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Research paper

Practices of assessment of pain, sedation, iatrogenic withdrawal syndrome, and delirium in European paediatric intensive care units: A secondary analysis of the European Prevalence of Acute Rehab for Kids in the paediatric intensive care unit study

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ABSTRACT

Background: Analgosedation is standard practice to ensure comfort and safety of critically ill children in paediatric intensive care units (PICUs). However, a significant number of children develop iatrogenic withdrawal syndrome or delirium with these drugs. The European Society of Paediatric and Neonatal Intensive Care published a position statement in 2016, but how successfully its recommendations have been implemented is unknown.

Objectives: Following were the objectives of this study: (i) to describe assessment practices (prevalence, measurement instruments, and frequency) for pain, sedation, iatrogenic withdrawal syndrome and delirium; (ii) to assess how practices meet the position statement; and (iii) to identify organisational factors associated with the use of recommendations for pain and sedation assessment.

Method: A secondary analysis of prospectively collected data from the multicentre prevalence study (European Prevalence of Acute Rehab for Kids in the PICU) conducted in 38 PICUs, across 15 European countries in 2018. Data from 453 children were analysed.

Results: Of the 38 PICUs, 97% assessed pain, 89% sedation, 82% withdrawal, and 42% delirium. These four symptoms were mainly assessed and documented by the Face, Legs, Activity, Cry, Consolability scale (39%) and Numerical Rating Scale (24%) every 8, 4, or 2 h for pain; the COMFORT-B (45%) and COMFORT (24%) scales every 8 or 2 h for sedation; the Sophia Observation withdrawal Scale (37%) and Withdrawal Assessment Tool-1 (32%) scales every 8 or 4 h for withdrawal and the Cornell Assessment Pediatric-Delirium (18%) and Sophia Observation Withdrawal Symptoms-Pediatric Delirium (16%) scales every 12 or 8 h for delirium. Concordance with the position statement recommendations was low to moderate (13–69%). Adherence to recommendations were influenced by the variables of nurse-to-patient ratio, type of hospital, and the number of PICU beds.

Conclusion: Based on prospectively collected data, there was variability in pain and sedation assessment practices and a lack of adherence with recommendations in the EU, particularly for delirium. These findings highlight the need for more proactive dissemination, and investigation of barriers and implementation strategies to improve evidence-based assessment practices.

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1. Introduction

In paediatric intensive care units (PICUs), carefully titrated analgosedation is integral to the care of critically ill children to keep them comfortable and safe.[1] It is used to reduce physical and psychological stress, to prevent and relieve pain, to aid in tolerating mechanical ventilation, and to avoid severe agitation potentially leading to accidental removal of medical equipment.[2] Analgesia and sedation are necessary to achieve therapeutic goals by controlling vital parameters, oxygenation, and ensuring ventilator synchronicity.[3] However, prolonged administration of these medications can lead to tolerance, oversedation, delirium, or iatrogenic withdrawal syndrome (IWS).[4–6]

Avoiding complications from uncontrolled pain, agitation, or oversedation demands the use of validated measurement instruments for pain, sedation, IWS, and delirium.[7] However, heterogeneity of the PICU population and different types of pain make assessment challenging. Furthermore, most PICU children are unable to communicate, because they are either too young, ventilated, or in a coma.[8–10] Thus, validated measurement instruments appropriate for age and communication ability should be used.[11] Despite the numerous pain and sedation measurement instruments available for preverbal and verbal children,[12] their level of implementation in PICU practice varies.[13]

In 2016, the European Society of Paediatric and Neonatal Intensive Care (ESPNIC) released a position statement to guide clinicians on assessing pain, sedation, IWS, and delirium, categorised across different ages in the PICU.[7] The latter provides guidance for practitioners in managing pain, sedation, IWS, and delirium and specifies the measurement instruments to use, the optimal frequency of assessments, as well as recommendations for management. The ESPNIC recommendations (see Table 1 are based on the best available evidence and clinical practices in the field of paediatric intensive care. A recent ESPNIC survey of 215 PICUs in 27 countries revealed that most PICUs follow recommended practices for pain and sedation assessment and documentation.[13] However, only 42% and 38% of PICUs report adhering to these practices for delirium and IWS assessment.[14] This survey relied on a single healthcare professional's perspective per PICU and lacked direct observation of actual practice. To date, little is known about the application of these recommendations in practice. Based on data from the European Prevalence of Acute Rehab for Kids in the PICU (EU PARK-PICU) study,[15] the research objectives of this project were to describe (i) the prevalence, types of measurement instruments, and frequency of assessment of pain, sedation, IWS, and delirium; (ii) the extent of practice alignment with recommendations for pain and sedation assessment; and (iii) the organisational variables associated with recommendation adherence.

Table 1
Summary of ESPNIC recommendations with GRADE of recommendation and applicability to study.

