scientific reports

Check for updates

OPEN

Incidence and factors associated with agitation in patients on mechanical ventilators in Amhara Region, North-West Ethiopia: a multi-center study

Temesgen Birlie Asmare[1]✉, Hailu Yimer Tawuye[2], Biresaw Ayen Tegegne[2] & Biruk Adie Admass[2]

Agitation is a common psychomotor disorder among critically ill patients on mechanical ventilators, posing significant risks to patients and adding strain to clinical services. Despite its importance, there is a lack of data on the incidence and contributing factors of agitation in the study area and across Ethiopia. This study, therefore, aims to assess the incidence and factors associated with agitation in patients on mechanical ventilators in the intensive care units of comprehensive specialized hospitals in the Amhara Region, North-West Ethiopia. A multi-center prospective follow-up study was conducted among 253 critically ill adult patients on mechanical ventilators in the Amhara region of Ethiopia from April 17, 2024, to July 16, 2024. Data were collected using a semi-structured questionnaire through chart reviews, observations, and interviews. Participants were selected using a consecutive sampling technique. The data were entered into Epi-Data version 4.6 and transferred to Stata version 17 for analysis. Bivariable and multivariable logistic regression analyses were performed to identify factors associated with agitation. Variables with a *p* value of less than 0.2 in the bivariable analysis were included in the multivariable analysis. Crude and adjusted odds ratios with 95% confidence intervals were used to identify factors associated with agitation. The results were presented in the form of text, tables, and figures. In the multivariable analysis, variables with a *p* value of less than 0.05 were considered statistically significant predictors. The overall incidence of agitation among patients on mechanical ventilators in intensive care units was 87.35% (95% CI 82.6, 91.2). Anxiety (Adjusted Odds Ratio (AOR) 3.5; 95% CI 1.28, 9.45), delirium (AOR 3.01; 95% CI 1.13, 7.97), pain (AOR 3.23; 95% CI 1.18, 8.85), hyperthermia (AOR 3.49; 95% CI 1.004, 12.15), hyponatremia (AOR 3.64; 95% CI 1.009, 13.11), and the use of restraints (AOR 3.49; 95% CI 1.11, 8.67) were statistically significant factors associated with agitation. In this study, the majority of participants experienced agitation. To reduce the incidence of agitation, we recommend addressing or preventing the development of anxiety, pain, delirium, hyperthermia, and hyponatremia, as well as minimizing the use of restraints in intensive care units.

Keywords Agitation, Intensive care unit, Mechanical ventilator, Ethiopia

Abbreviations

AOR	Adjusted odds ratio
BMI	Body mass index
BPS	Behavioral pain scale
CI	Confidence interval
COR	Crude odds ratio
CSH	Comprehensive Specialized Hospital
FAS	Face anxiety scale

[1]Department of Anesthesia, School of Medicine, College of Health Sciences, Debre Tabor University, Debre Tabor, Ethiopia. [2]Department of Anesthesia, School of Medicine, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia. ✉email: birlietemu@gmail.com

ICU	Intensive care unit
MV	Mechanical ventilator
RASS	Richmond agitation sedation scale
STATA	Statistical Software Package

Agitation is a common psychomotor disorder in critically ill patients on mechanical ventilators, often manifesting as disorientation, restlessness, tube pulling, and over-breathing the ventilator[1,2]. Previous studies have reported that 42–71% of critically ill patients experience agitation[3,4]. The experience of agitation in critically ill patients varies across studies, with reported prevalence rates of 45%, 52%, 59%, 68%, 71%, and 89%[1,5–9]. Sixteen percent (16%) of patients in the medical intensive care unit on mechanical ventilators experienced severe agitation[10]. Patients with a history of smoking, severe head injury, hospitalization for acute neurological disorders, moderate to severe pain, mechanical ventilation, and delirium are more likely to experience agitation[3,11].

Agitation increases metabolic demand, which may jeopardize energy balance and cause organ malfunction, which in turn leads to a patient's loss of homeostasis[3]. Agitation can lead to unfavorable outcomes such as prolonged stays in the intensive care unit (ICU), prolonged mechanical ventilation, increased frequency of nosocomial infections, higher unplanned extubations, removal of the central venous catheter, and higher frequency of surgical re-intervention due to anastomotic leaks[8,10]. The post-hospital mortality rate of agitated patients in the ICU is higher compared with that of non-agitated patients[12]. Furthermore, agitation can exacerbate other undesirable complications such as pain, anxiety, and delirium, which contribute to further physiological derangements and damage to the patient[13].

Protocols have been developed to reduce the occurrence of agitation and to manage agitation in ICU patients[14,15]. Despite these standards, proper implementation of the protocol in low- and middle-income countries is challenging due to limited resources[16]. Poor outcome of agitated patients in the ICU on mechanical ventilators is an important indicator of a low level of multidisciplinary work and resource utilization[17]. In the ICUs, reducing and managing agitation is most affected by the inadequate organizational structure of the ICU, a declining patient safety culture, inadequate documentation of problems, poor interdisciplinary collaboration, scarce resources, and inadequate professional knowledge[15,18]. Early identification and proactive management of agitation in ICU patients on mechanical ventilators have a great role in reducing the occurrence[19]. Despite its importance, there is a lack of data on the incidence and contributing factors of agitation in the study area and Ethiopia. This study, therefore, aims to assess the incidence and factors associated with agitation in patients on mechanical ventilators in the intensive care units of comprehensive specialized hospitals in the Amhara Region, North-West Ethiopia.

Methods and materials

Study design, period, and settings

A multi-center prospective follow-up study was conducted from April 17, 2024, to July 30, 2024, to determine the incidence of agitation and associated factors in critically ill patients on mechanical ventilators in the intensive care units of comprehensive specialized hospitals in the Amhara Region, North-West Ethiopia. The study involved five hospitals: the University of Gondar, Felege Hiwot, Tibebe Ghion, Debre Tabor, and Debre Markos.

University of Gondar Comprehensive Specialized Hospital, located in Gondar town, has separate medical and surgical ICUs with a total of 19 beds and an average monthly admission of 82 patients. Debre Tabor Comprehensive Specialized Hospital, located in Debre Tabor town, operates a mixed medical-surgical ICU with 5 beds and an average monthly admission of 25 patients. Tibebe Ghion and Felege Hiwot Comprehensive Specialized Hospitals, both located in Bahirdar town, each have mixed medical-surgical ICUs with a combined total of 20 beds and an average monthly admission of 74 patients. Debre Markos Comprehensive Specialized Hospital, located in Debre Markos town, also operates a mixed medical-surgical ICU with 4 beds and an average monthly admission of 16 patients. These hospitals provide a wide range of critical care services, supported by diverse healthcare teams.

