Anaesth Crit Care Pain Med 43 (2024) 101427

Contents lists available at ScienceDirect

Anaesthesia Critical Care & Pain Medicine

journal homepage: www.elsevier.com

Guidelines

Postoperative Pain Management in children: guidance from the Pain Committee of the European Society for Paediatric Anaesthesiology (ESPA Pain Management Ladder Initiative) Part II

Maria Vittinghoff [a,*], Per Arne Lönnqvist [b], Valeria Mossetti [c], Stefan Heschl [a], Dusica Simic [d], Vesna Colovic [e], Martin Hözle [f], Marzena Zielinska [g], Belen De Josè Maria [h], Francesca Oppitz [i], Diana Butkovic [j], Neil S. Morton [k]

[a] Department of Anesthesiology and Intensive Care Medicine, Medical University of Graz, Austria
[b] Paediatric Anaesthesia and Intensive Care, Section of Anaesthesiology and Intensive Care, Dept of Physiology and Pharmacology, Karolinska Institutet, Stockholm, Sweden
[c] Department of Anesthesia and Intensive Care, Regina Margherita Children's Hospital, Città Della Salute e Della Scienza, Torino, Italy
[d] University Children's Hospital, Medical Faculty University of Belgrade, Serbia
[e] Royal Manchester Children's Hospital, Central Manchester University Hospitals, Manchester, United Kingdom
[f] Section of Paediatric Anaesthesia, Department of Anaesthesia, Luzerner Kantonsspital, Luzern, Switzerland
[g] Department of Paediatric Anaesthesiology and Intensive Care, Wroclaw Medical University, Poland
[h] Department of Pediatric Anesthesia, Hospital Sant Joan de Deu, University of Barcelona, Spain
[i] Department of Pediatric Anesthesia, Wilhelmina Children's Hospital, University of Utrecht, The Netherlands
[j] Department of Pediatric Anesthesiology, Reanimatology and Intensive Medicine, Children's Hospital Zagreb, Croatia
[k] Retired Reader in Paediatric Anaesthesia and Pain Management, University of Glasgow, Glasgow, Scotland

ARTICLE INFO

Historique de l'article :
Available online 17 September 2024

Keywords:
Analgesics
Nonopioid drugs
Opioids
Pediatrics
Perioperative pain
Regional anesthesia

ABSTRACT

The ESPA Pain Management Ladder Initiative is a clinical practice advisory based upon expert consensus supported by the current literature to help ensure a basic standard of perioperative pain management for all children. In 2018 the perioperative pain management of six common pediatric surgical procedures was summarised. The current Pain Management Ladder recommendations focus on five more complex pediatric surgical procedures and suggest basic, intermediate, and advanced pain management methods. The aim of this paper is to encourage best possible pain management practice and to support institutions to create their own pain management concepts according to their financial and human resources due to the diversity of clinical settings in Europe. Furthermore, the authors underline that these recommendations are intended for inpatients only.
© 2024 The Authors. Published by Elsevier Masson SAS on behalf of Société française d'anesthésie et de réanimation (Sfar). This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Introduction

Despite efforts to improve perioperative pain management in children during the past decade [1–9], a high proportion of pediatric patients (up to 85% [10]) still suffer moderate to severe postoperative pain and 63% are suffering clinically significant pain when discharged home [11].

The reasons for inadequate perioperative pain management are diverse, differ between institutions and countries [12], and may be influenced by prior pain experience, the age, education, ethnicity, and cultural background of the patient [13], and beliefs of both the patients and the caregivers about pain [14].

A prospective mixed-method cross-sectional multicentre study in Denmark demonstrated that the postoperative pain management strategies did not meet the needs and expectations of the patients [15] because of incongruence between the intention and the implementation of postoperative pain management.

A recently published analysis of data from the multinational Pain registry "PAIN OUT infants" evaluated perioperative pain

* Corresponding author.
E-mail address: maria.vittinghoff@medunigraz.at (M. Vittinghoff).

https://doi.org/10.1016/j.accpm.2024.101427
2352-5568/© 2024 The Authors. Published by Elsevier Masson SAS on behalf of Société française d'anesthésie et de réanimation (Sfar). This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

management after appendectomy and tonsillectomy [16]. The analysis of these data included the use of analgesics and patient-related outcomes (PRO's). More non-opioid analgesics, a single dose of dexamethasone, and fewer opioids resulted in lower postoperative pain scores, fewer adverse effects, and less pain-related functional interference. The data analysis revealed that most children received less than one full daily dose of non-opioid analgesics and up to 31% of patients indicated the desire for additional pain treatment caused by substantial deficits in the concept, application, and dosing of analgesics. This publication underlines the importance of timely and sufficient use of non-opioid analgesics and the additional use of coanalgesic drugs as well as local and regional anesthesia [16,17].

Insufficient pain management leads to immediate distress, delayed recovery, prolonged postoperative pain, and possibly the development of chronic pain [18–20]. Furthermore, it may cause immediate and long-lasting behavior changes during medical treatment especially increased fear and sensitivity to pain [21].

Adequate postoperative pain management consists of patient-tailored and intervention-specific analgesic strategies. Guidelines on perioperative pain management such as the ANZCA [8] and German [9] guidelines give detailed recommendations for the use of certain drugs and methods based on the level of evidence. The recommendations are supplemented by conclusions based on clinical experience and expert opinion. However, they do not provide procedure-specific pain management plans. The aim of the ESPA Pain Ladder initiative is to fill this gap. This document is not a guideline but intends to provide a clinical practice advisory based upon expert consensus and is supported by the current literature to help ensure a basic standard of perioperative pain management for all children.

The purpose of this paper is to support institutions to implement the best possible analgesic treatment for all children in order to meet the postulation of the Convention on the Rights of the Child [22].

Material and methods

In October 2018 the ESPA Pain Committee met in Brussels during the annual ESPA congress and decided to continue with the ESPA Pain Management Ladder Project. Following the ESPA newsletter in December 2018, ESPA members suggested a number of common pediatric surgery procedures for the second set of the ESPA Pain Management Ladders. Based on these suggestions the ESPA Pain Committee decided to create a further set of five Pain Management Ladders. Following a further newsletter, twelve ESPA members volunteered to join the ESPA Pain Management Task Force. The Executive Board of ESPA has approved this project. In March 2019 the author's instructions were distributed and teams of three task force members created a new Pain Management Ladder. Each team comprised of pediatric anesthetists experienced in perioperative pain management of children from different parts of Europe. The aim was to provide a multimodal analgesic treatment approach including local and regional anesthetic techniques [23–28].

In September 2019 the Task Force met in Rotterdam to develop a consensus on controversial points in the first draft. Due to the pandemic situation, the consensus process was slowed down and had to be continued online. In May 2022 the final draft was displayed in the members section of the ESPA website for review and comment by ESPA members. The suggestions of the ESPA members were discussed and incorporated by the Task Force and approved by the Executive Board of ESPA.

The aims of the ESPA Pain Management Ladders and how to use them in daily practice were discussed in detail in the first publication [1]. The basic level should be achievable using drugs and methods that are safe, easy to use, and available in all institutions where complex operations are performed. This should be regarded as the minimal standard of care that needs to be provided before starting to perform these procedures in an institution. The intermediate and advanced levels are suggestions to help an institution create patient-tailored pain management for specific operations. Elective major procedures should only be performed in an institution if adequate postoperative pain management can be provided and this includes intravenous administration of opioids and non-opioid drugs in the ward. The first goal is to evaluate the existing pain management regimes using age-adapted monitoring tools, adjust the pain management if necessary, and re-evaluate for further improvement. The secondary goal is to climb up the pain ladder as far as possible using all available resources optimally including drugs, methods, and staff.

Recommendations

Local and regional anesthesia plays a major role at all three levels of the recommendations. In institutions with limited availability of ultrasound machines, caudal block or a number of peripheral nerve blocks such as femoral or fascia iliaca block may be safely performed using landmark techniques by an experienced pediatric anesthetist. Upper and lower extremity blocks may be performed with a nerve stimulator. However, ultrasound support should be used whenever available [29–31]. The authors recommend that regional blocks such as abdominal wall blocks (TAP or quadratus lumborum block) for safety reasons should only be performed if ultrasound guidance is available [32,33]. Furthermore, nerve stimulators do still have a place in the situation of "deep and steep blocks", *e.g.* lumbar plexus blocks. This frequently is referred to as "the dual guidance technique" [34]. The authors advocate the use of regional blocks that are well-established and frequently used in the perioperative treatment of pediatric patients. These blocks are considered safe when performed by an experienced pediatric anesthetist. In the last decade, a number of new peripheral blocks, *e.g.*, erector spinae plane block have been introduced which may have a place in specialized centers and for particular indications such as in patients with coagulation disorders [35–38].

In perioperative pediatric pain management, adjuncts are added to the local anesthetics to potentiate and prolong the local and regional effects of these drugs [39,40]. The most frequently used adjuvant is clonidine which can be safely used via the epidural and peripheral perineural route. For caudal blocks, preservative-free ketamine/S-ketamine and alpha-2 agonists (clonidine and dexmedetomidine) have been shown to be effective adjuncts in meta-analyses. Dexmedetomide may also be used when performing peripheral nerve blocks in children [41]. In epidural anesthesia, the rostral spread of the relatively water-soluble preservative-free morphine is used for special indications to achieve control of higher segmental pain [42–44]. If morphine is used via the epidural route, adequate monitoring (including pulse oximetry) must be provided in the postoperative period [42–44].

Non-opioid and co-analgesic drugs

The consistent intra- and postoperative use of non-opioid drugs (primarily NSAIDs, metamizole, and paracetamol) has an opioid-sparing effect [9,45]. Non-opioids together with opioids and local/regional anesthesia are the cornerstones of intraoperative pain management and are the main pier of postoperative pain management. The combined use of one or two different non-

opioid drugs together with local/regional anesthesia offers the possibility of total avoidance of intra- and postoperative opioids in special settings and for certain indications such as cleft lip and palate repair [46,47].

Intravenous lidocaine may be used during the procedure and in the early postoperative period, however, it needs adequate monitoring (continuous cardiac monitoring and patient observation) [48–50]. In situations and settings where regional anesthesia cannot be performed or is contraindicated, it could be used as part of a multimodal analgesic approach.

The intraoperative intravenous administration of alpha 2-agonists or ketamine has an opioid-sparing effect. It reduces the risk of respiratory impairment during recovery [51,52]. Furthermore, the additional sedation provided by alpha 2-agonists or ketamine reduces agitation in the recovery room [53–57]. Ketamine is widely available and can easily be used intraoperatively in a number of procedures and at all levels of the ESPA Pain Management Ladders [58]. Furthermore, intravenous methylprednisolone or dexamethasone are known to reduce postoperative swelling. Several studies have demonstrated, that intraoperative intravenous administration of dexamethasone prolongs the analgesic effect of single-shot regional blocks [59,60].

