ADDIS ABABA UNIVERSITY

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SCHOOL OF MEDICINE

THE PREVALENCE AND RISK FACTORS OF DELIRIUM IN PEDIATRIC INTENSIVE CARE UNIT OF TIKUR ANBESA ADDIS ABABA, ETHIOPIA, 2023

BY: DR. RODAS GIRMA (PEDIATRICS AND CHILD HEALTH RESIDENT)

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The Prevalence and Risk Factors of Delirium in Pediatric Intensive Care Unit of Tikur Anbesa, Addis Ababa, Ethiopia, 2023

Investigator: Dr. Rodas Girma (Pediatrics and Child Health Resident)

E-mail: rodasgirma40@gmail.com

Phone: +251 937566112

Advisor: Dr. Muluwork Tefera, Associate Professor, Pediatric Emergency and Critical Care Sub-Specialist

Co- Advisor: Dr. Dureti Kassim Psychiatrist, Child and Adolescent Psychiatry Fellow

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Declaration

I, the undersigned Pediatrics and Child Health Resident declare that this thesis is my original work in Fulfillment of the Requirements of the Specialty Certificate Program in Pediatrics and Child Health.

Name of the student: **Dr. Rodas Girma**

Date. _____

Signature_____

Approval of the primary Advisor

This thesis work has been submitted with our approval as the university advisor.

Name of the primary advisor: _____

Date. _____

Signature _____

Examining committee:

Name of examiner: _____

Signature: _____

Date: _____/_____/_____

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Acronyms and Abbreviations

AAU	Addis Ababa University
ARDS	Acute Respiratory Distress Syndrome
CAP-D	Cornell Assessment of Pediatric Delirium
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, 5th Edition
ICP	Intracranial Pressure
ICSOL	Intracranial Space Occupying Lesion
PAED	Pediatric Anesthesia Emergence Delirium Scale
PCAM-ICU	Confusion Assessment Method for the Intensive Care Unit for both Pediatric and Preschool Populations
PICU	Pediatric Intensive Care Unit
RASS	Richmond Agitation-Sedation Scale
SOS PD	The Sophia Observation Withdrawal Symptoms - Pediatric Delirium Scale
TASH	Tikur Anbessa Specialized Hospital

Abstract

Background: Delirium has been identified as a prevalent issue among hospitalized patients, particularly in the ICU setting. Despite its detrimental effects on patient outcomes, delirium often goes unnoticed and untreated. Emergence delirium, in particular, has emerged as a significant concern, necessitating consistent monitoring and documentation in pediatric patients.

Objective: The aim of this study is to ascertain the prevalence of delirium in the Pediatric Intensive Care Unit and assess associated risk factors.

Methods: This prospective cross-sectional study enrolled 86 children (aged 6 months to 14 years) admitted to TASH PICU between July and December 2023. Using Google Forms, data on demographics, comorbidities, medications, and delirium assessments PCAM-M and PsCAM-ICU) were collected. Simple random sampling included patients meeting specific criteria, excluding comatose individuals and those with RASS scores below -3. Descriptive statistics and logistic regression identified factors associated with delirium.

Results: The study included 86 patients of which, most patients were aged 6 months to 5 years (55.8%), with a higher proportion being male (65.5%). Clinical characteristics revealed low rates of comorbidities, with infections observed in 57% of cases. The prevalence of delirium among patients was 31.4%. Multivariable analysis identified infection, increased intracranial pressure (ICP), acute mental status changes, and occurrence of three or more errors as significantly associated with delirium.

Conclusion: The study at Tikur Anbessa Hospital's PICU reveals a 31.4% prevalence of delirium among pediatric patients, stressing the need for early recognition and intervention. Factors like infection, increased ICP, and mental status deviations significantly predict delirium, emphasizing comprehensive management strategies to mitigate its impact on patient outcomes.

Introduction

1.1. Background

The word "delirium" comes from the Latin verb "delirare," which literally translates as "to go out of the furrow," or "to be in danger." .(1) In accordance with the DSM-5, delirium is characterized by changes in cognition and disturbances of attention or awareness that appear suddenly, fluctuate in course, and are the outcome of a medical illness . However, it might be challenging to use this definition of delirium in pediatric because it must take into account the child's premorbid neurocognitive stage and linguistic skills (2).

Delirium can be caused by many factors, such as age, developmental delay, illness severity, coma, restraints, MV, and some drugs(3,4). It can also lead to worse outcomes, such as longer PICU and hospital stays, longer MV use, death, trauma, false memories, and hallucinations. Delirium affects 17% to 25% of ICU patients and lasts for about 2 days on average. Among children on MV, half of them can get delirium (5).

To prevent delirium, some strategies are: using less drugs, giving pain relief before sedation, not using benzodiazepines or anticholinergic, stopping sedation regularly, letting patients wake up spontaneously, and improving sleep quality by grouping care activities, playing soft music and lowering lights, providing earplugs and eye masks, and reducing noise (6).

Delirium can be detected and subsequently monitored by using validated assessment tools and scales. Numerous scales have been demonstrated to have high sensitivity and specificity for delirium, including the Pediatric Anesthesia Emergence Delirium Scale (PAED), the Cornell Assessment of Pediatric Delirium (CAP-D),and the Confusion Assessment Method for the Intensive Care Unit for both pediatric and preschool populations (PCAM-ICU and PSCAM-ICU, respectively) (7).

In the pediatric intensive care unit (PICU), these screenings are meant to be used at the patient's bedside. The CAP-D and PAED are generally used for observational delirium testing. While the PAED primarily screens for the development of delirium or delirium that develops after being under anesthesia, the CAP-D can be done on children of all ages. The PCAM-ICU (for children older than 5) (7).

To identify and treat delirium in critically ill children, widespread screening is required. The discovery of modifiable risk factors has made it possible to prevent delirium. Large scale studies are required to determine the long-term consequences of delirium in children. (8).

Both multi-component non-pharmacologic methods and the use of antipsychotics can significantly and safely reduce the prevalence of delirium in adults. On the other hand, there is not much information available regarding pediatric delirium prevention techniques. It might be a good idea to modify adult preventive strategies for children at high risk (9).

Delirium is a symptom of sudden brain failure brought on by a disease that is increasingly being recognized in children. Early investigations suggest that it is widespread, probably has unfavorable long-term consequences, and can be treated using both non pharmacologic and pharmacologic methods, despite the paucity of study in this area (10)

1.2. Statement of the problem

The primary symptoms of delirium, a brain disorder, include abrupt changes in arousal and cognition, delayed reactions, unceasingly agitated movements, and emotional instability (11).

Delirium is not a problem restricted to adults admitted to an ICU but also common in critically ill children. Besides PICU patients, certain populations of children outside the PICU are also at risk for developing delirium (e.g., hospitalized children with cancer) (12).

Delirium is a crucial diagnosis, both because it is difficult to manage and because it signifies a poor prognosis in the hospital and beyond. Several studies demonstrate, delirium in children is linked to higher mortality, longer hospital admissions, and cognitive abnormalities (13).

The early discovery of this condition may lead to a reduced course and morbidity because it can be treated with medication. It is essential to accurately evaluate and treat delirium in the pediatric hospital population due to its consequences (14).

1.3. Significance of the study

Pediatric delirium is a serious and often under-recognized condition that can have significant negative impacts on the health outcomes of critically ill children. Despite its importance there is a lack of data on the prevalence and associated factors of pediatric delirium in low- and middle-income countries including Ethiopia. This study will provide important data on the burden of pediatric delirium in patient admitted to the PICU at black lion hospital and will help to identify risk factors associated with this condition. The study will also assess the impact of pediatric delirium on critically ill children.

The finding of this study will have several important implications. First it will help to raise awareness of pediatric delirium among health care providers at Tikur Anbesa specialized hospital and other similar settings. This led to recognition and management of pediatric delirium which could ultimately improve health outcomes for critically ill children. Second the study will provide important data on the performance of the PCAM tool for delirium screening in critically ill children in low- and middle-income country setting. This information will be useful for health care providers in similar setting who are considering implementing delirium screening tools.

Finally, this study will contribute to the literature on pediatric delirium in low- and middle-income countries which is currently limited. The finding of this study will help to inform the development of targeted interventions to prevent and treat pediatric delirium in this setting.

Emergence delirium should be considered as a ‘vital sign’, which should be followed and documented in every child in the post anesthesia recovery period and every critically ill patient especially at PICU.

2. Literature review

2.1. Prevalence of delirium

In 2018, twenty-five pediatric critical care units in the US, the Netherlands, New Zealand, Australia, and Saudi Arabia participated in a multi-institutional point-prevalence study. Every child (n=994) admitted to the pediatric critical care units on the study days was enrolled, and the bedside nurse used CAPD to screen the kids for delirium. It was not possible to determine the mental condition of 159 children in whole. Out of the 835 participants that were left, 25% had delirium screening positive, 13% had comatose status, and 62% had neither delirium nor coma(16).

A cross-sectional study was carried out in PICUs from 2021 to 2022, at Kermanshah University of Medical Sciences in the west of Iran. The RASS and the CAPD questionnaire were used as assessment tools. The researcher evaluated delirium twice a day, in the morning and in the evening. The prevalence of delirium in PICU patients overall, among the 89 patients who participated in the study, was 25.3%.(17)

A prospective observational study carried out from September 1, 2020, to June 30, 2021, at the tertiary paediatric anaesthesia center by Department of Paediatric Anaesthesiology and Intensive Care Medicine, University Hospital Brno and Faculty of Medicine, Masaryk University, Czech Republic.In total, 2241 patients were hospitalized at the PACU, underwent general anaesthesia for surgical or diagnostic procedures, and had their eligibility evaluated. A total of 1222 patients were included in the final statistical analysis. The highest incidence of ED occurred when a PAED score with cutoff ≥10 points was used, where 89.0% of patients were described as delirious. Out of these patients, 78.9% met the criteria in at least two scoring systems and 54.8% met the criteria in all three scoring systems (PAED > 12, RASS or Watcha).(18)

To determine when delirium first appeared in children hospitalized to a pediatric intensive care unit (PICU) at a tertiary care hospital in North India between the ages of 5 and 18, a prospective cohort research was carried out. 105 children out of the 305 PICU admissions in total were included in the P-CAM assessment tool. The median duration of delirium was two days, with an incidence of 11.4%. The majority of the kids (58.3%) experienced mixed-type delirium, followed by hyperactive (25%) and hypoactive (167%) delirium(19).

