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Department of Anesthesiology Critical Care and Pain Medicine

Prevalence, Outcomes, and Associated factors of Unplanned Extubation at Pediatric And Neonatal Intensive Care Unit: Multi-Center study

By: Hayat Adem, MD

Advisor:

Dr. Ananya, MD, Ass. Prof of Anesthesiology and Critical Care and Main Medicine

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Abstract

Background: Unplanned extubation have imposed a sizable burden on mortality, disability and medical cost among pediatrics worldwide. Limited studies have investigated the prevalence, outcome, and attributable risk factors attributed to unplanned extubation

Objective: To assess prevalence, outcomes and attributable factors of UPE in pediatric intensive care unit, Tikur Anbessa specialized hospital, St. Paul, and Minilik II hospitals in Addis Ababa, Ethiopia 2024

Methodology: The prospective cross sectional was employed to investigate the incidence, outcomes and attributable risk factors with UPE at Tikur Anbesa, Paul, and Minilik II hospitals in Addis Ababa, Ethiopia. The normal distribution of continuous variables was assessed using Shapiro-Wilk test. The mean and standard deviation calculated for normality distributed data while median and interquartile range calculated for skewed data. A univariate and multivariate binary logistic regression analysis was performed to examine the factors associated UPE. The results of logistic regression reported as adjusted odds rations (OR) with 95% confidence intervals and p-value < 0.05 are considered statistically significant.

Results: The study included participants with a mean age of 4.6 years (SD=4), with a slight male predominance of 54.1%. The most common reasons for admission to the Pediatric ICU were respiratory distress with various causes (23.9%), cardiovascular conditions (21%), and neurological conditions (11.7%). The overall incidence of UPE in three hospitals was 37.6%. There were 47 neonates in the study participant from which 14(29.8%) had UPE which is lowered as compared to childhood 39.9%. The study observed that mortality rate after UPE is higher as compared in childhood (17%versus 7%) and low rate of tolerated after UPE (4.3%versus 10.1%). Upon adjusting for confounding factors using multivariate binary logistic regression, several variables were identified as statistically significant predictors of UPE. These included being male (adjusted odds ratio [AOR] = 2.4, 95% confidence interval [CI] 1.1-5.3, p = 0.032), having a GCS score of 10T (AOR = 7.1, 95% CI 1.9-26.3, p = 0.003, night shift (AOR = 3.2, 95% CI 1.07-9.5, p = 0.03, Agitate RASS core (AOR = 5.1, 95% CI 1.9-12.9, p = 0.001) and being on CPAP mode of ventilation (AOR = 6.3 95% CI 1.9-20.6 p = 0.002).

Conclusion: The incidence of UPE was significantly high with significant association with nigh shift, high RASS score, high nurse-to patient ration.

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Abbreviations and Acronyms

AOR	Adjuested odd ratio
COR	Crude odd ratio
ETT	Endotracheal tube
ICU	intensive care units
MV	mechanical ventilation
RASS	**Richmond Agitation-Sedation Scale**
UPE	Unplanned extubation
VIF	variance inflation factor

CHAPTER ONE: INTRODUCTION

1.1. Background

Endotracheal tube (ETT) intubation stands as a crucial lifesaving intervention regularly performed in intensive care units (ICUs) for patients necessitating respiratory assistance (1). Ensuring the sustained efficacy of endotracheal intubation ranks as the foremost imperative in the management of mechanically ventilated patients, safeguarding their lives by preserving vital ventilation through artificial airways in the ICU setting. However, complications associated with airway management can precipitate severe and potentially life-threatening conditions such as hypoventilation and hypoxia, underscoring the critical importance of vigilant monitoring and prompt intervention in these cases. Unplanned extubation refers to the inadvertent removal of an endotracheal tube (ETT) either during medical procedures or due to patient action(2, 3). Preventing unplanned extubation is paramount due to its potential to result in severe complications, including airway trauma, compromised hemodynamics and respiration, prolonged mechanical ventilation, and extended hospitalization. These complications contribute to increased mortality and morbidity rates, as well as inefficient allocation of resources(4, 5)