Intra- and postoperative use of opioids

Intraoperative opioids should be used with caution (details see Table 6) and titrated to effect. The administration of opioids increases the risk of postoperative respiratory impairment and

Table 1
Cleft lip and cleft palate repair.

Cleft lip and cleft palate		
	Intraoperative	**Postoperative**
Basic level	Intravenous fentanyl or opioid of choice in divided doses Local wound infiltration of the surgical field (by the surgeon) of a long acting local anesthetic a) Rectal NSAID [79,80] and/or b) Rectal paracetamol [81]	PACU: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain. Ward a) Rectal, oral or (if available) intravenous NSAID [47,82] and/or* b) Rectal, oral or (if available) intravenous paracetamol in adequate dosing during the entire postoperative period Oral, rectal or intravenous Tramadol or Intravenous nalbuphine# or other suitable agent (if available) as rescue&
Intermediate Level	Intravenous fentanyl or opioid of choice in divided doses Local wound infiltration of the surgical field (by the surgeon) of a long-acting local anesthetic a) Rectal or intravenous NSAID and/or b) Rectal or intravenous paracetamol [83]	PACU: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain Ward&: a) Rectal, oral or intravenous NSAID during the entire postoperative period [47,84] and/or* b) Rectal, oral or intravenous paracetamol during the entire postoperative period Oral, rectal or intravenous Tramadol or Intravenous nalbuphine# or other suitable agent (if available) as rescue&
Advanced Level	- a) Rectal or intravenous NSAID and/or b) Rectal or intravenous paracetamol Regional Anesthesia of the maxillary$^{\alpha}$ nerve at various locations with a long-acting local anesthetic. For cleft lip bilateral infraorbital nerve block [46,47,85–95] - In case of failed regional block: Fentanyl or opioid of choice in divided doses or if available continuous remifentanil or opioid of choice	PACU: - Intravenous fentanyl or other suitable agent (if available) to treat breakthrough pain. - Ward&: - a) Rectal, oral or intravenous NSAID during the entire postoperative period and/or* - b) Rectal, oral or intravenous paracetamol during the entire postoperative period Oral, rectal or intravenous Tramadol or - Intravenous nalbuphine# or other suitable agent (if available) as rescue&
Comments	$^{\alpha}$ Additional infiltration of soft palate with long acting local anesthetic might be necessary If available consider at all levels: Metylprednisolone or dexamethasone to reduce postoperative swelling [96] and Intraoperative addition of alpha 2-agonists [57,97] and / or Intraoperative addition of ketamine as co-analgesic drug [97] Development of procedure-specific ERAS protocol [98,99]	* Combination of NSAID and paracetamol reduces opioid use and will be useful if iv-rescue is not available & Aim for oral administration as soon as possible # In infants, for older children available opioid of choice & In institutions where metamizole is available it should be used as first line rescue analgesic.

Table 2
Correction of congenital hip dislocation.

Correction of congenital hip dislocation		
	Intraoperative:	**Postoperative:**
Basic level:	Intravenous fentanyl or opioid of choice in divided doses - Local wound infiltration of the surgical field (by the surgeon) of a long acting local anaesthetic a) Rectal NSAID and/or b) Rectal paracetamol	PACU: - Intravenous fentanyl or other suitable agent (if available) to treat serious break-through pain in Ward[&]: - a) Rectal, oral or (if available) intravenous NSAIDs and/or* - b) Rectal, oral or (if available) intravenous paracetamol during the entire postoperative period and Oral, rectal or intravenous Tramadol or other suitable agent (if available) as rescue[§]
Intermediate level:	a) Rectal or intravenous NSAID and/or b) Rectal or intravenous paracetamol and c) Regional anesthesia[α] with a long-acting local anesthetic combined with appropriate adjunct (clonidine) Landmark-based caudal block or epidural block[#] or Femoral nerve block (in femoral osteotomy only) or Fascia iliaca compartment block [100] d) If regional anesthesia is contraindicated: intravenous fentanyl or opioid of choice in divided doses	PACU. Intravenous fentanyl or other suitable agent (if available) to treat break-through pain Ward[&]: a) Rectal, oral or intravenous NSAID during the entire postoperative period and/or* b) Rectal, oral or intravenous paracetamol during the entire postoperative period and c/d) Oral, rectal or intravenous tramadol or other suitable agent (if available) as rescue. [§]
Advanced level:	- a) Rectal or intravenous NSAID and/or - b) Rectal or intravenous paracetamol and - c) Ultrasound-guided continuous peripheral block with a long-acting local anesthetic combined with appropriate adjunct (clonidine): • Femoral block (in femoral osteotomy only) or • Lumbar plexus block or • Suprainguinal fascia iliaca block or quadratus lumborum block [101,102] combined with psoas compartment block - d) Continuous epidural block with a long-acting local anesthetic combined with appropriate adjunct (clonidine). e) If regional anesthesia is contraindicated or unsuccessful • Fentanyl or opioid of choice in divided doses or if available • Continuous remifentanil or opioid of choice	PACU: Intravenous fentanyl or other suitable agents to treat break-through pain. Ward[&]: a/b) Intravenous/oral NSAID during the entire postoperative period and/or Intravenous/oral paracetamol in during the entire postoperative period plus c/d) Continuous nerve block or patient controlled regional anesthesia [103–106] or e) If continuous nerve block is contraindicated or unsuccessful Intravenous tramadol or other suitable agent (if available) as rescue[§] or Consider iv-PCA (patient controlled analgesia) including adequate monitoring [107]
Comments:	[#] Depending in the age of the patient. Caudal block for Infants and toddlers, lumbar epidural for older children. [α] If available ultrasound guidance should be used. If available consider at all levels: • Metylprednisolone or dexamethasone to reduce postoperative swelling [96] and • Intraoperative addition of alpha 2-agonists [57,97] and / or • Intraoperative addition of ketamine as co-analgesic drug [97] Development of procedure-specific ERAS protocol [65,108]	[*] Combination of NSAID and paracetamol reduces opioid use and will be useful if iv-rescue is not available. [&] Aim for oral administration as soon as possible. [§] In institutions where metamizole is available it should be used as first line rescue analgesic.

Table 3
Nissen fundoplication (open and laparoscopic).

Nissen fundoplication (open and laparoscopic)		
	Intraoperative:	***Postoperative:***
Basic level:	Intravenous fentanyl or opioid of choice in divided doses Local wound infiltration/local port-side infiltration with long acting local anesthetic [109] or Intravenous lidocaine [110–116] a) Rectal NSAID and/or b) Rectal paracetamol.	PACU: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain. Ward[&]: a) Rectal, oral or (if available) intravenous NSAIDs during the entire postoperative period and/or* b) Rectal, oral or (if available) intravenous paracetamol during the entire postoperative period Oral, rectal or intravenous tramadol or other suitable agent (if available) as rescue.
Intermediate level:	a) Rectal or intravenous NSAID or if not available rectal or intravenous paracetamol and/or b) Intravenous loading dose of metamizole (if available) plus - c) Regional anesthesia with a long-acting local anesthetic combined with appropriate adjunct • Ultrasound-guided bilateral peripheral block (subcostal TAP or quadratus lumborum block) [α] combined with appropriate adjunct (clonidine) (endoscopic) [117–119] • Landmark-based caudal blockade with long-acting local anaesthetics +/- adjunct (morphine if available[#]) - d) If regional anesthesia is contraindicated or unsuccessful: intravenous fentanyl or opioid of choice in divided doses	PACU: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain. Ward[&]: a) Oral or Intravenous NSAID or paracetamol during the entire postoperative period and/or* b) Oral or Intravenous metamizole (if available) during the entire postoperative period[§] c/d) Oral, rectal or intravenous tramadol or other suitable agent if available as rescue in the ward
Advanced level:	a) Intravenous NSAID or if not available rectal or intravenous paracetamol and/or b) Intravenous loading dose of metamizole (if available) Regional anesthesia c) Ultrasound-guided bilateral peripheral block (subcostal TAP or quadratus lumborum block combined with appropriate adjunct (clonidine) (endoscopic) d) Continuous thoracic epidural analgesia with long acting local anesthetic combined with appropriate adjunct (clonidine) (open) [120–122] e) If regional anesthesia is contraindicated: • Fentanyl or opioid of choice in divided doses or if available • Continuous remifentanil or opioid of choice	PACU: Intravenous fentanyl or other suitable agent to treat break-through pain. Ward[&]: a) Intravenous NSAID or paracetamol in adequate dosing during the entire postoperative period and/or* b) Intravenous metamizole in adequate dosing during the entire postoperative period[§] c/d/e) Intravenous tramadol or other suitable agent if available as rescue in the ward or c/e) Consider iv-PCA (patient controlled analgesia) including adequate monitoring (endoscopic) [123] d) Continuous epidural (patient controlled regional anesthesia) including adequate monitoring (open)
Comments:	[#] Only for open fundoplication in infants and small toddlers if adequate monitoring (pulse oximetry) is available for 24 h [α] For safety reason abdominal wall blocks should not be performed without ultrasound guidance If available consider at all levels: Metylprednisolone or dexamethasone to reduce postoperative swelling [96] and Intraoperative addition of alpha 2-agonists [57,97] and / or Intraoperative addition of ketamine as co-analgesic drug Development of procedure-specific ERAS protocol [64]	* Combination of NSAID and paracetamol might be useful if iv-rescue is not available [&] Aim for oral administration as soon as possible [§] A combination of two non-opioid drugs (NSAID, metamizole paracetamol) should always be used to reduce the need of an opioid rescue analgesic. In abdominal surgery metamizole (if available) should, due to its spasmolytic effect, be preferred over paracetamol.

PONV [61]. The intraoperative administration of PONV prophylaxis is highly recommended as part of an ERAS protocol (Enhanced recovery after surgery) [62–65]. The intraoperative continuous use of remifentanil is controversial since it can be associated with postoperative hyperalgesia. A recently published systematic review and meta-analysis suggests that the withdrawal of remifentanil at the end of the procedure induces a mild degree of hyperalgesia that is not clinically relevant, likely linked to a reduced pain threshold. The administration of a longer-acting opioid towards the end of the procedure as a pre-emptive postoperative dose can help to avoid a gap between intra- and postoperative analgesia [66]. According to the type of operation and the preferred age for the procedure, the ESPA Pain Committee recommends certain opioids for postoperative pain management in the ward [12,67]. These suggestions reflect the most frequently used pain management regimens supported by the literature for a given type of operation. A detailed listing of possible drugs is attached in the tables below. After major operations, children should be managed for at least 24–48 hours in a setting where intravenous opioid administration and adequate monitoring are possible (minimum care - pulse oximetry and clinical observation, preferably - high to intermediate care). In the general ward, an oral opioid should be made available for basic-level care, with an oral and intravenous opioid for intermediate and advanced levels. In certain procedures, intravenous patient-controlled analgesia (iv-PCA) may be an option in advanced-level care [68,69].