After being referred to a big, regional, children's hospital in South Africa with a consultation-liaison psychiatric program 23 children and adolescents were diagnosed with delirium using the fourth edition of the Diagnostic & Statistical Manual of Mental Disorders in August 2010.(20)

At the four teaching hospitals in Ethiopia, a multicenter prospective observational study was carried out at the post anesthetic care unit. Simple random sampling was used to choose older surgical patients who were hospitalized to the post anesthesia care unit and underwent elective surgery in the four teaching hospitals of Ethiopia, Jimma University's Institute of Health's Department of Anesthesia in 2022. The study's 384 elderly individuals had a rate of emergence delirium of 27.6%. (21)

Cross-sectional research was conducted in Jimma, Ethiopia from August 1 through September 30, 2022. 422 people, selected using a random sampling, were included in the study. Delirium and level of arousal were assessed using the Richmond Agitation Sedation Scale (RASS). The presence or absence of delirium was assessed using the Confusion Assessment Method (CAM) is 26.6% of subjects (n = 107) had delirium.(22)

2.2. Factors associated with delirium

A retrospective cohort analysis of all children enrolled in the MSKCC pediatric service between April 1 and June 30, 2015. All consecutive admissions between the ages of 0 and 21 during the three-month research period met the inclusion criteria. There was a total of 319 consecutive admissions, 186 patients, and 2731 hospital days. 35 patients had delirium diagnoses, with an incidence of 18.8%. Age 5 years (OR = 2.6, P =.026), brain tumor (OR = 4.7, P =.026), postoperative status (OR = 3.3, P =.014), and receipt of benzodiazepines (OR = 3.7, P .001) were risk factors that were independently linked to the development of delirium. Delirium was linked to a longer hospital stay, with delirious patients' median stays being 10 days as opposed to their non-delirious counterparts' being 5 days.(23)

Based on a study done in Brazil which is published on April 14, 2021. There was a statistical association between the occurrence of delirium and age less than 2 years; female gender ; use of mechanical pulmonary ventilation ; antiemetic’s ; anticholinergic , and changes in serum sodium and potassium .(24)

A descriptive study which is published on 26 august 2022 in which consecutive patients admitted to the PICU over a period of 12 months were screened daily for delirium among the 476 screened patients, 96 (20.2%) developed delirium. The independent risk factors associated with the development of delirium were respiratory failure, administration of benzodiazepines during PICU stay, and presence of multiple (≥2) risk factors for delirium. The mean length of PICU stay was significantly higher among delirious subjects with .(25)

A prospective, double-blind, randomized investigation was carried out at Daegu Catholic University Medical Center between November 2016 and September 2017 on children between the aged of 2 years to 8 years who had received general anesthesia. A stranger's voice (Group S, n=33) or the mother's voice (Group M, n=66 patients) were randomly allocated to each group.When compared to a stranger's voice, the mother's voice decreased the initial PAED score [mean (standard deviation), 9.8 (2.5) vs. 12.5 (4.1); P=0.002].Compared to a stranger's voice following general anesthesia, the mother's voice decreased emergence delirium scores and the incidence of emergence delirium in pediatric patients.(26)

The risks and treatment for both delirium and sleep disturbance are comparable in the ICU setting.(27) Risks can include hypoxia, mechanical ventilation, infection or inflammation, damage to the central nervous system (CNS), discomfort, and exposure to sedative drugs. In terms of sleep disruption, frequent interventions, intubation with mechanical breathing, and pain can cause insufficient sleep, fragmented sleep, and interfere with the natural progression of sleep stages.(28) Slow wave sleep and REM sleep will both be greatly diminished as a result of sedative medicines (benzodiazepines are known to inhibit REM sleep while opioids are known to reduce slow wave sleep). There is overlap between the risk factors for sleep disturbance and the risk factors for delirium.(29)

2.3. Conceptual framework

This framework proposes that pediatric delirium in the PICU arises from a multifactorial interplay of predisposing and precipitating factors. Predisposing factors include demographic characteristics such as younger age and developmental delay, clinical characteristics like known comorbid conditions, neurological/behavioral characteristics, and prior exposure to certain medications. Precipitating factors encompass acute illness, increased intracranial pressure (ICP), environmental conditions, and changes in medication. Delirium manifestations include acute changes in mental status, inattention, altered level of consciousness, and disorganized thinking. This framework suggests that vulnerable children exposed to specific combinations of these factors are at increased risk of developing delirium, highlighting the importance of targeted interventions and comprehensive care strategies in the PICU.

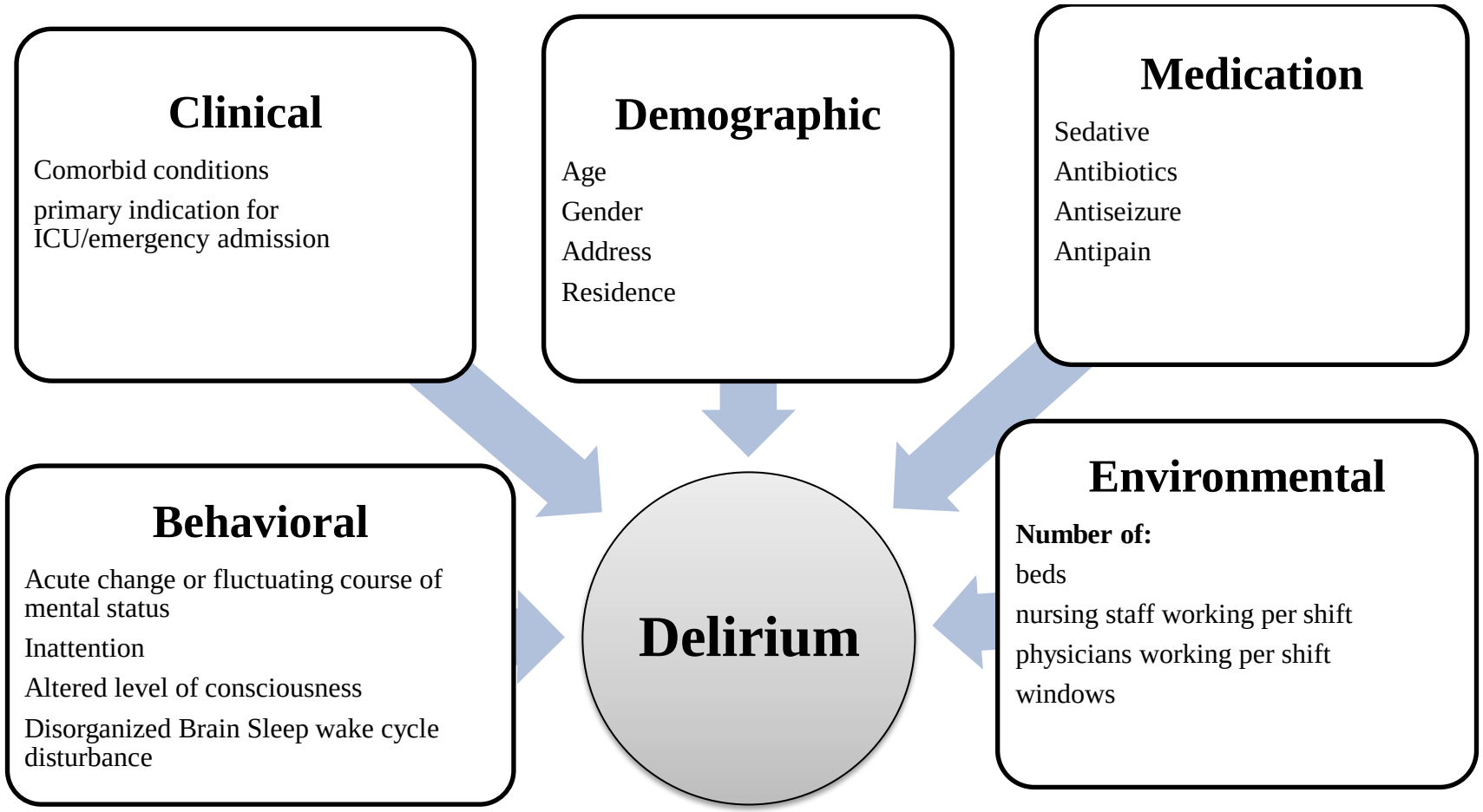

Figure 1: Conceptual framework of factors associated with delirium among patient admitted to pediatric intensive care unit TASH from July 2023 to December 2023

3. Objective

3.1. General objective

To assess the prevalence and risk factors of delirium in patient admitted to pediatric intensive care unit of Tikur Anbessa from July 2023 to December 2023.

3.2. Specific objectives

- To determine prevalence of delirium in PICU
- To determine associated factors of delirium in PICU

4. Methodology

4.1. Study area

Tikur Anbessa Specialized Hospital (TASH) serves as the largest referral hospital in Ethiopia, boasting 700 beds and operating as a university teaching hospital under the jurisdiction of the Federal Ministry of Health. Over time, TASH has evolved into the primary teaching hospital for both clinical and preclinical training across various disciplines, providing specialized clinical services not available elsewhere in the country. The hospital is staffed with dedicated doctors, nurses, and other healthcare professionals who deliver comprehensive healthcare services.

Within TASH, the Department of Pediatric and Child Health was established in 1964, training numerous medical doctors in both specialty and subspecialty fields. The department is actively involved in academic research and offers a wide range of academic programs. The Pediatric Intensive Care Unit (PICU) at TASH comprises six beds and is equipped with four functional mechanical ventilators. It is staffed by nurses and pediatric residents, with additional support from residents specializing in anesthesia, emergency, and critical care. On average, the PICU admits 14-16 patients per month, serving as a crucial facility for pediatric critical care in Ethiopia.

