attributable to the patients' pre-existing condition. Nonetheless, AEs may still arise from the underlying condition itself. The implementation of preventive protocols is strongly advised, as AEs, particularly VAP, postextubation stridor, and pneumothorax, lead to extended hospital stays, thereby heightening the risk of subsequent complications. Our analysis revealed a clear correlation between the occurrence of such complications and prolonged hospitalization.

Limitations

Considering the retrospective design of this analysis, the risk of unmeasured confounders and the introduction of bias were unavoidable. In addition, the study's single-center approach introduces a constraint in terms of the patient population size, potentially impacting the results, particularly in multivariate analysis, and restricts its broader implications. This shows the importance of multicenter investigations to clarify the primary risk factors and establish avenues for preventive interventions.

Conclusions

The AEs prevalence was notable in our study, with VAP being the most common complication. Nonrespiratory causes for admission, prolonged IMV duration, and the presence of comorbidities were significantly associated with increased risks of these AEs.

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Author contributions (CRediT statement)

- AME: Conceptualization (lead); Writing – original draft (lead); Writing – review and editing (equal)
- ANF: Data collection (lead); Formal analysis (lead); Writing – review and editing (equal)
- MAE: Methodology (lead); Data collection (supporting); Writing – review and editing (equal)
- RMZ: Data collection (supporting); Formal analysis (supporting); Writing – review and editing (equal).

Conflicts of interest

None Declared.

Ethical approval

The study was reviewed and approved by the Ethics Committee at the Faculty of Medicine, Benha University (Approval no.: RC# 16-4-2023, Approval Date: April 16, 2023). Also, the analysis was registered on ClinicalTrials.gov (NCT# 06368973).

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None.

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