1.2. Statement of the problem

Unplanned extubation poses a substantial burden on pediatric patients in intensive care units, leading to increased mortality rates, heightened morbidity, prolonged mechanical ventilation requirements, and extended stays in the ICU. In North American neonatal intensive care units (NICUs), UE leading to the need for reintubation is identified as the fourth most frequent adverse safety incident. The occurrence of unplanned extubation has been documented to vary significantly, with reported rates ranging from 0.5% to 35.8% based on a systematic review of the literature(6). The significant impact of unplanned extubation (UPE) necessitates increased attention, particularly in low- and middle-income countries where ICU resources are limited, and there is a shortage of skilled healthcare providers. The challenges posed by UPE in these settings highlight the urgent need for improved infrastructure, enhanced training programs, and greater support for critical care services to mitigate the detrimental effects on pediatric patients. A recent prospective study conducted in the intensive care units (ICUs) of referral hospitals in Addis Ababa, Ethiopia, has highlighted a significant prevalence of unplanned extubation events, with a rate of 19.74%.

1.3. Significance of the study

A study investigating the incidence of unplanned extubation, its outcomes, and associated factors among pediatric ICU patients holds considerable significance for various stakeholders within the healthcare ecosystem. A study provides valuable insights to the health care provider into the prevalence and implications of unplanned extubation events in pediatric ICUs. By understanding the factors contributing to these incidents and their outcomes, healthcare professionals can implement preventive measures, enhance patient monitoring protocols, and refine clinical practices to minimize the occurrence of unplanned extubation. Additionally, insights from the study can inform healthcare providers about effective strategies for managing unplanned extubation events when they do occur, thereby improving patient safety and outcomes. Policy makers can benefit from this study by gaining a deeper understanding of the healthcare resource implications associated with unplanned extubation in pediatric ICUs. By recognizing the impact of these incidents on mortality, morbidity, hospital stays, and medical costs, policymakers can prioritize the allocation of resources towards interventions aimed at preventing unplanned extubation and mitigating its adverse consequences. Furthermore, findings from the study can inform the development of healthcare policies and guidelines aimed at standardizing practices related to airway management and improving patient safety in pediatric critical care settings.

Healthcare advocates can leverage the findings of this study to raise awareness about the importance of patient safety in pediatric ICUs and advocate for initiatives aimed at reducing the incidence of unplanned extubation. By highlighting the significant impact of unplanned extubation on patient outcomes and healthcare resource utilization, advocates can mobilize support for investments in staff training, equipment upgrades, and quality improvement initiatives focused on enhancing airway management practices in pediatric critical care settings. Researchers can use the findings of this study to further investigate the underlying factors contributing to unplanned extubation events in pediatric ICUs and explore novel interventions aimed at preventing and managing these incidents. By building upon the existing evidence base, researchers can contribute to the development of evidence-based guidelines and protocols for

preventing unplanned extubation and improving patient outcomes in pediatric critical care.

This study stands out from previous local studies as it comprehensively UPE in neonates and pediatric children. Additionally, it compares the incidence of UPE and associated complications across various age groups, including neonates, infants, children aged 1-5 years, and those above 5 years old.

CHAPTER TWO

2. LITERATURE REVIEW

Unplanned extubation (UE) is a critical event that can happen when an endotracheal tube (ETT) is accidentally removed from a patient receiving invasive mechanical ventilation. The occurrence and impact of UE have been studied extensively, revealing varying rates and implications in different healthcare environments. In North American neonatal intensive care units (NICUs), UE leading to the need for reintubation is identified as the fourth most frequent adverse safety incident. The reported incidence of UE in NICUs ranges from 0.56 to 5.3 unplanned extubations per 100 ETT days, highlighting the significance of this issue in neonatal care. The occurrence of unplanned extubation has been documented to vary significantly, with reported rates ranging from 0.5% to 35.8% based on a systematic review of the literature(6). Studies conducted in different countries have highlighted this variability, with findings showing an unplanned extubation rate of 19% in the Philippines(7) and 22.5% in Taiwan(8). In contrast, research from developed nations such as Britain (4.47%), Belgium (4.2%)(9), and Spain (10%) (10)has reported lower rates of unplanned extubation incidents. These disparities underscore the impact of diverse healthcare practices, patient demographics, and intensive care unit (ICU) protocols on the prevalence of unplanned extubation events on