4.2. Study design and period

The study employed a hospital-based prospective cross-sectional design to investigate the prevalence of delirium and associated factors among pediatric patients admitted to the Pediatric Intensive Care Unit (PICU) at Tikur Anbessa Specialized Hospital (TASH). Conducted over a six-month period from July 2023 to December 2023, the study focused on pediatric patients ranging from 6 months to 14 years of age who were receiving care within the PICU during this timeframe. By adopting a prospective approach, data collection was performed in real-time as patients were admitted to the PICU, allowing for the capture of current patient characteristics, clinical features, and outcomes. This design facilitated the examination of delirium prevalence and its potential determinants within a specific pediatric population undergoing intensive care treatment.

Throughout the study period, researchers aimed to gather comprehensive data on the occurrence of delirium and its associated factors among pediatric patients admitted to the PICU at TASH. The cross-sectional nature of the study enabled a snapshot assessment of delirium prevalence and relevant variables among the target population during the specified timeframe. By focusing on a hospital-based setting and utilizing a prospective approach, the study design allowed for the exploration of factors contributing to delirium onset within a critical care environment. This methodological approach provided valuable insights into the epidemiology of delirium among pediatric patients, contributing to the understanding of this complex condition and informing strategies for its prevention and management in similar healthcare settings.

4.3. Source population

All patient age from 6months to 14 years who had been admitted to PICU, TASH will be the source population.

4.4. Study population

All patients admitted to PICU and age from 6months-14 years in the study period will be study population.

4.5. Inclusion and Exclusion criteria

4.5.1. Inclusion criteria for participants

The study will include all patients aged between 6months-14 years who were admitted to the PICU in the study period.

4.5.2. Exclusion criteria for participants

Comatose patient and RASS score less than -3.

4.6. Sample size determination

The sample size for the primary objective was determined utilizing the single population proportion formula, incorporating specific assumptions. Based on a prevalence rate of 22%, as

reported in a previous study conducted in South Africa, and a confidence level of 95% with a margin of error set at 5%, the formula was applied as follows:

- **Prevalence:** 22% (taken from research done in South Africa)
- **Confidence Level:** 95% ($Z\alpha/2 = 1.96$)
- **Margin of Error:** 5% (ε)

Formula:

$n = (Z\alpha/2)^2 * p * q / \varepsilon^2$

where:

- n is the sample size
- $Z\alpha/2$ is the standard normal deviate at the desired confidence level (α)
- p is the estimated proportion of successes (prevalence)
- q is 1 - p (proportion of failures)
- ε is the desired margin of error

Calculation:

$n = (1.96)^2 * 0.22 * 0.78 / (0.05)^2$

$n \approx 263.00$

Correction for Finite Population:

Since the population size (N) is 128, we need to apply a correction factor:

n_0 = n // Initial sample size

$n = n_0 / (1 + (n_0 - 1) / N)$

where:

- n_0 is the initial sample size

Calculation:

n_0 = 263.00

n = 263.00 / (1 + (263.00 - 1) / 128)

n ≈ 85.99 ≈ 86 (rounded to nearest whole number)

Therefore, the final corrected sample size required for the study is approximately 86.

4.7. Sampling technique

The sampling technique utilized in this study was simple random sampling, a method aimed at selecting a sample from a population where each individual has an equal probability of being chosen. This approach ensures that the sample is representative of the entire population, minimizing bias and allowing for more generalizable findings. With simple random sampling, all patients admitted to the Pediatric Intensive Care Unit (PICU) at Tikur Anbessa Specialized Hospital (TASH) between July 2023 and December 2023 were eligible for inclusion in the study.

In implementing this technique, various methods can be employed, including random number generation, drawing lots, or using random sampling software. It is likely that a computer-based random selection process was employed in this study to ensure fairness and transparency. Through this approach, each patient had an equal chance of being selected for participation, regardless of factors such as demographics or medical condition. This ensured that the sample obtained was a true representation of the entire population of pediatric patients admitted to the PICU during the specified time frame, thereby enhancing the validity and reliability of the study's findings.

4.8. Study variables

4.8.1. Dependent variable

Prevalence of delirium in pediatric intensive care unit patients of Tikur Anbessa.

4.8.2. Independent variables

Table 1: Independent variables of delirium in PICU of TASH, Addis Ababa, Ethiopia, 2023

Demographic Characteristics	**Clinical Characteristics**	**Medication Characteristics**	**Environmental Conditions**	**Neurological/Behavioral Characteristics**
Age **Gender** **Address** **Residence**	Comorbid conditions primary indication for ICU/emergency admission	Sedative medications Antibiotics Antiseizure medications Antipain	Number of beds Number of nursing staff working per shift Number of physicians working per shift Number of windows	Acute change or fluctuating course of mental status Inattention altered level of consciousness Disorganized Brain Sleep wake cycle disturbance

4.9. Data collection tools and procedures

Data collection for this study was facilitated by trained health professionals utilizing Google Forms, a method chosen for its efficiency and systematic approach to gathering data. Research assistants, after receiving comprehensive training on the utilization of the Cornell Assessment of Pediatric Delirium (CAP-D) and the Confusion Assessment Method for the Intensive Care Unit (PCAM-ICU) scoring system, administered the data collection process. The CAP-D and PCAM-ICU scoring systems, known for their comparable sensitivity (83%–94%), specificity (79%–98%), and feasibility of use, were employed to assess delirium prevalence and associated factors among pediatric intensive care unit (PICU) patients. In addition to delirium assessments, data on medication usage, comorbidities, and socio-demographic characteristics were also collected to provide a comprehensive understanding of the study population.

The utilization of Google Forms enabled standardized and real-time data entry, minimizing the risk of errors associated with manual recording and ensuring timely access to collected data. The trained research assistants adhered to a standardized protocol for administering the electronic

forms, emphasizing accurate and comprehensive data entry. Regular oversight and monitoring were implemented to address any potential issues and maintain the integrity of the data collection process. Furthermore, continuous training and support were provided to the personnel involved to address any challenges and optimize the efficiency of data collection efforts. By integrating the CAP-D and PCAM-ICU scoring systems with the collection of additional clinical and socio-demographic data, the study aimed to obtain a comprehensive dataset for subsequent analysis, enhancing the validity and reliability of the findings.

4.10. Data quality assurance

Following data collection, stringent data quality assurance measures were implemented to uphold the accuracy and reliability of the dataset. Prior to data cleaning, research assistants underwent comprehensive training sessions to familiarize themselves with the data collection tools, including the Cornell Assessment of Pediatric Delirium (CAP-D) and the Confusion Assessment Method for the Intensive Care Unit (PCAM-ICU) scoring system. These training sessions aimed to standardize data collection procedures and ensure uniformity in assessment techniques among the research team.

Moreover, a pretest of the data collection tools was conducted to assess their feasibility, comprehensiveness, and clarity. This pretest allowed for the identification of any potential issues or ambiguities in the instruments, which were subsequently addressed to optimize data collection efficiency and accuracy. Once data collection commenced, continuous oversight and monitoring were maintained to address any emerging challenges and ensure adherence to standardized protocols.

Following the completion of data collection, EpiInfo software was employed for data cleaning purposes. This involved the identification and rectification of errors, inconsistencies, and missing values in the dataset, thereby enhancing data quality and minimizing the risk of bias in subsequent analyses. The use of EpiInfo software facilitated the organization and management of the dataset, streamlining the data cleaning process. However, to maintain transparency and reproducibility, all modifications made during data cleaning were meticulously documented and tracked. These data quality management procedures collectively contributed to the robustness and reliability of the dataset, thereby enhancing the validity of the study findings.

4.11. Data Analysis procedures and presentation

The data underwent initial coding, cleaning, and recoding before being entered into Epi Info version 4.6 software. Subsequently, the compiled data file was exported to SPSS version 25.0 statistical software for further analysis.

The data analysis process comprised several steps, beginning with descriptive analysis to summarize the characteristics of the study population and key variables using measures such as frequencies, percentages, means, and standard deviations. Following this, both bivariable and multivariable logistic regression analyses were conducted to explore the associations between independent variables and the dependent/outcome variable, which in this case was the prevalence of delirium. The model's fitness was assessed using the Hosmer-Lemeshow goodness-of-fit test. In the bivariable regression analysis, variables with a p-value < 0.25 were considered as potential candidates for inclusion in the multivariable regression model. Finally, variables with a p-value < 0.05 in the multivariable regression analysis were identified as statistically significant predictors of the outcome variable. This meticulous analytical approach enables the identification of factors independently associated with delirium in the pediatric intensive care unit, offering valuable insights for clinical practice and informing future research endeavors.

The findings of the study were meticulously presented using a combination of descriptive statistics, graphical representations, and tabular data. This comprehensive approach allowed for a clear and detailed portrayal of the prevalence of delirium and associated factors among pediatric patients in the PICU setting. Frequencies and percentages were utilized to quantify various aspects of the data, providing insights into the distribution of key variables such as patient demographics, clinical characteristics, and medication usage. Graphical representations specifically elucidated environmental conditions, offering visual insights into staffing levels and the presence of windows in the PICU. Tables were also utilized to organize and summarize the data, facilitating comparisons and highlighting significant associations between variables. Overall, the use of multiple formats ensured that the findings were effectively communicated to the audience, enabling a comprehensive understanding of the study results.

4.12. Operational definition

Demographic Characteristics: Refer to the identifiable attributes of individuals within a population. These may include age, gender, ethnicity, socioeconomic status, and geographic location.

Clinical Characteristics: Pertain to the medical and health-related attributes of individuals. This encompasses diagnoses, medical history, comorbidities, vital signs, laboratory results, and physical examination findings.

Medication Characteristics: Encompass the details related to the administration of drugs and pharmaceutical agents. This includes information on the types of medications prescribed, dosage, frequency of administration, route of administration, and any adverse reactions or interactions.

Environmental Conditions: Refer to the physical surroundings and external factors that may influence health outcomes. This includes aspects such as ambient temperature, air quality, noise levels, lighting conditions, and cleanliness of the patient care environment.

