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Patient characteristics associated with posttraumatic stress symptoms in intensive care unit survivors during a one-year follow-up: A multicenter study

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ABSTRACT

Background: Intensive care unit (ICU) patients are at risk of suffering from posttraumatic stress symptoms (PTSS) after ICU survival.
Objectives: To describe the prevalence of high levels of PTSS the first year after ICU admission. Further, to identify specific combinations of patient characteristics (latent classes based on pre-ICU data, demographics, and clinical characteristics), and to investigate possible associations among these classes and PTSS at 3, 6, and 12 months after ICU admission.
Methods: Self-reported PTSS were measured with Impact of Event Scale-Revised (IES-R). PTSS and possible predictive factors (pre-ICU data, demographics, and clinical characteristics) were analyzed using descriptive statistics, latent class analysis, and linear mixed model for repeated measures.
Results: High PTSS levels (IES-$R \geq 33$) were reported by 14.9 % (95 % confidence interval [CI] [10.0; 21.1]), 16.7 % (95 % CI [11.5; 23.1]), and 18.4 % (95 % CI [12.9; 25.0]) of patients (sample 1, $n = 174$) at 3, 6, and 12 months, respectively. Three latent classes were identified (sample 2, $n = 417$). PTSS were significantly associated with class 2 (male with longer hospital stay) at 6 months and class 3 (age≥70, lower level of education, higher Simplified Acute Physiology Score, being mechanically ventilated) at all three measurement times.
Conclusions: The prevalence of high levels of PTSS is the greatest 12 months after ICU admission. Health professionals can use this information to be aware of specific groups of ICU patients reporting PTSS during the first year and follow up on these.

Introduction

Intensive care unit (ICU) patients are exposed to several physiological and psychological stressors which may result in posttraumatic stress symptoms (PTSS) ,[1] such as intrusive recollections, avoidance behavior, and hyperarousal symptoms.[2] A systematic review and meta-analysis including 48 studies reported point-prevalence estimates of posttraumatic stress disorder (PTSD) symptoms at three time points averaging 16 %, 17 %, and 19 %, at 3, 6, and 12 months after ICU admission, respectively.[3] However, these prevalences[3] were based on older studies

Abbreviations: ICU, intensive care unit; IES-R, impact of event scale-revised; LCA, latent class analysis; PTSS, posttraumatic stress symptoms.

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except for a fairly recent one published in 2018;[4] various instruments were used in measuring posttraumatic stress;[5-12] and several of the larger studies did not measure posttraumatic stress multiple times during follow-up.[10,13,14] To determine the prevalence of high levels of PTSS several times during the first year after ICU admission, additional studies using instruments validated for ICU patients are needed.

Thus far, drawing conclusions from the results of longitudinal studies on ICU-related PTSS is difficult due to the varying uses of the concepts of PTSD[15,16] and PTSS.[17] Some report a psychotherapeutic perspective,[18-20] or engaged specific patient populations, such as trauma patients,[21,22] or non-surgical patients.[17,23] Detecting time points when PTSS are at increased levels during the first year after ICU admission may be clinically important when planning post-ICU follow-up care. Our previous study identified possible predictive patient characteristics (pre-ICU unemployment, lower pre-ICU level of functioning in daily life, and episodes of agitation in the ICU) associated with high levels of PTSS three months following ICU admission.[24] In a systematic review and meta-analysis, a high prevalence of PTSD symptoms at 12 months was found to be more common in individuals with pre-ICU psychopathology and those receiving benzodiazepines or having frightening memories from their ICU stay.[25] However, longitudinal studies based on larger, mixed ICU populations, including patient characteristics prior to ICU admission are scarce. While conventional regression analyses are often used, no other models allow combinations of predictive factors and characteristics to be identified in an explorative manner, to the best of our knowledge. By using a latent class analysis (LCA), unobserved groupings or patterns between pre-ICU data, demographics, and clinical characteristics may be revealed which may give more insight in post-ICU PTSS.

We hypothesized that there are subgroups of patients which might be identified using some pre-ICU data, demographics, and clinical characteristics in ICU patients that are important for the development of post-ICU PTSS. Therefore, the objectives of our present study were to describe the prevalence of high levels of PTSS and identify specific combinations of patient characteristics (latent classes based on pre-ICU data, demographics, and clinical characteristics) and to investigate possible associations among these classes and PTSS at 3, 6, and 12 months after ICU admission.