Inclusion and exclusion criteria

All patients aged 18 years and older who were admitted to the ICUs and on mechanical ventilators (MV) from April 17, 2024, to July 30, 2024. Exclusion criteria comprised patients who died or were extubated before the outcome occurred or before the end of the follow-up period, those with unavailable medical records, patients admitted to the ICU more than once during the study, and those with conditions that interfered with the sedation scale scoring, such as continued administration of paralytics or being unarousable for 24 h or more. The study follows the Enhancing the Quality and Transparency of Health Research (EQUATOR) guideline, Strengthening the Reports of Observational Studies in Epidemiology (STROBE)[20].

Sample size

The sample size was determined using a single population proportion formula based on the following assumption since up to the author's search, there was no previous study conducted on this topic in Ethiopia. Therefore, it was assumed that the incidence of agitation in intensive care units under MV is 50% with a 95% confidence interval, and 5% margin of error, and the sample size is calculated as follows.

$$n = \left(Z_{a/2}\right)^2 P\,(1-P)\,/d^2$$

where n = sample size. Za/2 = the standard normal value at 95% CI. P = prevalence. D = margin of error. Therefore, the sample size $n = (1.96)^2 \times 0.5(1–0.5)/\,(0.05)^2$. n = 384.

By applying a finite population correction formula, the final sample size was,

$$NF = (n/1 + n/N)$$

Whereas, NF = final sample size. n = sample size. N = Total number of patients who had been admitted to the ICU and underwent MV within 3 months in comprehensive specialized hospitals in the Amhara region, Northwest Ethiopia (University of Gondar CSH = 102, Debre Tabor CSH = 71, Tibebe Ghion CSH = 62, Felege Hiwot CSH = 67, Debere Markos CSH = 53: total = 355 patients).

$$n = 384$$
$$N = 355$$
$$NF = 384/(1 + 384/355)$$
$$NF = 185$$

The total sample size after including a 10% non-response rate was:

$$NF = 185 + 19$$

NF = 204 participants, this was the minimum sample that needed to be included.

This calculated sample size (204) was the minimum sample size needed to be collected. However, since the number of adult patients on mechanical ventilators (MV) during the study period was manageable in terms of budget and time; the final sample size was 253 patients.

Sampling technique

The consecutive sampling technique was used to select participants. All comprehensive specialized hospitals in the Amhara Region, North-West Ethiopia were included in the study.

Variables of the study

Agitated A patient is deemed agitated when their score on the Richmond Agitation-Sedation Scale (RAAS) is between 1 and 4[21,22].
Pain A patient is considered to have pain when their Behavioral Pain Scale (BPS) score is greater than 3, indicating pain and a score of 5 or higher indicates moderate pain[23].
Delirium A patient is considered to have delirium if features 1 and 2 of the CAM-ICU are present, along with either feature 3 or feature 4[24].
Anxious According to the Faces Anxiety Scale (FAS), a patient is considered to be anxious when there is a little bit more up to the extreme of anxiety face[25,26].
Substance use A patient is considered a substance user if they have ever used any of the three commonly used psychoactive substances in their lifetime: alcohol, cigarettes, or chat[27,28].
Sodium level Hypernatremia is defined as a plasma sodium concentration greater than 145 mEq/L, while hyponatremia is defined as a plasma sodium concentration less than 135 mEq/L[29,30].
Potassium level Hyperkalemia is defined as a plasma potassium concentration greater than 5.5 mEq/L, while hypokalemia is defined as a plasma potassium concentration less than 3.5 mEq/L[29].
Temperature level Hyperthermia is defined as a core body temperature above 37.5 °C, while hypothermia is defined as a core body temperature below 36.5 °C[31,32].
Chloride level The normal range of serum chloride concentrations is 96–106 mEq/L. Hyperchloremia is defined as plasma chloride concentrations above 106 mEq/L, while hypochloremia is defined as plasma chloride concentrations below 96 mEq/L[33–35].

Data collection tools

A semi-structured questionnaire was used to collect data. The questionnaire consisted of three parts: 1. Demographic characteristics (age, sex, height, weight, and BMI) 2. Clinical characteristics (delirium, anxiety, pain, temperature, oxygen saturation, blood pressure, electrolyte levels, renal function tests, cause of ICU admission, presence of catheters, procedures, mode of mechanical ventilation, diurnal occurrence of agitation, previous history of psychiatric disease, and use of restraints) 3. Behavioral and medication-related factors (substance use and medications utilized).

Agitation status was assessed using the Richmond Agitation-Sedation Scale (RASS), a widely validated tool for evaluating agitation in patients on mechanical ventilators in the ICU. The RASS consists of 10 items that assess levels of agitation and sedation, with scores ranging from + 1 to + 4 indicating agitation, while scores from 0 to -5 suggest that the patient is not agitated[11]. The tool has demonstrated strong reliability and validity, with a Cronbach's alpha ranging from 0.91 to 0.94[36]. Agitation level was collected every 4 h from the time of patient intubation up to 5 days of ICU stay[11,37].

Pain levels were assessed using the Behavioral Pain Scale (BPS). The BPS consists of 12 items that evaluate pain based on three behavioral indicators: Facial expressions, movement of upper limbs, and compliance with ventilation. Each behavioral indicator includes 4 descriptors that are rated on a scale of 1–4. The total score on the scale ranges from 3 (indicating no pain) to 12 (representing the highest level of pain). The scale has a high inter-rater reliability of 0.95 (95% CI 0.94–0.97)[38].

Delirium status was assessed using the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU). The CAM-ICU Flowsheet tests the following features in a standardized manner: (1) acute onset or fluctuating course of a change from the mental status baseline, (2) inattention, (3) altered level of consciousness, and (4) disorganized thinking. A patient is considered positive for delirium if they exhibit features 1, 2, and either feature 3 or 4. The agreement (interrater reliability) between the 2 CAM-ICU Flowsheet investigators was very high (Cohen κ, 0.96; 95% confidence interval, 0.87–1.00)[39].

Anxiety level was assessed using the Facial Anxiety Scale (FAS), which is a single-item scale with five possible responses, ranging from a neutral face to a face showing extreme fear. The patient was shown the Faces Anxiety Scale on an 11 × 42-cm (4.3 × 16.5-in) card and asked to point to the face that represented how they felt at that time. To say the patient has anxiety should be a little bit more up to the extreme of anxiety face[40].

Data collection procedures

Demographic data, including the patient's age and sex, as well as variables such as electrolyte levels, renal function tests, temperature, oxygen saturation, blood pressure, cause of ICU admission, medications used, and ordered procedures, were recorded from the patient's chart. Information on the presence of catheters, the mode of mechanical ventilation, and the use of restraints was collected through observation. Substance use was assessed through patient interviews if the RASS sedation level was greater than −2, or from an attendant when necessary. A history of psychiatric disease was obtained from the patient's chart or through an interview. Height was measured, and ideal body weight was calculated accordingly. Additionally, variables such as pain, delirium, and anxiety were recorded every 4 h using the Behavioral Pain Scale, CAM-ICU, and Faces Anxiety Scale, respectively.