a global scale. Further exploration of the factors contributing to these differences can guide targeted interventions aimed at reducing the occurrence of unplanned extubation and enhancing patient safety in various healthcare environments worldwide. The epidemiological incidence rates of unplanned extubation (UE) in developed countries exhibit significant variability across various ICU settings and have shown little change, with reported rates ranging from 0.5% to 38.5%. Conversely, there is a notable lack of data on the incidence of unplanned extubation in developing countries. For example, in South Africa in 2004, the incidence of UE in the academic intensive care unit was reported at 10.3%(11). Similarly, in Egypt, at Zigzag University's respiratory ICU in 2019, the incidence was recorded at 11.02%(12). These statistics underscore the occurrence of unplanned extubation events in diverse healthcare settings globally, highlighting the importance of robust surveillance, research, and intervention strategies to address this critical patient safety issue across different socioeconomic contexts. Further exploration of these disparities can provide valuable insights for improving patient outcomes and reducing unplanned extubation incidents worldwide. A recent prospective study conducted in the intensive care units (ICUs) of referral hospitals in Addis Ababa, Ethiopia, has highlighted a significant prevalence of unplanned extubation events, with a rate of 19.74%(10). This finding underscores the importance of addressing unplanned extubation incidents within the critical care setting of Ethiopia's healthcare system. Further investigation into the underlying factors contributing to unplanned extubation in this specific context could offer valuable insights for enhancing patient safety measures and outcomes. In a related study, a nested unmatched case-control investigation was carried out at multiple government hospitals in Addis Ababa, Ethiopia, involving a cohort of 198 intubated pediatric patients. Among these patients, 66 cases of unplanned extubation were identified and analyzed alongside 132 control subjects. The study revealed an incidence rate of unplanned extubation at 7.2 occurrences per 100 days(13). These findings shed light on the frequency of unplanned extubation events in pediatric patients within the Ethiopian healthcare system and underscore the need for targeted interventions to mitigate such occurrences and improve overall patient care. Numerous international studies exploring the multifaceted factors influencing unplanned extubation events among pediatric patients in intensive care units (ICUs) have revealed a diverse range of contributors. These encompass a

spectrum of influences, including patient-specific characteristics, dynamics within the ICU team, activity-related variables, and considerations related to shifts and staffing patterns. Of particular note is the observation that male patients exhibit a higher propensity for unplanned extubation occurrences compared to their female counterparts. Furthermore, inadequate sedation levels or insufficient physical restraint measures have emerged as significant risk factors predisposing intubated patients to the potential hazards of unplanned extubation incidents. This comprehensive understanding of the complex interplay of factors surrounding unplanned extubation in pediatric ICU settings underscores the importance of tailored interventions and vigilant monitoring protocols to enhance patient safety and optimize clinical outcomes.

CHAPTER: OBJECTIVE

3.1. General objectives

- To assess the incidence, outcome and associated factors of unplanned extubation of mechanically ventilation children in PICU in Tikur Anbesa, St. Paul, and Minilk specialized hospital in Addis Ababa, Ethiopia, 2024

3.2. Specific objectives

- To identify the outcome of unplanned extubated mechanically ventilated children in PICU from three selectedhospitals
- To identify associated factors related to Unplanned extubated mechanically ventilated children

CHAPTER FOUR: METHODOLOGY

4.1. Study area and period

The research was carried out in three governmental hospitals in Addis Ababa such as Tikur Anbesa, St paul and Minilk hospital that operate as pediatric Intensive Care Units (PICU) and are equipped with advanced mechanical ventilators for pediatrics intubation. These hospitals have experienced neonatologists and pediatricians on staff. Data was collected from nov 11 ,2023- march 30, 2024

4.2. Study design

The prospective cross sectional study was employed to investigate the incidence, outcomes and factors associated with unplanned extubated patients on mechanical ventilation with admitted different indications in three hospitals

4.3. Study Period

The study was conducted at PICU at Tikur Anbesa, St Paul, and Minilk II Comprehensive Specialized Hospital from nov 11 ,2023- march 30, 2024

4.4. Population

4.4. 1. Source population:

- All pediatrics and neonates admitted to PICU and NICU during the study period

4.5 Study Population

- All pediatrics and neonates admitted to PICU and NICU requiring mechanical ventilation during the study period

4.6. Sampling method:

The selection of hospitals for this study was conducted using a convenient sampling technique, focusing on facilities known for their high-volume medical services and the availability of pediatric intensive care unit (ICU) facilities. This approach ensured that a diverse range of hospital settings and patient populations were included in the study, enhancing the generalizability of the findings to a broader healthcare context.