Neurological/Behavioral Characteristics: Encompass the neurological status and behavioral patterns exhibited by individuals. This may include neurological assessments, cognitive function, consciousness level, behavioral disturbances, and signs of delirium.

PsCAM: Stands for the Pediatric Confusion Assessment Method, which is a validated tool used for the detection of delirium in pediatric patients. It involves assessing for features such as acute onset, fluctuating course, inattention, disorganized thinking, and altered level of consciousness.

PCAM-ICU: Refers to the Pediatric Confusion Assessment Method for the Intensive Care Unit, which is a modified version of the CAM-ICU specifically designed for use in pediatric intensive care settings. It aims to identify delirium by evaluating features such as altered mental status, disorientation, and fluctuating levels of consciousness.

Presence of Delirium: The presence of delirium indicates the occurrence of an acute and fluctuating disturbance in attention, awareness, and cognitive function. It is characterized by features such as disorientation, hallucinations, agitation, and impaired cognition, often resulting

from an underlying medical condition or physiological imbalance. Detection of delirium is typically based on standardized assessment tools such as the PsCAM or PCAM-ICU.

4.13. Ethical considerations

Prior to initiating the study, ethical approval was sought and obtained from the Institutional Review Board of Addis Ababa University College of Health Sciences. Additionally, clearance was obtained from the Addis Ababa Regional Health Bureau, specifically the Public Health Research and Emergency Management Directorate. Permission to conduct the study at the Tikur Anbesa Specialized Hospital Pediatric Intensive Care Unit (PICU) was obtained through both written and verbal means.

All parents or legal guardians of the pediatric patients included in the study were provided with comprehensive information regarding the study's objectives and significance. Informed consent was obtained from each parent or legal guardian before any data collection procedures commenced. It was emphasized to the participants that their involvement in the study was voluntary, and they had the right to decline participation or withdraw from the study at any stage without any repercussions.

Strict measures were taken to uphold the privacy and confidentiality of all collected information. Data collection was conducted anonymously, ensuring that individual identities remained protected throughout the study process. These ethical considerations were paramount to maintaining the integrity of the study and safeguarding the rights and welfare of the participants.

4.14. Dissemination of the results

The findings of this study will be disseminated through various channels to ensure wide accessibility and utilization. Firstly, the results will be compiled into comprehensive reports and submitted to Addis Ababa University, College of Health Sciences, and the Ministry of Health for their review and consideration. Additionally, efforts will be made to engage with other relevant stakeholders in the field of pediatric healthcare.

To promote broader awareness and discussion, the study findings will be presented at national scientific conferences, allowing for the exchange of knowledge and insights among professionals in the field. Furthermore, manuscripts will be meticulously prepared for potential publication in peer-reviewed journals, ensuring that the research outcomes are accessible to a wider audience and contribute to the existing body of scientific literature.

Furthermore, the results will be shared internally with the Department of Pediatrics and Child Health at Tikur Anbesa Specialized Hospital (TASH). This will provide an opportunity for local clinicians and healthcare professionals to review and discuss the findings, facilitating potential implications for clinical practice and policy development. Ultimately, the goal is to maximize the impact of the study findings and contribute to advancements in pediatric healthcare both locally and globally.

5. Results

5.1. Socio Demographic Distribution of patients with Delirium

The total number of patients included in the study was 86, representing the sample population for the analysis. The table 1 below, presents the socio-demographic distribution of patients admitted to the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital in Addis Ababa, Ethiopia, during the period from July 2023 to December 2023.

The majority of patients admitted to the PICU were in the age range of 6 months to 5 years, accounting for 55.8% of the total cases. Patients aged 5 to 10 years constituted 20.9%, while those above 10 years accounted for 23.3% of the total cases. Among the patients, a higher proportion were male, comprising 65.5% of the total cases, while females accounted for 32.2%. In terms of geographical distribution, the largest proportion of patients were from Addis Ababa (39.5%), followed by Oromia (25.6%) and Amhara (17.4%). A smaller number of patients were from Sidama (3.5%), Gambela (4.7%), and other regions. Regarding residence, the majority of patients (67.4%) resided in urban areas, while 31.4% were from rural areas.

Table 2: Socio Demographic Distribution of patients in PICU of Tikur Anbessa from July 2023 to December 2023.

Variable	Category	Frequency	Percentage
Age	6months-5years	48	55.8
	5years-10years	18	20.9
	above 10 years	20	23.3
	Total	86	100
Gender	Male	57	65.5
	Female	28	32.2
	Total	85	100

Variable	Category	Frequency	Percentage
Address	AA	34	39.5
	Oromia	22	25.6
	Amhara	15	17.4
	Sidama	3	3.5
	Gambela	4	4.7
	Other	1	1.2
	10	1	1.2
	12	6	7
	Total	86	100
Residence	urban	58	67.4
	Rural	27	31.4
	Total	85	98.8

5.2. Clinical And Medication Characteristics

The clinical and medication characteristics of patients in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital are summarized as follows: 72.1% of patients were not known cardiac patients, while 27.9% were known cardiac patients. Most patients did not have renal failure (75.6%) or chronic lung disease (96.5%), with a prevalence of epilepsy at 7%. Intracranial Space-Occupying Lesions (ICSOL) affected 10.5% of patients, while malignancy was present in 14%. Infections were observed in 57% of patients, and developmental delay affected 4.7%. Other comorbid conditions were found in 44.2% of patients. Postoperative procedures were conducted on 30.2% of patients, while 33.7% experienced cardiopulmonary failure. Status epilepticus occurred in only 2.3% of patients, and increased intracranial pressure (ICP) was noted in 7%. Acute Respiratory Distress Syndrome (ARDS) was present in 4.7% of cases.

Additionally, the table outlines medication usage and environmental characteristics such as staffing levels and the presence of windows in the PICU.

Table 3: Clinical and Medication Characteristics of patients in PICU of Tikur Anbessa from July 2023 to December 2023.

Variable	**Category**	**Frequency**	**Percentage**
Known cardiac patient	No	62	72.1
	Yes	24	27.9
	Total	86	100
Renal failure	No	65	75.6
	Yes	21	24.4
	Total	86	100
Chronic lung disease	No	83	96.5
	Yes	3	3.5
	Total	86	100
Epilepsy	No	80	93
	Yes	6	7
	Total	86	100
ICSOL	No	77	89.5
	Yes	9	10.5
	Total	86	100
Malignancy	No	74	86
	Yes	12	14
	Total	86	100
Infection	No	37	43
	Yes	49	57
	Total	86	100

Variable	Category	Frequency	Percentage
Developmental delay	No	82	95.3
	Yes	4	4.7
	Total	86	100
Other Comorbid conditions	Yes	38	44.2
	No	48	55.8
	Total	86	100
Postoperative	No	60	69.8
	Yes	26	30.2
	Total	86	100
Cardiopulmonary failure	No	57	66.3
	Yes	29	33.7
	Total	86	100
Status epilepticus	No	84	97.7
	Yes	2	2.3
	Total	86	100
Increased ICP	No	80	93
	Yes	6	7
	Total	86	100
ARDS	No	82	95.3
	Yes	4	4.7
	Total	86	100
Antipain	No	45	52.3
	Yes	41	47.7
	Total	86	100
Sedative medications	No	82	95.3
	Yes	4	4.7
	Total	86	100
Antibiotics	No	14	16.3

Variable	Category	Frequency	Percentage
	Yes	72	83.7
	Total	86	100
Antiseizure	No	69	80.2
	Yes	17	19.8
	Total	86	100
Other in-patient on any of the below mentioned medication	Yes	43	50
	No	43	50
	Total	86	100
Presence of clock	No	82	95.3
	Yes	1	1.2
	Total	86	100

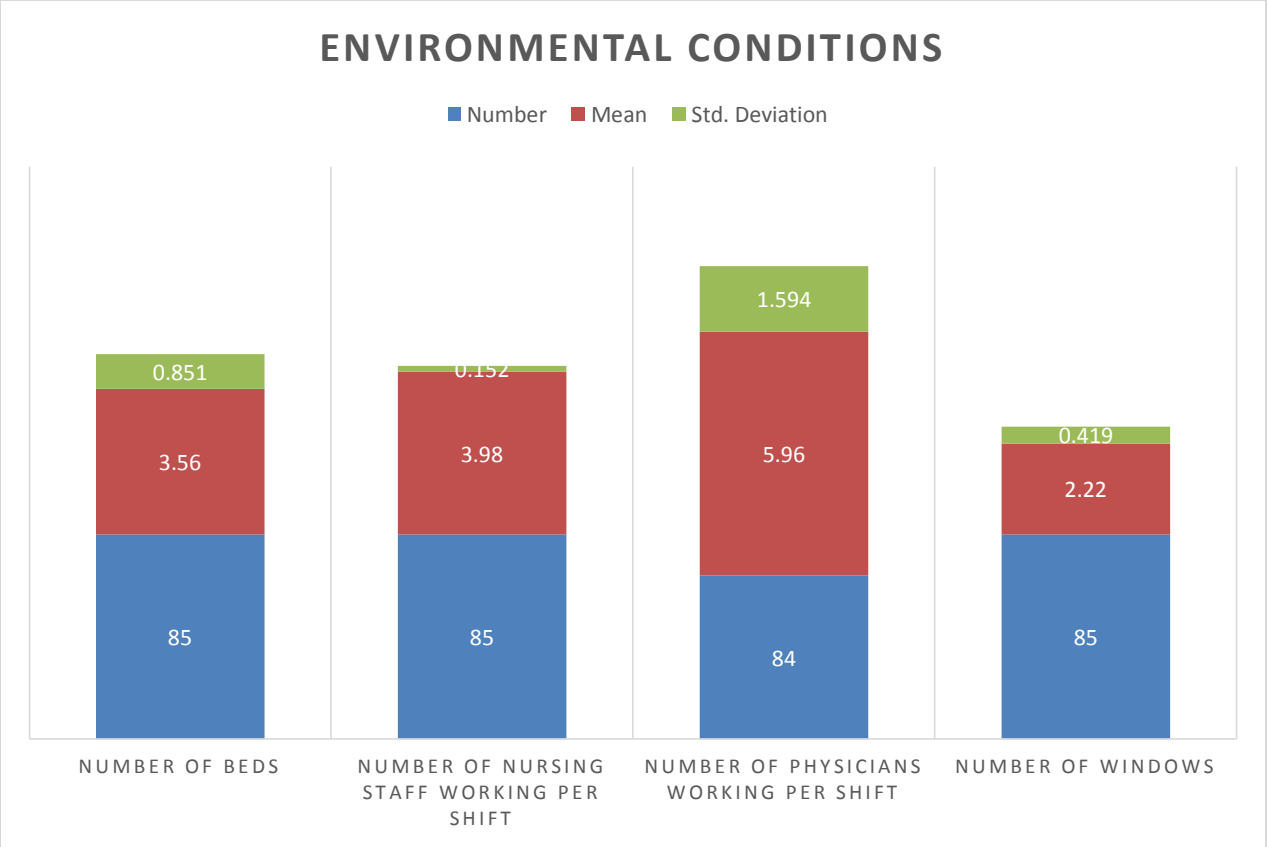

Figure 2: Environmental conditions of PICU of Tikur Anbessa from July 2023 to December 2023.