Methods

Study design and setting

This longitudinal cohort study is part of a multicenter study (NCT03714230) conducted in two hospitals in South-Eastern Norway. Six ICUs (one medical, one surgical, three mixed, and one medical high-dependency unit) providing advanced high-technological treatment and 24-hour intensivist-led care with a 1:1 nurse-to-patient ratio participated in the study. The recruitment period was October 2018–June 2020.

Participants

ICU patients $\geq$ 18 years, receiving mechanical ventilation or continuous vasoactive drug infusions or continuous monitoring $\geq$ 24 h and who responded to a questionnaire measuring PTSS (Impact of Event Scale-Revised [IES-R]) prior to ICU admission or at 3, 6, and 12 months following ICU admission were included in the study. The exclusion criteria were predefined cognitive deficits collected from medical records (e.g., dementia), inability to read or write in Norwegian, readmission to ICU within 72 h, admission to ICU because of organ preservation, or no permanent address.

Ethical approvals

The Regional Ethics Committee for Medical Research of South-Eastern Norway (2017/990–1), data security officers on each study site, and departmental leaders at each ICU approved the study. Patients or proxies (caregiver) gave their written and informed consent. When the consent was given by a proxy, informed consent was obtained from the patient when competent to decide on participation. Participation was voluntary, according to the Helsinki Declaration,[26] and could be ended at any time without reason.

Data collection

Pre-ICU data were collected from patients (or proxies if patients were unable to self-report) as soon as possible after inclusion, reflecting the week prior to ICU admission. The Hospital Anxiety and Depression Scale[27] was used to measure anxiety (range: 0–21) and depression (range: 0–21), and a cutoff of $\geq$ 8 on each subscale defined moderate levels of symptoms.[28] The Personal Activities of Daily Living scale (range: 0–6)[29] was used to measure functional status and the ability to perform basic daily activities; a score $\leq$ 2 indicated severe functional impairment, 3–5 indicated moderate impairment, and 6 indicated full function.[30] The Cognitive Failure Questionnaire (range: 0–100) was used to measure cognitive status, with a cutoff $\geq$ 43 indicating high level of cognitive failure.[31] The Clinical Frailty Scale (range: 1–9)[32] was used to measure frailty, and cutoff $\geq$ 5 was defined as frailty.[33] The Impact of Event Scale-Revised (IES-R) (range: 0–88) was used to measure PTSS.[34] These instruments are widely used in ICU populations[35-41] and have showed good psychometric testing.[28,35-37]

Demographics, collected in the same way as the pre-ICU data, included gender, age, civil status, educational level, and employment status. *Clinical characteristics*, obtained from the patients' medical records, included type of admission (non-surgical or emergency or elective surgery), comorbidities (Charlson Comorbidity Index,[42] range: 0–33), disease severity (Simplified Acute Physiology Score [SAPS II],[43] range: 0–163), nurses' workload (Nine Equivalents of Nursing Manpower Use Score,[44] range: 0–56 points per day), and length of both hospital and ICU stay (days). Data on pain, agitation, and delirium were collected once a day during daytime, during the first seven days in the ICU or until ICU discharge or death. Pain was defined as a score $\geq$ 4 on the Numeric Rating Scale (range: 0–10), $\geq$ 3 on the Critical Care Pain Observation Tool (range: 0–8), or $\geq$ 5 on the Behavioral Pain Scale (range: 3–12).[45,46] Agitation was defined as a score $\geq$ 1 on the Richmond Agitation Sedation Scale (range: –5 to +4). Delirium was defined as a positive score on the Confusion Assessment Method-ICU.[47] Pain, agitation, and delirium were dichotomized to a positive score (yes) if an episode had occurred at least once during data collection period.

Main outcome

The main outcome was PTSS measured at 3, 6, and 12 months after ICU admission. The IES-R[34] is a 22-item instrument with scores ranging from 0 to 88. The IES-R has shown good psychometric properties in physical trauma patients[48] and acute lung injury patients[37] and has exhibited high test–retest reliability and interrater reliability in patients surviving events such as earthquake and poisoning ($r_s = 0.86$).[49] In our sample, pre-ICU Cronbach's alpha was 0.98. In our procedures, IES-R scores at 3, 6, and 12 months (thinking about the ICU stay as the traumatic event) were collected using electronic or paper-formed self-reports by patients. Prior to each assessment time point of follow-up, participants were reminded by a phone-call or a text-message before the questionnaires were sent.

Statistical analyses

Patient characteristics are presented using descriptive statistics. Categorical data are reported using counts and percentages, and continuous variables are described as medians with interquartile ranges (IQR). To determine the prevalence of high levels of PTSS, a cutoff score

of ≥ 33 on the IES-R was used.[50] The point estimates are presented with 95 % confidence intervals (CI). (In the supplementary files, comparisons of each study sample and their comparators (e.g., non-responders) were made with Mann-Whitney Wilcoxon test (continuous variables with skewed distribution) or Pearson's chi-square test (pairs of categorical data)).