4.7. Sample size determination

Sample size was determined with taking the incidence of UPE for mechanical ventilated child 19.74%, which was obtained similar study in Ethiopia, a margin of error to be 5%, a confidence level of 95 % and considering incomplete data of 5 %, the representative sample of participants will be determined using a single proportion formula for a cross-sectional survey as follows.

$n = \frac{(\frac{Za}{2})^{2.}}{d^2} p.q = \frac{(1.96)^2}{(0.05)^2} * 0.8026 * 0.1974 = 246$ and 5% loss of data, 256 patients

4.8. Inclusion and exclusion criteria

4.8.1. Inclusion criteria

- All pediatrics and neonates nerequiring mechanical ventilation, irrespective of their gestational age, weight, or indication, were included in the study.

4.8.2. Exclusion criteria

- Pediatrics and neonates with lethal congenital anomalies were excluded from the study

4.9. Data collection and measurement

The structured questionnaire utilized in the study was crafted based on existing literature and encompassed sections on sociodemographic data, clinical profiles, and obstetrics history. Prior to the primary data collection, the questionnaire underwent a pretest with 5% of the sample size to ensure the clarity and relevance of the questions. Data collection was done by trained two general practitioner and the principal investigator checked the data consistency and completeness in each day.

4.10. Study Variables

4.10.1. Independent Variables

- Age
- Sex
- Indication to mechanical ventilation
- Shifting
- Nurse to patient ratio
- RASS score
- GCS
- ETT Fixator
- Duration of MV stay
- Resident seniority
- Physical restrained
- Sedative medication
- MV mode

4.10.2. Dependent Variables

- **Unplanned Extubation**

4.11. Data Analysis

The analysis was made with SPSS software with version 25. The categorical variables in the study were presented with using frequency, percentage, and compared between groups using the chi-square test. The normal distribution of continuous variables was assessed using Shapiro-Wilk test. The mean and standard deviation calculated for normality distributed data while median and interquartile range calculated for skewed data.

Multicollinearity test performed for categorical, continuous and binary variables. Multicollinearity measured by variance inflation factor (VIF) and tolerance. When a VIF was below five and tolerance was above 0.1, variables were forwarded to multivariable binary logistic regression analysis. Variables with a VIF score of ≥ 5 to 10 and tolerance below 0.1 were excluded from the final model.

A univariate and multivariate binary logistic regression analysis was performed to examine the factors associated mortality of mechanical ventilated neonates. Multivariable binary logistic model was employed to adjust cofounder factors. The results of logistic regression reported as adjusted odds rations (OR) with 95% confidence intervals and p-value < 0.05 are considered statistically significant.

4.12. Ethical Consideration

Ethical clearance to conduct this study was obtained from the Anesthesiology, Critical care and pain medicine Department's Research and Publications Committee of the School of Medicine, College of Health Sciences, Addis Ababa University. Confidentiality has been fully maintained during Data collection and further analysis and dissemination of results.

CHAPTER FIVE

5. RESULTS

The study included participants with a mean age of 4.6 years (SD=4), with a slight male predominance of 54.1%. The most common reasons for admission to the Pediatric ICU were respiratory distress with various causes (23.9%), cardiovascular conditions (21%), and neurological conditions (11.7%). The majority of patients were transferred from the ward (35.6%) and the operating room (29.3%). Ketamine was the most frequently used sedative during mechanical ventilation (41%), followed by Fentanyl (29.8%). The majority of patients who experienced unplanned extubation had a GCS score of 10T (48.8%) and 9T (20%). Unplanned extubations were more likely to occur during the night shift (45.9%) and in the afternoon (31.4%). The average duration of mechanical ventilation stay was 9.9 days (SD=7), with over 45% of patients staying for more than 10 days.

