

## Research Article

## Sedation and Analgesia Practice in Pediatric Intensive Care Units of Cairo University Children Hospitals

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### Abstract

**Background:** Critically ill pediatric patients often experience complex medical procedures, mechanical ventilation, pain and separation from their families, which tend to be painful and anxiety-provoking, necessitating the provision of analgesia and sedation to reduce associated stress. The aim of this study is to analyze the current approaches in sedation, analgesia and withdrawal practices among pediatric intensive care units' (PICUs) patients. **Methods:** This is a descriptive prospective study reviewing 80 pediatric patients admitted to PICUs of Cairo university hospitals from July 2021 - January 2022, describing their sedation and analgesia practice, indication, duration, dose, effect and side effects. **Results:** Eighty pediatric patients were enrolled, with a median age of 5.5 months, 51% of them were females (n= 41), and their weight ranged from 2.4 kg to 80 kg with a median of 6 kg. Pneumonia (53.8%) was the most common indication for admission with 49 patients needed mechanical ventilation showing the highest percentage (60%) among the indications of the sedation. Fentanyl used in 43.8%, 36% of patients needed multimodal medications, good sedation achieved in (67.5%), reduction of pain ranged from 44.44% to 100%. The median duration of PICU stay was 9.5 days. Vomiting presented in 15 % representing the most common side effect of sedo-analgesic use. Vital signs were found to be statistically significant indicator in assessing the efficacy of sedation and analgesia. **Conclusion:** The practice of adequate sedation and analgesia in PICUs is a fundamental tool; it improves our patients' vital signs, reduces pain, facilitates synchronization with mechanical ventilation and decreases the length of stay in post-operative patients. Enhancing the proper use of sedation and analgesia in PICUs for better patient's care, also, the importance of daily sedation interruption practice and its impact on patient's outcome should be emphasized in further studies.

**Keywords:** Sedation; analgesia; PICU; mechanical ventilation; pain.

### Introduction

Critically ill children experience substantial stress during hospitalization in a pediatric intensive care unit (PICU). They experience pain, anxiety, and fear due to their underlying disease, the PICU environment, invasive procedures, mechanical ventilation, and separation from their families<sup>1</sup>. Since then, adequate sedation and analgesia are key components in their care<sup>2</sup>.

The main indications of sedation and analgesia in PICU include better management of pain, anxiety, and agitation; promote amnesia; avoid

loss of catheters and endotracheal tube; and reduce cellular metabolism<sup>3</sup>.

Ensuring the safety and comfort of critically ill infants and children supported by mechanical ventilation is integral in the practice of pediatric critical care<sup>4</sup>. Over 90% of mechanically ventilated children receive sedatives as part of treatment to diminish anxiety or pain and ensure comfort<sup>5</sup>. Moreover, adequate sedation facilitates synchronization with mechanical ventilation and enables invasive procedures to be performed<sup>6</sup>.

Adequate postoperative pain assessment and management in pediatric patients may significantly improve their outcome, comfort and quality of life. Postoperative pain prolongs recovery and hospitalization; therefore, the severity of the pain and its management should be part of routine assessment<sup>7</sup>.

Also, sedation for procedures and short term interventions has advanced and expanded in the last decades; no longer the exclusive scope of anesthesiology, now it is being routinely used by the most varied of medical specialties, especially pediatric intensive care specialists<sup>8</sup>. The optimal level of sedation varies for each patient<sup>6</sup>, the adverse impact of inefficient sedation and analgesia practices at the PICU has become the focus of attention for researchers and clinicians<sup>9</sup>.

Since, there is no universally accepted standardized approach or practice guide for sedation–analgesia in critically ill pediatric patients<sup>10</sup>; We aimed in this study to analyze the current approaches in sedation, analgesia and withdrawal practices among PICUs of Cairo University Children Hospitals to be a guide for developing a standardized approach in those patients.

### Patients and Methods

This is a prospective descriptive study carried out in the PICUs of Cairo university children hospitals to analyze the current approaches in sedation, analgesia and withdrawal practices among PICUs of our hospitals over the period from July 2021 to January 2022.

All critically ill pediatric patients aged 1 month to 14 years old, receiving sedation and/or analgesia either mechanically ventilated, post-operative or in need for procedural sedations were enrolled, patients with known CNS problems were excluded.