To determine whether specific combinations of patient characteristics (e.g., possible predictive factors) were associated with PTSS, a latent class analysis (LCA)[51] was conducted. LCA is a data driven method that involves the use of a probabilistic algorithm to identify unobservable patterns or groupings or a specific combination of analyzed variables.[51,52] In the first step, we selected 20 variables (baseline data) assessing patient characteristics (pre-ICU data, demographics, and clinical characteristics) and investigated whether specific combinations of levels of these variables formed clinically meaningful groups. Since we anticipated that several of these possible predictive factors were correlated, we searched for variable combinations that were robust enough to be included in the LCA. To identify correlated variables, we computed a correlation matrix between the 20 variables using Pearson's correlation (value ≥ 0.5 indicating a strong correlation between all possible covariates).[53] Supplementary Table 1 presents the reasons why some variables were not selected for further analyses. In the second step, we fitted several LCA models and assessed which of them explained the largest proportion of variation in our baseline data.[54] This method enabled us to explore patterns and possible differences among patients in our dataset and to calculate the probability that each of the analyzed variables belonged to a specific class. When comparing the models, we used goodness-of-fit indices, such as the Bayesian information criterion (BIC), which balances the tradeoff between model fit and parsimony, and Akaike's information criterion (AIC), which estimates the amount of information that is lost in the model. Twelve baseline variables were included in the final LCA model. The variables included in the identified latent classes were the variables that had a frequency distribution between classes that differed notably, and which reached the highest levels in one class.

In the final part of the analysis, we assessed possible associations between latent classes based on patient characteristics (described above) and PTSS over time as the dependent variable using a general linear mixed (GLM) model for repeated measures with an unstructured covariance matrix. GLM models do not require full data, thus no imputation of missing data was necessary and the choice of the unstructured covariance structure allowed the latent classes to vary independently of each other.[55] We treated the IES-R as a continuous variable. The results of the regression analysis are presented as regression coefficients (B) with 95 % CIs.

All tests were two-sided, and p-values < 0.05 were considered statistically significant. All analyses were considered exploratory, so no correction for multiple testing was made.[56] The analyses were performed using Stata SE/16 (Stata Corporation, College Station, TX).[57]

Results

Of 1234 available patients, 603 agreed to participate. Study sample 1, consisting of 174 patients who responded to the IES-R at 3, 6, and 12 months, was used to estimate the prevalence of high levels of PTSS at all assessment time points. Study sample 2, comprising 417 patients who responded to the IES-R prior to ICU admission, was used to perform the LCA and to fit the mixed model for repeated measures. Details on these samples are presented in Fig. 1.

Study Samples

In study sample 1, the majority were male (64.4 %), had a median age of 62.0 years (IQR: 51.0; 71.0), a median ICU length of stay of 3.7 days (IQR: 1.9; 6.7), and a median SAPS II of 38.0 (IQR: 28.0; 50.0). In study sample 2, the majority were male (61.6%), had a median age of 63.0 years (IQR: 49.0; 72.0), a median ICU length of stay of 3.3 days (IQR: 1.8; 7.0), and a median SAPS II of 40.0 (IQR: 29.0; 52.0). Table 1 includes more details about both study samples. Both samples comprised patients who were healthier and less severely ill than the samples to which each sample were compared to (e.g., non-responders) (see Supplementary Table 2 and 3).

