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# A multicenter survey of pediatric caudal epidural anesthesia practices in resource-limited settings

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Caudal epidural blocks are commonly used anesthesia techniques in children. This multicenter study used an interviewer-administered questionnaire in 28 hospitals to describe pediatric caudal epidural anesthesia practice in the Palestinian healthcare system. Devices used to access the epidural space, methods used to ensure the accuracy of access to the epidural space, methods used to ensure the accuracy of access to the epidural space, methods used to ensure asepsis, local anesthetics, additives, and adjuncts used in pediatric caudal epidural blocks were collected. Responses were obtained from 162 anesthesiologists (response rate = 68.9%). Hollow needles were used to access the epidural space and catheters were used to administer local anesthetics, additives, and adjuncts in the epidural space. Aspiration before injection was the most frequently reported method to ensure accurate placement of needles, catheters, local anesthetics, additives, and adjuncts in the epidural space. Bupivacaine was the most commonly injected local anesthetic. During single short caudal epidural blocks, 57.4% of the anesthesiologists reported adhering to full aseptic techniques. The findings revealed significant variations in the practices of pediatric caudal epidural blocks. These variations could be associated with resource limitations, access to materials, local anesthetics, additives, and adjuncts. Developing and adopting evidence-based guidelines might promote congruence in pediatric caudal epidural anesthesia practices.

Keywords Pediatric anesthesia, Caudal epidural anesthesia, Regional anesthesia, Children, Cross-sectional

Caudal epidural blocks are commonly used anesthesia techniques in pediatric patients<sup>1</sup>. Pediatric caudal epidural anesthesia is performed by infiltration of local anesthetics in the fat tissues surrounding the roots of spinal nerves in the epidural space<sup>2</sup>. To access the epidural space, a suitable needle is often inserted into the space at the level of the hiatus sacralis, passing cranially through the sacrococcygeal membrane. A catheter (flexible plastic cannula) is often threaded through the needle and left into the epidural space for either intermittent or continuous injection of local anesthetics, additives, and adjuncts<sup>1–3</sup>. This technique is often used to facilitate performing surgeries or other interventions in pediatric patients with an inguinal hernia, circumcision, hypospadias, and orchiopexy, among other procedures<sup>1,4</sup>. The technique is also used to apply casts to immobilize newborns and achieve effective postoperative analgesia<sup>4,5</sup>.

Caudal epidural blocks were first performed as blind procedures based on anatomical landmarks and were successful in more than 96% of pediatric patients<sup>1,6</sup>. However, the success rates of these blind procedures are significantly lower in adults even when performed by experienced practitioners<sup>4</sup>. In today's practice, considerable variations in caudal epidural blocks have been reported<sup>1,4,6</sup>. Although many anesthesiologists are still using anatomical landmarks, ultrasonography and fluoroscopy are increasingly used to guide the insertion of epidural needles and catheters in the epidural space<sup>1,4,6</sup>. In addition, variations have also been reported in the use of local anesthetics, additives, and adjuncts<sup>4,7–9</sup>.

Bupivacaine, levobupivacaine, and ropivacaine are the most frequently used local anesthetics in pediatric caudal epidural blocks<sup>7</sup>. Additives and adjuncts have been used to increase the duration of action of the local anesthetics and maximize their effectiveness. Different additives and adjuncts were reportedly used in pediatric

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caudal epidural blocks. These additives and adjuncts included clonidine, ketamine, opioids, dexmedetomidine, dexamethasone, epinephrine, midazolam, and neostigmine<sup>4,8,9</sup>. It is important to note that each of these adjuncts has its benefits, drawbacks, and adverse effects.

