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SPECIAL INTEREST ARTICLE

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Postoperative pain management in children: Guidance from the pain committee of the European Society for Paediatric Anaesthesiology (ESPA Pain Management Ladder Initiative)

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Summary

The main remit of the European Society for Paediatric Anaesthesiology (ESPA) Pain Committee is to improve the quality of pain management in children. The ESPA Pain Management Ladder is a clinical practice advisory based upon expert consensus to help to ensure a basic standard of perioperative pain management for all children. Further steps are suggested to improve pain management once a basic standard has been achieved. The guidance is grouped by the type of surgical procedure and layered to suggest basic, intermediate, and advanced pain management methods. The committee members are aware that there are marked differences in financial and personal resources in different institutions and countries and also considerable variations in the availability of analgesic drugs across Europe. We recommend that the guidance should be used as a framework to guide best practice.

KEYWORDS

analgesics, nonopioid drugs, opioids, Pediatrics, perioperative pain, regional anesthesia

1 | INTRODUCTION

Adequate pain therapy cannot be taken for granted. Although the Declaration of Montreal (September 2010) states that "Access to Pain Management is a Fundamental Right", it is estimated that 80% of the global population is affected by insufficient pain management, and this is a serious problem in over 150 countries.[1,2] The greatest burden of inadequate pain management is carried by the elderly, pregnant, and breastfeeding women, children, drug addicted persons, and the mentally ill.[3] For many years there have been increasing efforts to improve the perioperative pain management of children but there are still a substantial number of children suffering perioperative pain.[4-10]

The practice of pediatric anesthesia varies considerably across Europe, including the provision of postoperative analgesia, as evidenced by the results of the recent Anaesthesia PRactice In Children Observational Trial (APRICOT).[11] The reasons are multifactorial but may reflect differences in knowledge, infrastructure, organization, and health care economics among EU countries. However, even in more affluent settings, pediatric postoperative pain management is highly variable and is still suboptimal in many centers.[12]

Against this background, it is important to define the minimum standards of pediatric postoperative pain relief that children can expect after surgical procedures even in settings with limited resources. It is also important to outline how pediatric postoperative pain relief may evolve and improve. This ESPA supported document may enable clinicians and departments to influence decision-making to improve and advance pediatric postoperative pain relief regardless of the local context since adherence to suggested guidelines has been shown to be helpful in improving pain management, eg, for pediatric tonsillectomy.[13]

Thus, the aim of the current ESPA initiative is to provide a consensus practice advisory document analogous to the WHO Pain Relief Ladder,[14] based pragmatically upon existing evidence and already published guidelines, to improve pediatric postoperative pain relief in Europe. Although primarily aimed at the European continent, we hope that it may also be applied in other countries around the world.

2 | MATERIALS AND METHODS

The ESPA Pain Committee selected 6 common pediatric surgical procedures and invited pediatric anesthetists experienced in treating postoperative pain from different countries to participate in working groups to develop 1 pain management ladder each aiming for a multimodal analgesic treatment approach[15,16] based upon the WHO Pain Relief Ladder including local and regional anesthetic techniques. In the first step, each member of a particular pain ladder group was invited to provide the individual pain management of his/her institution to collate the most common pain management concepts and drugs used for each type of operation. Following this, the concepts were discussed by the working group and the literature was reviewed, including existing evidence-based guidelines. The ESPA Pain Management Ladder is a clinical practice advisory based upon the consensus opinions of these working groups. As a result, a basic acceptable level of pain management was suggested which should be achievable by all, even in institutions with limited resources. Oral and rectal administration of nonopioid drugs and regional anesthesia play a crucial role since they are available in most places.[17-21] Good use of these modalities has an important opioid-sparing effect.[7,8,15,22] Intravenous opioids are reserved for intraoperative use and the early postoperative period in settings with adequate monitoring. Furthermore, in all procedures where endotracheal intubation is essential, the administration of a small dose of a short-acting opioid may be considered in order to attenuate the hemodynamic response to laryngoscopy and tracheal intubation,[23,24] albeit at the expense of the possibility of increased postoperative nausea and vomiting. Subanesthetic doses of ketamine/S-ketamine may be used to reduce intra- and early postoperative opioid requirements.[25,26]