ESPNIC recommendations	Recommendation GRADE	Applicability to the study
Pain		
Identify potential sources of pain and take appropriate actions	D	No
Use an age-appropriate tool to assess acute and pro- longed pain, i.e., the PIPP(-revised) in neonates and the COMFORT behaviour scale, FLACC, or MAPS in critically ill children	A	Yes
Parent and family assessment of pain should be considered in pain assessment	D	No
Pain assessment should take place routinely, depending on therapeutic goals but at greater frequency (1–2 h) if the patient is receiving any analgesic infusion	D	Partially
Pain assessment audits should take place regularly	C	No
The effect (e.g., increasing or decreasing of a pump, bolus) of a drug should be re-evaluated depending on the drug's half-life	D	No
The effect of a drug (e.g., increasing or decreasing of a pump, bolus) is re-evaluated depending on the drug's half-life	Not specified	No
Validated assessment tools for pain should be integrated in pain-related and non-pain-related treatment protocols	C	No
Sedation		
Search for potential causes of non-pain-related distress/discomfort to take appropriate actions	D	No
Use standardised sedation assessment tools with proven validity, reliability, and clinical utility; the COMFORT behaviour scale	A	Yes
Together with the vital signs, the level of sedation must be assessed and documented every 4–8 h or as indicated by the sedation score or the child's clinical condition	D	Yes
The effect of a drug (e.g., increasing or decreasing of a pump, bolus) is re-evaluated depending on the drug's half-life	Not specified	No
Validated assessment tools for should be integrated in pain-related and non-pain-related treatment protocols	C	No
Iatrogenic Withdrawal Syndrome		
The potential risk of opioid and/or benzodiazepine iatrogenic withdrawal syndrome should be considered after 5 days of continuous administration of these drugs	C	No
Use standardised IWS assessment instruments with proven clinical utility, validity and reliability in infants and children; WAT-1 or the SOS	A	Yes
Reassess for symptoms of withdrawal after treatment interventions	D	No
Validated assessment tools for withdrawal syndrome should be integrated in pain-related and non-pain-related treatment protocols	C	No
Delirium		
Search for potential sources of paediatric delirium and to take appropriate actions	D	No
Use CAP-D as an instrument to assess paediatric delirium	A	Yes
Together with the vital signs, delirium must be assessed and documented every 8–12 h (at least once per shift), 24–48 h after admission or as indicated by the delirium score of clinical condition of the child	D	Partially
Validated assessment tools for delirium should be integrated in pain-related and non-pain-related treatment protocols	C	No
GRADE = Grading of Recommendations, Assessment, Development and Evaluation (ref)		

Harris J, Ramelet A-S, van Dijk M, Pokorna P, Wielenga J, Tume L et al. Clinical recommendations for pain, sedation, withdrawal and delirium assessment in critically ill infants and children: an ESPNIC position statement for healthcare professionals. Intensive Care Med. 2016; 42(6):972–86.
Abbreviations: CAP-D: Cornell Assessment Pediatric-Delirium; ESPNIC: European Society of Paediatric and Neonatal Intensive Care; FLACC: Face, Legs, Activity, Cry, Consolability; MAPS; PIPP: Premature Infant Pain Profile; SOS: Sophia Observation withdrawal Scale; WAT-1: Withdrawal Assessment Tool-1.

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2. Method

2.1. Study design

We performed a quantitative descriptive secondary analysis of prospectively collected data from the 2018 EU PARK-PICU study.[15] The methods for the EU PARK-PICU study is described in detail elsewhere.[15] As the data were collected after the ESPNIC recommendations were published, this allowed for describing and quantifying current practices related to these recommendations.

2.2. Sampling

The sample included 38 PICUs across 15 European countries including all infants and children hospitalised for at least 72 h. This study included medical and surgical patients, with a total of 456 patients in the EU PARK-PICU study.[15] We excluded three patients over 18 years of age from our secondary analysis.

2.3. Data collection

In the EU PARK-PICU study, organisational data were collected through an electronic online survey (LimeSurvey©), completed by either a physician or a nurse manager at each site. Patient data were gathered from the patient records by bedside nurses. For the characteristics of variables (codebook), see Supplementary file 1.

2.4. Statistical analysis

Descriptive analyses were conducted to address the first objective, examining the prevalence of assessment, types of measurement instruments used, and assessment frequency at each site. For objectives 2 and 3, we based the analysis on the ESPNIC recommendations.[7] To assess how assessment practices aligned with ESPNIC recommendations,[7] the database was searched for relevant variables. Patient and organisational data were merged, and results were presented in contingency tables. These included proportions of patients for whom a recommended measurement instrument was used and whether it was used in accordance with the measurement instruments for age and communication ability (preverbal or mechanically ventilated). For this second objective, new variables were created but considered only pain and sedation as measurement instruments for IWS and delirium are valid and reliable regardless of age or communication ability.[16,17] In this study, we considered the COMFORT-B scale valid and reliable to assess pain in children up to the age of 3 years and to assess sedation in mechanically ventilated children up to 16 years of age (sedated children are usually intubated).[7] The Face, Legs, Activity, Cry, Consolability (FLACC) scale was considered valid and reliable to assess pain in nonintubated children up to 7 years of age[7] as the FLACC scale has not been validated in mechanically ventilated children.[9,18] In addition, pain assessment frequency during opioid infusion, and sedation assessment frequency for oversedation, adequate sedation, or undersedation were evaluated as per recommendations. Using the new variables created, logistic regression analyses were performed to identify organisational variables influencing recommended pain and sedation measurement instruments used. The selection of organisational variables was informed by existing literature[19–21] and the capacities of the elements in the database. Marginal probabilities were checked. The odds ratio (OR) between recommended scales and organisational variables (if age and ventilatory support, for pain and sedation, were associated with organisational variables) were explored.

Data were analysed using Stata 16 software (StataCorp. 2019. *Stata Statistical Software*: *Release 16*. College Station, TX: StataCorp LLC).