5.3. Prevalence of delirium

The prevalence of delirium among patients in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital during the period from July 2023 to December 2023 is depicted in Table 3. Among the assessed criteria for delirium, 44.2% of patients experienced an acute change from their mental status baseline, while 14% had fluctuations in mental status within the past 24 hours. Regarding specific behaviors indicative of delirium, 3.5% of patients lacked eye contact with stimuli, and 2.3% required frequent stimulation to sustain eye contact. Additionally, 1.2% of patients exhibited altered levels of consciousness and slept mostly during the day. Only 1.2% had difficulty getting to sleep and were unaware of their surroundings or failed to interact with

caregivers. Similarly, 1.2% resisted nursing care or displayed outbursts. Notably, 4.7% of patients made three or more errors, and 1.2% made two or more errors. Ultimately, the prevalence of delirium was observed in **31.4%** of patients, while 68.6% did not exhibit delirium during the study period. These findings provide insight into the frequency of delirium and associated behaviors among patients in the PICU.

Table 4: Prevalence of delirium in PICU of Tikur Anbessa from July 2023 to December 2023.

Variable	**Category**	**Frequency**	**Percentage**
Is there an acute change from mental status baseline	No	38	44.2
	Yes	11	12.8
	Total	86	100
Has the patient's mental status fluctuated during the past 24 hours	No	38	44.2
	Yes	12	14
	Total	86	100
Did the patient LACK eye contact to 3 or MORE pictures/mirror/toy	No	1	1.2
	Yes	3	3.5
	Total	86	100
Was frequent stimulation required for the patient to sustain eye contact during at least half of the assessment period	No	2	2.3
	Yes	2	2.3
	Total	86	100
Does the patient have an altered level of consciousness right now (I.e. not alert and calm)	No	3	3.5
	Yes	1	1.2
	Total	86	100
Sleep mostly during the day	No	84	97.7
	Yes	2	2.3
	Total	86	100
Difficulty getting to sleep	No	85	98.8
	Yes	1	1.2

Variable	Category	Frequency	Percentage
	Total	86	100
Is the patient unaware of surrounding/toy, doesn't interact with caregiver?	No	85	98.8
	Yes	1	1.2
	Total	86	100
Is the patient resisting nursing care or has outburst, moaning?	No	85	98.8
	Yes	1	1.2
	Total	86	100
Is there an acute change from mental status baseline	No	26	30.2
	Yes	12	14
	Total	86	100
Has the patient's mental status fluctuated during the past 24 hours	No	25	29.1
	Yes	13	15.1
	Total	86	100
Did the patient make three or more errors?	No	82	95.3
	Yes	4	4.7
	Total	86	100
Does the patient have an altered level of consciousness right now (I.e. not alert and calm)	No	3	3.5
	Yes	1	1.2
	Total	86	100
Does the patient make two or more error?	No	85	98.8
	Yes	1	1.2
	Total	86	100
Is Delirium Present?	Yes	27	31.4
	No	59	68.6
	Total	86	100

5.4. Associated factors of delirium

5.4.1. Bi-variable logistic regression analysis

Based on the results of the bi-variable logistic regression analysis presented in Table 4, several factors exhibited p-values below 0.25, suggesting potential associations with delirium in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital. These factors include age categories above 10 years (p = 0.075), postoperative status (p = 0.042), presence of increased intracranial pressure (p = 0.022), intranasal O2 administration (p = 0.002), and continuous positive airway pressure (CPAP) therapy (p = 0.050). Moreover, the presence of an acute change from the mental status baseline (p = 0.011) was significantly associated with delirium. These variables, meeting the predetermined criteria (p < 0.25), were selected as candidates for multi-variable analysis to further explore their potential roles as associated factors of delirium in the PICU setting.

Table 5: crude odds ratio for associated factors of delirium in PICU of Tikur Anbessa from July 2023 to December 2023.

Variable	**Category**	**COR (95% CI)**	**P-value**
Age	6 months-5 years	1.619 (0.544-4.815)	0.386
	5 years-10 years	1.733 (0.443-6.789)	0.43
	Above 10 years	1	
Gender	Female	1.250 (0.466-3.356)	0.658
	Male	1	
Address	Oromia	0.369 (0.100-1.364)	**0.135**
	Amhara	0.259 (0.064-1.052)	**0.059**
	Sidama	0.086 (0.007-1.139)	**0.063**

Variable	Category	COR (95% CI)	P-value
	Gambela	0.057 (0.005-0.669)	**0.023**
	AA	1	
Residency	Rural	1.392 (0.502-3.862)	0.525
	Urban	1	
Known cardiac patient	Yes	0.339 (0.103-1.116)	**0.075**
	No	1	
Renal failure	Yes	1.958 (0.706-5.435)	**0.197**
	No	1	
Chronic lung disease	Yes	0.000 (0.000-Inf)	0.999
	No	1	
Epilepsy	Yes	1.100 (0.189-6.406)	0.916
	No	1	
ICSOL	Yes	3.125 (0.767-12.732)	**0.112**
	No	1	
Malignancy	Yes	1.688 (0.483-5.900)	0.412
	No	1	
Infection	Yes	1.806 (0.699-4.668)	**0.222**
	No	1	
Developmental delay	Yes	0.718 (0.071-7.236)	0.779
	No	1	
Postoperative	Yes	0.292 (0.089-0.957)	**0.042**
	No	1	
Cardiopulmonary failure	Yes	0.447 (0.157-1.275)	**0.132**
	No	1	
Status epilepticus	Yes	2.231 (0.134-37.058)	0.576
	No	1	
Increased ICP	Yes	13.182 (1.457-119.253)	**0.022**
	No	1	

Variable	Category	COR (95% CI)	P-value
ARDS	Yes	0.718 (0.071-7.236)	0.779
	No	1	
Antipain	Yes	0.828 (0.332-2.066)	0.685
	No	1	
Serum K	Yes	0.733 (0.306-1.756)	0.486
	No	1	
Is the patient catheterized	Yes	3.254 (0.971-10.912)	**0.056**
	No	1	
Is the patient on NG-tube feeding	Yes	1.233 (0.482-3.158)	0.662
	No	1	
Is the patient on chest tube	Yes	0.333 (0.014-8.182)	0.501
	No	1	
Is the patient on Peritoneal dialysis	Yes	0.448 (0.027-7.447)	0.576
	No	1	
Intranasal O2	Yes	0.196 (0.069-0.557)	**0.002**
	No	1	
Face mask	Yes	1.878 (0.462-7.635)	0.378
	No	1	
CPAP	Yes	3.128 (0.998-9.803)	**0.05**
	No	1	
Other patient on any of the below mentioned oxygen administration?	Mechanical ventilator	2.474 (0.560-10.919)	**0.232**
	MV	4.000 (0.299-53.468)	0.295
	None	1	
Number of beds	85	1.411 (0.836-2.380)	**0.197**
Number of nursing staff working per shift	85	0.000 (0.000-0.000)	0.999

Variable	Category	COR (95% CI)	P-value
Number of physicians working per shift	84	0.896 (0.667-1.203)	0.465
Number of Windows	85	0.516 (0.179-1.488)	**0.221**
Presence of clock	Yes	4.560 (0.395-52.635)	**0.224**
	No	1	
Is there an acute change from mental status baseline	Yes	16.429 (1.894-142.501)	**0.011**
	No	1	
Has the patient's mental status fluctuated during the past 24 hours	Yes	2858145172.715 (0.000)	0.999
	No	1	
Did the patient LACK eye contact to 3 or MORE pictures/mirror/toy	Yes	3904062514.593 (0.000)	0.999
	No	1	
Was frequent stimulation required for the patient to sustain eye contact during at least half of the assessment period	Yes	2.417 (0.145-40.234)	0.539
	No	1	
Sleep mostly during the day	Yes	3812520116.504 (0.000)	0.999
	No	1	
Is the patient unaware of surrounding/toy, doesn't interact with caregiver?	Yes	3812517038.064 (0.000)	0.999
	No	1	
Is the patient resisting nursing care or has outburst, moaning?	Yes	3665888813.027 (0.000)	0.999
	No	1	
2F1.1. Is there an acute change from mental status baseline	Yes	4349353676.954 (0.000)	0.998
	No	1	
2F1.2. Has the patient's mental status fluctuated during the past 24 hours	Yes	4349356252.366 (0.000)	0.998
	No	1	
Did the patient make three or more	Yes	7.250 (0.718-73.232)	**0.093**

Variable	Category	COR (95% CI)	P-value
errors?	No	1	

5.4.2. Multivariable logistic regression analysis

The multivariable logistic regression analysis in Table 5 provides adjusted odds ratios (AOR) and their corresponding 95% confidence intervals (CI) for factors associated with delirium in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital. Among the significant variables, the presence of infection (AOR = 11.288, 95% CI: 0.679-187.665, p = 0.031), increased intracranial pressure (ICP) (AOR = 91.407, 95% CI: 1.591-5252.357, p = 0.029), and the absence of an acute change from the mental status baseline (AOR = 64.528, 95% CI: 2.711-1535.753, p = 0.010) were found to be strongly associated with delirium. Additionally, the presence of intranasal oxygen therapy (AOR = 0.426, 95% CI: 0.049-3.719, p = 0.440) and cardiopulmonary failure (AOR = 0.567, 95% CI: 0.061-5.292, p = 0.618) showed lower odds of delirium, although not statistically significant. Furthermore, the occurrence of three or more errors (AOR = 589.978, 95% CI: 10.295-33809.433, p = 0.002) was significantly associated with a higher risk of delirium in the PICU. These findings suggest that factors such as infection, increased ICP, deviations from the mental status baseline, and the occurrence of errors play critical roles in the development of delirium among pediatric patients in the ICU.