Data quality control

To ensure data quality, a pretest was conducted on 5% of patients on mechanical ventilation in the ICU at Dessie Comprehensive Specialized Hospital, which was not included in the main study. This pretest occurred three weeks before the actual data collection, and the contents were modified accordingly. Data collectors and supervisors received one day of training on the study's objectives and data collection methods from the principal investigator to familiarize them with the study. Nurses with BSc degrees working in the ICUs collected the data, while assigned senior anesthetists supervised the data collection process. Data were checked for completeness and clarity.

Data processing and analysis

The data were entered into EpiData version 4.6 and transferred to STATA version 17.0 for analysis. Descriptive results were presented in the form of text, tables, and figures. The distribution of continuous data was assessed using the Kolmogorov–Smirnov test, with non-normally distributed data reported as median with interquartile range and normally distributed data reported as mean with standard deviation.

The association between independent factors and the outcome variable was determined using the chi-squared test, bivariable, and multivariable logistic regression. Crude and adjusted odds ratios, along with 95% confidence intervals, were used to estimate the strength of associations. Statistically significant variables identified in the bivariable analysis were considered eligible for inclusion in the multivariable logistic regression model. Statistical significance was set at a p value of less than 0.2 for the bivariable analysis and less than 0.05 for the multivariable logistic regression. Multicollinearity was assessed using variance inflation factors (VIF = 1.13–1.41, mean VIF = 1.22), and model goodness of fit was evaluated using the Hosmer and Lemeshow test ($p = 0.2387$).

Ethical consideration

Ethical clearance was obtained from the University of Gondar College of Medicine and Health Sciences, School of Medicine Ethical Review Committee (reference number: 8/4/1401/2024). Additionally, ethical approvals and permission letters were secured from all comprehensive specialized hospitals where the study was conducted. After a brief explanation of the study's benefits and risks, written informed consent was obtained from the family or caregivers of each participant. The study adhered to the ethical principles outlined in the Declaration of Helsinki for medical research involving human subjects.

Confidentiality was maintained by concealing personal identifiers and securely storing completed questionnaires and results. Participants who experienced agitation, pain, delirium, or anxiety during data collection were referred to their respective clinicians for treatment.

Results

Demographic and behavioral characteristics of participants

Out of 274 intubated patients assessed for agitation during the study period, 253 were included in the analysis with a response rate of 92.3%. The remaining 21 patients were excluded as they did not meet the inclusion criteria: 13 patients died, and 8 were extubated before the outcome or completion of the follow-up period. The median age of the study participants was 40 years, with an interquartile range (IQR) of 29–53 years. Nearly three-fourths of the participants, 188 (74.31%), had a history of substance use, and 25 (9.88%) had a history of psychiatric disease (Table 1).

Clinical-related characteristics of patients

Note: In each category of medical and surgical causes of ICU admission, an individual patient might have more than one disease entity that contributes to their admission. Therefore, simply summing the individual disease entities may not accurately reflect the actual number of surgical or medical causes of admission.

Variables	Frequency (%)	Agitation	
		Yes	No
Age (years)			
18–64	232 (91.70)	204 (87.93)	28 (12.07)
≥65	21 (8.30)	17 (80.95)	4 (19.05)
Age (years) [Median (IQR)]	[40 (29, 53)]		
Sex			
Male	151 (59.68)	134 (88.74)	17 (11.26)
Female	102 (40.32)	87 (85.29)	15 (14.71)
BMI			
<18.5	7 (2.73)	5 (71.43)	2 (28.57)
18.5–24.9	246 (97.23)	216 (87.80)	30 (12.20)
>24.9	0	0	0
History of substance use			
Yes	188 (74.31)	170 (90.43)	18 (9.57)
No	65 (25.69)	51 (78.46)	14 (21.54)
Alcohol			
Yes	188 (100)	170 (90.43)	18 (9.57)
No	0	0	0
Smoking			
Yes	25 (13.30)	20 (80.00)	5 (20.00)
No	163 (86.70)	150 (92.02)	13 (7.98)
Chat			
Yes	23 (12.23)	20 (86.96)	3 (13.04)
No	165 (87.87)	150 (90.91)	15 (9.09)
History of psychiatric disease			
Yes	25 (9.88)	20 (80)	5 (20)
No	228 (90.12)	201 (88.16)	27 (11.84)
Depression			
Yes	18 (72)	15 (83.33)	3 (16.67)
No	7 (28)	2 (28.57)	5 (71.43)
Schizophrenia			
Yes	2 (8)	2 (100)	0
No	23(92)	8 (34.78)	15 (65.22)
Bipolar disorder			
Yes	5 (20)	4 (80)	1(20)
No	20 (80)	9 (45)	11(55)

Table 1. Demographic, behavioral, and psychiatric disorder-related characteristics of the participants admitted to adult intensive care units at comprehensive specialized hospitals of Amhara Region, Northwest Ethiopia, 2024. (N = 253). *BMI* body mass index, *IQR* interquartile range.

In the majority of participants, 154 (60.87%), the cause of admission to the ICU was surgical. The most frequent cause of admission for both surgical and medical cases was respiratory failure, with 60 (38.96%) and72 (72.73%) cases, respectively (Table 2). The mode of mechanical ventilation was pressure, volume, and mixed volume and pressure mode in 121 (47.83%), 93(36.76), and 39 (15.42) of the participants respectively. Procedures like positioning, suctioning, and wound care were performed on 250 (98.81%), 234 (92.49%), and 136 (53.75%) of participants respectively.

Plasma electrolytes, organ function, and vital sign characteristics of patients

Nearly half of the participants were normonatremic (124, 49.01%) and normokalemic (118, 46.64%), while half of the participants (129, 50.99%) were hyperchloremic (Table 3).

Incidence of agitation

The overall incidence of agitation in this study was 221 cases (87.35%), with a 95% confidence interval (CI) of (82.6, and 91.2) (Fig. 1). The highest incidence of agitation occurred at Debre Markos Comprehensive Specialized Hospital, while the lowest incidence was observed at Tibebe Gihon Specialized Comprehensive Hospital (Fig. 2). In the majority of participants, 122 (55.20%), the first episode of agitation occurred at night, and in most participants, 178 (80.54%), the first episode happened on the first day of ICU admission (Fig. 3).