Prevalence of high levels of PTSS during the first year after ICU admission

Twenty-six patients (14.9 %, 95 % CI [10.0; 21.1]) reported high

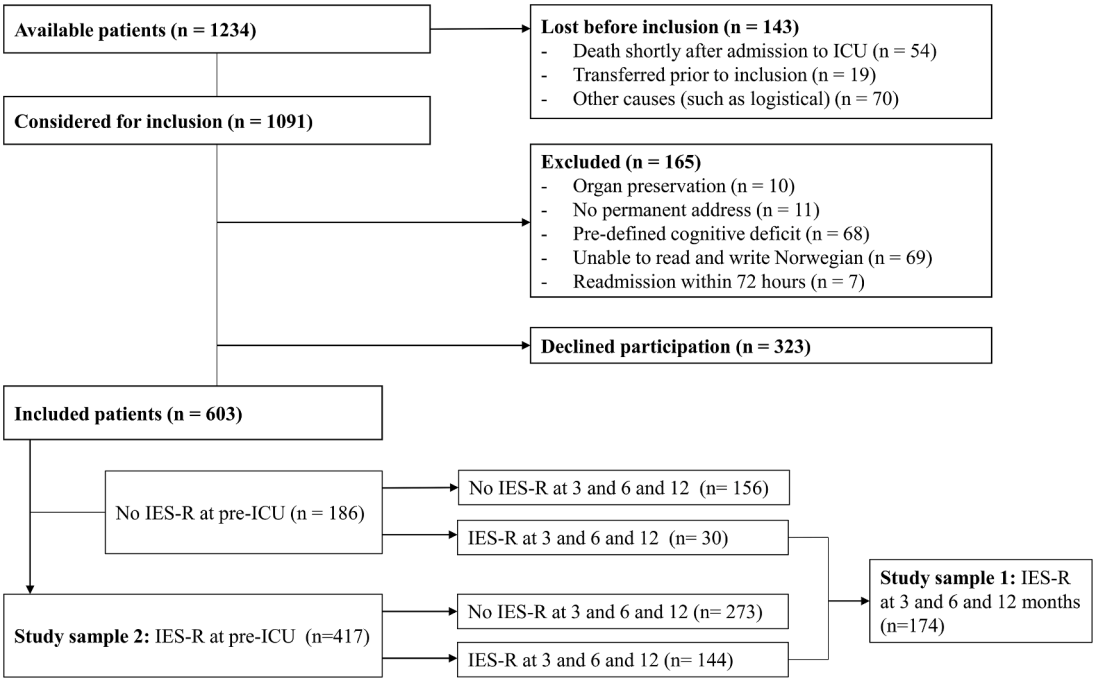

Fig. 1. Flowchart describing the recruitment process of study participants.

Table 1
Characteristics of patients analysed to identify the prevalence of high levels of PTSS (study sample 1) and those used in the latent class analysis (study sample 2).

	Study sample 1 (*n*=174)	Study sample 2 (*n*=417)
DEMOGRAPHICS AND CLINICAL CHARACTERISTICS	n (%)	n (%)
Gender		
Male	112 (64.4)	257 (61.6)
Female	62 (35.6)	160 (38.4)
Age (years)		
< 50	38 (21.8)	108 (25.9)
50–59	41 (23.6)	73 (17.5)
60–69	47 (27.0)	101 (24.2)
> 70	48 (27.6)	135 (32.4)
Civil status		
Married/partner	112 (64.4)	295 (70.7)
Unmarried/divorced/widowed	34 (19.5)	118 (28.3)
Missing (*n* = 28 vs. 4)	28 (16.1)	4 (1.0)
Education level		
Primary/secondary school	79 (45.4)	257 (61.6)
College/university	67 (38.5)	156 (37.4)
Missing (*n* = 28 vs. 4)	28 (16.1)	4 (1.0)
Employment status		
Unemployed/on sick leave/with disability	27 (15.5)	113 (27.1)
Fulltime/ part-time	66 (37.9)	134 (32.1)
Retired	54 (31.0)	168 (40.3)
Missing (*n* = 27 vs. 2)	27 (15.6)	2 (<0.1)
Type of admission		
Non-surgical	93 (53.5)	250 (59.9)
Elective surgery	24 (13.8)	47 (11.3)
Emergency surgery	57 (32.8)	120 (28.8)
	Median (IQR)	Median (IQR)
Age (years)	62.0 (51.0; 71.0)	63.0 (49.0; 72.0)
Simplified Acute Physiology Score II (SAPS II)	38.0 (28.0; 50.0)	40.0 (29.0; 52.0)
Nine Equivalents of nursing Manpower use Score (NEMS) (per day)	32.3 (26.0; 38.0)	33.3 (27.0; 39.0)
Length of stay in hospital (LOS-HOSP) (days)	12.3 (6.5; 19.2)	11.5 (6.3; 20.1)
Length of stay in intensive care unit (LOS-ICU) (days)	3.7 (1.9; 6.7)	3.3 (1.8; 7.0)
Mechanical ventilation (days) (*n* = 119 vs. 290)	1.9 (0.7; 5.8)	2.0 (0.5; 6.3)
Invasive ventilation (days) (*n* = 76 vs. 183)	2.8 (0.9; 6.0)	3.1 (0.9; 8.1)
Non-invasive ventilation (days) (*n* = 26 vs. 71)	0.5 (0.1; 1.1)	0.5 (0.1; 1.1)
Charlson Comorbidity Index (CCI) (total score)	3.0 (1.0; 5.0)	4.0 (1.0; 6.0)
	n (%)	n (%)
Episode of pain during first seven days in ICU	62 (35.6)	130 (31.2)
Episode of agitation during first seven days in ICU	12 (6.9)	26 (6.2)
Episode of delirium during first seven days in ICU	18 (10.3)	57 (13.7)
PRE-ICU DATA	Median (IQR)	Median (IQR)
Impact of Event Scale-Revised (IES-R) (*n* = 144 vs. 417)	0.0 (0.0; 14.5)	0.0 (0.0; 23.0)
IES-R ≥ 33 (*n* = 20 vs. 79)	47.0 (41.0; 49.0)	45.0 (40.0; 53.0)
Hospital Anxiety and Depression Scale-anxiety (HADS-A) ≥ 8 (*n* = 21 vs. 102)	10.0 (10.0; 12.0)	11.0 (9.0; 13.0)
Hospital Anxiety and Depression Scale-depression (HADS-D) ≥ 8 (*n* = 12 vs. 61)	9.0 (9.0; 10.0)	9.0 (8.0; 11.0)
Personal Activities of Daily Living (P-ADL) (*n* = 147 vs. 416)	6.0 (6.0; 6.0)	6.0 (6.0; 6.0)
≤ 2 (*n* = 4 vs. 19)	0.5 (0.0; 1.5)	1.0 (0.0; 2.0)
3-5 (*n* = 16 vs. 54)	5.0 (5.0; 5.0)	5.0 (4.0; 5.0)
6 (*n* = 127 vs. 343)	6.0 (6.0; 6.0)	6.0 (6.0; 6.0)
Cognitive Failures Questionnaire (CFQ) ≥ 43 (*n* = 4 vs. 35)	50.5 (46.0; 62.0)	48.0 (44.0; 53.0)
Clinical Frailty Scale (CFS) ≥ 5 (*n* = 7 vs. 48)	5.0 (5.0;7.0)	5.0 (5.0; 6.0)