3. Ethical considerations

The EU PARK-PICU study was approved by the institutional review board of the Erasmus Medical Center (EMC-2017-1037) with a waiver of informed consent, and no further approval was required for this secondary analyses. Permission to use the EU PARK-PICU anonymised dataset for this secondary analysis was obtained from the data custodian.

4. Results

PICU and patients' characteristics are shown in Table 2 and Table 3, respectively. Seventy percent (n = 319) of patients were under 3 years of age, and 52% (n = 235) were mechanically ventilated. The median length of PICU stay was 14 days (interquartile range = 6–36).

The nurse-to-patient ratio variable is presented in Table 4. Measurement instruments used and the frequency of assessment for pain, sedation, IWS and delirium are presented in Figs. 1 and 2.

4.1. Pain assessment

Most PICUs (n = 37, 97%) reported using a pain measurement instrument. The FLACC (n = 15, 40%) and the Numerical Rating Scale (n = 9, 24%) were the most frequently reported measurement instruments. Pain was mainly assessed (in the order of most frequently mentioned) every 4 h (n = 10, 26%) and 8 h (n = 10, 26%), then every 2 h (n = 7, 18%) with an overlap in the 2- to 4-h category. Some PICUs (n = 5, 13%) stated that they assessed pain according to the patient's condition, when necessary, during care, or when symptoms occurred. Some units reported using multiple scales, and one PICU stated that pain assessment was not applicable.

4.2. Sedation assessment

Sedation was assessed in 90% of PICUs (n = 34). Most sites (n = 17, 45%) used the COMFORT-B scale to assess sedation, followed by the COMFORT scale (n = 9, 24%). Sedation was mainly assessed every 8 h (n = 10, 26%), every 2 h (n = 8, 21%) or every 4 h (n = 7, 18%), with overlap in the 2- to 4-h category. Some PICUs (n = 2, 5%) noted that they only assessed sedation according to the patient's condition.

4.3. Iatrogenic withdrawal syndrome assessment

IWS was assessed in 31 PICUs (82%). Most sites used the Sophia Observation Withdrawal Symptoms (SOS) (n = 14, 37%) and the Withdrawal Assessment Tool-1 (WAT-1) (n = 12, 32%). IWS was mainly assessed every 8 h (n = 12, 32%) or every 4 h (n = 10, 26%). Some PICUs (n = 4, 11%) only assessed IWS according to the patient's condition.

4.4. Delirium assessment

Delirium was screened in 16 PICUs (42%). Most sites (n = 22, 58%) did not screen for delirium. Among those that were screened, the Cornell Assessment Pediatric-Delirium (CAP-D) (n = 7, 18%) and the Sophia Observation Withdrawal Symptoms-Pediatric Delirium (SOS-PD) (n = 6, 16%) were mostly used, and screenings were mainly performed every 12 h (n = 8, 21%) and every 8 h (n = 7, 18%).

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Table 2
Characteristics of hospitals and PICUs (N = 38).

Variable		Frequency (n)		Percentage (%)
Type of hospital	Academic teaching hospital	29		76
	Community hospital	1		3
	Freestanding children's hospital	8		21
Type of PICU	Medical only	6		16
	Medical/Surgical	12		32
	Medical/Surgical/Cardiac	19		50
	Cardiac	1		3
Number of PICU beds	1–10	16		42
	11–19	15		40
	20–29	6		16
	≥30	1		3
Number of PICU beds		mean (sd)	min	max
		16,3 (7,1)	4	31

med; min = minimum; max = maximum; PICUs = paediatric intensive care units; sd = standard deviation.

Table 3
Demographic and clinical characteristics of patients (N = 453).

Variable	Category	Frequency (n)	Percentage (%)
Sex	Female	213	47
	Male	240	53
Age category (years)	0–2	319	70
	3–6	39	9
	7–12	54	12
	13–18	41	9
Paediatric Overall Performance Category Scale	Good	107	24
	Mild disability	118	26
	Moderate disability	95	21
	Severe disability	126	28
	Coma/Vegetative State	7	2
Days of PICU stay (day1 = 3rd day of hospitalisation)	3–14 days	239	53
	15–30 days	82	18
	31–60 days	64	14
	61–90 days	27	6
	91–180 days	23	5
	181–365 days	14	3
	>365 days	4	1
Primary reason for admission	*Medical:*		
	Respiratory	124	27
	Cardiac	61	14
	Haematology/oncology	16	4
	Infectious/inflammatory	21	5
	Neurology	36	8
	Other	26	6
	Postsurgical:		
	Cardiac	79	17
	Neurology	19	4
	Orthopaedic	3	1
	Other	68	15
Respiratory support	No respiratory support	66	15
	Nasal cannula or face mask	30	7
	Heated high-flow nasal cannula	50	11
	Tracheostomy collar	18	4
	CPAP or BiPAP face mask	54	12
	Mechanical ventilation via ETT	177	39
	Mechanical ventilation via tracheostomy	58	13

CPAP = continuous positive airway pressure; BiPAP = bilevel positive airway pressure; ETT = endotracheal tube; PICU = paediatric intensive care unit.

Table 4
Characteristic of PICUs by patient: Nurse-to-patient ratio (N = 453).

Variable	Category	Frequency (n)	Percent (%)
Nurse-to-patient ratio	1:1	202	45
	1:2	208	46
	1:3	30	7
	2:1	13	3

PICU = paediatric intensive care unit.

4.5. Concordance of actual assessment practices with ESPNIC recommendations[7]

An overview of the results is presented in Table 5 and Fig. 1.