The practice of pediatric caudal epidural blocks was previously surveyed in some developed countries<sup>4,10–12</sup>. However, little is known about the practice, techniques, anesthetics, additives, and adjuncts used in pediatric caudal epidural blocks in resource-limited settings. Moreover, little is known about what could be associated with variations in the practice of pediatric caudal epidural blocks in resource-limited settings. Therefore, this study was conducted to describe the practice, techniques, anesthetics, additives, and adjuncts used in pediatric caudal epidural blocks in the Palestinian healthcare system. The study also aimed to investigate the factors that could be associated with variations in the practices used in pediatric caudal epidural blocks. The findings of this multicenter survey could be informative to decision-makers and policymakers in Palestine as well as in similar resource-limited settings.

# Methods

# Study design and settings

A cross-sectional observational design was used in this multicenter study. The data were collected from 28 different governmental and private hospitals in Palestine in the period between May 2022 and January 2023 using a questionnaire. The study was reported in adherence to the strengthening of the reporting of observational studies in epidemiology (STROBE) checklist<sup>13</sup>. Adherence to the STROBE checklist is shown in Supplementary Table S1.

# Study population, sample size, and recruitment

The study population was anesthesiologists practicing in Palestinian hospitals. The sample size needed for this study was calculated based on a population of 300 practicing anesthesiologists using a 95% confidence interval (95% CI) and tolerating a margin of error of 5%. An online sample size calculator (http://www.raosoft.com) was used to compute the sample size for this study<sup>14</sup>. The anesthesiologists were visited, invited, and recruited to participate in this study in their workplaces. Before their participation, the researchers explained the objectives of the study to the anesthesiologists and obtained their written informed consent. The anesthesiologists were included when they met the following inclusion criteria: (1) practiced in one of the governmental or private hospitals in Palestine, (2) performed pediatric caudal epidural blocks, (3) expressed willingness to participate in the study, and (4) provided written informed consent.

## The study tool

The study tool was a paper-based questionnaire that was designed specifically for this study. The questionnaire was based on previous studies that surveyed pediatric caudal epidural block practices elsewhere<sup>4,5,10,11,15</sup>. The questionnaire is provided in Supplementary Table S2. In addition to their demographic, practice, and training characteristics, the anesthesiologists were asked to describe their pediatric caudal epidural block practices. The anesthesiologists were asked to indicate the devices they use to access the epidural space, gauge sizes, methods to ensure the accuracy of access to the epidural space, and local anesthetics, additives, and adjuncts they used in pediatric caudal epidural blocks. In addition, the anesthesiologists were asked to indicate the upper age limit for the usage of caudal epidural blocks in children, the maximal duration they leave the catheter in situ after insertion, and the methods they use to ensure asepsis for single-shot pediatric caudal epidural blocks.

### Statistical analysis

The data collected in this study were transferred into Microsoft Excel Spreadsheets and entered into IBM SPSS v.21.0. Descriptive statistics like frequencies, percentages, mean  $\pm$  standard deviation (SD), and median with the corresponding [first quartile (Q1) and third quartile (Q3)] were generated. The categorical data were compared using Chi-square or Fisher's exact tests. In this study, p-values of less than 0.05 indicated statistical significance.

### Ethical approval

This study was conducted in adherence to the local and international ethical principles including those in the Declarations of Helsinki. Ethical approval was obtained from the Institutional Review Boards (IRB) of An-Najah National University (Protocol #: Med. Sep. 2022/40). All anesthesiologists provided written informed consent before they answered the questionnaire.

# Results

## Response rate and characteristics of the anesthesiologists

A total of 235 anesthesiologists were visited and invited to take part in the study. Responses were obtained from 162 anesthesiologists, giving a response rate of 68.9%. The flowchart of the recruitment is shown in Supplementary Figure S1. The mean length of experience of the anesthesiologists was  $17.6 \pm 10.8$  years (the median was 17 [9, 25] years). More than half (55.6%) of the anesthesiologists stated that they have received on site-training on pediatric caudal epidural anesthesia during practice and the majority (72.8%) performed 5 or fewer pediatric caudal epidural blocks per month. The demographic, practice, and training characteristics of the anesthesiologists are shown in Table 1.