Table 4
Thoracoscopy / Thoracotomy.

Thoracoscopy/Thoracotomy		
	Intraoperative:	***Postoperative:***
Basic level:	Intravenous fentanyl or opioid of choice in divided doses Local wound infiltration/local port-side infiltration with long acting local anesthetic or Intravenous lidocaine [110–116] a) Rectal NSAID and/or - b) Rectal paracetamol.	PACU: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain. Ward[&]: a) Rectal, oral or (if available) intravenous NSAID and/or* b) Rectal, oral or (if available) intravenous paracetamol during the entire postoperative period Oral and intravenous morphine or other suitable agent (if available) as rescue including adequate monitoring (pulse oximetry)
Intermediate level:	Intravenous fentanyl or opioid of choice in divided doses a) Rectal or intravenous NSAID or if not available rectal paracetamol and/or b) intravenous loading dose of metamizole (if available) Regional anesthesia[α]: c) Landmark based intercostal block or d) Paravertebral block (single shot) with a long acting local anesthetic combined with appropriate adjunct (clonidine) if available [124,125]	PACU: Intravenous fentanyl or other suitable agent to treat break-through pain Ward[&]: a) Oral or intravenous NSAID or paracetamol during the entire postoperative period and/or[#] b) Oral or Intravenous metamizole (if available) during the entire postoperative period c/d) Intravenous morphine or other suitable agent if available as rescue including adequate monitoring (pulse oximetry)
Advanced level:	a a) Rectal or intravenous NSAID or if not available rectal paracetamol and/or b) Intravenous loading dose of metamizole (if available) Regional anesthesia: • c)Ultrasound-guided continuous paravertebral block with a long acting local anesthetic combined with appropriate adjunct (clonidine) if available (thoracoscopic) [126–128] • d) Continuous thoracic epidural analgesia with a long acting local anesthetic combined with appropriate adjunct (clonidine) if available (open) [127,129] - e) If regional anesthesia is contraindicated or unsuccessful: • Fentanyl or opioid of choice in divided doses or if available • Continuous remifentanil or opioid of choice	PACU: Intravenous fentanyl or other suitable agent to treat break-through pain Ward[&]: a) Intravenous NSAID or paracetamol in adequate dosing during the entire postoperative period and/or[#] b) Intravenous metamizole (if available) in adequate dosing during the entire postoperative period c) Continuous regional (patient controlled regional anesthesia) including adequate monitoring (pulse oximetry) [130,131] d) Intravenous morphine or other suitable agent if available as rescue in the ward including adequate monitoring e) Consider iv-PCA (patient controlled analgesia) including adequate monitoring [129,132]
Comments:	[α] If available ultrasound guidance should be used. If available consider at all levels: Metylprednisolone or dexamethasone to reduce postoperative swelling [96] and Intraoperative addition of alpha 2-agonists [57,97] and / or Intraoperative addition of ketamine as co-analgesic drug Development of procedure-specific ERAS protocol [133]	* Combination of NSAID and paracetamol is recommended and might be essential if iv-rescue is not available. [#] A combination of two non-opioid drugs (NSAID, metamizole paracetamol) should always be used to reduce the need of an opioid rescue analgesic. [&] Aim for oral administration as soon as possible

Complex postoperative pain management concepts such as regional analgesia using catheter techniques, intravenous patient-controlled analgesia (PCA), and intravenous opioid administration in the ward can only be recommended if adequate monitoring (pulse oximetry and/or clinical observation) and experienced staff (preferably an Acute Pain Service team) are available around the clock. Depending on the age of the patient, PCA pumps can be programmed for nurse-controlled (NCA) or parent-controlled analgesia modes [70,71]. For details of monitoring and treatment of possible adverse effects of pain management, the ESPA Pain Management Committee suggests following already published recommendations [72–78].

The following Tables 1–6 provide the Pain Management Ladders for 5 frequently performed procedures in children.

Drug suggestions

Table 6 outlines some drug dosage suggestions for different pain management ladder levels. These suggestions are based on the available literature and ESPA does not accept any legal responsibility for these suggestions. As there are marked differences between European Countries concerning the availability and licensing of analgesic drugs the authors recommend that you consult the pharmacopeia of your country before using any of these dosage suggestions. Please be aware of the increased sensitivity to the effects of opioids in patients with obstructive sleep apnoea (OSA) which has been outlined in the previous publication [1]. Furthermore, the authors underline that these recommendations are intended for inpatients only [141–143].

Table 5
Hypospadias repair.

Hypospadias Repair		
	Intraoperative:	***Postoperative:***
Basic level:	- a) Rectal NSAID and/or - b) Rectal paracetamol Landmark-based regional anesthesia with long-acting local anesthetics Penile block [134,135] or bilateral pudendal nerve block [59] or Intravenous lidocaine [110–116]	PACU: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain. Ward[&]: a) Rectal or oral NSAIDs during the entire postoperative period and/or [*] b) Rectal or oral paracetamol during the entire postoperative period. Oral, rectal or intravenous Tramadol or Intravenous nalbuphine[#]or other suitable agent (if available) as rescue
Intermediate level:	a) Intravenous or rectal NSAID. and/or b) Intravenous loading dose of intravenous paracetamol. c) Alternative: loading dose of metamizole . Landmark-based or ultrasound guided caudal block[α] with long-acting local anesthetics +/- adjunct (clonidine) if available [136–138].	Ward[&]: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain. a) Oral or intravenous NSAID during the entire postoperative period and/or b) Oral or intravenous paracetamol during the entire postoperative c) Oral or intravenous metamizole during the entire postoperative period. - Oral, rectal or intravenous Tramadol or Intravenous nalbuphine[#] or other suitable agent (if available) as rescue
Advanced level:	a) Intravenous or rectal NSAID. and/or b) Intravenous or rectal paracetamol. c) Alternative: loading dose of metamizole Regional anaesthesia [β] d) Ultrasound guided caudal block [139] or e) Continuous lumbar epidural block with long-acting local anaesthetics combined with appropriate adjunct.[γ] f) If regional anesthesia is contraindicated or unsuccessful: Fentanyl or opioid of choice in divided doses or if available Continuous remifentanil or opioid of choice	PACU: Intravenous fentanyl or other suitable agent (if available) to treat break-through pain. Ward[&]: a) Oral or intravenous NSAIDs and/or b) Paracetamol during the entire postoperative period. - c) Intravenous or oral metamizole during the entire postoperative period. - d,f) Intravenous nalbuphin[#]or other suitable agent (if available) as rescue or - d,f) In major reconstructive surgery consider iv-PCA (patient controlled analgesia) including adequate monitoring - e) In case of epidural catheter: patient controlled regional anesthesia including adequate monitoring.
Comments	[α] If available ultrasound guidance should be used. [β] depends on the degree of Hypospadias and the type of operation [γ] Might be an option in severe proximal / perineal abnormalities If available consider at all levels: Metylprednisolone or dexamethasone to reduce postoperative swelling [59,96] and Intraoperative addition of alpha 2-agonists [57,97] and / or Intraoperative addition of ketamine as co-analgesic drug Development of procedure-specific ERAS protocol [140]	[#]In infants, for order children use opioid of choice

Table 6
Dosage suggestions.

	Dosage Suggestions
Rectal NSAIDs (Non-steroidal anti-inflammatory drugs)	
Ibuprofen	10 mg kg^{-1} every 8 h
Diclofenac	0.5–1 mg kg^{-1} every 8 h
Naproxen	5 to 7.5 mg kg^{-1} every 12 h
Oral NSAIDs	
Ibuprofen	10 mg kg^{-1} every 8 h
Diclofenac	1 mg kg^{-1} every 8 h
Intravenous NSAIDs	
Ketorolac	0.5–1 mg kg^{-1} kg up to 30 mg for a single intraoperative dose 0.15–0.2 mg kg^{-1} (max10 mg) every 6 h (short term therapy, maximum 48 h)
Ketoprofen	1 mg kg^{-1} every 8 h
Ibuprofen	10 mg kg^{-1} every 8 h
Rectal paracetamol (if rectal NSAID is not available)	
Paracetamol	20–40 mg kg^{-1} (15 mg kg^{-1} if< 10 kg) Single loading dose in association with anaesthesia; the higher dose is due to poor bioavailability from rectal route of administration
Oral paracetamol	
Paracetamol	10 to 15 mg kg^{-1} every 6 h (max daily dose: 60 mg/kg)
Intravenous paracetamol	
Paracetamol	loading dose: 15–20 mg kg^{-1} (Intravenous preparation: 10 mg ml^{-1}) 10–15 mg kg^{-1} every 6–8 hours
Intraoperative Opioids depending on age of the patient and the type of procedure	
Fentanyl	1–2 micrograms kg^{-1}
Morphine	25 to 100 micrograms kg^{-1} depending on age, titrated to effect
Piritramide	0.05 to 0.15 mg kg^{-1}
Alfentanil	10 to 20 micrograms kg^{-1}
Sufentanil	0.5–1 micrograms kg^{-1} bolus
Sufentanil	0.5–1 micrograms kg^{-1} bolus, continuous infusion of 0.5–1 micrograms kg^{-1} h^{-1}
Remifentanil	0.05 to 0.3 micrograms kg^{-1} min^{-1}
Intraoperative use of Ketamine/S-Ketamine	
Ketamine	0.5 mg kg^{-1} may be used as adjunct to intraoperative opioids, consider reduced dose (0.25–0,5 mg $kg^{-1)}$ when using S-ketamine, optional followed by continuous infusion of 0.1 – 0.2 mg kg^{-1} h^{-1} (max: 0.4 mg kg^{-1} h^{-1})
Intraoperative use of Co-analgesic Drugs	
Lidocaine	intravenous bolus: 1.5 mg kg^{-1}, continuous infusion 1.5 mg/ kg^{-1} h^{-1} until the end of the procedure
Methylprednisolone	1 mg kg^{-1}
Dexamethasone	0.15–0.25 mg kg^{-1} (max: 0.5 mg kg^{-1})
Clonidine	intravenous bolus: 1–3 micrograms kg^{-1}
Dexmedetomidine	intravenous bolus: 0.5–1 micrograms kg^{-1}, continuous infusion 0.2–0.7 micrograms kg^{-1} h^{-1} until the end of the procedure
Intraoperative/postoperative intravenous Metamizole	
Metamizole	10 to 15 mg kg^{-1}every 8 h 2.5 mg kg^{-1} h^{-1} (continuous infusion following an intraoperative loading dose) (Due to the risk of agranulocytosis after long-term use metamizole is recommended for short term postoperative use in a hospital setting only)
Intravenous analgesics for breakthrough pain in PACU depending on age and procedure	
Fentanyl	0.5 to 1.0 micrograms kg^{-1}, titrated to effect
Morphine	25 to 100 micrograms kg^{-1} depending on age, titrated to effect
Tramadol	1 to 1.5 mg kg^{-1}, titrated to effect
Ketamine/S-Ketamine	0.5 mg kg^{-1}, titrated to effect consider reduced dose (0.25–0.5 mg kg^{-1}) when using S-ketamine,
Piritramide	0.05 to 0.15 mg kg^{-1}, titrated to effect
Nalbuphine	< 3 months 0.05 mg kg^{-1} > 3 months 0.1 to 0.2 mg kg^{-1}, depending on age, titrated to effect
Intravenous analgesics for breakthrough pain in the ward, including adequate monitoring	
Tramadol	1 to 1.5 mg kg^{-1}, every 4–6 hours
Nalbuphine	< 3 months 0.05 mg kg^{-1} > 3 months 0.1 to 0.2 mg kg^{-1}, depending on age, every 3–4 hours
Morphine	< 3 months 25–50 micrograms kg^{-1}, every 4–6 hours 3–12 months 50–100 micrograms kg^{-1}, every 4–6 hours 1–5 years 100–150 micrograms kg^{-1}, every 4–6 hours 5–18 years 150–200 micrograms kg^{-1}, every 4–6 hours single dose adjusted according to response
Piritramide	0.05 to 0.15 mg kg^{-1} every 4–6 hours
Metamizole	10 to 15 mg kg^{-1} every 8 h
Oral analgesics for breakthrough pain in the ward	
Tramadol	1–1.5 mg kg^{-1}, every 4–6 hours
Metamizole	10 mg kg^{-1}every 8 h