Variables	Frequency (%)	Agitation	
		Yes (n %)	No (n %)
Causes of ICU admission			
Medical cause			
Yes	99 (39.13)	85 (85.86)	14 (14.14)
No	154 (60.87)	136 (88.31)	18 (11.69)
Respiratory failure			
Yes	72 (72.73)	63 (87.50)	9 (12.5)
No	27 (27.27)	22 (81.48)	5 (18.52)
Septic shock			
Yes	22 (22.22)	21 (95.45)	1 (4.55)
No	77 (77.78)	64 (83.12)	13 (16.88)
Cardiogenic shock			
Yes	5 (5.05)	4 (80)	1 (20)
No	94 (94.95)	81 (86.17)	13 (13.83)
Myocardial ischemia/infarction			
Yes	10 (10.10)	10 (100)	0
No	89 (89.90)	75 (84.27)	14 (15.83)
Congestive heart failure			
Yes	14 (14.14)	12 (85.71)	2 (14.29)
No	85 (85.86)	73 (85.88)	12 (14.12)
Drug overdose/ poisoning			
Yes	6 (6.06)	4 (66.67)	2 (33.33)
No	93 (93.94)	81 (87.10)	12 (12.90)
Stroke			
Yes	9 (9.09)	7 (77.78)	2 (22.22)
No	90 (90.91)	78 (86.67)	12 (13.33)
Other causes			
Yes	4 (4.04)	3 (75)	1 (25)
No	95 (95.96)	7 (7.37)	88 (92.63)
Surgical cause			
Yes	154 (60.87)	136 (88.31)	18 (11.69)
No	99 (39.13)	85 (85.86)	14 (14.14)
Respiratory failure			
Yes	60 (38.96)	56 (93.33)	4 (6.67)
No	94 (61.04)	80 (85.11)	14 (14.89)
Septic shock			
Yes	53 (34.42)	50 (94.34)	3 (5.66)
No	101 (65.58)	86 (85.15)	15 (14.85)
Traumatic head injury			
Yes	47 (30.52)	39 (82.98)	8 (17.02)
No	107 (69.48)	97 (90.65)	10 (9.35)
Hemorrhagic shock			
Yes	27(17.53)	25(92.59)	2(7.41)
No	127(82.47)	111(87.40)	16(12.60)
Delayed awakening			
Yes	17 (11.04)	14 (82.35)	3 (17.65)
No	137 (88.96)	122 (89.05)	15 (10.95)
Cardiac arrest			
Yes	9 (5.84)	8 (88.89)	1 (11.11)
No	145 (94.16)	128 (88.28)	17 (11.72)
Use of restraint			
Yes	192 (75.89)	176 (91.67)	16 (8.33)
No	61 (24.11)	45 (73.77)	16 (26.33)
Anxiety			
Yes	206 (81.42)	190 (92.23)	16 (7.77)
No	47 (18.58)	31 (65.96)	16 (34.04)
Continued			

Variables	Frequency (%)	Agitation	
		Yes (n %)	No (n %)
Delirium			
Yes	156 (61.66)	146 (93.59)	10 (6.41)
No	97 (38.34)	75 (77.32)	22 (26.68)
Pain			
Yes	201 (79.45)	183 (91.04)	18 (8.96)
No	52 (20.55)	38 (73.08)	14 (26.92)
Utilized medication in ICU care			
Benzodiazepines			
Yes	244 (96.44)	214 (87.70)	30 (12.3)
No	9 (3.56)	7 (77.78)	2 (22.22)
Opioids			
Yes	240 (94.86)	212 (88.33)	28 (11.67)
No	13 (5.14)	9 (69.23)	4 (30.77)
Neuroleptic drugs			
Yes	33 (13.04)	31 (93.94)	2 (6.06)
No	220 (86.96)	190 (86.36)	30 (13.64)
Indewelling catheters			
Genitourinary			
Yes	253 (100)	221 (87.35)	32 (12.65)
No	0	0	0
Gastrointestinal			
Yes	228 (90.12)	199 (87.28)	29 (12.72)
No	25 (9.88)	22 (88.00)	3 (12.00)
Head drainage catheter			
Yes	26 (10.28)	19 (73.08)	7 (26.92)
No	227 (89.72)	202 (88.99)	25 (11.01)
Chest tube			
Yes	12 (4.74)	10 (83.33)	2 (16.67)
No	241 (95.26)	211 (87.55)	30 (12.45)

Table 2. Clinical-related characteristics of the participants admitted to adult intensive care units at comprehensive specialized hospitals of Amhara Region, Northwest Ethiopia, 2024. (N = 253). Other causes in medical cause include Uremic encephalopathy, tetanus, seizure for airway protection, and upper airway obstruction secondary to metastatic esophageal cancer.

Factors associated with agitation

To assess factors associated with agitation in ICU patients on mechanical ventilators, both bivariable and multivariable logistic regression analyses were conducted. Variables such as anxiety, pain, delirium, temperature, sodium level, potassium level, chlorine level, substance use, and use of restraint had a *p* value less than 0.2 from the bivariable analysis. However, only anxiety, pain, delirium, temperature, sodium level, and use of restraint were statistically significant in the final multivariable logistic regression analysis.

Participants who had anxiety were 3.5 times more likely to develop agitation compared with those who had no anxiety (AOR 3.5; 95% CI 1.28, 9.45). Similarly, the participants who had delirium were three times more likely to develop agitation compared with those who had no delirium (AOR 3.01; 95% CI 1.13, 7.97). The study also displayed, participants who had pain were 3.23 times more likely to develop agitation compared to their counterparts (AOR 3.23; 95% CI 1.18, 8.85) (Table 4).

The odds of developing agitation were 3.49 (AOR 3.49, 95% CI 1.004, 12.150), and 3.64 times (AOR 3.64, 95% CI 1.009, 13.108) higher in participants with hyperthermia and hyponatremia than in participants with normothermia and normonatremia respectively. Similarly, the odds of developing agitation were 3.11 (AOR 3.49, 95% CI 1.11, 8.67) times higher in participants using restraints than their counterparts (Table 4).

Discussion

Patients admitted to the ICU after developing agitation tend to have worse outcomes and poor prognoses. Identifying the possible factors associated with agitation will help to improve the outcome of the patients. This study aimed to determine the incidence and factors associated with agitation.

In the current study, the overall incidence of agitation was 87.35% (95% CI 82.6, 91.2). The finding is in line with the study carried out in Turkey (89%)[5]. However, the findings were higher than studies conducted in France (52%)[8], Brazil (31.8%)[3], and the USA (Virginia Commonwealth University, University of Puerto Rico Medical Sciences Campus, and Northeastern USA) (17.5%), (59%), (68%)[1,11,41]. The possible discrepancy might be that