3 | HOW TO USE THE ESPA PAIN MANAGEMENT LADDER

Before an institution considers changes in pain management, it has to be decided if there is a need for change.[27] Therefore, the first step would be to evaluate the current pain management for a certain type of operation. The drugs used and whether doses prescribed are actually administered are useful baseline assessments. It is strongly suggested that standardized pain assessment for the duration of hospital stay should be used, preferably with validated age-appropriate pain assessment tools.[28-34] Useful audit markers are the proportion of each patient's time spent with pain scores below 4/10 and child and family experiences of pain. If a lack of adequate pain management is revealed, a plan to improve the pain management and evaluate this improvement will be needed.[35,36] Considering pain as a vital sign is an excellent way to engender change, with incorporation of pain assessment into charts, nursing routines, and education programs. This must include an algorithm showing what actions to take when a pain score is high and how to evaluate the efficacy of any analgesic interventions.[34]

The primary aim is to attain at least the basic level of the ESPA Pain Management Ladder. Since the basic level uses drugs and methods that are widely available, are proven to work, are safe, and do not require any complex monitoring, the major change initially required to achieve successful pain management is education, not new drugs or high-tech delivery systems. Basic techniques can do the job in a high proportion of cases if physicians and nurses are trained to take responsibility for providing pain control[37] and all staff dealing with children give pain assessment and pain management a high priority.

The secondary goal is to climb up the pain ladder as far as possible using all available resources. The intermediate and advanced

levels should be considered as suggestions. These steps represent a gradual increase in complexity and require specific equipment and infrastructure. Analgesia may be improved: for example, a substantial improvement of success rate when using ultrasound-guided ilioinguinal/iliohypogastric nerve block instead of a landmark-based technique; using intravenous paracetamol greatly increases the likelihood of having adequate plasma levels of paracetamol in the recovery room.[38-40]

The ESPA Pain Management Ladder may help to provide practitioners with a document to present to their local officials with the aim of promoting and improving postoperative analgesia for the pediatric population (Table 1). Surgical colleagues and hospital administrators should be aware that acceptable standards of pain management have to be provided and resourced before surgery in infants and children is undertaken.[41] The ability of structured initiatives to substantially improve postoperative analgesia in resource limited settings has recently been presented by Dr Burke (Tygerberg Children's Hospital, South Africa)[42] as well after day surgery in more affluent circumstances.[43]

The aim is to develop a pediatric pain management portfolio that can be adapted for local use based upon availability of drugs, national recommendations, and drug registration rules in different countries. The target should be to achieve and maintain pain scores below the intervention threshold of 4 (on a 10-point scale). Pain