Table 6 (*Continued*)

	Dosage Suggestions
Morphine	When changing from intravenous to oral administration the daily dose should be increased by 2–3 times due to lower bioavailablilty. <3 months 50–100 micrograms kg^{-1}, every 4–6 hours 3–12 months 100–150 micrograms kg^{-1}, every 4–6 hours 1–5 years 150–200 micrograms kg^{-1}, every 4–6 hours 5–18 years 200–300 micrograms kg^{-1}, (max10 mg) every 4–6 hours single dose adjusted according to response
PCA (patient controlled analgesia) including adequate monitoring	
	Morphine PCA according to institutional standards based on the current literature Fentanyl PCA according to institutional standards based on the current literature Piritramide PCA according to institutional standards based on the current literature

	Dosage Suggestions	**Adjuvant**
Long-acting local anesthetics for wound infiltration, port-side infiltration and peripheral nerve block		
Bupivacaine 0.25 %,	maximum dose 1 ml kg^{-1} (= 2.5 mg kg^{-1})	
Levo-bupivacaine 0.25 %	maximum dose 1 ml kg^{-1} (= 2.5 mg kg^{-1})	
Ropivacaine 0.2 %	maximum dose 1.5 ml kg^{-1} (= 3 mg kg^{-1})	
Long-acting local anesthetics for landmark-based maxillary nerve block and external nasal nerve block		
Bupivacaine 0.25 %	0.15 ml kg^{-1}	
Levo-bupivacaine 0.25 %	0.15 ml kg^{-1}	
Ropivacaine 0.2 %	0.15 ml kg^{-1}	
Long-acting local anesthetics for thoracic epidural block		
Bupivacaine 0.25 %	0.2–0.3 ml kg^{-1} (max10 ml) initially	preservative-free Clonidine 1–2 micrograms kg^{-1}
Levo-bupivacaine 0.25 %	0.2–0.3 ml kg^{-1} (max10 ml) initially	
Ropivacaine 0.2 %	0.2–0.3 ml kg^{-1} (max10 ml) initially	
Long-acting local anesthetics for lumbar epidural block		
Bupivacaine 0.25 %	0.5 ml kg^{-1} (max15 ml) initially	preservative-free Clonidine 1–2 micrograms kg^{-1}
Levo-bupivacaine 0.25 %	0.5 ml kg^{-1} (max15 ml) initially	
Ropivacaine 0.2 %	0.5 ml kg^{-1} (max15 ml) initially	
Long-acting local anesthetics for landmark-based and ultrasound-guided caudal block		
Bupivacaine 0.25 %	1.0 ml kg^{-1}	preservative-free Clonidine 1–2 micrograms kg^{-1} or
Levo-bupivacaine 0.25 %	1.0 ml kg^{-1}	Morphine 30 to 50micrograms kg^{-1} (only with adequate monitoring)
Ropivacaine 0.2 %	1.0 ml kg^{-1}	
Long-acting local anesthetics for ultrasound-guided paravertebral block		
Bupivacaine 0.25 %	0.2–0.5 ml kg^{-1}	preservative-free Clonidine 1–2 micrograms kg^{-1}
Levo-bupivacaine 0.25 %	0.2–0.5 ml kg^{-1}	
Ropivacaine 0.2 %	0.2–0.5 ml kg^{-1}	
Long-acting local anesthetics for nerve stimulator guided femoral nerve block and fascia iliaca block?		
Bupivacaine 0.25 %	0.2–0.5 ml kg^{-1}	preservative-free Clonidine 1–2 micrograms kg^{-1}
Levo-bupivacaine 0.25 %	0.2–0.5 ml kg^{-1}	
Ropivacaine 0.2 %	0.2–0.5 ml kg^{-1}	
Long-acting local anesthetics for ultrasound-guided fascia iliaca and quadratus lumborum block		
Bupivacaine 0.25 %	0.2–0.5 ml kg^{-1}	preservative-free Clonidine 1–2 micrograms kg^{-1}
Levo-bupivacaine 0.25 %	0.2–0.5 ml kg^{-1}	
Ropivacaine 0.2 %	0.2–0.5 ml kg^{-1}	
Long-acting local anesthetics for ultrasound guided rectus sheath block and subcostal TAP:		
Bupivacaine 0.25 %	0.2–0.5 ml kg^{-1} per side	preservative-free Clonidine 1 microgram kg^{-1} per side
Levo-bupivacaine 0.25 %	0.2–0.5 ml kg^{-1} per side	
Ropivacaine 0.2 %	0.2–0.5 ml kg^{-1} per side	
Long-acting local anesthetics for landmark based and ultrasound guided intercostal block		
Bupivacaine 0.25 %	0.1 ml kg^{-1}	preservative-free Clonidine 1–2 micrograms kg^{-1}
Levo-bupivacaine 0.25 %	0.1 ml kg^{-1}	
Ropivacaine 0.2 %	0.1 ml kg^{-1}	
Continuous or patient controlled regional anesthesia including adequate monitoring		
According to institutional standards based on the current literature Continuous rate of Bupivacine 0.25 or Ropivacaine 0.2% (0.1–0.3 ml kg^{-1} h^{-1})		Preservative-free clonidine 0.2 to 0.4 micrograms kg^{-1} h^{-1}

	Dosage Suggestions antiemetic drugs	
Dexamethasone	0.15 mg kg^{-1} every 12 h	
Ondansetron	0.15 mg kg^{-1} every 8 h	not to be combined with tramadol
Metoclopramide	0.1 mg kg^{-1} every 8 h	not to be combined with tramadol; not if <1y old

Discussion

The recommendations of the ESPA pain management ladders are well-established pain management concepts employed in European pediatric surgery centers and their use is well documented by the literature. This document does not claim completeness and does not take into account the special conditions of patients with complex underlying diseases.

The authors are aware of the difficulties in transferring detailed and well-functioning pain management plans between hospitals. Therefore, we would like to emphasize that each institution develops its own institution-specific pain management concepts for each procedure [144,145].

The analysis of real-life data from the Pain registry "PAIN OUT infants" revealed the inadequate administration of non-opioid drugs, which are the main pier of postoperative pain management. It was demonstrated that although the significance of regional anesthesia and the efficacy of non-opioid drugs are well-known implementation of this knowledge often failed even in highly experienced centers. The intention of the authors is to improve daily clinical practice by offering treatment concepts that rely on local/regional anesthesia, the administration of a full daily dose of non-opioid drugs by the clock, and a minimum use of opioids in the postoperative period. The most important way to achieve this is an exact prescription. There has to be a detailed prescription for opioid rescue medication that should include the age- and weight-adapted single dose, the maximum daily dose, and the minimum time interval between doses. Finally, pain management protocols should be regularly evaluated and adapted as needed [146].

For assessment of the efficacy and safety of postoperative pain therapies, age adapted scores are recommended [147–154].

Conclusions

The ESPA Pain Ladder Part II is a continuation of previous recommendations for perioperative pain management in children. This is a synthesis of existing guidelines, taking into account the availability of medications and other resources, economic costs, and patient safety. We hope that the suggestions in this article will further improve pain management in children not only in Europe but also in other parts of the world.

Ethics approval

No ethics approval is required.

Funding

The ESPA Pain Management Ladder project received no external funding.

Conflict of interest

Marzena Zielinska is a member of the editorial board of ACCPM. All other authors declare no conflict of interest.