Data were collected from patient's files and clinical progress notes of all admitted patients enrolled in our study including: patient's age, sex, weight, indication for PICU admission, duration of PICU stay, duration on MV, indication and dose of sedation, sedation type (mono-therapy / multimodal therapy), level of sedation and its dose (minimal (anxiolytic) / moderate (conscious sedation) / deep / general anesthesia), potential side effects of sedative

used, assessment of withdrawal manifestations, and assessment of daily sedation interruption. Vital signs (upon admission and on sedation), GCS assessment, Pain score using the FLACC Scale for young patients (2months – 8 years) and Wong-Baker Faces Pain Scale for older ones (3 – 18 years), and the FOUR score for mechanically ventilated patients before and after sedation were all documented.

### Statistical analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations and ranges when parametric and median, inter-quartile range (IQR) when data found non-parametric. Also qualitative variables were presented as number and percentages. The comparison between groups with qualitative data were done by using *Chi-square test*. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:  $P > 0.05$ : Non significant

### Results

This is a prospective descriptive study reviewing 80 pediatric patients admitted in the pediatric intensive care units of Cairo university children hospitals over a period of 6 months from July 2021 to January 2022.

In our study, the age of the studied group ranged from 1 month to 13 years with a median of 5.5 months. Fifty one percent of cases were females (n= 41), the weight of the studied group ranged from 2.4 kg to 80kg with a median of 6 kg. Pneumonia was the most common cause of PICU admission in 53.8% (n=43), while 35% were post-operative pediatric surgery patients, the duration of PICU stay of the studied group ranged from 2 days to 45 days with a median (IQR) of 9.5 days (5–17.5), and 61.3% of patients needed mechanical ventilation (Table 1).

The most frequent indication of sedo-analgesia in our patients was MV in 60% (n=48), followed by pain control that represented 35 % (n=28) and 5% for procedural sedation. Fifty one of our patients (63.8%) needed single agent for sedation or analgesia while 36.3% (n=29) needed multimodal medications. Fentanyl was

the most commonly used medication which represented 43.8%, followed by midazolam (28.8%). The duration of each drug used ranged from 1 - 30 days with a median (IQR) of 3 days (2 – 6). Fentanyl and midazolam was the most common combination used in 41.4% (n=12) (Figure 1).

Sixty-seven and half percent (n=54) of our patients had adequate sedation, most of them was achieved by fentanyl and midazolam (Table 2). Vomiting was the most common side effect observed in the studied group, representing 15%, followed by constipation in 3.8% of patients, however, in our study, side effects were found to have no statistically significant relation to the duration of the medications used. Unfortunately, the concept of

daily sedation interruption was not practiced in our patients.

The GCS, the FOUR and pain scores of every patient were documented before and upon administration of sedo-analgesics. The FOUR score ranged from 6 to 13 with a mean of  $9.67 \pm 2.08$ . The pain score before giving sedation ranged from 6 to 9, while after giving sedation ranged from 0 to 5. Reduction of pain was achieved in 44.44% to 100% with a median (IQR) of  $70.60 \pm 11.28$  (Table 3).

It was found that 47.5% of patients upon PICU admission were hypertensive, 86.3% were tachycardic and 87.5% were tachypenic. Improvement of vital signs before and after application of sedation and analgesia was found to be statistically.

**Table (1): Characteristics of the studied population.**

		<b>No. = 80</b>
<b>Sex</b>	<b>Female</b>	41 (51.3%)
	<b>Male</b>	39 (48.8%)
<b>Age (months)</b>	<b>Median (IQR)</b>	5.5 (3 – 13.5)
	<b>Range</b>	1 – 156
<b>Weight (kg)</b>	<b>Median (IQR)</b>	6 (4.5 – 9.25)
	<b>Range</b>	2.4 – 80
<b>Indication Of PICU admission</b>	<b>Pneumonia</b>	43 (53.8%)
	<b>Post-Operative pediatric surgery</b>	28 (35%)
	<b>Heart failure</b>	3 (3.8%)
	<b>Peritoneal dialysis</b>	2 (2.5%)
	<b>Post bronchoscope</b>	2 (2.5%)
	<b>Disturbed conscious level</b>	1 (1.3%)
	<b>Sepsis</b>	1 (1.3%)
<b>Duration of PICU stay(days)</b>	<b>Median (IQR)</b>	9.5 (5 – 17.5)
	<b>Range</b>	2 – 45
<b>Need for mechanical ventilation</b>	<b>No</b>	31 (38.7%)
	<b>Yes</b>	49 (61.3%)
<b>Duration on MV (days)</b>	<b>Median (IQR)</b>	6 (4 – 12)
	<b>Range</b>	1 – 40