TABLE 1 Quality improvement steps using the ESPA Pain Ladder

	Procedure	Goal
Step 1	Written individualized standard prescription for current pain management for the procedure	Exact prescription and administration of analgesics prescribed for each patient to improve pain management
Step 2	Pain assessment: at least 3 times per day until discharge to check pain experience and efficacy of analgesia. Consider pain as a vital sign.	Makes pain visible by use of appropriate assessments. If inadequate pain management is revealed, improve the pain management regimen and culture
Step 3	Improve pain management education and delivery of at least basic level of ESPA Pain Ladder.	Ensure analgesics are given as prescribed. Ensure pain is assessed regularly Ensure pain score is <4/10 for as much time as possible
Step 4	Re-evaluate to check for improvements	Further adaptation of management if necessary
Step 5	Introduce intermediate and advanced levels as appropriate to local needs and circumstances	Ensure efficacy and safety by comprehensive education, staffing, and monitoring
Example of improvement of pain management for Inguinal Hernia Repair		
	Problem	Improvement step
Step 1	The lack of institutional agreement about how pain management should be performed has led to individual interpretation and management with variable efficacy. No prescription for breakthrough pain in PACU (nurse has to call physician)	Multidisciplinary agreement with written institutional instruction using techniques in basic level of ESPA Pain Ladder *Intraoperative pain management:* rectal NSAID or if not available rectal paracetamol (loading dose). Local anesthetic infiltration by the surgeon, *Postoperative management:* Oral NSAIDs and/or paracetamol in adequate dosing on demand or preferably timed by the clock
Step 2	Missing or irregular pain assessment	Regular pain assessment demonstrates inadequate pain management (prolonged breakthrough pain in PACU and frequent high pain scores in the ward) and proves the need for improvement of the pain management regimen
Step 3	Inadequate pain management	Adaptation of pain management—new standard prescription order: *Intraoperative pain management:* Rectal NSAID or if not available rectal paracetamol (loading dose) Local wound infiltration by the surgeon of a long-acting local anesthetic. *Postoperative management:* Intravenous fentanyl or morphine to treat breakthrough pain in the PACU. Oral NSAIDs and/or paracetamol in adequate dosing during the entire perioperative period.
Step 4	Persistent breakthrough pain in the ward in a number of patients	Reassessment: leads to the use of intravenous nalbuphine or oral tramadol for serious breakthrough pain in the ward.
Step 5	Consider intermediate or advanced solutions depending on resources, experience and training	Intraoperative regional block Use of adjuncts to prolong block Intravenous paracetamol intraoperatively On the clock systemic analgesia regimen Oral opioids for breakthrough pain Day care if appropriate ensuring adequate take home analgesia pack

TABLE 2 Inguinal hernia repair

Inguinal hernia repair (>1 mo of age)[138]		
	Intraoperative	**Postoperative**
Basic level	• Rectal NSAID or if not available rectal paracetamol.[43-47] • Local wound infiltration by the surgeon of a long-acting local anesthetic.[48]	• Intravenous fentanyl or morphine to treat breakthrough pain in the PACU.[49-53] • Oral NSAIDs and/or paracetamol in adequate dosing during the entire postoperative period.[43-46]
Intermediate level	• Rectal NSAID or if not available rectal paracetamol • Landmark-based ilioinguinal/iliohypogastric or caudal blockade with long-acting local anesthetics ± adjunct clonidine if available.[54,139-141]	• Intravenous fentanyl or morphine or other suitable agent (if available) to treat breakthrough pain in the PACU.[55,142] • Oral NSAIDs and/or paracetamol in adequate dosing during the entire postoperative period. • Intravenous nalbuphine or oral tramadol for serious breakthrough pain in the ward.[56,57,143]
Advanced level	• Intravenous ketorolac or rectal NSAID.[144] • Intravenous loading dose of paracetamol.[58,59] • Ultrasound-guided peripheral blocks (eg, ilioinguinal/iliohypogastric, TAP, paravertebral or ultrasound-guided caudal blockade with long-acting local anesthetics combined with appropriate adjunct).[145-147]	• Intravenous fentanyl or morphine or other suitable agent (if available) to treat breakthrough pain in the PACU. • Oral NSAIDs and/or paracetamol in adequate dosing during the entire postoperative period. • Intravenous nalbuphine or oral tramadol as rescue in the ward