Variables	Frequency (%)	Agitation	
		Yes (n %)	No (n %)
Sodium (meq/L)			
Hyponatremia (< 135)	60 (23.72)	55 (91.67)	5 (8.33)
Normonatrermia (135–145)	124 (49.01)	102 (82.26)	22 (17.74)
Hypernatremia (> 145)	69 (27.27)	64 (92.75)	5 (7.25)
Sodium (meq/L) [Mean (SD)]	[139.94 (7.43)]		
Potassium (meq/L)			
Hypokalemia (< 3.5)	111 (43.87)	104 (93.69)	7 (6.31)
Normokalemia(3.5–5.5)	118 (46.64)	98 (83.05)	20 (16.95)
Hyperkalemia (> 5.5)	24 (9.49)	19 (79.17)	5 (20.83)
Potassium (meq/L) [Median (IQR)]	[3.58(3.24, 4.27)]		
Chlorine (meq/L)			
Hypochloremia(< 96)	18 (7.11)	16 (88.89)	2 (11.11)
Normochloremia(96–106)	106 (41.90)	89 (83.96)	17 (16.04)
Hyperchloremia(> 106)	129 (50.99)	116 (89.92)	13 (10.08)
Chlorine (meq/L) [Mean (SD)]	[105.82(8.14)]		
Blood urea nitrogen(mg/dl)			
6–40	176 (69.57)	154 (87.50)	22 (12.50)
> 40	77 (30.43)	67 (87.01)	10 (12.99)
Blood urea nitrogen(mg/dl) [Median (IQR)]	[33 (24.6, 46)]		
Creatinine level(mg/dl)			
< 0.7	34 (13.44)	29 (85.29)	5 (14.71)
0.7–1.4	147 (58.10)	130 (88.44)	17 (11.56)
> 1.4	72 (28.46)	62 (86.11)	10 (14.89)
Creatinine level (mg/L) [Median (IQR)]	[1.02 (0.84, 1.54)]		
Temperature (°C)			
Hypothermia(< 36.5)	51 (20.16)	45 (88.24)	6 (11.76
Normothermia(36.5–37.5)	117 (46.25)	95 (81.20)	22 (18.80)
Hyperthermia(> 37.5)	85 (33.60)	81 (95.29)	4 (4.71)
Temperature(°c) [Median (IQR)]	[36.92 (36.52, 37.63)]		
Oxygen saturation (spo2)			
< 95	14(5.53)	14(100)	0
95–100	239(94.47)	207(86.61)	32(13.39)
Oxygen saturation(spo2) [Median (IQR)]	[99 (98, 100)]		
Mean blood pressure (mmHg)			
< 70	105(41.50)	93(88.57)	12(11.43)
70–100	133(52.57)	116(87.22)	17(12.88)
> 100	15(5.93)	12(80.00)	3(20)
Mean blood pressure (mmHg) [Median (IQR)]	[74(64, 87)]		

Table 3. Factors related to the investigation and vital sign characteristics of participants admitted to adult intensive care units at comprehensive specialized hospitals of Amhara Region, Northwest Ethiopia, 2024. (N = 253). n-frequency, meq/L-mill equivalent per liter, °C-degree Celsius, mmHg-milliliter mercury, mg/dl-milligram per deciliter, IQR-Interquartile Range, and SD-Standard Deviation.

in the study carried out in France[8], they used also a different assessment tool which was a modified Ramsey scale; the different results from this tool might be intrinsic scoring procedures and design. In Brazil's[3] study, they were used to diagnose agitation, if the RASS value was greater than or equal to plus two, which may underestimate the incidence since the current study used a cut-of-point greater than equal to plus one.

Additionally, in the USA[1,11,41] all three studies had a smaller sample size than the current study which may underestimate the actual value plus both Virginia Commonwealth University and the University of Puerto Rico Medical Sciences Campus, USA studies; the study were retrospective chart reviews which might have missed the outcome variable record. Moreover, contrary to the current study, which was assessed six times (every 4 h) in a day, in the Northeastern, USA study the agitation assessment interval was only two times a day, which might miss the outcome variable recognition due to far apart time interval. Finally, the current study only includes patients on mechanical ventilators, who had a higher incidence of agitation than non-mechanical ventilator patients[11].

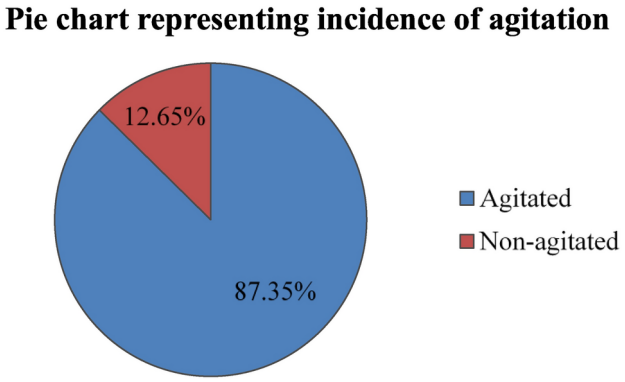

Fig. 1. Incidence of agitation occurrence in participants admitted to adult intendive care units at comprehensive specialized hospitals of Amhara Region, Northwest Ethiopia.

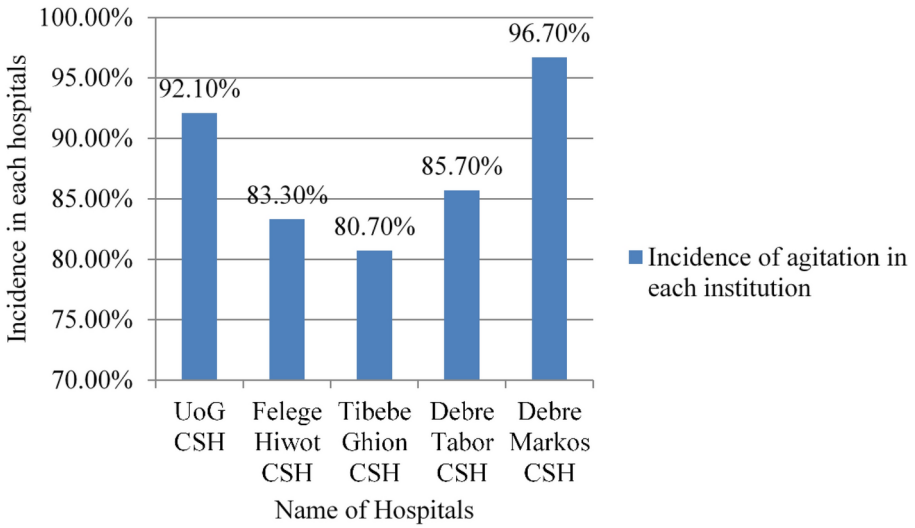

Fig. 2. Indicdence of agitation in patients on MV in ICUs in each comprehensive specialized hospital in Amhara Region, Noth-west Ethiopia.

In this study delirium, pain, anxiety, hyperthermia, hyponatremia, and use of restraint had a statistically significant association with agitation.

In the current study delirium had a significant association with agitation. The odds of developing agitation in adults with delirium were three times higher than in their counterparts, the finding is supported by a study conducted in Brazil[3], Texas[42], and the USA[1,43]. This might be due to patients with delirium may become agitated as a result of the disorientation and confusion they are experiencing. Furthermore, agitation can be driven by delirium in several ways, including neurotransmitter imbalances, inconsistent sleep–wake cycles, sensory overload, and underlying medical disorders; such as pain, and may escalate the occurrence of agitation in delirious patients[44].

In this study pain had a significant association with agitation; the odds of developing agitation in adult patients with pain were more than three times compared to those who had no pain. This finding is supported by studies conducted in Brazil[3], Virginia[11], and USA[1,43]. This may be due to the sympathetic nervous system and hypothalamic pituitary adrenal axis being activated by pain, leading to the release of catecholamine, (such as noradrenaline and adrenaline) and cortisol; these hormones induce agitation and anxiety. Moreover, pain may cause immune-compromization, which leads to infection that may release cytokines that have direct brain stimulation and pain may cause sleep disturbance and cognitive impairment. Therefore the above-listed combined effects of pain might trigger agitation occurrence[45,46].