Variable	n	%			
Gender					
Female	29	17.9			
Male	133	82.1			
Place of employment					
Private	101	62.3			
Governmental	61	37.7			
Number of pediatric caudal epidural blocks performed per month					
<5	118	72.8			
5-10	37	22.8			
>10	7	4.3			
Training on pediatric caudal epidural blocks					
Received on site-training during practice	90	55.6			
Received formal training during specialty education	72	44.4			

 Table 1. Demographic, practice, and training characteristics of the anesthesiologists.

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## Pediatric caudal epidural anesthesia practices

#### The device used to access the epidural space

The anesthesiologists reported that they used hollow needles to access the epidural space and catheters (flexible plastic cannulas) to administer local anesthetics, additives, and adjuncts. While the majority of the anesthesiologists did not specify a particular hollow needle, 2 (1.2%) specified using Tuohy and Stylleted needles and 1 (0.6%) specified using Butterfly needles (Table 2). Of the anesthesiologists, the vast majority (90.1%) stated that they used gauges in sizes 22G and 24G.

# The method used for ensuring accurate placement of needles, catheters, local anesthetics, additives, and adjuncts in the caudal epidural space

The anesthesiologists reported using different methods for ensuring the accurate placement of needles, catheters, local anesthetics, additives, and adjuncts in the epidural space. The most frequently reported methods were aspiration before injections, the passage of needles and catheters through the sacrococcygeal ligament, ease of needles and catheters advancement into the caudal epidural space, injection of local anesthetic into the caudal epidural space (Table 2). On the other hand, ultrasound imaging was the least frequently used method.

### The local anesthetics, additives, and adjuncts injected

The anesthesiologists reported that the most frequently injected local anesthetics were bupivacaine (91.4%) and lignocaine/lidocaine (16.0%) (Table 2). On the other hand, ropivacaine and levobupivacaine were less frequently reported. Additives and adjuncts included ketamine, opioids, midazolam, dexamethasone, and clonidine.

#### The upper age limit for using caudal epidural anesthesia in children

More than half (50.4%) of the anesthesiologists reported that the upper age limit for using caudal epidural anesthesia in children was 4 years (Table 2). On the other hand, 15.4% of the anesthesiologists stated that there was no upper age limit.

# *The maximum duration the anesthesiologist leaves the catheter in situ* Of the anesthesiologists, 60 (37.0%) stated that they leave the catheter in situ for less than 24 h.

# *The methods used to provide asepsis*

More than half (57.4%) of the anesthesiologists reported using gloves, gowns, and masks together to ensure asepsis (Table 2). On the other hand, 37.7% of the anesthesiologists reported using gloves only.

# Association between variables of the anesthesiologists and their pediatric caudal epidural anesthesia practices

Female anesthesiologists were more likely to use gauge size 22G (Chi-square test = 3.9, p-value < 0.05) compared to male anesthesiologists. The anesthesiologists who practiced in private hospitals were more likely to report aspiration before injection as a method for ensuring accurate placement of needles, catheters, local anesthetics, additive and adjuncts in the epidural space (Chi-square test = 11.8, p-value < 0.01), more likely to use lignocaine/ lidocaine (Chi-square test = 6.5, p-value < 0.05), ketamine (Fisher's exact test = 4.0, p-value < 0.05), and more likely to leave the catheter in situ for up to 24 h.

The anesthesiologists who performed more than 5 caudal epidural blocks per month were more likely to use gauge size 24G (Chi-square test = 5.0, p-value < 0.05), more likely to use saline injection into caudal epidural space for ensuring accurate placement of needles, catheters, local anesthetics, additive and adjuncts in the epidural space (Chi-square test = 4.2, p-value < 0.05), and less likely to use opioids (Chi-square test = 15.9, p-value < 0.001) compared to the anesthesiologists who performed 5 or less caudal epidural insertions per month.