TABLE 3 Circumcision

Circumcision[138]		
	Intraoperative	**Postoperative**
Basic level	• Rectal NSAID or if not available rectal paracetamol.[43-47] • Penile block with long-acting local anesthetic.[54,139,148]	• Intravenous fentanyl or morphine to treat breakthrough pain in the PACU.[49-53] • Oral NSAIDs (eg, ibuprofen) and/or paracetamol in adequate dosing during the entire postoperative period.[43-46]
Intermediate level	• Rectal NSAID or if not available rectal paracetamol • Penile block or landmark-based caudal blockade with long-acting local anesthetics ± adjunct clonidine if available.[139,149]	• Intravenous fentanyl or morphine or other suitable agent (if available) to treat breakthrough pain in the PACU.[55,142] • Intravenous nalbuphine or other suitable agent (if available) to treat serious breakthrough pain in the ward.[56,57,143] • Oral NSAIDs (eg, ibuprofen) and/or paracetamol in adequate dosing during the entire postoperative period
Advanced level	• Intravenous ketorolac (if available) or rectal NSAID.[144] • Intravenous loading dose of paracetamol.[58,59] • Ultrasound-guided penile block or ultrasound-guided caudal blockade with long-acting local anesthetics combined with appropriate adjunct.[150,151]	• Intravenous fentanyl or morphine or other suitable agent (if available) to treat serious breakthrough pain in the PACU. • Intravenous nalbuphine or other suitable agent (if available) to treat serious breakthrough pain in the ward. • Oral NSAIDs (eg, ibuprofen) and/or paracetamol in adequate dosing during the entire postoperative period

assessment should be performed regularly and at least 3 times per day, with reassessment after analgesia to ensure efficacy. Analgesia prescriptions should be individualized and adjusted based upon adequate, regular assessments. Invasive techniques such as continuous opioid infusions, PCA, and NCA require "round-the-clock" availability of specially trained staff. Table 1 gives an example of quality improvement using the ESPA Pain Management Ladder.

4 | RECOMMENDATIONS

The following Tables 2-7 provide the Pain Management Ladders for 6 frequently performed procedures in children.

4.1 | Drug and dosage suggestions

Below are some suggestions regarding dosing of some of the drugs that may be applicable to the different pain management ladder levels based on the available literature.[2,26,44-129] Table 8 shows dosage suggestions for systemic analgesia, special care must be taken when prescribing opiods in patients with obstructive sleep apnea. In Table 9, the reader can find dosage suggestions for regional anesthesia and Table 10 lists suggestions for the treatment of PONV.

These are only suggestions and ESPA does not accept any legal responsibility for these suggestions. Please confer with the pharmacopeia of your country before using these dosage suggestions. This

TABLE 4 Pyloromyotomy

Pyloromyotomy (open and laparoscopic)[138,152,153]		
	Intraoperative	**Postoperative**
Basic level	• Fentanyl or opioid of choice.[49-53] • Rectal paracetamol[154] • Local wound infiltration/local port-side infiltration by the surgeon of a long-acting local anesthetic.[54,139,155,156]	• Intravenous fentanyl or other suitable agent (if available) to treat breakthrough pain in the PACU.[49-53] • Oral or rectal paracetamol in adequate dosing during the entire postoperative period.[44-46]
Intermediate level	• Intravenous paracetamol or rectal NSAID.[58,59,154,157] • Landmark-based caudal blockade with long-acting local anesthetics ± adjunct clonidine if available.[158]	• Intravenous nalbuphine or other suitable agent (if available) to treat serious breakthrough pain in the PACU.[56,57,143] • Oral or rectal NSAIDs (eg, ibuprofen) and/or paracetamol in adequate dosing during the entire postoperative period.[43]
Advanced level	• Intravenous metamizole or rectal NSAID. • Intravenous loading dose of paracetamol.[58,154] • Ultrasound-guided rectus sheath block or bilateral subcostal TAP or ultrasound-guided caudal blockade with long-acting local anesthetics combined with appropriate adjunct.[155,159-162]	• Intravenous nalbuphine or other suitable agent (if available) to treat breakthrough pain in the PACU. • Oral or rectal NSAIDs (eg, ibuprofen) and/or paracetamol in adequate dosing during the entire postoperative period. • intravenous nalbuphine or oral tramadol as rescue in the ward