Table 1:Sociodemographic and clinical characteristics of study participants admitted in TASH, St. Paul, and Minilk admitted at PICU Addis Ababa, Ethiopia 2024

Variable	Response	Frequency	Percentage
Age	below 5	103	50.2
	Above	102	49.8
Sex	Female	94	45.9
	Male	111	54.1
From	OR	60	29.3
	Ward	73	35.6
	Labor	34	16.6
	EOPD	38	18.5
Causes of admission	UAO	17	8.3
	Shock	24	11.7
	RDS	49	23.9
	Endocrine	18	8.8
	Neuro	24	11.7
	Renal failure	17	8.3
	Cardiovascular	43	21.0
	Trauma	13	6.3
RASS score	Agitated	78	38.0
	Alert and Calm	37	18.0
	Sedated	90	43.9
Sedative medication	Benzodiazepine	29	14.1
	Ketamine	84	41.0
	Propofol	31	15.1
	Fentanyl	61	29.8
Physical restrain	No	118	57.6
	Yes	87	42.4
ETT fixator	Plaster	49	23.9
	Rollbandge	52	25.4
	Plaster +Rollbandge	104	50.7
GCS	10T	100	48.8

	9T	41	20.0
	8T	26	12.7
	<8T	38	18.5
Nurse to patient ratio	1:1	75	36.6
	1:2	70	34.1
	1:3	60	29.3
Shift time	Morning shift	47	22.9
	Afternoon	64	31.2
	Night	94	45.9
Seniority of resident	Junior	123	60.0
	Senior	82	40.0
Mode of MV	SIMV	84	41.0
	PRVC	25	12.2
	CPAP	48	23.4
	AC	48	23.4

Among patient with UPE, 51.9% had reintubation, 19(24.7%) was expired due to different complication, and 23.4% tolerated after UPE. Cardi arrest is the most common cause of death (42.2%) followed air way obstruction 36.8%.

Table 2:Outcomes after unplanned extubations among pediatrics patients admitted in TASH, St. Paul, and Minilk Hospital, Addis Ababa, 2024

Variable	Response	Frequency	Percentage change
Unplanned Extubation	No	128	62.4
	Yes	77	37.6
Outcomes N=77	Reintubation	40	51.9%
	Death	19	24.7
	Tolerated UPE	18	23.4
Causes of deaths N=19	Air way obstruction	7	36.8
	RDS	4	21
	Cardiac arrest	8	42.2

There were 47 neonates in the study participant from which 14(29.8%) had UPE which is lowered as compared to infant 38.3%, 1-5 years 47.8%, and above 5 years 38.6% of UPE during the study period. The sociodemographic and clinical characteristics of neonates were displayed in Table 3. Most of Neonates (78.7%) were from Sait Paul and

mainly admitted with RDS of different causes (23.4%). It is difficult to conduct analytic analysis for factors associated with UPE in neonates due to small sample. However, the study observed that mortality rate after UPE is higher as compared in infant, 1-5 years and above 5years (17%versus 4.3%versus 8.7% versus 8% respectively) and low rate of tolerated after UPE (4.3%versus 10.1%).

Table 3: Sociodemographic and clinical characteristics of Neonates admitted in TASH, St. Paul, and Minilk admitted at NICU Addis Ababa, Ethiopia 2024

Variable	Response	Frequency	Percentage
Hospital	TASH	6	12.8
	St. Paul	37	78.7
	Minilik	4	8.5
Sex	Female	20	42.6
	Male	27	57.4
From	OR	9	19.1
	Ward	21	44.7
	Labor	7	14.9
	EOPD	10	21.3
RASS Score	Agitated (+1 to 5)	22	46.8
	Alert and Calm (_1 to+1)	8	17.0
	Sedated (-2 to _4)	17	36.2
Admission diagnosis	UAO	4	8.5
	Shock	5	10.6
	RDS	11	23.4
	Endocrine	5	10.6
	Neuro	3	6.4
	Renal failure	6	12.8
	Cardiovascular	9	19.1
	Birth Trauma	4	8.5
Sedative medication	Benzodiazepine	4	8.5
	Ketamine	25	53.2
	Propofol	7	14.9
	Fentanyl	11	23.4
Physical restrain	No	23	48.9
	Yes	24	51.1
GCS	10T	23	48.9
	9T	12	25.5
	8T	2	4.3
	<8T	10	21.3
ETT tube fixator	Plaster	6	12.8
	Rollbandge	12	25.5
	Plaster +Rollbandge	29	61.7
Nurse to neonate ration	1:1	21	44.7
	1:2	14	29.8
	1:3	12	25.5
Mode of MV	SIMV	15	31.9
	PRVC	5	10.6
	CPAP	11	23.4
	AC	16	34.0