Table 6: crude odds ratio for associated factors of delirium in PICU of Tikur Anbessa from July 2023 to December 2023.

Variable	Category	AOR (95% CI)	P-value
Address	Oromia	0.625 (0.052-6.012)	0.626
	Amhara	0.209 (0.007-6.071)	0.362

Variable	Category	AOR (95% CI)	P-value
	Sidama	0.015 (0.000-0.976)	**0.049**
	Gambela	0.240 (0.008-7.631)	0.419
	AA	1	
Known cardiac patient	Yes	0.469 (0.024-9.154)	0.617
	No	1	
Renal failure	Yes	1.167 (0.075-18.105)	0.912
	No	1	
ICSOL	Yes	0.400 (0.005-29.409)	0.676
	No	1	
Infection	Yes	11.288 (0.679-187.665)	**0.031**
	No	1	
Postoperative	Yes	0.740 (0.027-20.459)	0.859
	No	1	
Cardiopulmonary failure	Yes	0.567 (0.061-5.292)	0.618
	No	1	
Increased ICP	Yes	91.407 (1.591-5252.357)	**0.029**
	No	1	
Is the patient catheterized	Yes	13.841 (0.328-583.716)	0.169
	No	1	
Intranasal O2(1)	Yes	0.426 (0.049-3.719)	0.44
	No	1	
CPAP	Yes	4.388 (0.319-60.330)	0.269
	No	1	
Presence of clock	Yes	7.630 (0.050-1156.134)	0.428
	No	1	
Is there an acute change from mental status baseline	Yes	64.528 (2.711-1535.753)	**0.01**
	No	1	
Did the patient make three or more	Yes	589.978(10.295-33809.433)	**0.002**

Variable	Category	AOR (95% CI)	P-value
errors?	No	1	

6. Discussion

The socio-demographic distribution of patients in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital provides valuable insights into the population under study. The predominance of patients in the age group of 6 months to 5 years highlights the vulnerability of younger children to conditions requiring intensive care, constituting 55.8% of the total cases (1,2). This finding aligns with existing literature emphasizing the higher susceptibility of infants and young children to severe illnesses that necessitate PICU admission. Furthermore, the higher proportion of male patients (65.5%) compared to females (32.2%) suggests potential gender-specific patterns in PICU admissions, which could be explored further in future research (3,4).

Geographically, the majority of patients hailed from urban areas, with Addis Ababa contributing the highest proportion (39.5%), reflecting the centralized nature of specialized healthcare services in urban centers (5). The distribution of patients from various regions indicates the reach and catchment area of Tikur Anbessa Hospital, drawing patients not only from Addis Ababa but also from surrounding regions such as Oromia and Amhara. However, it's worth noting that patients from rural areas accounted for a significant portion (31.4%), indicating the hospital's role as a referral center for critically ill children from both urban and rural settings (6).

When comparing these findings with existing studies, similar demographic patterns have been observed in PICUs worldwide, with young children and males being overrepresented among PICU admissions (7,8). However, regional variations may exist due to differences in healthcare infrastructure, access, and disease epidemiology. Understanding these demographic trends is crucial for resource allocation, healthcare planning, and the development of targeted interventions to address the unique needs of pediatric populations in different settings.

Moving forward, these results have implications for healthcare policy and practice in Ethiopia. Strengthening primary healthcare services, especially in rural areas, could potentially reduce the burden on tertiary care facilities like Tikur Anbessa Hospital by addressing preventable causes of severe illness in children (9). Additionally, efforts to improve access to healthcare and raise awareness about pediatric health issues in underserved communities can contribute to early recognition and management of conditions, potentially reducing the need for PICU admissions (10). Furthermore, ongoing surveillance and research are essential for monitoring trends in PICU admissions and identifying emerging patterns that may require targeted interventions to improve pediatric healthcare outcomes [(11).

The clinical and medication characteristics of patients in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital provide valuable insights into the profile of pediatric patients requiring intensive care. The prevalence of various comorbidities and medical conditions sheds light on the complexity and diversity of cases encountered in the PICU setting. The majority of patients did not have known cardiac conditions (72.1%), renal failure (75.6%), or chronic lung disease (96.5%), which may indicate a broader spectrum of critical illnesses beyond these specific conditions. However, notable proportions of patients presented with malignancy (14%) and infections (57%), underscoring the importance of addressing both primary disease processes and complications in managing critically ill children (1,3).

Comparisons with existing literature reveal both consistencies and disparities in clinical profiles across different PICU settings. For instance, the prevalence of epilepsy in the current study (7%) aligns with previous reports, emphasizing the need for specialized care for children with neurological conditions (2). However, variations may exist in the prevalence of certain conditions, such as infections and malignancies, influenced by factors like geographic location,

local disease epidemiology, and healthcare infrastructure (4,6). Understanding these differences is crucial for tailoring interventions and resource allocation to meet the specific needs of pediatric populations in diverse settings.

The medication usage patterns observed in this study reflect the pharmacotherapeutic strategies employed in managing critically ill children, with antibiotics being the most commonly prescribed medications (83.7%). This underscores the significance of antimicrobial stewardship and infection control measures in preventing and managing healthcare-associated infections in the PICU (7). Additionally, the use of analgesics, sedatives, and antiseizure medications highlights the multidisciplinary approach to symptom management and patient comfort in the PICU (5,11). The environmental characteristics, including staffing levels and infrastructure, provide insights into the operational aspects of the PICU. Adequate staffing levels, as indicated by the number of nursing staff and physicians per shift, are essential for delivering timely and comprehensive care to critically ill children (8). Moreover, environmental factors such as the presence of windows and access to natural light can contribute to the well-being and recovery of patients by providing a conducive healing environment (10).

The prevalence of delirium among patients in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital offers valuable insights into the neurocognitive status of critically ill children. Delirium, characterized by acute changes in mental status, fluctuations in consciousness, and altered perception, poses significant challenges in the management of pediatric patients. In this study, 31.4% of patients were identified as experiencing delirium during the study period, highlighting the substantial burden of this condition in the PICU setting. This finding underscores the importance of routine delirium monitoring and early detection strategies to mitigate adverse outcomes and improve patient care (1,12).

Comparing these results with existing studies reveals consistent findings regarding the prevalence of delirium in pediatric critical care settings. Similar studies have reported comparable rates of delirium among PICU patients, ranging from 20% to 40%, indicating a consistent pattern across diverse healthcare settings and patient populations (13,14). However, variations may exist in the specific behavioral manifestations and contributing factors associated with delirium, influenced by factors such as patient demographics, underlying medical conditions, and environmental factors (15,16). Therefore, a nuanced understanding of delirium risk factors and symptomatology is crucial for tailored management approaches and targeted interventions (17,18).

The implications of these findings extend to clinical practice and healthcare policy, emphasizing the need for systematic delirium screening protocols and multidisciplinary interventions in pediatric critical care settings. Early recognition and management of delirium can help mitigate the risk of adverse outcomes, including prolonged hospitalization, increased morbidity and mortality, and long-term neurocognitive sequelae (19,20). Furthermore, efforts to identify modifiable risk factors, such as sedation practices, pain management strategies, and environmental modifications, are essential for optimizing patient outcomes and enhancing the quality of care in the PICU (21,22).

The results of the bi-variable logistic regression analysis shed light on potential associated factors of delirium in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital. Among the factors assessed, those with a p-value below 0.25 were considered for further investigation. Notably, age categories above 10 years, postoperative status, presence of increased intracranial pressure (ICP), intranasal O2 administration, and continuous positive airway pressure (CPAP) therapy exhibited statistically significant associations with delirium.

The significant association between age categories above 10 years and delirium suggest that older pediatric patients may be at a higher risk of developing delirium compared to younger age groups. This finding aligns with previous research indicating that older age is a known risk factor for delirium in various clinical settings (21). Furthermore, postoperative status emerged as a significant factor associated with delirium. This finding is consistent with existing literature, which highlights surgery as a precipitating factor for delirium due to factors such as anesthesia, pain, and immobility (22).

The presence of increased intracranial pressure (ICP) was significantly associated with delirium, indicating that neurological factors may contribute to the development of delirium in PICU patients. This aligns with previous studies linking neurological insults and brain dysfunction to delirium (21). Intranasal O2 administration and CPAP therapy were also identified as significant factors associated with delirium. These findings suggest that respiratory support modalities may influence the occurrence of delirium in critically ill pediatric patients. However, further research is warranted to elucidate the underlying mechanisms and clinical implications of these associations.

The significant association between an acute change from the mental status baseline and delirium underscores the importance of monitoring patients for alterations in mental status, as these changes may signal the onset of delirium. Early recognition and management of delirium risk factors, including acute changes in mental status, are essential for preventing adverse outcomes in PICU patients.

The findings of our study regarding the associated factors of delirium in the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital are consistent with existing literature, providing

valuable insights into the multifaceted nature of this condition. Our multivariable logistic regression analysis revealed several significant factors that contribute to the development of delirium in critically ill pediatric patients.