Abbreviation: IQR = interquartile range.

levels of PTSS (cutoff ≥ 33) at 3 months, 29 patients (16.7 %, 95 % CI [11.5; 23.1]) at 6 months, and 32 patients (18.4 %, 95 % CI [12.9; 25.0]) at 12 months. Thus, the proportion of patients with high levels of PTSS increased during the first year, although the estimates did not differ enough to reach the level of statistical significance. In total, 16 patients (9.2 %) reported high levels at all time points, 4 patients reported high levels at 3 and 6 months (not at 12 months), and 5 patients did not report high levels at 3 and 6 months but did so at 12 months. More details on which patients reported high levels of PTSS are presented in Fig. 2.

Specific combinations of patient characteristics that formed latent classes

When evaluating different models derived using the LCA, a three-class model was found to have the best fit (BIC value: 14,342.0; AIC value: 14,140.4) (Table 2). The model-based proportions of all analyzed patients in each of the identified latent classes were 39.1 % for class 1, 15.1 % for class 2, and 45.8 % for class 3.

Class 1 (*n* = 162, 100 %) comprised patients working full-time or part-time (*n* = 87, 53.7 %) and who were < 50 years old (*n* = 73, 45.1 %). Class 2 (*n* = 62, 100 %) predominantly consisted of males (*n* = 41, 66.1 %) with a hospital stay longer than 11.5 days (*n* = 62, 100 %). Class 3 (*n* = 193, 100 %) was mainly composed of patients whose highest education level was primary or secondary school (*n* = 133, 68.9 %), who were ≥ 70 years of age (*n* = 101, 52.3 %), and who had a SAPS II ≥ 40.0 points (*n* = 173, 89.6 %) and received mechanical ventilation during ICU stay (*n* = 152, 78.8 %) (Table 3).

Associations between PTSS (continuous variable) and latent classes during the one-year follow-up

Using class 1 as a reference, PTSS were significantly associated with class 2 (i.e., males with a longer hospital stay) at 6 months after ICU admission (*B* = 6.6, 95 % CI [0.36; 12.80]), who scored 6.6 points higher on average on IES-R compared to those in class 1. Again, using class 1 as a reference, PTSS were significantly associated with class 3 at 3 months (*B* = 6.5, 95 % CI [2.11; 10.91], at 6 months (*B* = 6.1, 95 % CI [1.63; 10.47], and at 12 months after ICU admission (*B* = 6.2, 95 % CI [1.60; 10.84] (Table 4). In other words, patients in class 3 (i.e., those who had low levels of education, were ≥ 70 years old, had SAPS II ≥ 40.0 points, and received mechanical ventilation) scored 6.1–6.5 points more on the IES-R at all measurement times points compared to those in class 1 (i.e., working and < 50 years).