References

[1] Vittinghoff M, Lönnqvist P-A, Mossetti V, Heschl S, Simic D, Colovic V, et al. Postoperative pain management in children: guidance from the Pain committee of the European Society for Paediatric Anaesthesiology (ESPA Pain Management Ladder Initiative). Pediatr Anesth 2018;28:493–506. http://dx.doi.org/10.1111/pan.13373.
[2] Walther-Larsen S, Aagaard GB, Friis SM, Petersen T, Møller-Sonnergaard J, Rømsing J. Structured intervention for management of pain following day surgery in children. Pediatr Anesth 2016;26:151–7. http://dx.doi.org/10.1111/pan.12811.
[3] Chou R, Gordon DB, de Leon-Casasola OA, Rosenberg JM, Bickler S, Brennan T, et al. Management of Postoperative Pain: A Clinical Practice Guideline From the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. J Pain 2016;17:131–57. http://dx.doi.org/10.1016/j.jpain.2015.12.008.
[4] Walker SM. Pain after surgery in children. Curr Opin Anaesthesiol 2015;28:570–6. http://dx.doi.org/10.1097/ACO.0000000000000227.
[5] Association of Paediatric Anaesthetists of Great Britain and Ireland. Good practice in postoperative and procedural pain management, 2nd edition. Paediatr Anaesth 2012;22(Suppl 1):1–79. http://dx.doi.org/10.1111/j.1460-9592.2012.03838.x.
[6] Howard R, Carter B, Curry J, Morton N, Rivett K, Rose M, et al. Good practice in postoperative and procedural pain management. Background. Paediatr Anaesth 2008;18(Suppl 1):1–3. http://dx.doi.org/10.1111/j.1155-5645.2008.02423.x.
[7] Jaksch W, Messerer B, Baumgart H, Breschan C, Fasching G, Grögl G, et al. [Austrian interdisciplinary recommendations on pediatric perioperative pain management: background, aims, methods and key messages]. Schmerz 2014;28:7–13. http://dx.doi.org/10.1007/s00482-013-1382-2.
[8] Schug SA, Palmer GM, Scott DA, Alcock M, Halliwell R, Mott JF, et al. Acute Pain Management: Scientific Evidence (5th edition). Melbourne: 2020. https://www.awmf.org/leitlinien. [Accessed 12 Sept 2024]
[9] S3-Leitlinie Behandlung akuter perioperativer und posttraumatischer Schmerzen. 2022.
[10] Makhlouf MM, Garibay ER, Jenkins BN, Kain ZN, Fortier MA. Postoperative pain: factors and tools to improve pain management in children. Pain Manag 2019;9:389–97. http://dx.doi.org/10.2217/pmt-2018-0079.
[11] Williams G, Bell G, Buys J, Moriarty T, Patel A, Sunderland R, et al. The prevalence of pain at home and its consequences in children following two types of short stay surgery: a multicenter observational cohort study. Paediatr Anaesth 2015;25:1254–63. http://dx.doi.org/10.1111/pan.12749.
[12] Rabbitts JA, Groenewald CB, Räsänen J. Geographic differences in perioperative opioid administration in children. Paediatr Anaesth 2012;22:676–81. http://dx.doi.org/10.1111/j.1460-9592.2012.03806.x.
[13] Tan H, Mendoza BA, Fortier MA, Kain Z. Perioperative pain disparity in children: a call for action. Paediatr Anaesth 2022;32:1365–7. http://dx.doi.org/10.1111/pan.14557.
[14] Mędrzycka-Dąbrowska W, Dąbrowski S, Basiński A. Problems and barriers in ensuring effective acute and postoperative pain management - an international perspective. Adv Clin Exp Med 2015;24:905–10. http://dx.doi.org/10.17219/acem/26394.
[15] Walther-Larsen S, Pedersen MT, Friis SM, Aagaard GB, Rømsing J, Jeppesen EM, et al. Pain prevalence in hospitalized children: a prospective cross-sectional survey in four Danish university hospitals. Acta Anaesthesiol Scand 2017;61:328–37. http://dx.doi.org/10.1111/aas.12846.
[16] Bernhart K, Becke-Jakob K, Lehmann T, Harnik M, Seiler S, Meissner W, et al. Analgesic use and favourable patient-reported outcome measures after paediatric surgery: an analysis of registry data. Br J Anaesth 2023;130:74–82. http://dx.doi.org/10.1016/j.bja.2022.09.028.
[17] Stamer UM, Bernhart K, Lehmann T, Setzer M, Stüber F, Komann M, et al. "Desire for more analgesic treatment": pain and patient-reported outcome after paediatric tonsillectomy and appendectomy. Br J Anaesth 2021;126:1182–91. http://dx.doi.org/10.1016/j.bja.2020.12.047.
[18] Fortier MA, Chou J, Maurer EL, Kain ZN. Acute to chronic postoperative pain in children: preliminary findings. J Pediatr Surg 2011;46:1700–5. http://dx.doi.org/10.1016/j.jpedsurg.2011.03.074.
[19] Rabbitts JA, Fisher E, Rosenbloom BN, Palermo TM. Prevalence and predictors of chronic postsurgical pain in children: a systematic review and meta-analysis. J Pain 2017;18:605–14. http://dx.doi.org/10.1016/j.jpain.2017.03.007.
[20] Batoz H, Semjen F, Bordes-Demolis M, Bnard A, Nouette-Gaulain K. Chronic postsurgical pain in children: prevalence and risk factors. A prospective observational study. Br J Anaesth 2016;117:489–96. http://dx.doi.org/10.1093/bja/aew260.
[21] Hartmann A, Welte-Jzyk C, Al-Nawas B, Daubländer M. Neurophysiological changes and chronic pain in cleft patients. J Cranio-Maxillofacial Surg 2019;47:1875–80. http://dx.doi.org/10.1016/j.jcms.2019.10.002.
[22] UNICEF. In: Convention on the Rights of the Child; 1990, https://www.unicef.org/child-rights-convention/convention-text.
[23] Yaster M. Multimodal analgesia in children. Eur J Anaesthesiol 2010;27:851–7. http://dx.doi.org/10.1097/EJA.0b013e328338c4af.
[24] Wong I, St John-Green C, Walker SM. Opioid-sparing effects of perioperative paracetamol and nonsteroidal anti-inflammatory drugs (NSAIDs) in children. Pediatr Anesth 2013;23:475–95. http://dx.doi.org/10.1111/pan.12163.
[25] Schug SA, Manopas A. Update on the role of non-opioids for postoperative pain treatment. Best Pract Res Clin Anaesthesiol 2007;21:15–30.
[26] Jöhr M. Practical pediatric regional anesthesia. Curr Opin Anaesthesiol 2013;26:327–32. http://dx.doi.org/10.1097/ACO.0b013e3283606a1e.
[27] Ivani G, Mosseti V. Pediatric regional anesthesia. Minerva Anestesiol 2009;75:577–83.
[28] Lönnqvist P-A. Blocks for pain management in children undergoing ambulatory surgery. Curr Opin Anaesthesiol 2011;24:627–32. http://dx.doi.org/10.1097/ACO.0b013e32834a276d.
[29] Rubin K, Sullivan D, Sadhasivam S. Are peripheral and neuraxial blocks with ultrasound guidance more effective and safe in children? Paediatr Anaesth 2009;19:92–6. http://dx.doi.org/10.1111/j.1460-9592.2008.02918.x.
[30] Gelfand HJ, Ouanes JPP, Lesley MR, Ko PS, Murphy JD, Sumida SM, et al. Analgesic efficacy of ultrasound-guided regional anesthesia: a meta-analysis.