4.5.1. Pain

When the COMFORT-B scale was used to assess pain on the study days (23 of 453 patients, 5%), it aligned with age (range 0–3

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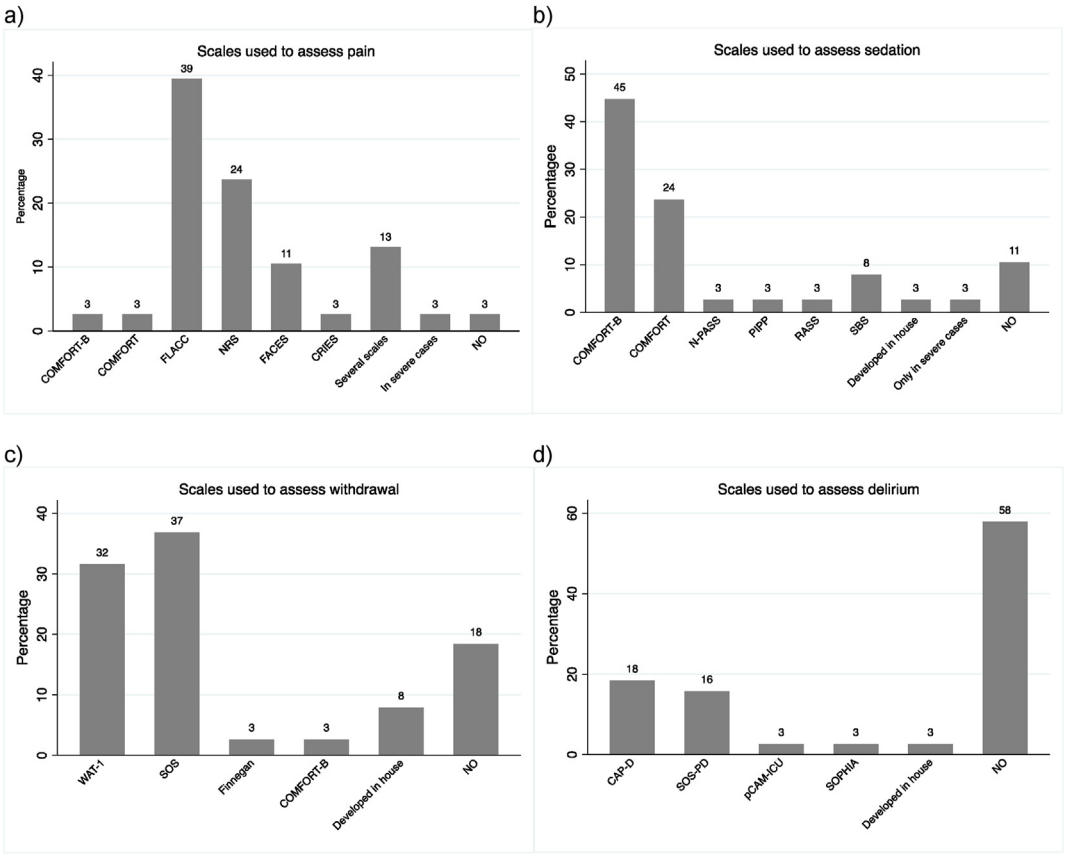

Fig. 1. Assessment tools. CAP-D: Cornell Assessment Pediatric-Delirium; COMFORT-B = COMFORT behaviour; CRIES = Crying, requires O_2 for SaO_2 <95%; Increased vital signs, Expression, Sleepless; FLACC: Face, Legs, Activity, Cry, Consolability; NRS: Numerical Rating Scale; N-PASS = Neonatal Pain, Agitation and Sedation Scale; pCAM-ICU: Pediatric Confusion Assessment Method for the ICU; PIPP = Premature Infant Pain Profile; RASS = Richmond Agitation–Sedation Scale; SBS = State Behavioral Scale; SOS: Sophia Observation withdrawal Scale; SOS-PD: Sophia Observation Withdrawal Symptoms-Pediatric Delirium scale; WAT-1: Withdrawal Assessment Tool-1.

years)[7] recommendations in 78% (n = 18) of patients. For the FLACC (n = 179, 40%), it aligned with age (newborn to 7 years old)[7] in 30% (n = 54) of patients.

Pain assessments occurred every 8 h for patients receiving a continuous opioid infusion for >30 min (n = 45, 27%), as well as for those not receiving such infusion (n = 79, 28%) (see Supplementary file 2 Table S1). In cases of oversedation (COMFORT-B score < 11),[7] assessments were predominantly conducted every 8 h (14 of 154 documented cases, 36%) and every 2 h (13 of 154, 33%) (see Supplementary file 2 Table S2). When patients were adequately sedated (COMFORT-B score between 11 and 22),[7] pain assessments primarily occurred every 8 h (42 of 154, 37%). However, when patient were undersedated (COMFORT-B score >22),[7] pain assessment was deemed inapplicable in all cases (2 of 154, 100%).

4.5.2. Sedation

When the COMFORT-B scale was used to assess sedation (n = 228 out of 453 patients, 50%), it aligned for age and ventilatory support recommendations in 50% (n = 115) of patients. Sedation was mainly measured every 8 h (14 of 154, 36%) when the child was oversedated (COMFORT-B score < 11)[7] (see Supplementary file 2, Table S3). When the patient was adequately sedated (COMFORT-B score between 11 and 22),[7] sedation was mainly assessed every 8 h (42 of 154, 37%). When the patient was undersedated (COMFORT-B score > 22),[7] sedation was assessed every 2 h (2 of 154, 100%).