Discussion

The key findings in this paper were that the prevalence of high levels of PTSS was 14.9 %, 16.7 % and 18.4 % at 3, 6, and 12 months after ICU admission, respectively, and that three latent classes of patient characteristics were identified, by using LCA as a statistical approach. Two of the classes were associated with PTSS during the first year after ICU admission. To the best of our knowledge, these findings have not been reported before and may be clinically relevant when planning ICU follow-up care. The prevalence of high levels of PTSS was at its greatest at 12 months, but the increase from 14.9 % to 18.4 % during the first year after ICU admission was not statistically significant. Our estimates were very similar to the previous results in a systematic review.[3] However, when studied in ICU survivors with acute lung injury over a 24-month period, the point estimates of the prevalence rates at the measurement times points varied between 20 % and 24 %, with the highest values measured at 3 months.[23] Thus, all the prevalence rates were higher than our findings. While we used a cutoff score of ≥ 33 to identify patients with high levels of PTSS, other studies used different scores, such as ≥ 20[58] or ≥ 35.[6] The prevalence estimates may vary for this reason. Our findings also revealed that, on an individual level, some patients scored below the set cutoff at one measurement time point, indicating fluctuating PTSS levels for some patients. Since the

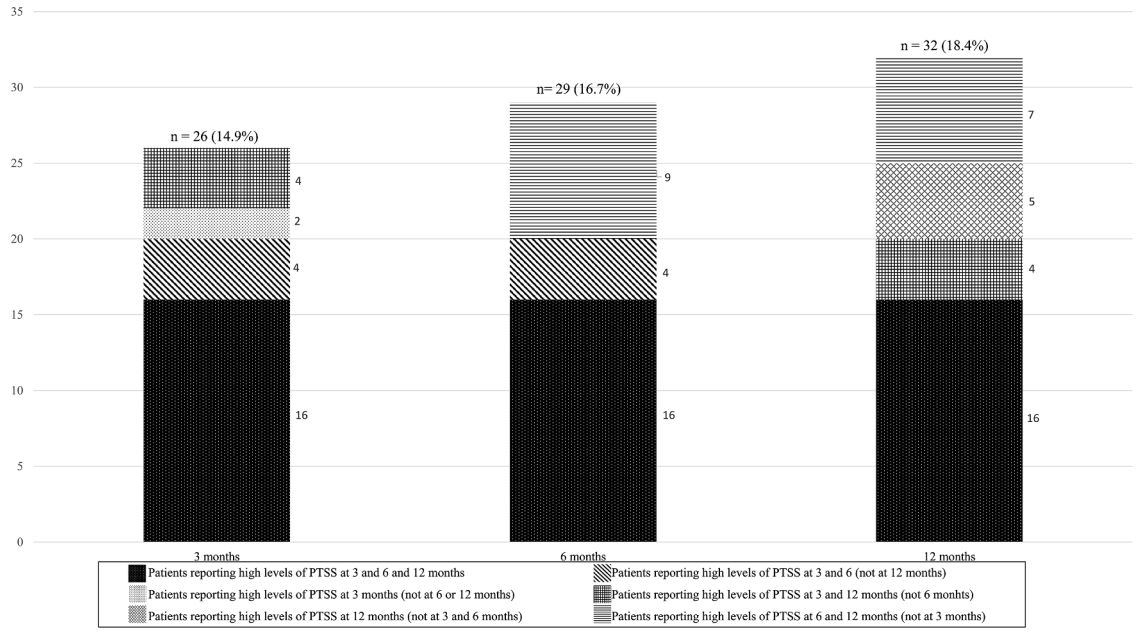

Fig. 2. Prevalence of how patients reported high levels of PTSS at 3, 6, and 12 months after ICU admission (n = 174).

Table 2
Probability of latent class membership and goodness-of-fit indices of latent class models.

	Frequency	Model based distribution of class membership (%)	AIC	BIC
Class 1	162	39.1	18,197.7	18,262.2
Class 2	62	15.1	15,363.1	15,496.2
Class 3	193	45.8	14,140.4	14,342.0

Abbreviations: AIC = Akaike's information criterion. BIC = Bayesian information criterion.

prevalence of high levels of PTSS was greatest at 12 months after ICU admission, we suggest that PTSS-related follow-up care should exceed the 12-month period which we followed our patients; it is likely that some patients report high levels of PTSS more than 12 months after ICU admission.