J Clin Anesth 2011;23:90–6. http://dx.doi.org/10.1016/j.jclinane.2010.12.005.
[31] Boretsky KR, Camelo C, Waisel DB, Falciola V, Sullivan C, Brusseau E, et al. Confirmation of success rate of landmark-based caudal blockade in children using ultrasound: a prospective analysis. Paediatr Anaesth 2020;30:671–5. http://dx.doi.org/10.1111/pan.13865.
[32] Bhalla T, Sawardekar A, Dewhirst E, Jagannathan N, Tobias JD. Ultrasound-guided trunk and core blocks in infants and children. J Anesth 2013;27:109–23. http://dx.doi.org/10.1007/s00540-012-1476-5.
[33] Greaney D, Everett T. Paediatric regional anaesthesia: updates in central neuraxial techniques and thoracic and abdominal blocks. BJA Educ 2019;19:126–34. http://dx.doi.org/10.1016/j.bjae.2018.12.003.
[34] Vassiliou T, Eider J, Nimphius W, Wiesmann T, De Andres J, Müller H-H, et al. Dual guidance improves needle tip placement for peripheral nerve blocks in a porcine model. Acta Anaesthesiol Scand 2012;56:1156–62. http://dx.doi.org/10.1111/j.1399-6576.2012.02740.x.
[35] Sari S, Kumar J, Turan A. New peripheral nerve blocks and local anesthetics. Curr Opin Crit Care 2021;27:733–42. http://dx.doi.org/10.1097/MCC.0000000000000873.
[36] Kaye AD, Green JB, Davidson KS, Gennuso SA, Brown ML, Pinner AM, et al. Newer nerve blocks in pediatric surgery. Best Pract Res Clin Anaesthesiol 2019;33:447–63. http://dx.doi.org/10.1016/j.bpa.2019.06.006.
[37] Karmakar MK, Lönnqvist P-A. The clinical use of the thoracic erector spinae plane block. Con - ESPB is not useful for thoracic analgesia. J Clin Anesth 2024;93111353. http://dx.doi.org/10.1016/j.jclinane.2023.111353.
[38] Lönnqvist P-A. Fascial plane blocks in children-Scientifically supported or not? Paediatr Anaesth 2024;34:13–8. http://dx.doi.org/10.1111/pan.14752.
[39] Lönnqvist PA. Adjuncts should always be used in pediatric regional anesthesia. Paediatr Anaesth 2015;25:100–6. http://dx.doi.org/10.1111/pan.12526.
[40] Lundblad M, Lönnqvist PA. Adjunct analgesic drugs to local anaesthetics for neuroaxial blocks in children. Curr Opin Anaesthesiol 2016;29:626–31. http://dx.doi.org/10.1097/ACO.0000000000000372.
[41] Lundblad M, Trifa M, Kaabachi O, Ben Khalifa S, Fekih Hassen A, Engelhardt T, et al. Alpha-2 adrenoceptor agonists as adjuncts to peripheral nerve blocks in children: a meta-Analysis. Paediatr Anaesth 2016;26:232–8. http://dx.doi.org/10.1111/pan.12825.
[42] Rosen KR, Rosen DA. Caudal epidural morphine for control of pain following open heart surgery in children. Anesthesiology 1989;70:418–21. http://dx.doi.org/10.1167/8.5.1.
[43] AM-H Ho, Torbicki E, Winthrop AL, Kolar M, Zalan JE, MacLean G, et al. Caudal catheter placement for repeated epidural morphine doses after neonatal upper abdominal surgery. Anaesth Intensive Care 2022;50:141–5. http://dx.doi.org/10.1177/0310057X211062240.
[44] Das S, Acharya R, Patro M, Moda N, Mounika G. Caudal Morphine in pediatric patients: a comparison of two different doses in children undergoing infra-umbilical surgery - A prospective, randomized, double-blind study. Anesth Essays Res 2022;16:360–5. http://dx.doi.org/10.4103/aer.aer_120_22.
[45] Schug SA, Palmer GM, Scott DA, Halliwell R, Trinca J. Acute pain management: scientific evidence, fourth edition, 2015. Med J Aust 2016;204:315–7. http://dx.doi.org/10.5694/mja16.00133.
[46] Pfaff MJ, Nolan IT, Musavi L, Bertrand AA, Alford J, Krishna V, et al. Perioperative pain management in cleft lip and palate surgery: a systematic review and meta-analysis of randomized controlled studies. Plast Reconstr Surg 2022;150:145e–56e. http://dx.doi.org/10.1097/PRS.0000000000009231.
[47] Flowers T, Winters R. Postoperative pain management in pediatric cleft lip and palate repair. Curr Opin Otolaryngol Head Neck Surg 2021;29:294–8. http://dx.doi.org/10.1097/MOO.0000000000000719.
[48] Kościelniak-Merak B, Batko I, Kobylarz K, Sztefko K, Kocot-Kępska M, Tomasik PJ. Impact of intravenous, perioperative-administrated lidocaine on postoperative serum levels of endogenous opioids in children. Curr Pharm Des 2019;25:3209–15. http://dx.doi.org/10.2174/1381612825666190718153209.
[49] Heath C, Hii J, Thalayasingam P, von Ungern-Sternberg BS, Sommerfield D. Perioperative intravenous lidocaine use in children. Paediatr Anaesth 2023;33:336–46. http://dx.doi.org/10.1111/pan.14608.
[50] Batko I, Kościelniak-Merak B, Tomasik PJ, Kobylarz K, Wordliczek J. Lidocaine as an element of multimodal analgesic therapy in major spine surgical procedures in children: a prospective, randomized, double-blind study. Pharmacol Rep 2020;72:744–55. http://dx.doi.org/10.1007/s43440-020-00100-7.
[51] Elshammaa N, Chidambaran V, Housny W, Thomas J, Zhang X, Michael R. Ketamine as an adjunct to fentanyl improves postoperative analgesia and hastens discharge in children following tonsillectomy - a prospective, double-blinded, randomized study. Paediatr Anaesth 2011;21:1009–14. http://dx.doi.org/10.1111/j.1460-9592.2011.03604.x.
[52] Alghamdi F, Roth C, Jatana KR, Elmaraghy CA, Rice J, Tobias JD, et al. Opioid-sparing anesthetic technique for pediatric patients undergoing adenoidectomy: a pilot study. J Pain Res 2020;13:2997–3004. http://dx.doi.org/10.2147/JPR.S281275.
[53] Afshari A. Clonidine in pediatric anesthesia: the new panacea or a drug still looking for an indication? Curr Opin Anaesthesiol 2019;32:327–33. http://dx.doi.org/10.1097/ACO.0000000000000724.
[54] Kiski D, Malec E, Schmidt C. Use of dexmedetomidine in pediatric cardiac anesthesia. Curr Opin Anaesthesiol 2019;32:334–42. http://dx.doi.org/10.1097/ACO.0000000000000731.
[55] Schnabel A, Reichl SU, Poepping DM, Kranke P, Pogatzki-Zahn EM, Zahn PK. Efficacy and safety of intraoperative dexmedetomidine for acute postoperative pain in children: a meta-analysis of randomized controlled trials. Paediatr Anaesth 2013;23:170–9. http://dx.doi.org/10.1111/pan.12030.
[56] Patel A, Davidson M, Tran MCJ, Quraishi H, Schoenberg C, Sant M, et al. Dexmedetomidine infusion for analgesia and prevention of emergence agitation in children with obstructive sleep apnea syndrome undergoing tonsillectomy and adenoidectomy. Anesth Analg 2010;111:1004–10. http://dx.doi.org/10.1213/ANE.0b013e3181ee82fa.
[57] Rudikoff AG, Tieu DD, Banzali FM, Nguyen CV, Rettig RL, Nashed MM, et al. Perioperative acetaminophen and dexmedetomidine eliminate post-operative opioid requirement following pediatric tonsillectomy. J Clin Med 2022;11. http://dx.doi.org/10.3390/jcm11030561.
[58] Masaracchia MM, Sites BD, Lee J, Thomas JJ, Fernandez PG. Subanesthetic ketamine infusions for the management of pediatric pain in non-critical care settings: an observational analysis. Acta Anaesthesiol Scand 2019;63:1225–30. http://dx.doi.org/10.1111/aas.13429.
[59] Ben KS, Ben SA, Blaiti H, Kaddour R, Hassen AF, Pardessus P, et al. The potentiating effect of intravenous Dexamethasone upon preemptive pudendal block analgesia for hypospadias surgery in children managed with Snodgrass technique: a randomized controlled study: dexamethasone for pain management in children. BMC Anesthesiol 2024;24:145. http://dx.doi.org/10.1186/s12871-024-02536-3.
[60] Termpornlert S, Vijitpavan A, Ngodngamthaweesuk M, Sangkum L, Saeaeh L, Pipatpongsa B, et al. Analgesic efficacy of intravenous dexamethasone as an adjunct to ultrasound-guided paravertebral block with bupivacaine in video-assisted thoracoscopic surgery. J Pain Res 2022;15:2351–61. http://dx.doi.org/10.2147/JPR.S372780.
[61] King MR, De Souza E, Anderson TA. The association of intraoperative opioid dose with postanesthesia care unit outcomes in children: a retrospective study. Can J Anaesth 2024;71:77–86. http://dx.doi.org/10.1007/s12630-023-02612-1.
[62] Kovac AL. Postoperative nausea and vomiting in pediatric patients. Paediatr Drugs 2021;23:11–37. http://dx.doi.org/10.1007/s40272-020-00424-0.
[63] Ames WA, Machovec K. An update on the management of PONV in a pediatric patient. Best Pract Res Clin Anaesthesiol 2020;34:749–58. http://dx.doi.org/10.1016/j.bpa.2020.05.007.
[64] Hidayah BA, Toh ZA, Cheng LJ, Syahzarin BD, Zhu Y, Pölkki T, et al. Enhanced recovery after surgery in children undergoing abdominal surgery: meta-analysis. BJS Open 2023;7. http://dx.doi.org/10.1093/bjsopen/zrac147.
[65] Loganathan AK, Joselyn AS, Babu M, Jehangir S. Implementation and outcomes of enhanced recovery protocols in pediatric surgery: a systematic review and meta-analysis. Pediatr Surg Int 2022;38:157–68. http://dx.doi.org/10.1007/s00383-021-05008-8.
[66] Dello Russo C, Di Franco V, Tabolacci E, Cappoli N, Navarra P, Sollazzi L, et al. Remifentanil-induced hyperalgesia in healthy volunteers: a systematic review and meta-analysis of randomized controlled trials. Pain 2024;165:972–82. http://dx.doi.org/10.1097/j.pain.0000000000003119.
[67] Cravero JP, Agarwal R, Berde C, Birmingham P, Coté CJ, Galinkin J, et al. The Society for Pediatric Anesthesia recommendations for the use of opioids in children during the perioperative period. Paediatr Anaesth 2019;29:547–71. http://dx.doi.org/10.1111/pan.13639.
[68] Epstein HM. Postoperative patient-controlled analgesia in the pediatric cardiac intensive care unit. Crit Care Nurse 2017;37:55–61. http://dx.doi.org/10.4037/ccn2017724.
[69] Sharp D, Jaffrani A. A PRISMA systematic review on the safety and efficacy of patient-controlled analgesia (PCA) in pediatrics. J Pediatr Nurs 2021;61:219–23. http://dx.doi.org/10.1016/j.pedn.2021.06.002.
[70] Muirhead R, Kynoch K, Peacock A, Lewis PA. Safety and effectiveness of parent- or nurse-controlled analgesia in neonates: a systematic review. JBI Evid Synth 2022;20:3–36. http://dx.doi.org/10.11124/JBIES-20-00385.
[71] Howard RF, Lloyd-Thomas A, Thomas M, Williams DG, Saul R, Bruce E, et al. Nurse-controlled analgesia (NCA) following major surgery in 10,000 patients in a children's hospital. Paediatr Anaesth 2010;20:126–34. http://dx.doi.org/10.1111/j.1460-9592.2009.03242.x.
[72] Heinrich M, Mechea A, Hoffmann F. Improving postoperative pain management in children by providing regular training and an updated pain therapy concept. Eur J Pain (United Kingdom) 2016;20:586–93. http://dx.doi.org/10.1002/ejp.770.
[73] Boric K, Dosenovic S, Jelicic Kadic A, Batinic M, Cavar M, Urlic M, et al. Interventions for postoperative pain in children: an overview of systematic reviews. Paediatr Anaesth 2017;27:893–904. http://dx.doi.org/10.1111/pan.13203.
[74] Zieliński J, Morawska-Kochman M, Zatoński T. Pain assessment and management in children in the postoperative period: a review of the most commonly used postoperative pain assessment tools, new diagnostic methods and the latest guidelines for postoperative pain therapy in children. Adv Clin Exp Med 2020;29:365–74. http://dx.doi.org/10.17219/acem/112600.
[75] Schultz-Machata AM, Weiss M, Becke K. What's new in pediatric acute pain therapy? Curr Opin Anaesthesiol 2014;27:316–22. http://dx.doi.org/10.1097/ACO.0000000000000074.
[76] Martin DP, Bhalla T, Beltran R, Veneziano G, Tobias JD. The safety of prescribing opioids in pediatrics. Expert Opin Drug Saf 2014;13:93–101. http://dx.doi.org/10.1517/14740338.2013.834045.
[77] Nelson KL, Yaster M, Kost-Byerly S, Monitto CL. A national survey of american pediatric anesthesiologists: patient-controlled analgesia and other intrave-