TABLE 5 Adeno-tonsilectomy

Adeno-tonsillectomy[138,163] Warning: In patients with obstructive sleep apnea extra caution is warranted (avoid/minimize opioid dosage, enhance monitoring, longer hospital stay)[131,132]		
	Intraoperative	**Postoperative**
Basic level	• Intravenous fentanyl in divided doses • Rectal NSAID or if not available rectal paracetamol after induction of anesthesia or oral paracetamol or NSAID as a part of premedication (preemptive analgesia).[164] • Local wound infiltration by the surgeon of a long-acting local anesthetic.[60,139,165-169]	• Intravenous fentanyl or morphine or other suitable agent (if available) to treat breakthrough pain in the PACU[51,170-172] • Oral NSAIDs and/or paracetamol in adequate dosage during the entire postoperative period from the moment when the oral intake will be possible.[173,174] • Intravenous or oral tramadol or other suitable agent if available as rescue in the ward.[175-178]
Intermediate level	• Intravenous fentanyl or opioid of choice in divided doses • Loading dose of paracetamol/NSAID intravenously, after induction of anesthesia. In small children, rectal approach could be considered as well as oral paracetamol as a part of premedication (preemptive analgesia).[179-182] • Loading dose of tramadol or other suitable agent if available: nalbuphine, piritramide before the end of anesthesia. • Local wound infiltration by the surgeon of a long-acting local anesthetic.	• Intravenous tramadol or other suitable agent according to intraoperative loading dose (if available) to treat serious breakthrough pain in the PACU. • Intravenous paracetamol in immediate postoperative period.[183] • Oral NSAIDs and/or paracetamol in adequate dosage during the entire postoperative period from the moment when the oral intake is possible. • Intravenous or oral tramadol or other suitable agent if available: nalbuphine, piritramide as rescue in the ward.[143,184,185]
Advanced level	• Intravenous fentanyl or opioid of choice in divided doses or remifentanil infusion • Loading dose of paracetamol/NSAID intravenously, after induction of anesthesia or loading dose of metamizole. In small children, rectal approach could be considered as well as oral paracetamol as a part of premedication (preemptive analgesia).[61,186] • Loading dose of tramadol or other suitable agent if available: nalbuphine, piritramide before the end of anesthesia.	• Intravenous tramadol or other suitable agent according to intraoperative loading dose (if available) to treat breakthrough pain in the PACU. • Intravenous paracetamol in immediate postoperative period or • Metamizole in divided doses.[186] • Oral NSAIDs and/or paracetamol in adequate dosage during the entire postoperative period from the moment when the oral intake is possible • Intravenous or oral tramadol or other suitable agent if available: nalbuphine, piritramide as rescue in the ward. • Consider iv-PCA including adequate monitoring[62,187]

TABLE 6 Appendicectomy

Appendicectomy (open and laparoscopic)[63,138,188]		
	Intraoperative	**Postoperative**
Basic level	• Intravenous fentanyl in divided doses[49] • Local wound infiltration/local port-side infiltration by the surgeon with a long-acting local anesthetic[54,156] • Rectal NSAID or paracetamol[44,45]	• Intravenous fentanyl or morphine or other suitable agent (if available) to treat breakthrough pain in the PACU[50,51,189] • Oral NSAID or paracetamol, in adequate dosing during the entire postoperative period • iv or oral tramadol or other suitable agent if available as rescue in the ward[56,175]
Intermediate level	• Intravenous fentanyl or opioid of choice in divided doses • Landmark-based ilioinguinal/iliohypogastric block with long-acting local anesthetic combined with appropriate adjunct (clonidine)[139] • Intravenous NSAID or loading dose of metamizole[61,64]	• Intravenous fentanyl or morphine or other suitable agent (if available) to treat breakthrough pain in the PACU[55] • Intravenous NSAID or paracetamol in adequate dosing during the entire postoperative period[190] • Intravenous metamizole (if available) in adequate dosing during the entire postoperative period[61] • iv or oral tramadol or other suitable agent if available as rescue in the ward
Advanced level	• Intravenous fentanyl or opioid of choice in divided doses or remifentanil infusion • Ultrasound-guided peripheral blocks (eg, ilioinguinal/iliohypogastric, transversus abdominis plane block, paravertebral block with long-acting local anesthetic combined with appropriate adjunct (clonidine)[22,191,192] • Intravenous NSAID or loading dose of metamizole	• Intravenous fentanyl or other suitable agent (if available) to treat breakthrough pain in the PACU • Intravenous NSAID, or paracetamol or metamizole in adequate dosing during the entire postoperative period • iv or oral tramadol or other suitable agent if available as rescue in the ward or • Consider iv-PCA (patient controlled analgesia) including adequate monitoring.[65,66,193]