4.5.3. Iatrogenic withdrawal syndrome

In 69% of cases (311 of 453 patients), a recommended measurement instrument was used, including the SOS in 38% of patients (n = 172) and the WAT-1 in 31% of patients (n = 139). IWS was mainly assessed every 8 h (n = 130, 29%) and every 4 h (n = 116, 26%).

4.5.4. Delirium

The CAP-D was used in 13% of patients (n = 59 out of 453 patients) to screen for delirium. Delirium was not assessed in most patients (n = 284, 63%). When delirium assessment was performed, it was mostly performed every 12 h (n = 95, 21%) and every 8 h (n = 72, 16%). In 86% (n = 391) of the patients, there was no delirium screening in the 24 h before data collection.

4.6. Organisational variables that may influence the use of recommendations

The variables included in the regression analyses were the nurse-to-patient ratio, hospital type, and the number of PICU beds.

The overall results are summarised in Table 6.

4.7. ESPNIC recommendation: use of the COMFORT-B scale for pain assessment in children aged 0–3 years

In the logistic regression model, only the number of PICU beds had a statistically significant influence (p =< 0.0001) on the recommended use of the COMFORT-B scale for pain assessment in children

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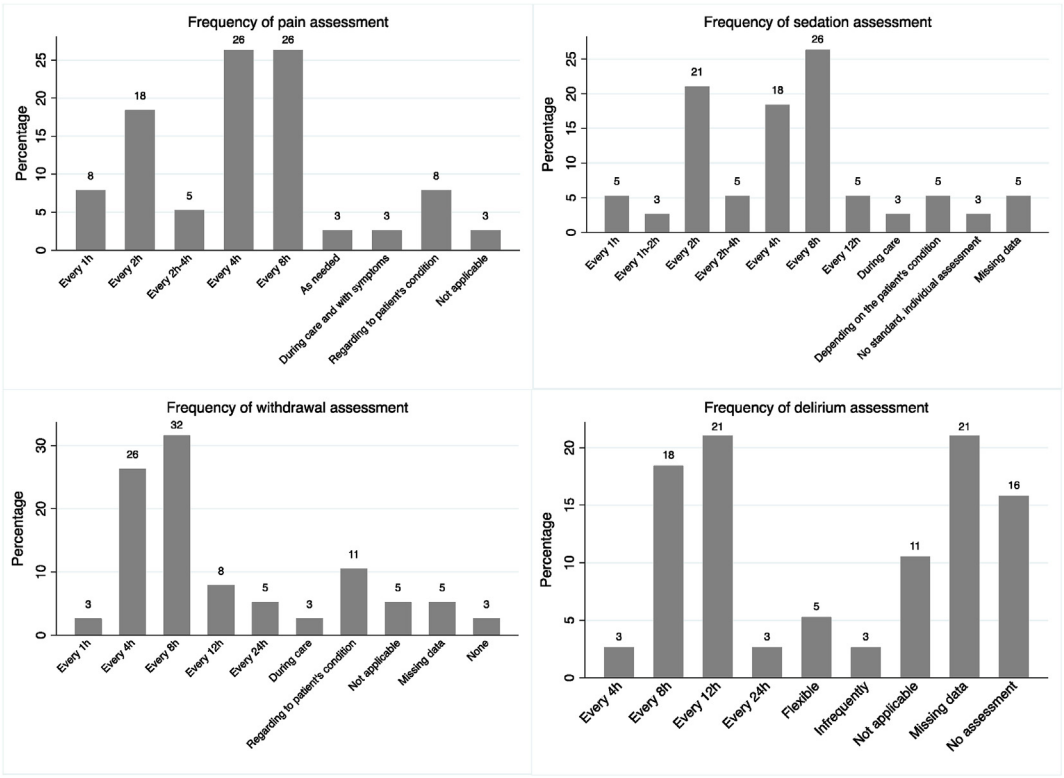

Fig. 2. Frequency of assessment.

aged 0–3 years. For each additional PICU bed, adherence increased by 6.5% (OR = 1.065, 95% confidence interval [CI]: 1.03–1.1). The mean probability of using the COMFORT-B scale, as recommended, was 62% (95% CI: 0.35–0.87) for a 2:1 ratio and 73% (95% CI: 0.58–0.89) for a 1:3 ratio. The mean probability of using the COMFORT-B scale as recommended was 56% (95% CI: 0.23–0.88) in community hospitals, 68% (95% CI: 0.62–0.73) in academic teaching hospitals, and 77% (95% CI: 0.7–0.84) in freestanding children's hospital.

4.8. ESPNIC recommendation: Use of the COMFORT-B scale for sedation assessment in intubated children

In the logistic regression model, only the nurse-to-patient ratio was statistically significant (p =< 0.0001). Comparing a 1:1 nurse-to-patient ratio as the reference group, hospitals with 1:2 and 1:3 ratios had 68% (OR = 0.32, 95% CI; 0.21–0.48) and 75% (OR = 0.25, 95% CI: 0.11–0.57) lower chance of appropriately using the COMFORT-B scale for sedation assessment in mechanically ventilated patients, respectively.