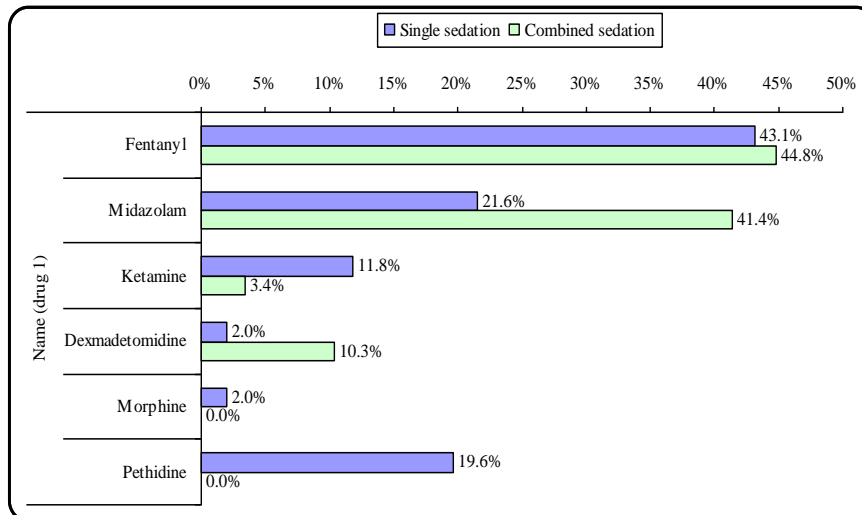


Figure (1) Sedative and analgesic agents used and its type.

Table (2): Comparison between drugs and efficacy of sedation and analgesia.

Drug	Level of Sedo-analgesia					
	Appropriate		Under-sedation		Over-sedation	
	No.	%	No.	%	No.	%
<b>Fentanyl</b>	24	44.4%	10	47.6%	1	20.0%
<b>Midazolam</b>	11	20.4%	9	42.9%	3	60.0%
<b>Ketamine</b>	5	9.3%	1	4.8%	1	20.0%
<b>Dexmedetomidine</b>	3	5.6%	1	4.8%	0	0.0%
<b>Morphine</b>	1	1.9%	0	0.0%	0	0.0%
<b>Pethidine</b>	10	18.5%	0	0.0%	0	0.0%

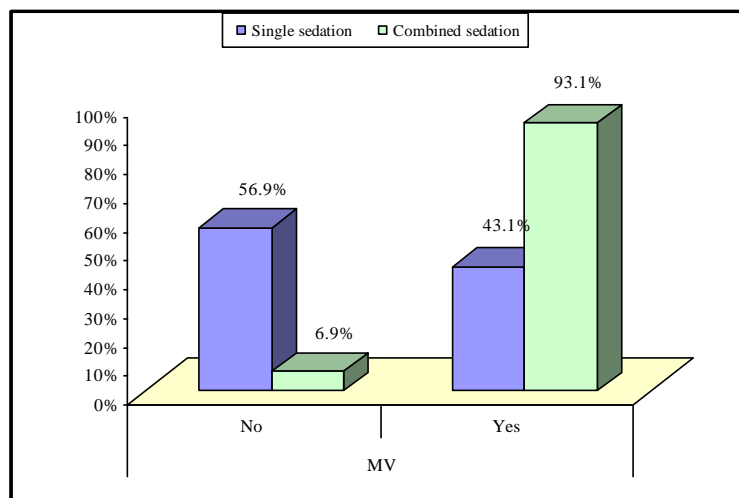
Table (3): The GCS, The FOUR and Pain scores of the studied group.