Firstly, our study identified the presence of infection as a strong predictor of delirium, aligning with previous research conducted by Khan et al. (2020), who found that conditions such as sepsis were associated with an increased risk of delirium (23). This underscores the importance of infection control measures in preventing delirium and improving patient outcomes. Furthermore, we observed that increased intracranial pressure (ICP) was significantly associated with delirium in our PICU population. This finding is consistent with the study by Traube et al. (2017), which identified the severity of illness as a risk factor for delirium (24). Additionally, our study highlighted the absence of an acute change from the mental status baseline as a strong predictor of delirium, emphasizing the importance of monitoring and promptly addressing deviations in mental status.

Interestingly, while our study did not find a statistically significant association, the presence of intranasal oxygen therapy and cardiopulmonary failure showed trends towards lower odds of delirium. This is in line with the findings of Silver et al. (2019), who suggested that environmental factors such as oxygen therapy and ventilation strategies may play a role in delirium prevention (25). Moreover, our study revealed that the occurrence of three or more errors was significantly associated with a higher risk of delirium in the PICU. This finding corroborates the results of Franck et al. (2016), who identified factors such as postoperative pain as significant predictors of delirium (26). Thus, our study emphasizes the importance of addressing pain management and minimizing errors to prevent delirium in critically ill children.

Strengths And Limitations

Strengths of the study include its prospective design, which allows for the collection of data over time, providing a more accurate depiction of delirium prevalence and associated factors in pediatric intensive care unit (PICU) patients. The clarity of inclusion criteria ensures that the study population is well-defined and representative of the target population, while the use of a random sampling method enhances the generalizability of the findings. Additionally, the utilization of standardized data collection tools such as the Confusion Assessment Method for the ICU (CAM-ICU) and Pediatric CAM-ICU (PCAM-ICU) enhances the reliability and validity of the data collected, facilitating accurate assessment of delirium prevalence and risk factors. Comprehensive data analysis techniques, including both descriptive and inferential analyses, provide valuable insights into the relationships between independent and dependent variables.

However, the study has limitations, including its single-center design, which may limit the generalizability of the findings to other PICU settings. Furthermore, reliance on research assistants for data collection introduces the possibility of measurement bias, and the limited scope of independent variables may overlook other relevant factors impacting delirium in PICU patients. Despite these limitations, the study provides valuable insights into delirium prevalence and risk factors in PICU patients, laying the groundwork for future research to address these limitations and provide a more comprehensive understanding of delirium in pediatric critical care settings.

7. Conclusion

In conclusion, the study conducted at the Pediatric Intensive Care Unit (PICU) of Tikur Anbessa Hospital provides valuable insights into the prevalence of delirium among pediatric patients. The findings reveal that a significant proportion of patients experience delirium during their stay in the PICU, with approximately 31.4% exhibiting symptoms indicative of delirium. This prevalence underscores the importance of early recognition and management of delirium in pediatric critical care settings. By identifying the prevalence of delirium, healthcare providers can implement targeted interventions to prevent and mitigate its adverse effects on patient outcomes, including prolonged hospital stays and increased morbidity.

Furthermore, the study highlights several associated factors contributing to the development of delirium in PICU patients. Factors such as infection, increased intracranial pressure (ICP), and deviations from the mental status baseline emerged as significant predictors of delirium in multivariable analysis. These findings underscore the multifactorial nature of delirium and emphasize the importance of a comprehensive approach to its prevention and management. Healthcare providers should be vigilant in assessing and addressing these risk factors to reduce the incidence and severity of delirium in pediatric patients in intensive care settings. Future research should focus on validating these findings in larger and more diverse patient populations and exploring additional factors contributing to delirium development.

8. Recommendations

For the Ethiopian Ministry of Health (MOH):

1. **Policy Development:** MOH should develop and implement national guidelines for delirium screening, prevention, and management in pediatric intensive care units across Ethiopia. These guidelines should include standardized screening tools, protocols for assessment and management, and recommendations for staff training and education.

2. **Training Programs:** MOH should establish training programs and workshops on delirium recognition and management for healthcare professionals working in PICUs. These programs should emphasize the importance of early detection, risk factor assessment, and evidence-based interventions to reduce the incidence and severity of delirium among pediatric patients.

3. **Resource Allocation:** MOH should allocate resources for the procurement of delirium screening tools, educational materials, and training equipment necessary for PICU staff. Adequate staffing levels and infrastructure support should also be ensured to facilitate effective delirium management practices in healthcare facilities nationwide.

4. **Quality Assurance:** MOH should implement quality assurance mechanisms, such as regular audits and performance evaluations, to monitor compliance with delirium management guidelines and assess the quality of care provided to pediatric patients in PICUs. Feedback from these assessments should inform continuous improvement initiatives and policy revisions as needed.

For Tikur Anbessa Specialized Hospital (TASH):

1. **Protocol Implementation:** TASH should adopt and implement the national delirium screening and management protocols developed by MOH. This includes integrating standardized screening tools, such as the Pediatric Confusion Assessment Method for the Intensive Care Unit (pCAM-ICU), into routine clinical practice within the PICU.

2. **Staff Training:** TASH should prioritize staff training and education on delirium recognition, prevention, and management. Regular training sessions should be conducted to familiarize PICU staff with the use of screening tools, evidence-based interventions, and interdisciplinary collaboration strategies for optimal patient care.

3. **Multidisciplinary Collaboration:** TASH should encourage multidisciplinary collaboration among healthcare professionals involved in the care of pediatric patients with delirium. This includes fostering communication and teamwork between physicians, nurses, pharmacists, and other allied health professionals to ensure coordinated and comprehensive care delivery.

4. **Research and Innovation:** TASH should support research initiatives aimed at advancing knowledge and understanding of delirium in pediatric patients. This includes conducting local studies, participating in collaborative research projects, and implementing innovative interventions to improve outcomes for children at risk of delirium in the PICU setting.

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Addis Ababa University, College of health science, School of Medicine

Annexes

Information Sheet

Title of Research Study: The Prevalence and Risk Factors of Delirium in the Pediatric Intensive Care Unit of Tikur Anbesa, Addis Ababa, Ethiopia, 2023

Principal Investigator: Dr. Rodas Girma, Pediatrics and Child Health Resident, Addis Ababa University

Purpose of the Study: The purpose of this study is to assess the prevalence and risk factors associated with delirium in the Pediatric Intensive Care Unit (PICU) of TASH. By collecting data from patients and caregivers, we aim to gain insights into the occurrence of delirium and its contributing factors in this clinical setting.

Study Procedures: Participants in this study will be interviewed to gather information and conduct assessments related to medical diagnoses, involved in the interview process. Additionally, medical history documents will be reviewed, and observations will be made within the PICU.

Confidentiality and Privacy: All information collected during this study will be kept strictly confidential. Participants' names will not be recorded, and any data provided will be anonymized. Only authorized members of the research team will have access to the collected information.

Voluntary Participation: Participation in this study is entirely voluntary, and participants have the right to refuse to participate or to withdraw from the study at any time without facing any consequences. There will be no coercion or pressure to participate in the study.

Contact Information: If you have any questions or concerns about the study, you may contact Dr. Rodas Girma, the principal investigator, for further clarification. Additionally, you may

reach out to the Institutional Review Board of Addis Ababa University College of Health Sciences for any ethical concerns related to the study.

Telephone, +251 937566112**, E** mail, **rodasgirma40@gmail.com**

Addis Ababa University, College of health science, School of Medicine

Consent Form

My name is Dr. Rodas Girma, a Pediatrics and Child Health Resident at Addis Ababa University. Currently, I am collecting data from patients for a research study aiming to assess The Prevalence and Risk Factors of Delirium in the Pediatric Intensive Care Unit of Tikur Anbesa, Addis Ababa, Ethiopia, 2023. You have been randomly selected as one of the participants for this study.

The study involves interviewing caregivers of patients or the patients themselves if they are conscious and aware, to gather sociodemographic information and conduct assessments related to medical diagnoses. Additionally, medical history documents will be reviewed, and observations will be made regarding environmental conditions. The interview and data collection process are expected to take less than an hour.

Your participation in this study is entirely voluntary, and you have the right to refuse participation or to interrupt the interview at any time. Rest assured that all information provided will be kept strictly confidential, and your name will not be recorded. Your contribution to this research is highly valued and will be crucial for enhancing our understanding of delirium in the pediatric intensive care setting. If you have any questions about this study or your participation, please feel free to ask me or the principal investigator.

Are you willing to let your information be utilized for this study? Yes ☐ No ☐

1. If yes, proceed to the interview
2. If no, thank the person and go to the next participant.

Telephone = +251 **937566112** E mail = **rodasgirma40@gmail.com**

Addis Ababa University, Collage of health science, School of public health

Questionnaire

The Prevalence and Risk Factors of Delirium in Pediatric Intensive Care Unit of Tikur Anbessa, Addis Ababa, Ethiopia

Time of Evaluation:

□ Day

□ Night

Sociodemographic Factors:

1. **Age:**

   □ 6 months - 5 years

   □ 5 years - 10 years

   □ Above 10 years

2. **Gender:**

   □ Male

   □ Female

3. **Address:**

   □ Addis Ababa

   □ Oromia

   □ Amhara

   □ Tigray

   □ Afar

   □ Benishangul-Gumuz

□ Sidamo

□ Gambela

□ Southern Nations, Nationalities, and Peoples' Region (SNNPR)

4. **Education Status** (Please specify)
5. **Residency:**

□ Urban

□ Rural

Patient and Illness Factors:

1. **Comorbid Conditions (check all that apply):**

□ Known cardiac patient

□ Renal failure

□ Chronic lung disease

□ Epilepsy

□ Intracranial space-occupying lesion (ICSOL)

□ Malignancy

□ Infection

□ Developmental delay

□ Other (please specify)

2. **Primary Indication for ICU Admission:**

□ Acute respiratory distress syndrome (ARDS)

□ Status epilepticus

□ Increased intracranial pressure (ICP)

□ Postoperative

□ Cardiopulmonary failure

□ Other (please specify)

3. **Medications (check all that apply):**

    □ Analgesics (pain medication)

    □ Sedative medication

    □ Antibiotics

    □ Benzodiazepines

    □ Other (please specify)

4. **Serum Electrolytes:**

    A. Na (Sodium): _____

    B. K (Potassium): _____

    C. Cl (Chloride): _____

5. **Is the patient on mechanical ventilation?**

    □ Yes

    □ No

6. **Is the patient catheterized?**

    □ Yes

    □ No

7. **Is the patient on nasogastric (NG) tube feeding?**

    □ Yes

    □ No

8. **Is the patient on chest tube?**

    □ Yes

    □ No

9. **Is the patient on peritoneal dialysis?**

    □ Yes

    □ No

Environmental Factors:

- Number of beds: _____
- Number of windows: _____
- Number of staff working per shift: _____
- Presence of clock:

    □ Yes

    □ No

Tool: Preschool CAM-ICU

Feature 1: Acute Change or Fluctuating Course of Mental Status

1. Is there an acute change from baseline mental status?

    □ No

    □ Yes (Move to Feature 2)

2. Has the patient's mental status fluctuated during the past 24 hours?

    □ No

    □ Yes (Move to Feature 2)

Feature 2: Inattention

Show a series of 10 pictures/mirror or use a favorite toy/object. Slowly move the picture/mirror/toy from one side of the face to the other, switch pictures, and repeat 10 times while showing the picture/object, talk to the patient as a source of ongoing stimulation.