In a hospital with a 1:2 nurse-to-patient ratio, the mean probability that the COMFORT-B scale was used appropriately to assess sedation in intubated patients was 66.3% (95% CI: 0.6–0.73). This probability increased to 84.6% (95% CI: 0.65–1.04) with a 2:1 ratio. The mean probability was 38.5% (95% CI: 0.32–0.45) when there was one nurse for two patients and 33.3% (95% CI: 0.16–0.5) with one nurse for three patients. The mean probability of using the COMFORT-B scale for sedation assessment as recommended was over 44% (95% CI: 0.12–0.77) in community hospitals, 48% (95% CI: 0.43–0.54) in academic teaching hospitals, and 60% (95% CI: 0.52–0.68) in freestanding children's hospital.

Table 5
Summary of assessment tools used in accordance with the ESPNIC recommendations, age, and ventilatory support for each patient (N = 453).

		Measurement instruments based on ESPNIC recommendations	Correct instrument used % (n)		Correct use based on age % (n)		Correct use based on age and ventilatory support % (n)
Symptom measured	Pain	COMFORT-B	5 (23)	45[d] (202)	78[a]		N/A
		FLACC	40 (179)		N/A		30 (54)[c]
	Sedation	COMFORT-B	50 (228)		N/A		50 (115)
	IWS	WAT-1	31 (139)	69[d] (311)	30.7 (139)[b]	69[d] (311)	N/A
		SOS	38 (172)		38 (172)[b]		N/A
	Delirium	CAP-D	13 (59)		13 (59)[b]		N/A

The COMFORT-B scale was considered valid for pain assessment in patients aged 0–3 years and for sedation assessment in ventilated patients aged 0–16 years. The FLACC scale was considered valid for nonventilated patients aged 0–7 years.
N/A = not applicable.
CAP-D: Cornell Assessment Pediatric-Delirium; COMFORT-B: COMFORT behaviour; ESPNIC: European Society of Paediatric and Neonatal Intensive Care; FLACC: Face, Legs, Activity, Cry, Consolability; PICU: paediatric intensive care unit; SOS: Sophia Observation withdrawal Scale; WAT-1: Withdrawal Assessment Tool-1.
[a] Meaning: among the PICUs who used the COMFORT-B scale to assess pain, it was used according to the validated age in 78.26% of patients.
[b] Valid for all patients, regardless of age and ventilatory support.
[c] Refers to patients without ventilatory support.
[d] Cumulative percentage.

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Table 6
Associations of recommended use of the COMFORT-B and FLACC for pain and/or sedation assessment, and organisational data (nurse-to-patient ratio, type of hospital, and the number of PICU beds).

	Recommended use of the COMFORT-B scale for pain assessment			
	No, n (%)	Yes, n (%)	OR [95% CI]	Mean probability % [95% CI]
Nurse-to-patient ratio				
1:1 (ref.)	56 (41.8)	146 (45.8)	–	72.28[b] [0.66–0.78]
1:2	65 (48.5)	143 (44.8)	0.84 [0.55–1.29]	68.75[b] [0.62–0.75]
1:3	8 (6)	22 (6.9)	1.05 [0.44–2.5]	73.33[b] [0.58–0.89]
2:1	5 (3.7)	8 (2.5)	0.61 [0.19–1.96]	61.53[b] [0.35–0.88]
Type of hospital				
Academic (ref.)	97 (72.4)	205 (64.3)	–	67.88[b] [0.63–0.73]
Community	4 (3)	5 (1.6)	0.59 [0.16–2.25]	55.56[a] [0.23–0.88]
Freestanding children's hospital	33 (24.6)	109 (34.2)	1.56 [0.99–2.47]	76.76[b] [0.7–0.84]
The number of PICU beds				
Mean (sd)	14.2 (6.9)	17.2 (7)	1.065[b] [1.03–1.1]	
	Recommended use of the COMFORT-B scale for sedation assessment			
	No, n (%)	Yes, n (%)	OR [95% CI]	Mean probability % [95% CI]
Nurse-to-patient ratio				
1:1 (ref.)	68 (31.2)	134 (57)	–	66.34[b] [0.6–0.73]
1:2	128 (58.7)	80 (34)	0.32[b] [0.21–0.48]	38.46[b] [0.32–0.45]
1:3	20 (9.2)	10 (4.3)	0.25[a] [0.11–0.57]	33.33[b] [0.16–0.5]
2:1	2 (0.9)	11 (4.7)	2.79 [0.6–12.95]	84.62[b] [0.65–1.04]
Type of hospital				
Academic (ref.)	156 (71.6)	146 (62.1)	–	48.34[b] [0.43–0.54]
Community	5 (2.3)	4 (1.7)	0.85 [0.23–3.25]	44.44[a] [0.12–0.77]
Freestanding children's hospital	57 (26.2)	85 (36.2)	1.59 [1.06–2.39]	59.86[b] [0.52–0.68]
The number of PICU beds				
Mean (sd)	16.16 (6.7)	16.47 (7.4)	1 [0.98–1.03]	
	Recommended use of the FLACC scale for pain assessment			
	No, n (%)	Yes, n (%)	OR [95% CI]	Mean probability % [95% CI]
Nurse-to-patient ratio				
1:1 (ref.)	148 (53.1)	54 (31)	–	26.73[b] [0.21–0.33]
1:2	104 (37.3)	104 (59.8)	2.74[b] [1.81–4.14]	50[b] [0.43–0.57]
1:3	15 (5.4)	15 (8.6)	2.74[a] [1.26–5.98]	50[b] [0.32–0.68]
2:1	12 (4.3)	1 (0.6)	0.23 [0.03–1.8]	7.7 [-0.07–0.22]
Type of hospital				
Academic (ref.)	178 (63.8)	124 (71.3)	–	41.06[b] [0.36–0.47]
Community	5 (1.8)	4 (2.3)	1.15 [0.3–4.36]	44.44[a] [0.12–0.77]
Freestanding children's hospital	96 (34.4)	46 (26.4)	0.69 [0.45–1.05]	32.39[b] [0.25–0.4]
The number of PICU beds				
Mean (sd)	16.2 (7.5)	16.6 (6.4)	1.01 [0.98–1.03]	