		No. = 80
<b>GCS Before</b>	Mean ± SD	13.62 ± 2.13
	Range	8 – 15
<b>FOUR Score</b>	Mean ± SD	9.67 ± 2.08
	Range	6 – 13
<b>Pain Score Before</b>	Median (IQR)	8 (8 – 8)
	Range	6 – 9
<b>GCS after</b>	Mean ± SD	14.55 ± 1.07
	Range	11 – 15
<b>Pain Score after</b>	Median (IQR)	2 (2 – 3)
	Range	0 – 5

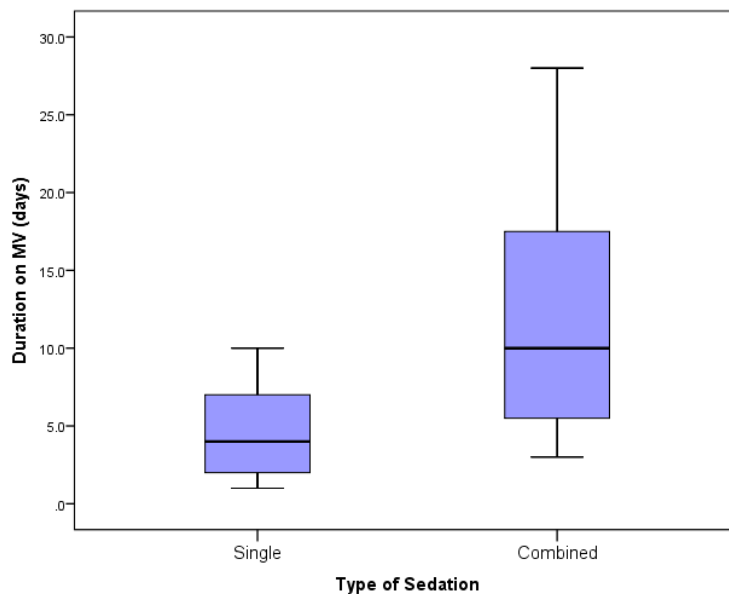
**Table (4): Compression between the vital signs upon admission and after sedation.**

		On admission		After		Test value*	P-value	Sig.
		No.	%	No.	%			
Blood Pressure	Normal	36	45.0%	51	63.8%	5.668	0.017	S
	Hypertension	38	47.5%	17	21.3%	12.218	0.000	HS
	Hypotension	6	7.5%	12	15.0%	2.254	0.133	NS
Heart Rate	Normal	11	13.8%	63	78.8%	67.982	0.000	HS
	Tachycardia	69	86.3%	17	21.3%	67.982	0.000	HS
Respiratory Rate	Normal	10	12.5%	72	90.0%	96.160	0.000	HS
	Tachypnea	70	87.5%	8	10.0%	96.160	0.000	HS

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value < 0.01: highly significant (HS) \*:Chi-square test**



**Figure (2a): Relation between MV and number of sedative agents.**



**Figure (2b): Relation between duration on MV and number of sedative agents.**

significant in our study ( $P=0.000$ ) (Table 4). Adequate sedation and analgesia were represented clinically on the patients by improving vital signs and synchronization with the MV.

In our study, the use of multimodal sedo-analgesic therapy was correlated significantly with longer PICU stay ( $P\text{-value} =0.001$ ). Patients admitted for pneumonia and was in need for ventilatory support were more correlated to the use of multimodal therapy ( $P=0.001$ ), while those who were admitted for post-operative care show significant use of single agents ( $P=0.000$ ). Also, patients who used multimodal therapy showed statistical significant longer duration of mechanical ventilation ( $P=0.000$ ) (Figure 2).

### Discussion

Optimal level of sedation and analgesia is one of the most important issues regarding optimizing patient care in PICUs. Several factors can provoke stress, anxiety, and pain in children which can lead to undesirable effects in critically ill patients<sup>10</sup>.

Similarly, postoperative pain management is also essential to improve patient comfort and ensure a good postoperative experience. Adequate pain management requires an accurate assessment of pain, with an adequate scale, patient self-report is the best way to assess such a subjective experience. However, in the pediatric population, proxy reports based on child observations are needed for children who are too young to use self-report tool<sup>11</sup>.

In this prospective study we reviewed 80 pediatric patients admitted in PICUs of Cairo university children hospitals and requiring any level of sedation and analgesia over a period of 6 months with age ranged from 1 month to 13 years and a median of 5.5 months.