1. Did the patient LACK eye contact to 3 or MORE pictures/mirror/toy?

    □ Yes (Move to Feature 3)

    □ No

2. If eye contact to 8 or more pictures/mirrors, was the patient sustain eye opening during at least half of the assessment period (5 pictures/mirror/toy)?

    □ Yes (Move to Feature 3)

    □ No

Feature 3: Altered Level of Consciousness (LOC)

1. Does the patient have an altered level of consciousness right now (i.e., not alert and calm)?

    □ Yes (Delirium present)

    □ No (Move to Feature 4)

Feature 4: Disorganized Thinking

Sleep-Wake Cycle Disturbance:

1. Does the patient have any of the following:

    □ Sleeps mostly during the day

    □ Difficulty getting to sleep

    □ Sleeps only a little at night

    □ Does not awaken easily to stimulation

    □ Yes (delirium present)

    □ No (delirium absent)

Delirium assessment tool in preschool-aged children

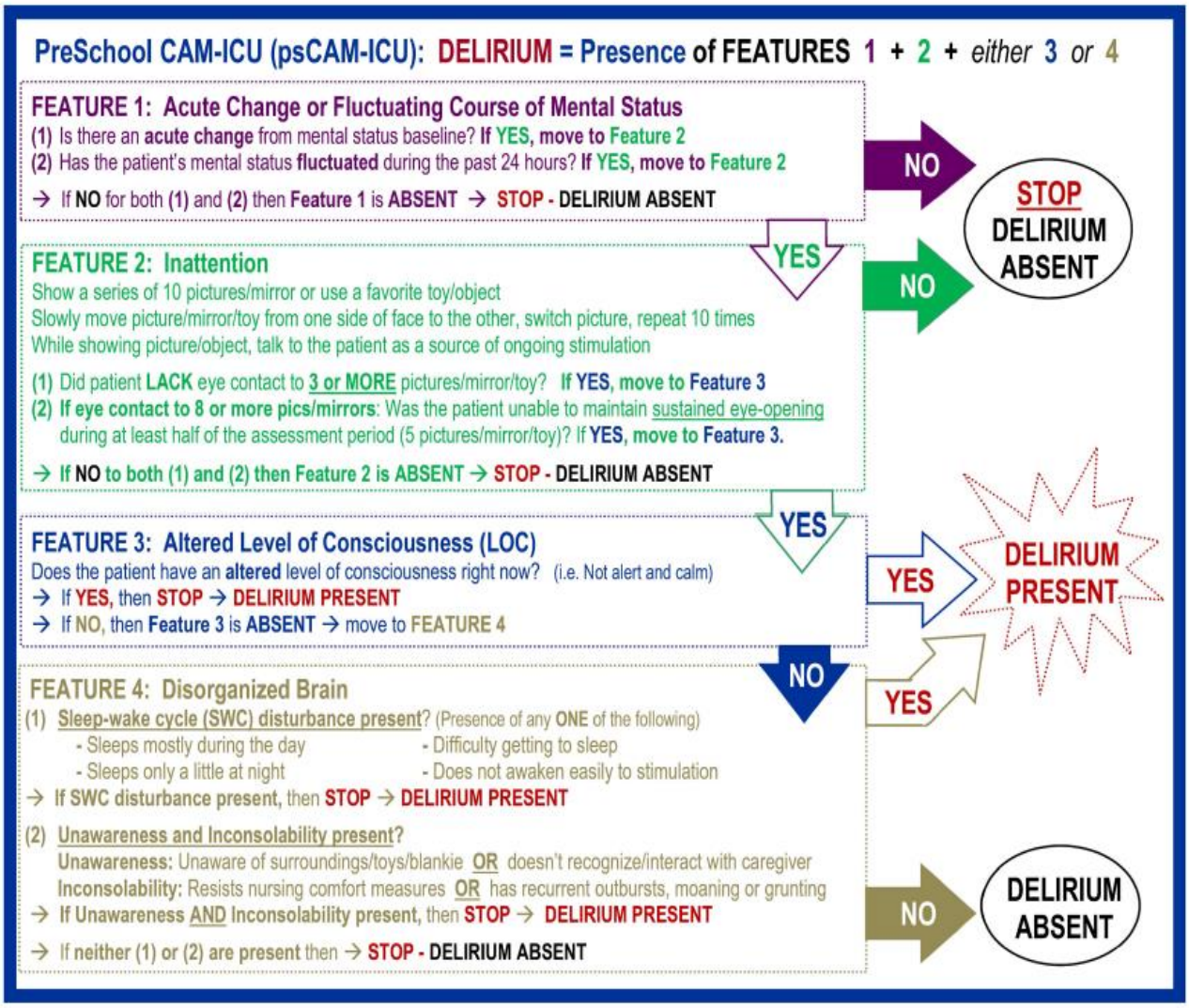

Figure 3: Decision tree for delirium assessment in preschool-aged children using psCAM-ICU

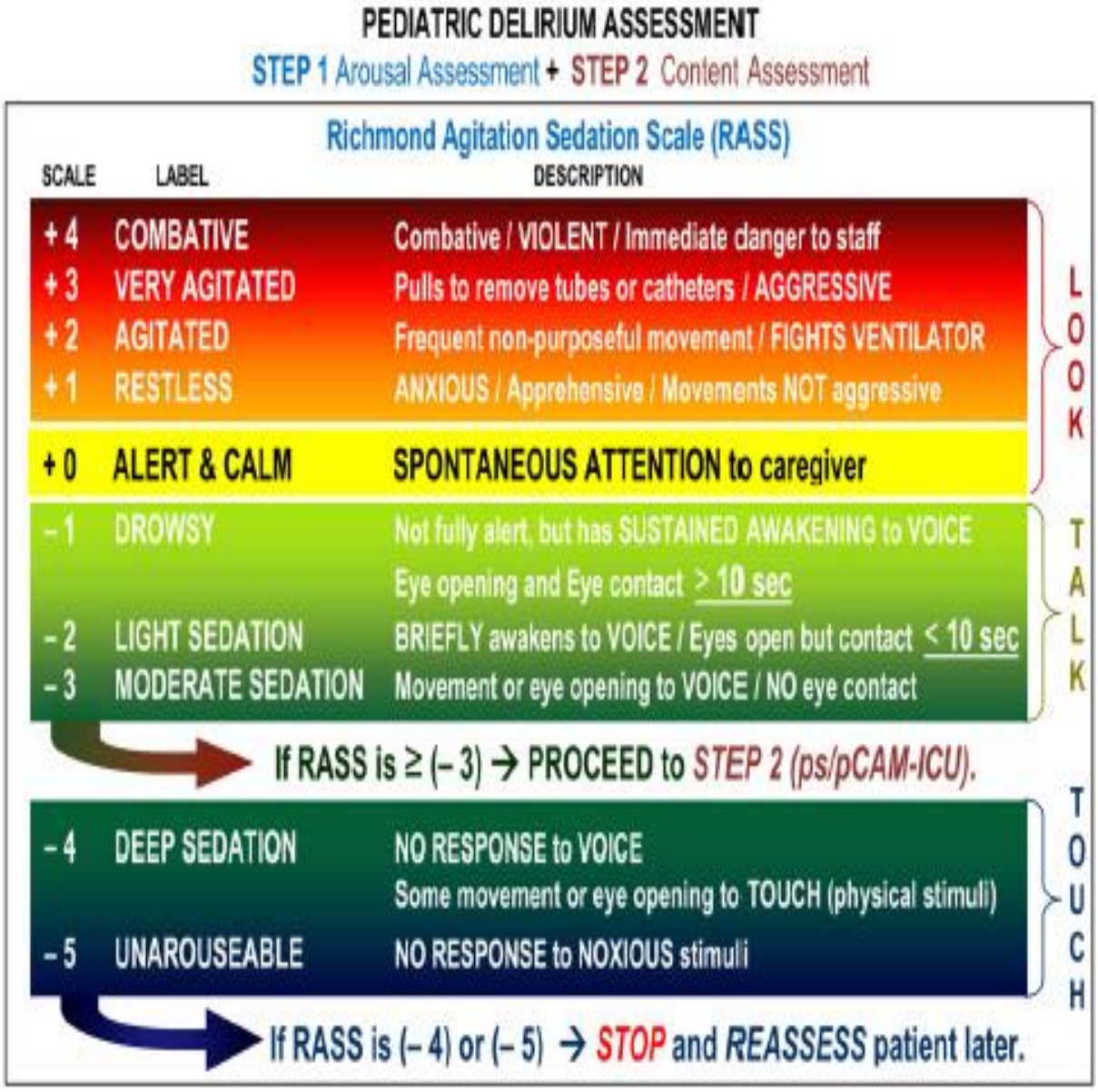

Figure 4: Preschool CAM-ICU Assessment for Delirium: Identification of Features: Acute change or fluctuating course of mental status, Inattention, Altered level of consciousness (LOC), and disorganized thinking (sleep-wake cycle disturbance or unawareness and inconsolability)