N.B.: The recommended use refers only to the appropriate age category and ventilatory support.
CI: confidence interval; COMFORT-B: COMFORT behaviour; FLACC: Face, Legs, Activity, Cry, Consolability; OR: odds ratio; PICU: paediatric intensive care unit; ref: reference group; sd: standard deviation.
[a] Statistically significant, p-value < 0.005.
[b] Statistically significant, p-value < 0.0001.

4.9. ESPNIC recommendation: use of the FLACC scale for pain assessment in nonintubated children

The logistic regression model showed that the nurse-to-patient ratio was the only statistically significant variable (p =< 0.0001). Against the reference group of 1:1 nurse-to-patient ratio, a hospital with 1:2 and 1:3 ratios had a 2.7 greater chance that the FLACC was used appropriately for pain assessment in non-intubated patients (OR = 2.7, 95% CI: 1.81–4.14 and 95% CI: 1.26–5.98, respectively). In a hospital with a 1:1 ratio, the mean probability that the FLACC was used as recommended for pain assessment in nonintubated patients was 26.7% (95% CI: 0.2–0.33). The mean probability was 50% when the hospital had a 1:2 ratio (95% CI: 0.43–0.57) and 1:3 ratio (95% CI: 0.32–0.68). The mean probability of using the FLACC for pain assessment as recommended was over 32% (95% CI: 0.25–0.4) in freestanding children's hospitals, 42% (95% CI: 0.36–0.47) in academic teaching hospitals, and 44% (95% CI: 0.12–0.77) in community hospitals.

5. Discussion

This is the first study to report on the actual practices of pain, sedation, IWS, and delirium assessment practices across 15 European countries using prospectively collected data and their accordance with the ESPNIC position statement.[7] The findings highlight several clinical gaps. Firstly, measurement of delirium was suboptimal. Secondly, significant variations in the frequency of assessments suggest a lack of consensus on the optimal frequency of assessment. Thirdly, the use of measurement instruments was not always appropriate, suggesting a lack of training in their use. Finally, compliance with recommendations on the use of measurement instrument seems to be influenced by factors such as staffing, and PICU and hospital characteristics.

Our results showed that **pain assessment** was well established in all participating European PICUs, except one. Our findings indicate a slightly higher adherence to recommended practices than those reported in the online survey conducted by Davierio et al. They found that 81% of European PICUs surveyed assessed and documented pain

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on a daily basis.[13] This difference could be explained by a wider and more representative sample of PICUs in Europe in the ESPNIC survey than in the EU PARK-PICU, where nearly half of the PICUs were located in northern Europe and predominantly Western Europe. The FLACC scale was the most frequently used measurement instrument for pain assessment, which is congruent with the ESPNIC survey results[13] and a survey of 15 North American PICUs.[22] Interestingly, despite being widely validated for pain and sedation assessment, the COMFORT-B scale was not commonly used for pain assessment in our study; results that are not congruent with what was reported in the ESPNIC survey, where the COMFORT-B scale appeared to be the second most frequently used scale after the FLACC to assess pain in the PICU.[13] This difference may be due to local preferences because both scales are validated for assessing pain in PICU patients. Despite high adherence to assessment practices in our study, many PICUs inappropriately used pain measurement instruments, particularly the COMFORT-B scale, considering the age and communication ability for which they were developed. Both the COMFORT scale and the COMFORT-B scale possess the ability to assess both pain-related distress and agitation/sedation,[23,24] posing challenges for bedside nurses and potentially leading to incorrect use. This is concerning because a validated measurement instrument is only valid when used appropriately and in its intended population.[25] Inaccurate pain assessment is likely to result in inadequate treatment and unnecessary suffering. Hence, there is a need for further education on the correct use of available pain measurement instruments for PICU children, especially when several studies indicated that nurses lack confidence with the use of pain measurement instruments, both in PICU[26] and critical care[27] settings.

Regarding **sedation assessment**, the COMFORT-B scale was the most common measurement instrument used in this study, followed by the COMFORT scale, which is in line with the recommendations.[7] Unlike the COMFORT-B scale, the COMFORT scale includes physiological indicators such as blood pressure and heart rate,[24] despite the controversy of using vital signs to measure distress.[28]

For **IWS assessment**, our results showed a higher usage of the SOS than the WAT-1 scale. This contrasts with the literature, where the WAT-1 is mostly cited.[29–31] The European preference for the SOS is probably due to its development by Dutch researchers, a country well represented in the EU PARK-PICU study,[15] whereas the WAT-1 originates from North America.[17] The ESPNIC survey also showed a preference for the WAT-1 followed by the SOS.[14] Regardless of scale preference, these two instruments are recommended in the ESPNIC positions statement.