The duration of PICU stay of the studied group ranged from 2 days to 45 days with a median of 9.5 days and the use of combined sedo-analgesic therapy was correlated significantly with longer PICU stay ( $P\text{-value} =0.001$ ). Also, in our study pneumonia was the most common cause for PICU admissions of the studied group (53.8%), followed by post-operative pediatric surgeries (26.3%). Sixty one percent of our patients were mechanically ventilated with duration ranged from 1 - 40 days and a median

of 6 days, patients admitted for pneumonia and in need for ventilatory support were more correlated to the use of multimodal sedo-analgesics ( $P=0.001$ ).

Most of our patients showed hypertension, tachycardia, tachypnea upon admission which showed a good response to sedoanalgesic drugs ( $P=0.000$ ). This was in concordance with Dickson et al., which reviewed 1,111 post-operative patients showing a significant improvement of BP after sedoanalgesic drugs ( $P = 0.001$ ) also improvement of heart rate ( $P < 0.001$ )<sup>12</sup>.

Fentanyl was the most commonly used drug in 43.8% of patients, followed by midazolam (28.8 %) and duration ranged from 1 - 30 days with fentanyl and midazolam as a common combination in 37.9%, and were the most commonly chosen combination in mechanically ventilated patients. On the other hand, fentanyl and pethidine were most commonly used in controlling pain. This matched Ekinci et al., results which analyzed the approaches in sedation, analgesia, withdrawal, and delirium practices among 27 PICUs in Turkey, reported that opiates was the most common drug used for post-operative pain in 40% and fentanyl show the highest percent 85.1% with preference of benzodiazepines plus opiates (81.4%) in sedoanalgesia during MV in PICUs<sup>10</sup>. On the other hand, Patel et al., showed Non-Opioid Analgesic was the most common drugs used in 58.4% of centers followed by fentanyl in 26.2 % with a duration ranged from 2 to 81 days ( $P<0.05$ )<sup>13</sup>.

The concept of daily sedation interruption was not well practiced at our hospital. In 2016 Vet et al., compared daily sedation interruption plus protocolized sedation to protocolized sedation only in 129 children by multicenter randomized controlled trial in 3 pediatric intensive care units in the Netherlands From October 2009 to August 2014 showed that median number of ventilator-free days did not differ, median ICU and hospital length of stay were similar in both groups, daily sedation interruption in addition to protocolized sedation did not improve clinical outcome and was associated with increased mortality compared with protocolized sedation only<sup>6</sup>. Also Colleti Junior et al., which had a survey of 14 questions was distributed by e-mail to Brazilian critical care pediatricians

showed that the majority (85.7%) of physicians did not practice daily sedation interruption<sup>9</sup>.

Among the possible side effects of the sedative agents, vomiting was the most common side effect of the studied group (15%) which was found to be more frequent with the use of multimodal sedo-analgesics ( $P=0.017$ ). Hara et al., which enrolled 903 pediatric patients received procedural sedation and analgesia in the ER showed that desaturation happened in 8.9% followed by vomiting 2.4%<sup>14</sup>. Also Cohen et al. that included 1,164 pediatric patients given PSA in the ED showed that 6.8% had vomiting, and 5.4% had a desaturation or required respiratory interventions ( $P=0.01$ )<sup>15</sup>.

In our study, significant pain reduction was achieved from scores of 6-9 to 0-5 with percentage of pain reduction reaching 44.4% to 100%. Similarly, Bringuier et al., which reported assessment of pain and anxiety of 123 children using the facial action summary score (FASS) show that the median pain score before administration of analgesia were 3.06, and after analgesia the mean pain scores were 1.25<sup>11</sup>.

### Conclusion

The practice of adequate sedation and analgesia in PICUs is a fundamental tool improves patients' vital signs, reduce pain, facilitates synchronization with mechanical ventilation and decreases the length of stay in post-operative patients. Pneumonia was the most common cause for sedation need in our patients, and fentanyl was the most commonly used drug for pain control in our PICUs for its analgesic power with limited side effects.

We recommend enhancing the proper use of sedation and analgesia in PICUs and procedural sedo-analgesia for better patient's care and to reduce patient's morbidity, also, the importance of daily sedation interruption practice and its impact on patient's outcome should be emphasized in further studies.

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