Duration of MV Stay	below 3 days	10	21.3
	4-9 days	12	25.5
	above 10 days	25	53.2
UPE	No	33	70.2
	Yes	14	29.8
Outcome	Reintubation	4	8.5
	Death	8	17.0
	Tolerated UPE	2	4.3
	No extubation	33	70.2

Table 4: Comparing the rate of UPE and complications between Neonate and Childhood among pediatrics and NICU patients admitted in TASH, St. Paul, and Minilk Hospital, Addis Ababa, 2024

Variable	Response	Neonate	Infant	1.01-5yr	Above 5.01
Unplanned Extubation	No	33(70.2%)	29(61.7)	12(52.2%)	54(61.4%)
	Yes	14(29.8%)	18(38.3%)	11(47.8%)	34(38.6%)
Outcome after UPE N=77	Reintubation	4(8.5%)	13(27.7%)	4(17.4%)	19(21.6%)
	Death	8(17%)	2(4.3%)	2(8.7%)	7(8%)
	Tolerated UP	2(4.3%)	3(6.4%)	1(4.3%)	12(13.6%)

The study conducted in three high-volume medical hospitals revealed a high prevalence of unplanned extubation (UPE) in pediatric ICU patients, with a rate of 37.6%. Various factors were found to be associated with UPE in the univariate binary logistic regression analysis, including sex, physical restraint, RASS score, GCS, nurse to patient ratio, resident seniority, shift time, type of sedative medication, ETT tube fixation, duration of mechanical ventilation (MV) stay, and mode of ventilation. Upon adjusting for confounding factors using multivariate binary logistic regression, several variables were

identified as statistically significant predictors of UPE. These included being male (adjusted odds ratio [AOR] = 2.4, 95% confidence interval [CI] 1.1-5.3, p = 0.032), having a GCS score of 10T (AOR = 7.1, 95% CI 1.9-26.3, p = 0.003, night shift (AOR = 3.2, 95% CI 1.07-9.5, p = 0.03, Agitate RASS core (AOR = 5.1, 95% CI 1.9-12.9, p = 0.001) and being on CPAP mode of ventilation (AOR = 6.3 95% CI 1.9-20.6 p = 0.002). Ketamine sedation was found to have a significant protective effect against unplanned extubation in pediatric patients, with an adjusted odds ratio of 0.22 (95% CI: 0.09-0.6, p=0.002).

Table 5:Univariate and multivariate binary logistic regression analysis to identify factors associated with Unplanned Extubation at TASH, St. Paul and Minilik ICU Ethiopia 2024

Variable	Response	No	Yes	COR	P	AOR	P
Sex	Female	68	26	1		1	
	Male	60	51	2.2(1.2,3.9)	0.008*	2.4(1.1,5.3)	0.032*
Age	below 5	66	37	1			
	Above 5	62	40	1.2(0.7,2.0)	0.62		
From	OR	41	19	1			
	Ward	40	33	1.8(0.9,3.6)	0.11		
	Labor	21	13	1.3(0.5, 3.2)	0.51		
	EOPD	26	12	0.9(.41,2.3)	0.98		
Cause of admission	UAO	9	8	1			
	Shock	16	8	0.4(0.1,1.44)	0.15		
	RDS	29	20	0.4(0.1,1.44)	0.16		
	Endocrine	13	5	0.12(0.03,0.54)	0.006		
	Neuro	17	7	0.43(0.18,1.7)	0.23		
	Renal failure	13	4	0.17(0.04,0.75)	0.02		
	Cardiovascular	26	17	0.32(0.09,1.14)	0.08		
	Trauma	5	8	1.02(0.19,5.6)	0.97		
RASS score	Agitated	41	37	2.8(1.5,5.4)	0.002	5.0(1.9,12.9)	0.001*
	Alert and Calm	19	18	3(1.3,6.5)	0.009	6.4(2.0,20.1)	0.002*
	Sedated	68	22	1		1	