TABLE 7 Limb fractures

Limb fractures (>1 mo of age)[138]		
	Intraoperative	**Postoperative**
Basic level	• Fentanyl or opioid of choice in divided doses[49] • Rectal NSAID or rectal paracetamol[44,45] • If possible fracture infiltration by the surgeon with long-acting local anesthetic	• Intravenous morphine or fentanyl or morphine or other suitable agent (if available) to treat breakthrough pain in the PACU[50,51,55,67] • Oral NSAIDs and/or paracetamol in adequate dosing during the entire postoperative period. • iv or oral tramadol or other suitable agent (if available) as rescue in the ward[56]
Intermediate level	• Intravenous NSAID or intravenous paracetamol • Landmark-guided peripheral nerve block (eg, interscalene, supraclavicular, axillar block for the upper limb; femoral, adductor canal, sciatic block, eventually in association, for the lower limb) with a long-acting local anesthetic combined with appropriate adjunct (clonidine) if available. If using a double block consider the total amount of local anesthetic.[54,139,194-197] • If PNB is contraindicated fentanyl or opioid if choice in divided doses	• Intravenous morphine or fentanyl or other suitable agent (if available) to treat breakthrough pain in the PACU • Oral NSAIDs and/or paracetamol in adequate dosing during the entire postoperative period. • iv or oral tramadol or other suitable agent (if available) as rescue in the ward
Advanced level	• Intravenous ketorolac. • Intravenous loading dose of intravenous NSAID or paracetamol. • Ultrasound-guided peripheral nerve block single, shot or continuous infusion, (eg, interscalene, supraclavicular, axillar block for the upper limb; femoral, adductor canal, sciatic block, eventually in association, for the lower limb) with a long-acting local anesthetic combined with appropriate adjunct (clonidine) if available. If using a double block consider the total amount of local anesthetic.[198-202] • If PNB is contraindicated: fentanyl or opioid of choice in divided doses.	• Intravenous fentanyl or other suitable agent (if available) to treat serious breakthrough pain in the PACU. • iv/oral paracetamol or iv/oral NSAID in adequate dosing during the entire postoperative period.[203] • iv or oral tramadol or other suitable agent (if available) as rescue in the ward • Consider patient-controlled regional anesthesia or iv-PCA if needed