#	Item	n	%
1	The devices used to access epidural space		
	Needles		
	Hollow needle, non-specified	157	96.9
	Stylleted needle	2	1.2
	Tuohy needle	2	1.2
	Butterfly needle	1	0.6
	Catheters, non-specified	162	100.0
2	The gauge sizes		
	18G	8	4.9
	20G	12	7.4
	22G	122	75.3
	24G	24	14.8
3	The method used for ensuring accurate placement of needles, catheters, local anesthetics, additives, and adjuncts in the epidural space		
	Aspiration before injection	104	64.2
	Needle passage through the sacrococcygeal ligament	68	42.0
	Ease of cannula advancement into the caudal epidural space	57	35.2
	Injection of local anesthetic into caudal epidural space	46	28.4
	Air injection into caudal epidural space	46	28.4
	Saline injection into caudal epidural space	31	19.1
	Swoosh test	10	6.2
	Ultrasound imaging	5	3.1
4	Local anesthetics used		
	Bupivacaine	148	91.4
	Lignocaine/lidocaine	26	16.0
	Ropivacaine	6	3.7
	Levobupivacaine	1	0.6
5	Additives and adjuncts		
	Ketamine	151	93.2
	Opioids	96	59.3
	Midazolam	7	4.3
	Dexamethasone	6	3.7
	Clonidine	3	1.9
6	The upper age limit for the usage of caudal epidural anesthesia in children		
	3 months	2	1.2
	6 months	2	1.2
	1 year	7	4.3
	2 years	14	8.6
	3 years	9	5.6
	4 years	82	50.6
	5 years	2	1.2
	6 years	4	2.5
	7 years	1	0.6
	8 years	1	0.6
	10 years	8	4.9
	12 years	1	0.6
	13 years	2	1.2
	14 years	1	0.6
	15 years	1	0.6
	No Limit	25	15.4
7	The maximum duration the anesthesiologist leaves the catheter in situ		
	<12 h	99	61.1
	Up to 24 h	60	37.0
	Up to 36 h	3	1.9
8	The methods used to provide asepsis for single-shot caudal epidural		
Co	ntinued		

Item	n	%
Gloves, gowns, and masks	93	57.4
Gloves only	61	37.7
No touch technique	4	2.5
Gloves and masks	5	3.1
Scrubbing the site of insertion with chlorhexidine	2	1.2

Table 2. Pediatric caudal epidural block practices reported by the anesthesiologists.

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The anesthesiologists who received formal training on caudal epidural anesthesia during specialty education/ training were more likely to inject saline into the caudal epidural space to ensure accurate placement of needles, catheters, local anesthetics, additives, and adjuncts in the epidural space (Chi-square test = 16.9, p-value < 0.001), leave the catheter in situ for up to 24 h (Chi-square test = 4.8, p-value < 0.05), and less likely to use opioids (Chisquare test = 6.1, p-value < 0.05) compared to those who received on-site training.

### Discussion

An accumulating body of anecdotal evidence suggested large variations in the techniques, local anesthetics, additives, and adjuncts used in pediatric regional anesthesia<sup>4,10,11</sup>. Little was reported on the practices of anesthesiologists regarding pediatric caudal epidural anesthesia in resource-limited settings. For the first time, a survey was conducted among anesthesiologists in the Palestinian healthcare system to report the current state of pediatric caudal epidural anesthesia practice. The findings of this study showed variations in the techniques, local anesthetics, additives, and adjuncts used in pediatric caudal epidural blocks. These findings could be informative to anesthesiologists, decision-, and policymakers who could be interested in improving regional anesthesia practices in children through developing and adopting evidence-based guidelines and standardized techniques for performing caudal epidurals in children. In addition, more resources can be allocated to increase the use of ultrasound imaging to guide caudal epidural blocks in children. The use of ultrasound can increase the safety and quality of caudal epidural blocks in children<sup>16</sup>.