In our study anxiety had a significant positive influence on agitation development; participants who had anxiety were three and half times more likely to develop agitation compared with those who had no anxiety. The result is supported by studies conducted in the USA[42,43,47]. This is because anxiety may cause agitation by interfering with physiological processes, elevating a person's level of arousal, causing thoughts to race, hindering cognition, causing sleep cycles to be disturbed, and encouraging avoidance actions. So, people can effectively

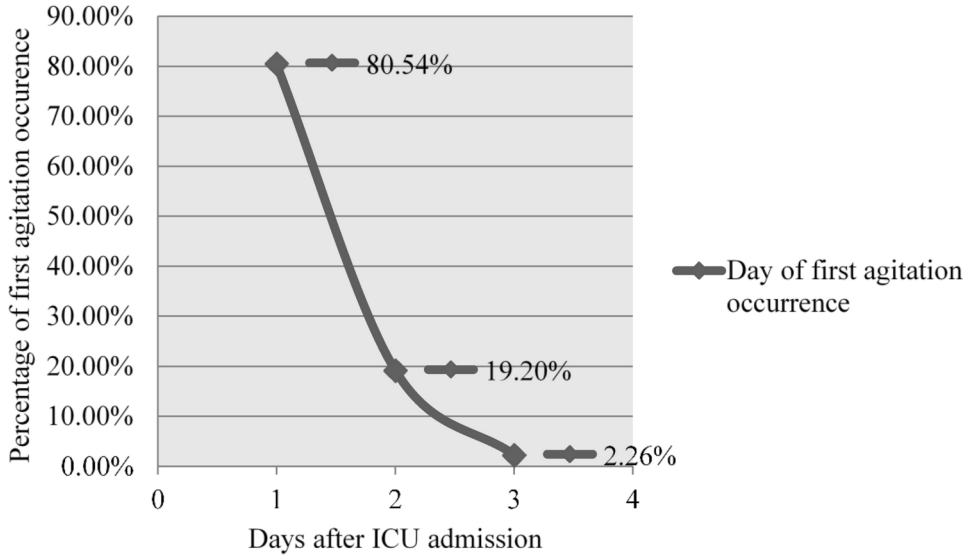

Fig. 3. Day of first agitation occurrence in participants admitted to adult intensive care units at comprehensive specialized hospitals of Amhara Region, Nothwest Ethiopia.

control their anxiety and lessen agitation by treating these underlying issues using therapy, calming methods, stress management techniques, and pharmaceuticals if needed[48–50].

Hyperthermia had a significant association with agitation; participants who had hyperthermia were three and a half times more likely to develop agitation compared with normothermia. This finding is comparable with a study carried out in France[8]. This may be the result of hyperthermia may increase stress response that leads to the release of catecholamine and other catabolic hormones that may put the brain and other organs under stress which triggers agitation. Moreover, hyperthermia can significantly affect brain function, leading to dehydration and neurotransmitter imbalances, particularly affecting GABA and glutamate levels. This interplay can exacerbate agitation and cognitive deficits. In addition, hyperthermia can cause cognitive impairment, anxiety, and hypothalamus damage, thus all synergize agitation occurrence[51–54].

Hyponatremia had a significant positive influence on agitation occurrence; the odds of developing agitation were more than three and a half times higher than normonatremia. The finding is comparable with a study conducted in France[8]. This is a result of hyponatremia increasing the influx of water into the intra-cellular space resulting in cellular swelling, which can lead to cerebral edema and encephalopathy, then edema and encephalopathy will lead to cognitive impairment and agitation[55].

The use of restraints also had a significant association with agitation in adult patients in ICU; the odds of developing agitation in patients who used restraints were more than three times higher than the patients who had not used restraints. This finding is supported by the two studies done in the USA[1,4]. This is might while using physical restraints there is the risk of damaging limbs, and emotional arousal due to the stress of restraint. Moreover, it causes delirium also, which causes disorientation and confusion they are experiencing and enhances agitation presence[56–59].

Strengths and limitations of the study

Up to our search, this is the first study determining the incidence and associated factors of agitation in ICU mechanically ventilator adult patients in the study area and the country. In addition, the study was multi-center and we used primary data. Even though this study tries to determine the incidence of agitation and associated factors, it doesn't determine the outcome of participants and management practice of agitation. In addition, in this study for hypoxia diagnosis only we used pulse oximetry, this may not replace arterial blood gas analysis plus this study didn't show the effect of serum lactate level on agitation because thus two investigations were not available in our setup.

Conclusion and recommendation

In this study, most of the patients on mechanical ventilators experienced agitation. Pain, anxiety, delirium, hyperthermia, hyponatremia, and use of restraints were significantly associated with agitation occurrence.

To reduce the incidence of agitation, we recommend treating or preventing the development of anxiety, pain, delirium, hyperthermia, and hyponatremia and avoiding using restraints in intensive care unit care. For future researchers, we recommend conducting a longitudinal study to assess the short and long-term impact of agitation on the outcome of patients in adult intensive care units. Moreover, we recommend investigating some variables extrapolated from arterial blood gas analysis results and serum lactate levels, thus were not tested whether they had an association with agitation in the current study.

Variables	Agitation		COR (95% CI)	AOR (95% CI)	*P* value
	Yes (n %)	No (n %)			
Anxiety					
Yes	190 (85.97%)	16 (50%)	6.13 (2.78,13.51)	3.48 (1.28,9.45)	0.015*
No	31 (14.03%)	16 (50%)	1	1	
Delirium					
Yes	146 (66.06%)	10 (31.25%)	4.28 (1.93, 9.51)	3.01 (1.13,7.97)	0.027*
No	75 (33.94%)	22 (68.75%)	1	1	
Pain					
Yes	183 (82.81%)	18 (56.25%)	3.75 (1.72, 8.18)	3.23 (1.18, 8.85)	0.023*
No	38 (17.19%)	14 (43.75%)	1	1	
Temperature(°C)					
< 36.5	45 (20.36%)	6 (18.75%)	1.74 (0.66, 4.58)	2.43 (0.78,7.64)	0.128
36.5–37.5	95 (42.99%)	22 (68.75%)	1	1	
> 37.5	81 (36.65%)	4 (12.50%)	4.69 (1.55, 14.17)	3.49 (1.004, 12.15)	0.049*
History of substance use					
Yes	170 (76.92%)	18 (56.25%)	2.59 (1.21, 5.57)	1.56 (0.55, 4.39)	0.403
No	51 (23.08%)	14 (43.75%)	1	1	
Sodium level(meq/L)					
< 135	55(24.89%)	5(15.63%)	2.37(0.85, 6.61)	3.64 (1.009,13.108)	0.048*
135–145	102 (46.15%)	22 (68.75%)	1	1	
> 145	64 (28.96%)	5 (15.63%)	2.76 (0.99, 7.66)	1.61 (0.46, 5.59)	0.456
Potassium level (meq/L)					
< 3.5	104 (47.06%)	7 (21.88%)	3.03 (1.23, 7.49)	1.88 (0.25, 14.17)	0.364
3.5–5.5	98 (44.34%)	20 (62.50%)	1	1	
> 5.5	19 (8.60%)	5 (15.63%)	0.77 (0.26, 2.32)	0.363 (0.099,1.325)	0.125
Chlorine level(meq/L)					
< 96	16 (7.24%)	2 (6.25%)	1.53 (0.32, 7.26)	1.88 (0.25, 14.17)	0.540
96–106	89 (40.27%)	17 (53.13%)	1	1	
> 106	116 (52.49%)	13 (40.63%)	1.70 (0.79, 3.69)	2.04 (0.76, 5.46)	0.158
Use of restraint					
Yes	176 (79.64%)	16 (50%)	3.91 (1.82, 8.42)	3.11 (1.11, 8.67)	0.030*
No	45 (20.36%)	16 (50%)	1	1	