We chose a three-class model, as the goodness-of-fit indices in this model-based distribution of class membership had the lowest AIC- and BIC-values. We tried both a two-class and a four-class solution, however, the two-class model was not strong enough to outsource class membership, and the four-class model evened the tradeoff between the four classes. In the three-class model, our data revealed that two of the three latent classes based on specific combinations of patient characteristics were significantly associated with increased PTSS during the first year after ICU admission. At six months, increased levels of PTSS were significantly associated with being male and having a longer hospital stay (class 2). This finding could imply that targeted follow-up care around six months after ICU admission would be beneficial for this patient group. Follow-up consultations focusing on the various symptoms developed after ICU stay were found to reduce PTSD symptoms about six months after ICU treatment in a previous meta-analysis.[59] Therefore, interventions such as follow-up consultations may benefit these patients six months after ICU admission. This possibility needs further exploration.

A statistically significant association was identified between increased levels of PTSS and the patient group characterized by older age, lower levels of education, higher SAPS II, and having received mechanical ventilation during ICU stay (class 3) at all measurement times. To the best of our knowledge, similar findings have not been reported elsewhere. This finding was a bit unexpected since, previously, PTSS were found to be associated with younger age.[60] However, we found an association between PTSS and a combination of patient characteristics including older age. These findings revealed a vulnerable group needing special attention involving personalized follow-up care.[61] The clinical impact for personalized follow-up care is that these patients (class 3) report increased levels of PTSS at all measurement time points. Thus, they could specifically benefit from a longer post-ICU follow-up period to ensure continuity of care from the ICU to the hospital ward and to other healthcare institutions and general practitioners. Continuity of care requires preparedness on the part of the multi-professional team due to the complexity of symptoms following critical illness in the ICU (i.e., post-intensive care syndrome).[59,62] From an ICU perspective, screening patients at risk of PTSS is recommended.[3] Our findings indicate that healthcare professionals would be advised to be aware of the specific combination of patient characteristics (older age, lower levels of education, higher SAPS II, and receiving mechanical ventilation during ICU stay) in class 3. Presumably, the percentage of older patients being admitted to ICU will continue to increase in the years to come,[63] resulting in an even greater demand for safe and evidence-based care routines.

Multiple factors may impact PTSS among ICU survivors over time, and different types of patients may have various care needs. Thus, future research is recommended to explore additional patient characteristics in large and mixed ICU populations, exceeding a one-year follow-up period.

Strengths and limitations

A major strength of this study is the large number of patients being

Table 3
Results of the latent class analysis and the model-based distribution of variables in each latent class.

	Latent class 1 $n = 162$ (%)	Latent class 2 $n = 62$ (%)	Latent class 3 $n = 193$ (%)
Gender			
Male	95 (58.6)	**41 (66.1)**	121 (62.7)
Female	67 (41.4)	21 (33.9)	72 (37.3)
Civil status			
Married or living with partner	113 (69.8)	43 (69.4)	139 (72.0)
Unmarried, divorced, widowed	46 (28.4)	18 (29.0)	54 (28.0)
Education level			
Primary or secondary	90 (55.6)	34 (54.8)	**133 (68.9)**
College or university	70 (43.7)	27 (43.5)	59 (30.6)
Employment status			
Disabled, unemployed, or on sick leave	43 (26.5)	27 (43.5)	43 (22.3)
Working full-time or part-time	**87 (53.7)**	20 (32.3)	27 (14.0)
Retired	31 (19.1)	14 (22.6)	123 (63.7)
Type of admission			
Non-surgical	97 (59.9)	30 (48.4)	123 (63.7)
Elective surgery	21 (13.0)	12 (19.4)	14 (7.3)
Emergency surgery	44 (27.1)	20 (32.3)	56 (29.0)
Age			
< 50	**73 (45.1)**	17 (27.4)	18 (9.3)
50–59	39 (24.1)	13 (21.0)	21 (10.9)
60–69	26 (16.0)	22 (35.5)	53 (27.5)
≥70	24 (14.8)	10 (16.1)	**101 (52.3)**
Simplified Acute Physiology Score II (SAPS II)			
Median score ≥ 40.0	13 (8.0)	33 (53.2)	**173 (89.6)**
Median score < 40.0	149 (92.0)	29 (46.8)	20 (10.4)
Length of Stay Hospital (LOS-HOSP) (days)			
Median days ≥ 11.5	44 (27.2)	**62 (100.0)**	102 (52.8)
Median days < 11.5	118 (72.8)	0 (0.0)	91 (47.2)
Mechanical ventilation			
Yes	90 (55.6)	48 (77.4)	**152 (78.8)**
No	72 (44.4)	14 (22.6)	41 (21.2)
Pre-ICU Impact of Event Scale-Revised (IES-R) ≥33*			
Yes	38 (23.5)	11 (17.7)	30 (15.5)
No	124 (76.5)	51 (82.3)	163 (84.5)
Pre-ICU Hospital Anxiety and Depression-Anxiety (HADS-A) ≥8*			
Yes	42 (25.9)	17 (27.4)	43 (22.3)
No	120 (74.1)	45 (72.6)	150 (77.7)
Pre-ICU Hospital Anxiety and Depression-Depression (HADS-D) ≥8*			
Yes	22 (13.6)	12 (19.4)	27 (14.0)
No	140 (86.4)	50 (80.6)	166 (86.0)