Needle techniques were used to access the caudal epidural space in the first caudal epidural pediatric anesthesia<sup>17-21</sup>. Although needles continued to be used for a long time, recent surveys have reported that needles and catheters are predominantly used by anesthesiologists to access the caudal epidural space and inject anesthetics, additives, and adjuncts in pediatric patients<sup>4,10,11</sup>. In this study, needles and catheters of different gauge sizes were used by the anesthesiologists. It is noteworthy to mention that little was disseminated on the practical aspects of accessing the caudal epidural space in pediatric patients<sup>20,22,23</sup>. Similarly, the outcomes of using needles and catheters in pediatric caudal epidural anesthesia were not compared before<sup>10</sup>. The appropriate gauge size for performing a pediatric caudal epidural block depends on the age, weight, and size of the child. In practice, anesthesiologists often use gauges in sizes 22-24G for infants<sup>4,10,11</sup>. For older children, gauges in sizes 20-22G are more suitable<sup>24,25</sup>. It is noteworthy to mention that the length of the needle should be appropriate for the depth of the sacral canal, which can vary based on the anatomy of the pediatric patient. Therefore, the anesthesiologists should ensure that the needle does not pass through the sacral canal and enter the spinal cord, which can cause serious complications. Previous studies have shown that the use of incorrect tools including needles of inappropriate sizes and lengths resulted in avoidable neurological problems<sup>4</sup>. In this study, local anesthetics, additives, and adjuncts were injected into the caudal epidural space using catheters (flexible plastic cannulas). The findings reported in this study were consistent with those reported in a survey of anesthesiologists in the UK<sup>10</sup>. Injection of local anesthetics, additives, and adjuncts in the caudal epidural space using catheters can reduce the risk of injury, allow better drug distribution, increase safety, and improve patient comfort<sup>26–29</sup>. The flexible plastic cannulas are blunt-tipped, have a flexible tube, and therefore are less likely to cause damage to the nerve roots compared to needles. Additionally, flexible plastic cannulas can be guided accurately and precisely to the caudal epidural space, thus, allowing the positioning of the local anesthetics closer to the nerve roots. Moreover, flexible plastic cannulas can be secured in place, thus, reducing the risk of accidental dislodgement and/or movement during the procedure. Because of these advantages, anesthesiologists use flexible plastic cannulas in pediatric caudal epidural anesthesia. Previous surveys reported that anesthesiologists used hollow needles, stylletted needles, Tuohy needles, and butterfly needles in pediatric caudal anesthesia<sup>10,30</sup>. Each of these needles has its specific advantages and disadvantages. Therefore, the anesthesiologists might decide on which device to use based on the specific circumstances of the case. Moreover, developing and adopting evidence-based guidelines and recommendations might help promote congruence.

The anesthesiologists in this study reported that they used different methods for ensuring the accurate placement of needles, catheters, local anesthetics, additives, and adjuncts in the epidural space. Aspiration before injection, needle passage through the sacrococcygeal ligament, and ease of the cannula advancement into the caudal epidural space were the most commonly reported methods used by anesthesiologists. Similar to the anesthesiologists in the UK, the anesthesiologists who were included in this study rarely used the Swoosh test and ultrasound imaging<sup>10,31</sup>. The use of this technique was previously shown to be associated with hemodynamic instabilities and neurological issues<sup>32,33</sup>. Despite being considered an unsafe practice, 46 (28.4%) of the anesthesiologists in this study reported injecting air into the epidural space<sup>32</sup>. The percentage of anesthesiologists who reported using this risky technique in this study was higher than that reported in the UK<sup>10</sup>. Injecting air into the epidural space in pediatric patients can be associated with venous air embolism<sup>34</sup>. The use of this unsafe practice can be explained by perceived convenience and familiarity. Moreover, some anesthesiologists might

believe that using air provides a clearer indication of the epidural space. In addition, this study was conducted in resource-limited settings where the majority of the anesthesiologists lacked access to ultrasound imaging for performing caudal epidurals in children. Future studies might be conducted to explore the motives of the anesthesiologists behind these practices.