Table 4. Multivariable logistic regression showing factors associated with agitation among adult intensive care unit patients at comprehensive specialized hospitals of Amhara Region, Northwest Ethiopia, 2024. 1-Reference, AOR-Adjusted Odds Ratio, COR-Crude Odds Ratio; CI-Confidence-interval, n-frequency, meq/L-milliequivalent per liter, °C-degree Celsius, and *variables statistically significant *p* value.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to confidentiality but are available from the corresponding author upon reasonable request.

Received: 2 October 2024; Accepted: 11 February 2025
Published online: 18 February 2025

References

1. O'Connor, H., Al-Qadheeb, N. S., Joseph, B., White, A. & Devlin, J. W. Agitation during prolonged mechanical ventilation at a long term acute care hospital. In *A48 MECHANICAL VENTILATION* A1708-A (American Thoracic Society, 2012).
2. Kiekkas, P., Samios, A., Skartsani, C., Tsotas, D. & Baltopoulos, G. I. Fever and agitation in elderly ICU patients: A descriptive study. *Intensive Crit. Care Nurs.* **26**(3), 169–174 (2010).
3. Almeida, T. M. L. D., Azevedo, L. C. P. D., Nosé, P. M. G., Freitas, F. G. R. D. & Machado, F. R. Risk factors for agitation in critically ill patients. *Rev. Bras. Ter. Intensiva* **28**, 413–419 (2016).
4. Burk, R. S., Grap, M. J., Munro, C. L., Schubert, C. M. & Sessler, C. N. Agitation onset, frequency, and associated temporal factors in critically ill adults. *Am. J. Crit. Care* **23**(4), 296–304 (2014).
5. Bahar, A. & Güner, M. Determination of the risk factors and delirium in the intensive care unit. *Anatol. Curr. Med. J.* **5**(1), 7–13 (2023).
6. Burk R. Predictors of agitation in the critically ill. 2013.
7. Burk, R. S., Grap, M. J., Munro, C. L., Schubert, C. M. & Sessler, C. N. Predictors of agitation in critically ill adults. *Am. J. Crit. Care Off. Publ. Am. Assoc. Crit. Care Nurs.* **23**(5), 414–423 (2014).