Abbreviations:
* = pre-ICU values entered in the LCA as fixed effects.

Footnote: Of all variables that were included in the LCA, the number of missing values because of missing respondents was less than five.

Table 4
Associations between class membership and posttraumatic stress symptoms (continuous variable) over time. Linear mixed model with repeated measures.

	B	95 % CI		p-value
Class 1 (3 months)	(ref)			
Class 1 (6 months)	(ref)			
Class 1 (12 months)	(ref)			
Class 2 (3 months)	5.8	–0.44;	12.00	0.069
Class 2 (6 months)	6.6	0.36;	12.80	0.038*
Class 2 (12 months)	6.5	–0.27;	13.19	0.060
Class 3 (3 months)	6.5	2.11;	10.91	0.004*
Class 3 (6 months)	6.1	1.63;	10.47	0.007*
Class 3 (12 months)	6.2	1.60;	10.84	0.008*

Abbreviations: B = regression coefficient; * = significant with p-value < 0.05; 95 % CI = 95 % confidence interval; ref = reference group.

followed over a 12-month period. Our longitudinal design with repeated measures made it possible to explore associations between PTSS and latent classes of patient characteristics over time to help inform individualized treatment. The analytical method (LCA) that we chose to use is not often used in ICU studies about PTSS. LCA is a purely data-driven method, which may reveal associations (latent classes) not found or observable in conventional regression analyses. However, the present classes were also clinically relevant in addition to being identified using the LCA approach. There might be other variables, or higher level of detail in some variables collected (such as delirium), of interest to collect and analyze using the LCA approach; if so, new latent classes could have been revealed. Additionally, we present pre-ICU data but no data on prior histories of diagnosed psychiatric illnesses, prior traumatic life situations, the presence of coping skills, or the available types of post-ICU treatment. It should be noted that the pre-ICU measures were collected after ICU admission; thus, there is a risk of recall bias. Also, of the 1234 ICU patients who were available for the study, 603 (49 %) agreed to participate which may have resulted in a potential sampling bias, as this was a longitudinal study with a one-year follow-up period. Further, during the final part of the enrollment period, the first COVID-19 wave was present in Norway, and no visitors were allowed at the ICUs which made it more difficult to receive consent from the caregivers. However, only 12 COVID-19 positive patients agreed to participate and were included in the study, and these were too few to perform subgroup analyses with concerning their level of PTSS. Though, in a recent national study on Norwegian COVID-19 ICU patients, the prevalence of PTSS was lower, than in ICU populations without COVID-19.[64]

Conclusions

The prevalence of high levels of PTSS is highest 12 months after ICU admission. Of three latent classes identified, two latent classes based on pre-ICU data, demographics, and clinical characteristics had statistically significant associations with increased levels of PTSS: one at six months and the other in all follow-up time points. Healthcare professionals can be aware that specific groups of patients may have different follow-up needs, implying that the follow-up period should exceed one year. Future research designed to ease PTSS in specific patient groups is recommended.

CRediT authorship contribution statement

Klara Friberg: Writing – review & editing, Writing – original draft, Resources, Investigation, Formal analysis, Data curation, Conceptualization. **Kristin Hofsø:** Writing – review & editing, Methodology, Conceptualization. **Tone Rustøen:** Writing – review & editing, Project administration, Methodology, Conceptualization. **Johan Ræder:** Writing – review & editing, Methodology. **Milada Hagen:** Writing – review & editing, Methodology, Formal analysis. **Kathleen Puntillo:** Writing – review & editing, Methodology. **Brita Fosser Olsen:** Writing – review & editing, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

We, the authors, do not have any ethical conflicts or financial interests to disclose.

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entitled to authorship are listed as authors. All authors have given final approval for this version of the manuscript to be published. This work was performed on the data platform "Tjeneste for Sensitive Data" facilities, owned by the University of Oslo.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.hrtlng.2024.02.011.

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