While the techniques reported by anesthesiologists may provide indications for accurate placement of needles, catheters, local anesthetics, additives, and adjuncts in the epidural space, ultrasound imaging is widely recognized as the most reliable method for ensuring accurate placement of needles, catheters, local anesthetics, additive and adjuncts in the epidural space<sup>35</sup>. Using ultrasound imaging in guiding pediatric caudal epidural anesthesia can increase the success rate, decrease complications, and help detect anatomical anomalies<sup>4,34–37</sup>. However, the anesthesiologists who were included in this study reported infrequent use of this helpful technique<sup>4,38</sup>. The findings reported in this resource-limited setting were comparable to those reported in the UK<sup>10,39</sup>. These findings were not surprising because of the limited availability, higher costs, time restraints, and need for special training on using ultrasound imaging in pediatric caudal epidural anesthesia.

In general, local anesthetics can be associated with higher rates of adverse effects including cardiotoxicity and neurotoxicity in pediatric patients compared to adults<sup>40</sup>. The higher incidence of adverse effects and toxicity of local anesthetics in pediatric patients can be explained by the immaturity of the cytochrome P450 enzyme system that is responsible for the metabolism of local anesthetics like bupivacaine and ropivacaine<sup>4,41</sup>. In addition, binding to plasma proteins and intrinsic clearance are important factors to consider in the toxicokinetics of local anesthetics<sup>41</sup>. A previous report showed that neonates were prone to bupivacaine-induced cardiac toxicity<sup>42</sup>. Moreover, ropivacaine has fewer toxic potentials compared to bupivacaine<sup>41</sup>. In this study, the vast majority of the anesthesiologists reported using bupivacaine. These findings were consistent with those previously reported by anesthesiologists<sup>4,10,11</sup>. In this study, only 1 anesthesiologist reported using levobupivacaine. It is noteworthy to mention that bupivacaine can cause prolonged motor block compared to ropivacaine or levobupivacaine<sup>43</sup>. Probably the popular use of bupivacaine compared to levobupivacaine can be explained by the cheaper cost of bupivacaine, particularly in resource-limited settings.

Adjuncts are often used with local anesthetics to prolong their duration of postoperative analgesia. Clonidine was previously reported as one of the most commonly used adjuncts to local anesthetics in pediatric caudal epidural anesthesia<sup>4,10</sup>. Contrarily, clonidine was reported to be infrequently used by the anesthesiologists in this study. On the other hand, ketamine and opioids were the most commonly reported additives and adjuncts used by anesthesiologists in pediatric caudal epidural anesthesia. Previous studies have suggested that combining ketamine with local anesthetics can prolong postoperative analgesia compared to clonidine<sup>44,45</sup>. On the other hand, ketamine was previously linked to neurotoxicity<sup>46</sup>. Similarly, the use of opioids was previously shown to be associated with adverse effects including pruritus, nausea, vomiting, urinary retention, and respiratory depression<sup>47</sup>. In this study, some anesthesiologists also reported using midazolam. Midazolam is a short-acting benzodiazepine adjunct used in regional anesthesia, including epidural anesthesia<sup>48</sup>. Previous studies have shown that midazolam has analgesic effects when epidurally administered with bupivacaine<sup>49,50</sup>. It has been argued that epidural midazolam could be associated with sedation and hypotension, however, the safety and efficacy of epidural midazolam were not established in children<sup>48</sup>.

Although about half of the anesthesiologists indicated that the upper age limit for using caudal epidural anesthesia in children was 4 years, the findings of this study showed an observable variability in the answers of the anesthesiologists. In the UK, more anesthesiologists reported that the upper age limit for using caudal epidural anesthesia in pediatric patients was 1 year<sup>10</sup>. However, previous studies have indicated that caudal epidurals can be safely administered to children weighing up to 50 kilograms<sup>51,52</sup>. The majority of the anesthesiologists reported that they often leave the catheter in situ for less than 12 h. The anesthesiologists in the UK reported that they often leave the catheter in situ for longer periods<sup>10</sup>. The findings of this study also showed that the practices of the anesthesiologists varied by gender, experience, and training. Taken together, these results indicate significant variation in the practice of pediatric caudal epidural blocks among anesthesiologists in different settings.