Sedative medications	Benzodiazepine	21	8	0.3(0.1,0.69)	0.007	0.4(0.1,1.3)	0.1
	Ketamine	59	25	0.3(0.14,588)	0.001	0.22(0.09,0.6)	0.002*
	Propofol	23	8	0.24(0.09,0.63)	0.003	0.3(0.08,1.0)	0.053
	Fentanyl	25	36	1		1	
GCS	10T	54	46	5.6(2.0,15.6)	0.001	7.1(1.9,26.3)	0.003*
	9T	24	17	4.7(1.5,14.4)	0.007	3.9(1.01,17.1)	0.048*
	8T	17	9	3.5(1.0,12.1)	0.048	4.4(0.9,21.2)	0.06
	<8T	33	5	1		1	
Physical restrain	No	64	54	2.4(1.3,4.3)	0.005	3.7(1.6,8.6)	0.002*
	Yes	64	23	1		1	
ETT fixator	Plaster	24	25	3.0(1.5,6.1)	0.003	2.2(0.8,5.9)	0.1
	Rollbandge	27	25	2.6(1.3,5.3)	0.006	1.9(.73,5.2)	0.18
	Plaster +Rollbandge	77	27	1		1	
Nurse to patient ratio	1:1	57	18	1		1	
	1:2	39	31	2.5(1.24,5.12)	0.011	1.3(0.5,3.3)	0.6
	1:3	32	28	2.8(1.3,5.8)	0.006	1.9(0.7,4.8)	0.3
Shift	Morning shift	37	10	1		1	
	Afternoon	39	25	2.4(1.0,5.6)	0.049	3.2(1.4,9.6)	0.04*
	Night	52	42	3.0(1.3,6.7)	0.008	3.2(1.07,9.5)	0.03*
Seniority of residents	Junior	67	56	2.4(1.3,4.5)	0.004	1.7(0.7,3.98)	0.2
	Senior	61	21	1		1	
Mode of MV	SIMV	48	36	3.3(1.4,7.6)	0.006	4.2(1.4,12.9)	0.011*
	PRVC	18	7	1.7(0.5,5.2)	0.4	1.8(0.42,8.1)	0.4
	CPAP	23	25	4.7(1.9,11.8)	0.001	6.3(1.9,20.6)	0.002
	AC	39	9	1			
Duration of MV	below 3 days	22	21	2.4(1.1,5.1)	0.021	1.1(0.38,3.1)	0.8
	4-9 days	40	30	1.9(0.98,3.7)	0.051	1.2(0.5,2.8)	0.7
	above 10 days	66	26			1	

CHATPTER SIX: Discussion and Recommendation

6.1. Discussion

This research offers a thorough examination of the occurrence, consequences, and contributing factors linked to unplanned extubation among pediatric patients in three prominent medical facilities in Ethiopia. The study revealed that the incidence of unplanned extubation was 36%. Furthermore, the incidence of this event varied significantly across various healthcare settings, ranging from 0.5% to 35.8%, as determined through a systematic review of existing literature(6). Research conducted in high-income countries like Britain (4.47%) and Belgium (4.2%) revealed a relatively low incidence of unplanned extubation (UPE)(8, 9). In contrast, studies conducted in low- to middle-income countries showed higher rates of UPE, with occurrences reported at 19% in the Philippines, 22.5% in Taiwan, 10.3% in South Africa, 11.02% in Egypt, and 19.74% in Ethiopia(6, 7, 11-13). These findings highlight the variability in UPE rates across different sociodemographic development of the countries, the human resource capacity, the ICU setup capacity and emphasize the need for further investigation into the factors contributing to this phenomenon globally.

Numerous studies conducted in various countries have identified a range of factors associated with unplanned extubation (UPE) in pediatric intensive care unit (ICU) patients. Among these factors, agitation as measured by the Richmond Agitation-Sedation Scale (RASS) was found to be significantly associated with a fivefold higher risk of UPE ($p=0.001$). This observation is consistent with findings from other international studies, suggesting that agitated patients may be more prone to instability and increased movement, potentially leading to inadvertent removal of the endotracheal tube (ETT) during medical care(10, 15).