TABLE 8 Dosage suggestions for systemic analgesia

Basic level	Intermediate level	Advanced level	Dosage suggestions
Rectal NSAIDs (Nonsteroidal anti-inflammatory drugs)			
Ibuprofen	Ibuprofen	Ibuprofen	10 mg kg^{-1} every 8 h
Diclofenac	Diclofenac	Diclofenac	1 mg kg^{-1} every 8 h
Naproxen	Naproxen	Naproxen	5-7.5 mg kg^{-1} every 12 h
Oral NSAIDs			
Ibuprofen	Ibuprofen	Ibuprofen	10 mg kg^{-1} every 8 h
Diclofenac	Diclofenac	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} (max 10 mg) every 6 h (short-term therapy, maximum 48 h)
		Ketoprofen	1 mg kg^{-1} every 8 h
Rectal paracetamol (if rectal NSAID is not available)			
Paracetamol	Paracetamol	Paracetamol	20-40 mg kg^{-1} (15 mg kg^{-1} if <10 kg) Single loading dose in association with anesthesia; the higher dose is due to poor bioavailability from rectal route of administration
Oral paracetamol			
Paracetamol	Paracetamol	Paracetamol	10-15 mg kg^{-1} every 6 h
Intravenous paracetamol			
		Paracetamol	<10 kg: 7,5 mg kg^{-1} >10 kg: 15 mg kg^{-1} Intravenous preparation: 10 mg mL^{-1}
Intraoperative opioids depending on age and procedure			
Fentanyl	Fentanyl	Fentanyl	1-2 μg kg^{-1}
Morphine	Morphine	Morphine	25-100 μg kg^{-1} depending on age, titrated to effect
	Piritramide	Piritramide	0.1-0.15 mg kg^{-1}
	Alfentanil	Alfentanil	10-20 μg kg^{-1}
	Sufentanil	Sufentanil	0.5-1 μg kg^{-1} bolus
		Sufentanil	0.5-1 μg kg^{-1} bolus then continuous infusion of 0.5-1 μg kg^{-1} h^{-1}
		Remifentanil	0.05-0.3 μg kg^{-1} min^{-1}
Intraoperative use of ketamine/S-ketamine			
Ketamine/S-Ketamine	Ketamine/S-Ketamine	Ketamine/S-Ketamine	0.5 mg kg^{-1} may be used as adjunct to intraoperative opioids, consider reduced dose when using S-ketamine
Intraoperative/postoperative intravenous Metamizol			
		Metamizole	10-15 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	Fentanyl	Fentanyl	0.5-1.0 μg kg^{-1}, titrated to effect
Morphine	Morphine	Morphine	25-100 μg kg^{-1} depending on age, titrated to effect
Tramadol	Tramadol	Tramadol	1-1.5 mg kg^{-1}, titrated to effect
Ketamine/S-Ketamine	Ketamine/S-Ketamine	Ketamine/S-Ketamine	0.5 mg kg^{-1}, titrated to effect, consider reduced dose when using S-ketamine
	Piritramide	Piritramide	0.1-0.15 mg kg^{-1}, titrated to effect
	Nalbuphine	Nalbuphine	0.1-0.2 mg kg^{-1}, depending on age, titrated to effect

(Continues)

TABLE 8 (Continued)

Basic level	Intermediate level	Advanced level	Dosage suggestions
Intravenous analgesics for breakthrough pain in the ward			
Tramadol	Tramadol	Tramadol	1-1.5 mg kg^{-1}, every 4-6 h
	Nalbuphine	Nalbuphine	0.1-0.2 mg kg^{-1}, depending on age, every 3-4 h
	Piritramide	Piritramide	0.1-0.15 mg kg^{-1} every 4-6 h
	Metamizole	Metamizole	10-15 mg kg^{-1} every 8 h
Oral analgesics for breakthrough pain in the ward			
Tramadol	Tramadol	Tramadol	1-1.5 mg kg^{-1}, every 4-6 h
	Metamizole	Metamizole	10 mg kg^{-1} every 8 h
Patient Controlled Analgesia (PCA) 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	
		Tramadol/Metamizole PCA according to institutional standards based on the current literature	