More than half of the anesthesiologists in this study reported that they used gloves, gowns, and masks (full aseptic technique) for single-shot caudal epidural blocks. The anesthesiologists in the UK reported higher adherence to the full aseptic technique for single-shot caudal epidural blocks<sup>10</sup>. Although these findings indicate variation in adherence to full aseptic techniques in different settings, few studies were conducted to determine the optimal aseptic practices while performing pediatric caudal epidural anesthesia. The Association of Anesthetists of Great Britain and Ireland recommended adherence to full aseptic techniques (complete hand washing, using caps, gowns, and masks, large sterile drape, and scrubbing the site of insertion by chlorhexidine or iodine) when performing spinal, epidural, or caudal procedures<sup>4,53</sup>. Although previous studies have shown that it was uncommon for pediatric patients to suffer central neuraxial infections like meningitis, epidural abscess, or systemic sepsis after receiving caudal epidural blocks, it has been argued that adherence to full aseptic techniques can reduce the incidence of infections following caudal epidural blocks<sup>30,54</sup>.

#### Strengths and limitations of the study

The findings of this study should be interpreted after considering the following strengths and limitations. First, this is the first study that was conducted to describe pediatric caudal epidural anesthesia practices in resourcelimited settings. Understanding the current practices of anesthesiologists is a prerequisite to informing decisions and policies that might be implemented to improve the safety of practices in this fragile group of patients. Second, a good response rate was obtained in this study. Additionally, the anesthesiologists who responded to this study were diverse in terms of gender, type of hospital in which they practiced, number of pediatric caudal epidural blocks performed, and training received on caudal access in children. This diversity should have improved the representativeness of the anesthesiologists practicing in Palestine. Third, the study tool used in this study was based on previous studies that were conducted elsewhere. This should have allowed comparing and contrasting practices in different settings.

On the other hand, the study had some limitations. First, this study was conducted using a cross-sectional design. Longitudinal studies are more powerful in exposing changes in practice trends over time. Second, the data collected in this study were self-reported by the anesthesiologists. Therefore, desirability and recall bias cannot be excluded. Third, as the study was conducted using an interviewer-administered questionnaire, the interviewers could have used prompts to obtain more details on the practices of the anesthesiologists like the types of hand wash and antiseptics used before they performed pediatric caudal epidural anesthesia. Fourth, success rates and complications association with pediatric caudal epidural blocks performed in the Palestinian practice were not assessed. Future studies might consider assessing success rates and complications associated with pediatric caudal epidural blocks.

# Conclusion

The findings revealed significant variations in the practices of pediatric caudal epidural blocks. These variations could be associated with resource limitations, access to materials, local anesthetics, additives, and adjuncts. The findings of this study could be informative to decision-makers and policymakers who might need to develop and adopt evidence-based guidelines and recommendations to promote congruence in pediatric caudal epidural anesthesia practices and improve patient outcomes. Future studies are still needed to report changes in pediatric caudal epidural anesthesia practices over time. More studies are also needed to report on the success and failure rates, outcomes, and complications of pediatric caudal epidural blocks in resource-limited settings.

### Data availability

All data relevant to this study were included in the results section of this manuscript.

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### Author contributions

RS, MJ, IM, and HH were involved in the conception and design of the work, analysis, and interpretation of data, drafting, and final approval of the manuscript. MA, MZ, AO were involved in the data acquisition, analysis, drafting of the work and final approval of the version to be published. The authors read and approved the final manuscript.

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# **Declarations**

### Ethics approval and consent to participate

This study was conducted in adherence to the local and international ethical principles including those in the Declarations of Helsinki. Ethical approval was obtained from the Institutional Review Boards (IRB) of An-Najah National University. All anesthesiologists provided written informed consent before they answered the questionnaire.

# Competing interests

The authors declare no competing interests.

# Additional information

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