Regarding **delirium screening**, a significant finding was that the majority of PICUs in the EU PARK-PICU study did not conduct screening.[15] The lack of regular delirium screening in the PICU has also been reported elsewhere,[14,32] demonstrating the difficulty of integrating such practice into standard care for children receiving analgosedation for more than 72 h. Delirium screening is certainly more complex than assessing pain and sedation because delirium has different types (hyper active or hypo active, or mixed) and screening includes different steps based on arousal (sedation score), mental status, attention, consciousness level, and sleep disturbance, as in the Preschool Confusion Assessment Method for the ICU (psCAM-ICU).[33] PICU nurses, at the bedside, play a crucial role in screening for delirium in children and mitigating or minimising precipitating factors for delirium.[34] However, a study evaluating PICU staff knowledge revealed a lack of knowledge in areas such as delirium pathophysiology, available screening measurement instruments, and risk factor identification.[35] Comprehensive education programmes addressing these knowledge gaps in clinical practice are needed because evidence suggests such education programmes increase nursing knowledge of delirium, self-confidence, and attitudes towards delirium in PICU settings.[36]

For those practicing regular delirium screening, the CAP-D and SOS-PD were the main screening measurement instruments used in the EU PARK-PICU study,[15] which aligns with the ESPNIC recommendations[7] and could be explained by the practicality of the CAP-D and the SOS-PD to screen delirium at the bedside.[37,38] Other validated delirium scales such as the Pediatric Confusion Assessment Method for the ICU (pCAM-ICU) and psCAM-ICU are also recommended,[2,7] covering the age ranges of PICU children. The psCAM-ICU is validated for children aged 6 months to 5 years[39] and the pCAM-ICU for children over 5 years of age.[40–42] However, both measurement instruments were not used together in our study. The ESPNIC survey revealed a similar low usage rate of the pCAM-ICU (11% of 215 PICUs).[14] Given the validity of all these delirium scales, selection is likely based on factors other than evidence, such as measurement instruments recommended in clinical practice guidelines endorsed by a unit, research group influence, availability of translated versions in languages other than English, perceived ease of use, and other contextual factors.

We found a positive linear correlation between the number of PICU beds and the recommended use of the COMFORT-B scale for pain assessment. However, this correlation did not extend to the assessment of sedation and the recommended use of the FLACC scale for pain assessment, indicating a lack of a trend. In contrast, Daverio et al.[13] found higher proportions of pain and sedation management protocols in low-volume PICUs, suggesting better evidence-based practice culture in these PICUs. Our results also show that nurses were more likely to use of the FLACC scale for pain assessment in PICUs with better staffing, particularly for 1:2 and 1:3 nurse-to-patient ratios. These results may be linked to the ease of use of the FLACC scale, compared to the COMFORT-B scale, whose items are longer to document and more complex to assess. Moreover, it is assumed if a nurse cares for 2 or 3 patients, they are likely not intubated, making the FLACC scale more relevant.[9,18] The COMFORT-B scale's ability to assess both pain and sedation offers benefits and drawbacks in clinical assessment.

Implementing clinical recommendations in practice involves multiple implementation strategies that involve knowing the local context in which recommendations are to be implemented, including the barriers and the facilitators to clinical recommendations implementation at professional and organisational level.[43–45] Some studies highlight the importance of models or frameworks to facilitate implementation in practice and change.[20,43,44]

6. Strengths and limitations

The strength of this study lies in its dual investigation of both practice adherence with the ESPNIC position statement and the examination of organisational variables as influencers to compliance with recommendations. Some limitations need acknowledgement. First, the results do not represent the short PICU stays, but the study included patients admitted 3 days or longer only. Second, inherent to secondary analysis was that analyses were limited to the data collected in the primary data, yet the data available were considered of good quality, with an insignificant number of missing data. Third, we recognise that actual compliance with the recommendations is based only on the data collection period. Finally, as this was a voluntary study, it is possible that the least compliant centres did not participate in the study.

7. Implications for practice and research

This study has highlighted the practical challenges associated with evaluating pain, sedation, IWS, and delirium, including the abundance of recommended measurement instruments that may

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confuse clinicians, insufficient training in the use of these measurement instrument, and a lack of clear guidelines regarding the optimal assessment frequency to ensure high-quality care. Further research is warranted to clarify the utilisation of these measurement instruments, streamline their application, explore effective and cross-functional strategies for implementing best practices across diverse clinical settings, and determine the ideal assessment frequency tailored to the individual patient's symptoms as well as taking organisational constraints into consideration. Such research will enhance the practical applicability of recommendations.

8. Conclusion

The findings of this study emphasise the critical importance of accurate and consistent assessment. While most PICUs incorporate these evaluations into their routines, notable disparities persist in comparison to ESPNIC recommendations. It is essential that clinical teams recognise the importance of accurate assessment of pain, sedation, delirium, and IWS to guide decision-making and positively influence patient outcomes. Consistent training for healthcare personnel and clinical oversight can facilitate optimal and standardised execution of these assessments, tailored to the specifics of each clinical environment. Moreover, additional initiatives are required to heighten awareness regarding the harmful impacts of delirium and to integrate systematic and protocolised screening practices.

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CRediT authorship contribution statement

Silvia Alvarado: conceptualisation, design of subgroup analyses, application of statistical analyses, writing, conducting the research process.

Ibo Macdonald: conceptualisation, writing, cosupervision of the research project, review.

Chanez Vivianne: cosupervision of the research project, review.

Kudchadkar Sapna: design of original study from which dataset was obtained and review.

Ista Erwin: conceptualisation, methodology, provided the database and information on the data, review.

Anne–Sylvie Ramelet: conceptualisation, methodology, validation, review, main supervision.

Conflict of interest

The authors declare no conflicts of interest.

Data availability statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Appendix A. Supplementary data

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