TABLE 9 Dosage suggestions for regional anesthesia

	Dosage suggestions	Adjuvant
Long-acting local anesthetics for wound infiltration, port-side infiltration, fracture infiltration or peripheral nerve block		
Bupivacaine 0.25%	Maximum dose 1 mL kg^{-1} (=2.5 mg kg^{-1})	
L-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 ilioinguinal/iliohypogastric nerve block		
Bupivacaine 0.25%	0.3-0.5 mL kg^{-1} (=0.75-1.25 mg kg^{-1})	If available, consider the use of preservative-free clonidine 1-2 μg kg^{-1} as adjunct
L-bupivacaine 0.25%	0.3-0.5 mL kg^{-1} (=0.75-1.25 mg kg^{-1})	
Ropivacaine 0.2%	0.3-0.5 mL kg^{-1} (=0.6-1 mg kg^{-1})	
Long-acting local anesthetics for landmark-based and ultrasound-guided caudal block		
Bupivacaine 0.25%	1.0 mL kg^{-1} (up to 1.5 mL kg^{-1} for pyloromyotomy)	Preservative-free clonidine 1-2 μg kg^{-1} or Preservative-free ketamine or S-ketamine if >12 mo of age: 0.5-1 mg kg^{-1}
L-bupivacaine 0.25%	1.0 mL kg^{-1} (up to 1.5 mL kg^{-1} for pyloromyotomy)	
Ropivacaine 0.2%	1.0 mL kg^{-1} (up to 1.5 mL kg^{-1} for pyloromyotomy)	
Long-acting local anesthetics for ultrasound-guided ilioinguinal/iliohypogastric nerve block and paravertebral block		
Bupivacaine 0.25%	0.1-0.2 mL kg^{-1}	Preservative-free clonidine 1-2 μg kg^{-1}
L-bupivacaine 0.25%	0.1-0.2 mL kg^{-1}	
Ropivacaine 0.2%	0.1-0.2 mL kg^{-1}	
Long-acting local anesthetics for landmark-based and ultrasound-guided dorsal penile nerve block		
Bupivacaine 0.25%	0.1-0.2 mL kg^{-1}	Preservative-free clonidine 1-2 μg kg^{-1}
L-bupivacaine 0.25%	0.1-0.2 mL kg^{-1}	
Ropivacaine 0.2%	0.1-0.2 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 μg kg^{-1} per side
L-bupivacaine 0.25%	0.2-0.5 mL kg^{-1} per side	
Ropivacaine 0.2%	0.2-0.5 mL kg^{-1} per side	
Continuous or patient controlled regional anesthesia including adequate monitoring		
According to institutional standards based on the current literature		Preservative-free clonidine 0.2-0.4 μg kg^{-1} h^{-1}

also applies to maximum drug doses that may be used. Some of the analgesic drugs or formulations may not be available in all counties.

Be aware of increased sensitivity to the effects of opioids in patients with obstructive sleep apnea (OSA) and markedly increased risk of opioid-induced ventilatory impairment (OIVI) in the

TABLE 10 Treatment of postoperative nausea and vomiting (PONV)

	Dosage suggestions	
Dexamethasone	0.15 mg kg^{-1} every 8 h	
Ondansetron	0.05-0.1 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 <1 y old

postoperative period.[130] It is recommended that opioids should be avoided in the postoperative period in this population if possible or if needed, minimize opioid dosage (25%-50% of usual dosage), and titrate dose to effect with enhanced postoperative monitoring and longer hospital stay.[131,132]

4.1.1 | Monitoring standards

Clinical and electronic monitoring standards will depend on age, comorbidities, extent and complexity of the surgery, and use of sedative medications. Particular care is required in infants <1 year of age, when opioid infusion techniques are used and where surgery becomes complicated. Specific monitoring for complications of regional analgesic techniques should be used, especially for continuous infusion techniques and in younger infants. For details on monitoring and treatment of possible adverse effects, the ESPA pain management committee suggests following already available recommendations such as those published by the Australian and New Zealand College of Anesthetists or the Association of Pediatric Anesthetists of Great Britain and Ireland.[8,133,134] Concerning the safe use of regional anesthesia in children, the joint practice advisory from the European Society of Regional Anaesthesia and Pain Therapy (ESRA) and the American Society of Regional Anesthesia and Pain Medicine (ASRA) is recommended.[135]

4.1.2 | Use of corticosteroids

Corticosteroids may enhance postoperative pain relief and prolong the duration of regional anesthesia and help to prevent postoperative nausea and vomiting.[136,137]

5 | CONCLUSIONS

The ESPA Pain Ladder is a synthesis of existing guidelines, availability of medications and other resources, economic costs, and patient safety. We hope that the suggestions in this article will help improve pediatric postoperative analgesia in Europe and other parts of the world.

ETHICAL APPROVAL

No ethics approval provided.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

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