nous opioid therapies in pediatric acute pain management. Anesth Analg 2010;110:754–60. http://dx.doi.org/10.1213/ANE.0b013e3181ca749c.
[78] Hayes J, Dowling JJ, Peliowski A, Crawford MW, Johnston B. Patient-controlled analgesia plus background opioid infusion for postoperative pain in children: a systematic review and meta-analysis of randomized trials. Anesth Analg 2016;123:991–1003. http://dx.doi.org/10.1213/ANE.0000000000001244.
[79] Mireskandari SM, Makarem J. Effect of rectal diclofenac and acetaminophen alone and in combination on postoperative pain after cleft palate repair in children. J Craniofac Surg 2011;22:1955–9. http://dx.doi.org/10.1097/SCS.0b013e31822ea7fd.
[80] Sylaidis P, O'Neill TJ. Diclofenac analgesia following cleft palate surgery. Cleft Palate Craniofac J 1998;35:544–5. http://dx.doi.org/10.1597/1545-1569_1998_035_0544_dafcps_2.3.co_2.
[81] Carr L, Gray M, Morrow B, Brgoch M, Mackay D, Samson T. Opioid sparing in cleft palate surgery. Cleft Palate Craniofac J 2018;55:1200–4. http://dx.doi.org/10.1177/1055665618764516.
[82] Pierson BW, Cardon BS, Anderson MP, Glade RS. A comparison of nonopioid and opioid oral analgesia following pediatric palatoplasty. Cleft Palate Craniofac J 2017;54:170–4. http://dx.doi.org/10.1597/15-135.
[83] Nour C, Ratsiu J, Singh N, Mason L, Ray A, Martin M, et al. Analgesic effectiveness of acetaminophen for primary cleft palate repair in young children: a randomized placebo controlled trial. Paediatr Anaesth 2014;24:574–81. http://dx.doi.org/10.1111/pan.12393.
[84] Dudley S, Spence M, Frederick R, Stocks R. Postoperative use of ketorolac improves pain management and decreases narcotic use following primary cleft palate surgery. Cleft Palate Craniofac J 2022;59:1371–6. http://dx.doi.org/10.1177/10556656211042168.
[85] Doyle E, Hudson I. Anaesthesia for primary repair of cleft lip and cleft palate: a review of 244 procedures. Pediatr Anesth 1992;2:139–45. http://dx.doi.org/10.1111/j.1460-9592.1992.tb00189.x.
[86] Prabhu KP, Wig J, Grewal S. Bilateral infraorbital nerve block is superior to peri-incisional infiltration for analgesia after repair of cleft lip. Scand J Plast Reconstr Surg Hand Surg 1999;33:83–7. http://dx.doi.org/10.1080/02844319950159668.
[87] Bösenberg AT, Kimble FW. Infraorbital nerve block in neonates for cleft lip repair: anatomical study and clinical application. Br J Anaesth 1995;74:506–8. http://dx.doi.org/10.1093/bja/74.5.506.
[88] Suresh S, Voronov P, Curran J. Infraorbital nerve block in children: a computerized tomographic measurement of the location of the infraorbital foramen. Reg Anesth Pain Med 2006;31:211–4. http://dx.doi.org/10.1016/j.rapm.2005.11.017.
[89] Salloum ML, Eberlin KR, Sethna N, Hamdan US. Combined use of infraorbital and external nasal nerve blocks for effective perioperative pain control during and after cleft lip repair. Cleft Palate Craniofac J 2009;46:629–35. http://dx.doi.org/10.1597/08-142.1.
[90] Rajamani A, Kamat V, Rajavel VP, Murthy J, Hussain SA. A comparison of bilateral infraorbital nerve block with intravenous fentanyl for analgesia following cleft lip repair in children. Paediatr Anaesth 2007;17:133–9. http://dx.doi.org/10.1111/j.1460-9592.2006.02032.x.
[91] Takmaz SA, Uysal HY, Uysal A, Kocer U, Dikmen B, Baltaci B. Bilateral extraoral, infraorbital nerve block for postoperative pain relief after cleft lip repair in pediatric patients: a randomized, double-blind controlled study. Ann Plast Surg 2009;63:59–62. http://dx.doi.org/10.1097/SAP.0b013e3181851b8e.
[92] Echaniz G, de Miguel M, Merritt G, Sierra P, Bora P, Borah N, et al. Bilateral suprazygomatic maxillary nerve blocks vs. infraorbital and palatine nerve blocks in cleft lip and palate repair: a double-blind, randomised study. Eur J Anaesthesiol 2019;36:40–7. http://dx.doi.org/10.1097/EJA.0000000000000900.
[93] Feriani G, Hatanaka E, Torloni MR, da Silva EMK. Infraorbital nerve block for postoperative pain following cleft lip repair in children. Cochrane Database Syst Rev 2016;4CD011131. http://dx.doi.org/10.1002/14651858.CD011131.pub2.
[94] Mesnil M, Dadure C, Captier G, Raux O, Rochette A, Canaud N, et al. A new approach for peri-operative analgesia of cleft palate repair in infants: the bilateral suprazygomatic maxillary nerve block. Paediatr Anaesth 2010;20:343–9. http://dx.doi.org/10.1111/j.1460-9592.2010.03262.x.
[95] Morzycki A, Nickel K, Newton D, Ng MC, Guilfoyle R. In search of the optimal pain management strategy for children undergoing cleft lip and palate repair: a systematic review and meta-analysis. J Plast Reconstr Aesthet Surg 2022;75:4221–32. http://dx.doi.org/10.1016/j.bjps.2022.06.104.
[96] Kheirabadi D, Shafa A, Hirmanpour A, Zareh F. Prophylactic effects of intravenous dexamethasone and lidocaine on attenuating hemodynamic-respiratory and pain complications in children undergoing cleft palate repair surgery with general anesthesia. J Pain Palliat Care Pharmacother 2020;34:63–8. http://dx.doi.org/10.1080/15360288.2019.1706691.
[97] Kayyal TA, Wolfswinkel EM, Weathers WM, Capehart SJ, Monson LA, Buchanan EP, et al. Treatment effects of dexmedetomidine and ketamine on postoperative analgesia after cleft palate repair. Craniomaxillofac Trauma Reconstr 2014;7:131–8. http://dx.doi.org/10.1055/s-0034-1371446.
[98] Asadourian PA, Lu Wang M, Demetres MR, Imahiyerobo TA, Otterburn DM. Closing the gap: a systematic review and meta-analysis of enhanced recovery after surgery protocols in primary cleft palate repair. Cleft Palate Craniofac J 20221056656221096632. http://dx.doi.org/10.1177/10556656221096631.
[99] Esfahanian M, Marcott SC, Hopkins E, Burkart B, Khosla RK, Lorenz HP, et al. Enhanced recovery after cleft palate repair: a quality improvement project. Pediatr Anesth 2022. http://dx.doi.org/10.1111/pan.14541.
[100] Wang G, Wang X, Li S. [Effect of fascia iliaca compartment block with ropivacaine on early analgesia in children with development dislocation of the hip received salter arthroplasty treatment]. Zhonghua Yi Xue Za Zhi 2011;91:2638–40.
[101] Ince I, Hamadnalla H, Hassan M, Qiu Y. Ultrasound-guided quadratus lumborum plane block for congenital hip dislocation surgery: dermatomes and osteotomes. J Clin Anesth 2019;54:140. http://dx.doi.org/10.1016/j.jclinane.2018.10.044.
[102] Ahiskalioglu A, Yayik AM, Alici HA, Ezirmik N. Ultrasound guided transmuscular quadratus lumborum block for congenital hip dislocation surgery: report of two pediatric cases. J Clin Anesth 2018;49:15–6. http://dx.doi.org/10.1016/j.jclinane.2018.05.018.
[103] Momeni M, Crucitti M, de Kock M. Patient-controlled analgesia in the management of postoperative pain. Drugs 2006;66:2321–37.
[104] Antok E, Bordet F, Duflo F, Lansiaux S, Combet S, Taylor P, et al. Patient-controlled epidural analgesia versus continuous epidural infusion with ropivacaine for postoperative analgesia in children. Anesth Analg 2003;97:1608–11. http://dx.doi.org/10.1213/01.ANE.0000089962.08693.25.
[105] Birmingham PK, Suresh S, Ambrosy A, Porfyris S. Parent-assisted or nurse-assisted epidural analgesia: is this feasible in pediatric patients? Paediatr Anaesth 2009;19:1084–9. http://dx.doi.org/10.1111/j.1460-9592.2009.03151.x.
[106] Duflo F, Qamouss Y, Rémond C, Pouyau A, Heilporn A, Taylor P, et al. Patient-controlled regional analgesia is effective in children: a preliminary report. Canadian J Anesth 2004;51:928–30. http://dx.doi.org/10.1007/BF03018893.
[107] Voepel-Lewis T, Marinkovic A, Kostrzewa A, Tait AR, Malviya S. The prevalence of and risk factors for adverse events in children receiving patient-controlled analgesia by proxy or patient-controlled analgesia after surgery. Anesth Analg 2008;107:70–5. http://dx.doi.org/10.1213/ane.0b013e318172fa9e.
[108] Li J, Rai S, Ze R, Tang X, Liu R, Hong P. Enhanced recovery care versus traditional non-ERAS care following osteotomies in developmental dysplasia of the hip in children: a retrospective case-cohort study. BMC Musculoskelet Disord 2020;21:234. http://dx.doi.org/10.1186/s12891-020-03243-z.
[109] di Pace MR, Cimador M, Catalano P, Caruso A, Sergio M, Casuccio A, et al. Efficacy of periportal infiltration and intraperitoneal instillation of ropivacaine after laparoscopic surgery in children. J Laparoendosc Adv Surg Tech A 2009;19:821–5. http://dx.doi.org/10.1089/lap.2009.0232.
[110] Sun Y, Li T, Wang N, Yun Y, Gan TJ. Perioperative systemic lidocaine for postoperative analgesia and recovery after abdominal surgery: a meta-analysis of randomized controlled trials. Dis Colon Rectum 2012;55:1183–94. http://dx.doi.org/10.1097/DCR.0b013e318259bcd8.
[111] Weibel S, Jelting Y, Pace NL, Helf A, Eberhart LH, Hahnenkamp K, et al. Continuous intravenous perioperative lidocaine infusion for postoperative pain and recovery in adults. Cochrane Database Syst Rev 2018;6CD009642. http://dx.doi.org/10.1002/14651858.CD009642.pub3.
[112] Beaussier M, Delbos A, Maurice-Szamburski A, Ecoffey C, Mercadal L. Perioperative use of intravenous lidocaine. Drugs 2018;78:1229–46. http://dx.doi.org/10.1007/s40265-018-0955-x.
[113] Lemming K, Fang G, Buck ML. Safety and tolerability of lidocaine infusions as a component of multimodal postoperative analgesia in children. J Pediatr Pharmacol Ther 2019;24:34–8. http://dx.doi.org/10.5863/1551-6776-24.1.34.
[114] Herminghaus A, Wachowiak M, Wilhelm W, Gottschalk A, Eggert K, Gottschalk A. [Intravenous administration of lidocaine for perioperative analgesia. Review and recommendations for practical usage]. Anaesthesist 2011;60:152–60. http://dx.doi.org/10.1007/s00101-010-1829-0.
[115] Hall EA, Sauer HE, Davis MS, Anghelescu DL. Lidocaine infusions for pain management in pediatrics. Paediatr Drugs 2021;23:349–59. http://dx.doi.org/10.1007/s40272-021-00454-2.
[116] Foo I, Macfarlane AJR, Srivastava D, Bhaskar A, Barker H, Knaggs R, et al. The use of intravenous lidocaine for postoperative pain and recovery: international consensus statement on efficacy and safety. Anaesthesia 2021;76:238–50. http://dx.doi.org/10.1111/anae.15270.
[117] Sola C, Menacé C, Bringuier S, Saour A-C, Raux O, Mathieu O, et al. Transversus abdominal plane block in children: efficacy and safety: a randomized clinical study and pharmacokinetic profile. Anesth Analg 2019;128:1234–41. http://dx.doi.org/10.1213/ANE.0000000000003736.
[118] Desgranges F-P, de Queiroz M, Chassard D. Continuous oblique subcostal transversus abdominis plane block: an alternative for pain management after upper abdominal surgery in children. Pediatr Anesth 2011;21:982–3. http://dx.doi.org/10.1111/j.1460-9592.2011.03582.x.
[119] Genç Moralar D, Tok Cekmecelioglu B, Aslan M, Hergünsel GO. Effect of quadratus lumborum block on postoperative analgesic requirements in pediatric patients: a randomized controlled double-blinded study. Minerva Anestesiol 2020;86:150–6. http://dx.doi.org/10.23736/S0375-9393.19.13361-5.
[120] Wilson GA, Brown JL, Crabbe DG, Hinton W, McHugh PJ, Stringer MD. Is epidural analgesia associated with an improved outcome following open Nissen fundoplication? Paediatr Anaesth 2001;11:65–70. http://dx.doi.org/10.1046/j.1460-9592.2001.00597.x.