8. Jaber, S. et al. A prospective study of agitation in a medical-surgical ICU: Incidence, risk factors, and outcomes. *Chest* **128**(4), 2749–2757 (2005).
9. Mahmood, S., Mahmood, O., El-Menyar, A., Asim, M. & Al-Thani, H. Predisposing factors, clinical assessment, management and outcomes of agitation in the trauma intensive care unit. *World J. Emerg. Med.* **9**(2), 105 (2018).
10. Woods, J. C. et al. Severe agitation among ventilated medical intensive care unit patients: Frequency, characteristics and outcomes. *Intensive Care Med.* **30**, 1066–1072 (2004).
11. Burk, R. S., Grap, M. J., Munro, C. L., Schubert, C. M. & Sessler, C. N. Predictors of agitation in critically ill adults. *Am. J. Crit. Care* **23**(5), 414–423 (2014).
12. Chevrolet, J.-C. & Jolliet, P. Clinical review: Agitation and delirium in the critically ill–significance and management. *Crit. Care* **11**(3), 1–5 (2007).
13. McGovern, C., Cowan, R., Appleton, R. & Miles, B. Pain, agitation and delirium in the intensive care unit. *Anaesth. Intensive Care Med.* **19**(12), 634–640 (2018).
14. Barr, J. & Pandharipande, P. P. The pain, agitation, and delirium care bundle: Synergistic benefits of implementing the 2013 pain, agitation, and delirium guidelines in an integrated and interdisciplinary fashion. *Crit. Care Med.* **41**(9 Suppl 1), S99–S115 (2013).
15. Carrothers, K. M. et al. Contextual issues influencing implementation and outcomes associated with an integrated approach to managing pain, agitation, and delirium in adult ICUs. *Crit. Care Med.* **41**(9 Suppl 1), S128–S135 (2013).
16. Barr, J. et al. Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit: Executive summary. *Am. J. Health Syst. Pharm.* **70**(1), 53–58 (2013).
17. Haniffa, R. et al. Improving ICU services in resource-limited settings: Perceptions of ICU workers from low-middle-, and high-income countries. *J. Crit. Care* **44**, 352–356 (2018).
18. Souza, T. L., Azzolin, K. O. & Fernandes, V. R. Multiprofessional care for delirium patients in intensive care: integrative review. *Rev. Gauch. Enferm.* **39**, e20170157 (2018).
19. Freeman, S., Yorke, J. & Dark, P. Patient agitation and its management in adult critical care: A integrative review and narrative synthesis. *J. Clin. Nurs.* **27**(7–8), e1284–e1308 (2018).
20. Von Elm, E. et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Lancet* **370**(9596), 1453–1457 (2007).
21. Nassar Junior, A. P., Pires Neto, R. C., Figueiredo, W. B. D. & Park, M. Validity, reliability and applicability of Portuguese versions of sedation-agitation scales among critically ill patients. *Sao Paulo Med. J.* **126**(4), 215–219 (2008).
22. Sessler, C. N. et al. The Richmond agitation-sedation scale: Validity and reliability in adult intensive care unit patients. *Am. J. Respir. Crit. Care Med.* **166**(10), 1338–1344 (2002).
23. Ahlers, S. J., van der Veen, A. M., van Dijk, M., Tibboel, D. & Knibbe, C. A. The use of the behavioral pain scale to assess pain in conscious sedated patients. *Anesth. Analg.* **110**(1), 127–133 (2010).
24. Brummel, N. E. et al. Implementing delirium screening in the intensive care unit: Secrets to success. *Crit. Care Med.* **41**(9), 2196 (2013).
25. Gustad, L. T., Chaboyer, W. & Wallis, M. Performance of the faces anxiety scale in patients transferred from the ICU. *Intensive Crit. Care Nurs.* **21**(6), 355–360 (2005).
26. McKinley, S., Coote, K. & Stein-Parbury, J. Development and testing of a faces scale for the assessment of anxiety in critically ill patients. *J. Adv. Nurs.* **41**(1), 73–79 (2003).
27. Gebremariam, T. B., Mruts, K. B. & Neway, T. K. Substance use and associated factors among Debre Berhan University students, Central Ethiopia. *Subst. Abuse Treat. Prev. Policy* **13**, 1–8 (2018).
28. Gizaw, A. T., Amdisa, D. & Lemu, Y. K. Predictors of substance use among Jimma University instructors, Southwest Ethiopia. *Subst. Abuse Treat. Prev. Policy* **15**, 1–10 (2020).
29. Butterworth, J. F., Mackey, D. C. & Wasnick, J. D. *Morgan and Mikhail's Clinical Anesthesiology Cases* (McGraw Hill Professional, 2020).
30. Reddi, A. S. *Fluid, electrolyte and acid-base disorders* 391–401 (Springer, 2018).
31. Thomas, K. A. et al. Seasonal mapping of NICU temperature. *Adv. Neonatal Care* **10**(2), 83–87 (2010).
32. Phukubye, P. M. Operating theatre room temperatures and relative humidity levels at a central hospital.
33. Nandhini S, Sham L. A Comprehensive Review of Chloride Management in Critically Ill Patients. Cureus. 2024;16(3).
34. Sagar, N. & Lohiya, S. A comprehensive review of chloride management in critically ill patients. *Cureus* **16**(3), e55625 (2024).
35. Singh, P., Mishra, S. & Singh, V. Prognostic significance of serum chloride levels in congestive heart failure. *Chest* **14**, 16–23 (2023).
36. Ely, E. W. et al. Monitoring sedation status over time in ICU patients: Reliability and validity of the Richmond Agitation-Sedation Scale (RASS). *JAMA* **289**(22), 2983–2991 (2003).
37. Dubois, M.-J., Bergeron, N., Dumont, M., Dial, S. & Skrobik, Y. Delirium in an intensive care unit: a study of risk factors. *Intensive Care Med.* **27**(8), 1297–1304 (2001).
38. Payen, J.-F. et al. Assessing pain in critically ill sedated patients by using a behavioral pain scale. *Crit. Care Med.* **29**(12), 2258–2263 (2001).
39. Guenther, U. et al. Validity and reliability of the CAM-ICU flowsheet to diagnose delirium in surgical ICU patients. *J. Crit. Care* **25**(1), 144–151 (2010).
40. McKinley, S., Stein-Parbury, J., Chehelnabi, A. & Lovas, J. Assessment of anxiety in intensive care patients by using the faces anxiety scale. *Am. J. Crit. Care* **13**(2), 146–152 (2004).
41. Arroyo-Novoa, C. M., Figueroa-Ramos, M. I. & Puntillo, K. A. Occurrence and practices for pain, agitation, and delirium in intensive care unit patients. *Puerto Rico Health Sci. J.* **38**(3), 156 (2019).
42. Fraser, G. L., Prato, B. S., Riker, R. R., Berthiaume, D. & Wilkins, M. L. Frequency, severity, and treatment of agitation in young versus elderly patients in the ICU. *Pharmacotherapy* **20**(1), 75–82 (2000).
43. Siegel, M. D. Management of agitation in the intensive care unit. *Clin. Chest Med.* **24**(4), 713–725 (2003).
44. Gleason, O. C. Delirium. *Am. Fam. Physician* **67**(5), 1027–1034 (2003).
45. Habiger, T. F., Flo, E., Achterberg, W. P. & Husebo, B. S. The interactive relationship between pain, psychosis, and agitation in people with dementia: Results from a cluster-randomised clinical trial. *Behav. Neurol.* **2016**, 7036415 (2016).
46. Sampson, E. L. et al. Pain, agitation, and behavioural problems in people with dementia admitted to general hospital wards: A longitudinal cohort study. *Pain* **156**(4), 675–683 (2015).
47. Fraser, G. L., Prato, B. S., Riker, R. R., Berthiaume, D. & Wilkins, M. L. Frequency, severity, and treatment of agitation in young versus elderly patients in the ICU. *Pharmacother. J. Hum. Pharmacol. Drug Ther.* **20**(1), 75–82 (2000).
48. Cohen-Mansfield, J. & Billig, N. Agitated behaviors in the elderly: I. A conceptual review. *J. Am. Geriatr. Soc.* **34**(10), 711–721 (1986).
49. Miller, C. W., Hodzic, V. & Weintraub, E. Current understanding of the neurobiology of agitation. *West. J. Emerg. Med.* **21**(4), 841 (2020).
50. Zeller, S. L., Holloman, G. H. Jr & Wilson, M. P. Management of agitation. *Psychiatry* 2479–2486 (2015).
51. Aubanel, S., Bruiset, F., Chapuis, C., Chanques, G. & Payen, J.-F. Therapeutic options for agitation in the intensive care unit. *Anaesth. Crit. Care Pain Med.* **39**(5), 639–646 (2020).
52. Caroff, S. N., Watson, C. B. & Rosenberg, H. Drug-induced hyperthermic syndromes in psychiatry. *Clin. Psychopharmacol. Neurosci.* **19**(1), 1 (2021).

53. Cremer, O. L. & Kalkman, C. J. Cerebral pathophysiology and clinical neurology of hyperthermia in humans. *Prog. Brain Res.* **162**, 153–169 (2007).
54. Crippen, D. Life-threatening brain failure and agitation in the intensive care unit. *Crit. Care* **4**, 1–10 (2000).
55. Moritz, M. L. & Ayus, J. C. Dysnatremias in the critical care setting. *Sepsis Kidney Mult. Organ Dysfunct.* **144**, 132–157 (2004).
56. Hine, K. The use of physical restraint in critical care. *Nurs. Crit. Care* **12**(1), 6–11 (2007).
57. Teece, A., Baker, J. & Smith, H. Identifying determinants for the application of physical or chemical restraint in the management of psychomotor agitation on the critical care unit. *J. Clin. Nurs.* **29**(1–2), 5–19 (2020).
58. Thomann, S., Zwakhalen, S., Richter, D., Bauer, S. & Hahn, S. Restraint use in the acute-care hospital setting: A cross-sectional multi-centre study. *Int. J. Nurs. Stud.* **114**, 103807 (2021).
59. Zulian, L. R. et al. Factors associated with the use of physical restraint in intensive care patients. *Rev. Esc. Enferm. USP* **54**, e03571 (2020).

Author contributions

Temesgen Birlie Asmare, Hailu Yimer Tawuye, Biresaw Ayen Tegegne, and Biruk Adie Admass involved in the study design and data interpretation. Temesgen Birlie Asmare conceived the study, performed the data analysis, and drafted the manuscript. Hailu Yimer Tawuye, Biresaw Ayen Tegegne, and Biruk Adie Admass approved the final manuscript for publication. All authors revised and approved the final version of the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

Correspondence and requests for materials should be addressed to T.B.A.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.