Several important risk factors have been identified in studies examining the occurrence of unplanned extubation (UPE) in pediatric intensive care units (ICUs). One such factor is a higher Glasgow Coma Scale (GCS) score of 10T, which was found to be associated with a more than sevenfold increased risk of UPE (p=0.003). Various studies have consistently shown that patients with a higher level of consciousness, indicated by a GCS score greater than 9T, are more likely to experience UPE(15). This discrepancy may be attributed to the fact that patients with higher levels of consciousness, or a GCS score greater than 9T, often receive higher levels of sedation, potentially increasing the risk of UPE. Furthermore, our study revealed a significant association between night shifts and the incidence of UPE, with a more than threefold increase in risk (p=0.03). This finding is supported by previous research, which suggests that staff working during night shifts may be more fatigued due to longer working hours and potential disruptions to their natural sleep-wake cycle(10, 14). Additionally, the biological sleep-wake cycle may play a role in increasing the risk of UPE during night shifts, as patients may be more easily disturbed by ventilator alarms and monitoring during nighttime hours. Staff members working overnight may also experience sleepiness or reduced alertness due to the challenges of working against their natural circadian rhythms. Ketamine sedation was found to have a significant protective effect against unplanned extubation in pediatric patients (p=0.002).

Our research findings revealed a notable difference in the occurrence of unplanned extubation (UPE) between patients managed by junior residents compared to those managed by senior residents. Specifically, patients under the care of junior residents had a 1.7 times higher risk of experiencing UPE, although this association was not statistically significant (p=0.2). This contrasts with previous studies conducted in Ethiopia(10), which reported a more than fivefold increased likelihood of UPE in patients managed by junior residents compared to senior residents. The discrepancy in findings may be attributed to various factors, including the learning curve of junior residents, their higher workload and stress levels, and potentially less experience in managing patients in the intensive care unit. Additionally, our study identified several other risk factors associated with the occurrence of UPE. Patients with less than three days on mechanical ventilation, a higher nurse-to-patient ratio, and those with

endotracheal tube fixation using plaster or roll bandage showed a higher rate of UPE. However, these associations did not reach statistical significance. Further research is needed to explore the underlying mechanisms behind these risk factors and their impact on the occurrence of UPE in pediatric intensive care units.

6.2. Recommendations

Based on the findings of our study, which revealed a significantly higher incidence of unplanned extubation (UPE) compared to previous local and international studies, it is crucial for pediatric ICU health workforce, policymakers, and researchers to take proactive steps to address this issue. The identified risk factors, including higher Glasgow Coma Scale (GCS), agitation, higher nurse-to-patient ratio, the use of plaster or roll bandage ETT fixators, and care by junior residents, highlight the need for targeted interventions to prevent UPE in pediatric intensive care units.

For the pediatric ICU health workforce, we recommend:

- Providing comprehensive training and education programs for healthcare providers, especially junior residents, on proper patient assessment and management to reduce the risk of UPE.

- Implementing standardized protocols and guidelines for sedation management and endotracheal tube fixation to ensure consistent and safe care practices.

- Encouraging interprofessional collaboration between nurses and physicians to optimize patient care and reduce the likelihood of UPE incidents.

To policymakers, we suggest:

- Allocating resources for quality improvement initiatives focused on preventing UPE in pediatric ICUs, including staffing optimization and workload management strategies.

- Advocating for the development and implementation of evidence-based guidelines for the prevention of UPE to promote standardized care practices across healthcare facilities.

- Considering the impact of staffing levels and supervision on patient safety when making healthcare workforce allocation decisions.

For researchers, we propose:

- Conducting further studies to explore the effectiveness of specific interventions, such as sedation protocols or educational programs, in reducing the incidence of UPE in pediatric ICUs.

- Investigating the best practices for securing endotracheal tubes in pediatric patients to prevent UPE, including evaluating different fixation methods.

- Collaborating with healthcare providers and policymakers to develop evidence-based recommendations for preventing UPE and improving patient outcomes in pediatric intensive care settings.

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