[121] McNeely JK, Farber NE, Rusy LM, Hoffman GM. Epidural analgesia improves outcome following pediatric fundoplication. A retrospective analysis. Reg Anesth 1997;22:16–23. http://dx.doi.org/10.1016/s1098-7339(06)80051-9.
[122] Lejus C, Surbled M, Schwoerer D, Renaudin M, Guillaud C, Berard L, et al. Postoperative epidural analgesia with bupivacaine and fentanyl: hourly pain assessment in 348 paediatric cases. Paediatr Anaesth 2001;11:327–32. http://dx.doi.org/10.1046/j.1460-9592.2001.00659.x.
[123] Albrecht S, Fechner J, Geisslinger G, Maass AB, Upadhyaya B, Moecke H, et al. Postoperative pain control following remifentanil-based anaesthesia for major abdominal surgery. Anaesthesia 2000;55:315–22. http://dx.doi.org/10.1046/j.1365-2044.2000.01122.x.
[124] Lukošienė L, Kalibatienė L, Barauskas V. Intercostal nerve block in pediatric minimally invasive thoracic surgery. Vol. 19; 2012.
[125] Matsota P, Livanios S, Marinopoulou E. Intercostal nerve block with Bupivacaine for post-thoracotomy pain relief in children. Eur J Pediatr Surg 2001;11:219–22. http://dx.doi.org/10.1055/s-2001-17148.
[126] Chalam KS, Patnaik SS, Sunil C, Bansal T. Comparative study of ultrasound-guided paravertebral block with ropivacaine versus bupivacaine for post-operative pain relief in children undergoing thoracotomy for patent ductus arteriosus ligation surgery. Indian J Anaesth 2015;59:493–8. http://dx.doi.org/10.4103/0019-5049.162988.
[127] Davies RG, Myles PS, Graham JM. A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy–a systematic review and meta-analysis of randomized trials. Br J Anaesth 2006;96:418–26. http://dx.doi.org/10.1093/bja/ael020.
[128] Yeung JHY, Gates S, Naidu BV, Wilson MJA, Gao Smith F. Paravertebral block versus thoracic epidural for patients undergoing thoracotomy. Cochrane Database Syst Rev 2016;2CD009121. http://dx.doi.org/10.1002/14651858.CD009121.pub2.
[129] Tseng W-C, Lin W-L, Lai H-C, Huang T-W, Chen P-H, Wu Z-F. Fentanyl-based intravenous patient-controlled analgesia with low dose of ketamine is not inferior to thoracic epidural analgesia for acute post-thoracotomy pain following video-assisted thoracic surgery: a randomized controlled study. Medicine 2019;98e16403. http://dx.doi.org/10.1097/MD.0000000000016403.
[130] Tomaszek L, Fenikowski D, Komotajtys H, Gawron D. Ropivacaine/Fentanyl vs. Bupivacaine/Fentanyl for pain control in children after thoracic surgery: a randomized study. Pain Manag Nurs 2019;20:390–7. http://dx.doi.org/10.1016/j.pmn.2019.02.007.
[131] Weber T, Mätzl J, Rokitansky A, Klimscha W, Neumann K, Deusch E, et al. Superior postoperative pain relief with thoracic epidural analgesia versus intravenous patient-controlled analgesia after minimally invasive pectus excavatum repair. J Thorac Cardiovasc Surg 2007;134:865–70. http://dx.doi.org/10.1016/j.jtcvs.2007.05.050.
[132] Butkovic D, Kralik S, Matolic M, Kralik M, Toljan S, Radesic L. Postoperative analgesia with intravenous fentanyl PCA vs epidural block after thoracoscopic pectus excavatum repair in children. Br J Anaesth 2007;98:677–81. http://dx.doi.org/10.1093/bja/aem055.
[133] Downing L, Ramjist JK, Tyrrell A, Tsang M, Isaac L, Fecteau A. Development of a five point enhanced recovery protocol for pectus excavatum surgery. J Pediatr Surg 2023;58:822–7. http://dx.doi.org/10.1016/j.jpedsurg.2023.01.028.
[134] Kundra P, Yuvaraj K, Agrawal K, Krishnappa S, Kumar LT. Surgical outcome in children undergoing hypospadias repair under caudal epidural vs penile block. Paediatr Anaesth 2012;22:707–12. http://dx.doi.org/10.1111/j.1460-9592.2011.03702.x.
[135] Seyedhejazi M, Azerfarin R, Kazemi F, Amiri M. Comparing caudal and penile nerve blockade using bupivacaine in hypospadias repair surgeries in children. Afr J Paediatr Surg 2011;8:294–7. http://dx.doi.org/10.4103/0189-6725.91673.
[136] Zhu C, Wei R, Tong Y, Liu J, Song Z, Zhang S. Analgesic efficacy and impact of caudal block on surgical complications of hypospadias repair: a systematic review and meta-analysis. Reg Anesth Pain Med 2019;44:259–67. http://dx.doi.org/10.1136/rapm-2018-000022.
[137] Hansen TG, Henneberg SW, Walther-Larsen S, Lund J, Hansen M. Caudal bupivacaine supplemented with caudal or intravenous clonidine in children undergoing hypospadias repair: a double-blind study. Br J Anaesth 2004;92:223–7. http://dx.doi.org/10.1093/bja/aeh028.
[138] Ozen V, Yigit D. Caudal epidural block versus ultrasound-guided dorsal penile nerve block for pediatric distal hypospadias surgery: a prospective, observational study. J Pediatr Urol 2020;16:438.e1–8. http://dx.doi.org/10.1016/j.jpurol.2020.05.009.
[139] Ahiskalioglu A, Yayik AM, Ahiskalioglu EO, Ekinci M, Gölboyu BE, Celik EC, et al. Ultrasound-guided versus conventional injection for caudal block in children: a prospective randomized clinical study. J Clin Anesth 2018;44:91–6. http://dx.doi.org/10.1016/j.jclinane.2017.11.011.
[140] Rove KO, Brockel MA, Saltzman AF, Dönmez MI, Brodie KE, Chalmers DJ, et al. Prospective study of enhanced recovery after surgery protocol in children undergoing reconstructive operations. J Pediatr Urol 2018;14:252.e1–9. http://dx.doi.org/10.1016/j.jpurol.2018.01.001.
[141] Kokki H. Nonsteroidal anti-inflammatory drugs for postoperative pain: a focus on children. Paediatr Drugs 2003;5:103–23.
[142] Dahmani S, Michelet D, Abback PS, Wood C, Brasher C, Nivoche Y, et al. Ketamine for perioperative pain management in children: a meta-analysis of published studies. Paediatr Anaesth 2011;21:636–52. http://dx.doi.org/10.1111/j.1460-9592.2011.03566.x.
[143] sio De Oliveira GS, Almeida MD, Benzon HT, McCarthy RJ. Perioperative single dose systemic dexamethasone for postoperative pain a meta-analysis of randomized controlled trials. Anesthesiology 2011;115:575–88.
[144] Kost-Byerly S, Chalkiadis G. Developing a pediatric pain service. Paediatr Anaesth 2012;22:1016–24. http://dx.doi.org/10.1111/pan.12004.
[145] Meissner W, Ullrich K, Zwacka S. Benchmarking as a tool of continuous quality improvement in postoperative pain management. Eur J Anaesthesiol 2006;23:142–8. http://dx.doi.org/10.1017/S026502150500205X.
[146] Emons MI, Petzke F, Stamer UM, Meißner W, Koschwitz R, Erlenwein J. Current practice of acute pain management in children—a national follow-up survey in Germany. Paediatr Anaesth 2016;26:883–90. http://dx.doi.org/10.1111/pan.12947.
[147] Redmann AJ, Wang Y, Furstein J, Myer CM, de Alarcón A. The use of the FLACC pain scale in pediatric patients undergoing adenotonsillectomy. Int J Pediatr Otorhinolaryngol 2017;92:115–8. http://dx.doi.org/10.1016/j.ijporl.2016.11.016.
[148] Crellin DJ, Harrison D, Santamaria N, Babl FE. Systematic review of the Face, Legs, Activity, Cry and Consolability scale for assessing pain in infants and children: is it reliable, valid, and feasible for use? Pain 2015;156:2132–51. http://dx.doi.org/10.1097/j.pain.0000000000000305.
[149] Büttner W, Finke W. Analysis of behavioural and physiological parameters for the assessment of postoperative analgesic demand in newborns, infants and young children: a comprehensive report on seven consecutive studies. Paediatr Anaesth 2000;10:303–18.
[150] Hicks CL, von Baeyer CL, Spafford PA, van Korlaar I, Goodenough B. The Faces Pain Scale-Revised: toward a common metric in pediatric Pain measurement. Pain 2001;93:173–83.
[151] Miró J, Castarlenas E, de la Vega R, Solé E, Tomé-Pires C, Jensen MP, et al. Validity of three rating scales for measuring pain intensity in youths with physical disabilities. Eur J Pain 2016;20:130–7. http://dx.doi.org/10.1002/ejp.704.
[152] Bailey B, Gravel J, Daoust R. Reliability of the visual analog scale in children with acute pain in the emergency department. Pain 2012;153:839–42. http://dx.doi.org/10.1016/j.pain.2012.01.006.
[153] Royal College of Nursing. The recognition and assessment of acute pain in children - Update of full guideline 2009.
[154] Zieliński J, Morawska-Kochman M, Zatoński T. Pain assessment and management in children in the postoperative period: a review of the most commonly used postoperative pain assessment tools, new diagnostic methods and the latest guidelines for postoperative pain therapy in children. Adv Clin Exp Med 2020;29:365–74. http://dx.doi.org/10.17219/acem/112600.