European Society of
Regional Anaesthesia
& Pain Therapy

ESRA ITALIA

ESRA Italian Chapter

XXVIII CONGRESSO NAZIONALE

PRESIDENTE
DEL CONGRESSO
Luciano Calderone

MZ EVENTS

PALERMO 5-7 Ottobre
XXVIII CONGRESSO NAZIONALE

European Society of Regional Anaesthesia & Pain Therapy
ESRA ITALIA

RICETTE D'AUTORE: farmaci, dose/volume e concentrazione

Dott.ssa Veronica Diotto
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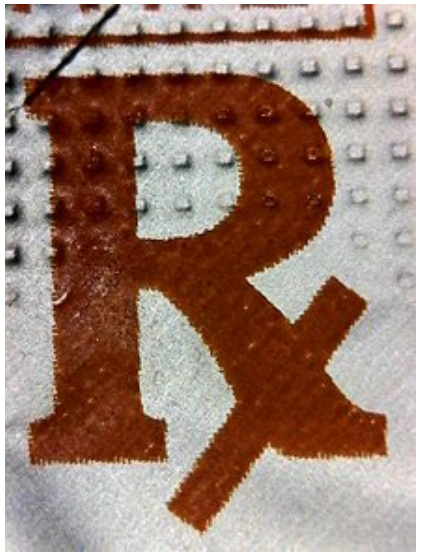
Ospedale dei Bambini Vittore Buzzi, Milano
ASST Fatebenefratelli Sacco

''*RECIPE*'' or ''PRESCRIPTION''

Recipere, imperative form Recipe!

The word derives from Latin (with the same spelling) and meant "***TAKE***". It was used exclusively by medical doctors who would write '***RECIPE***' at the top of prescriptions. It only survives in this sense today in the pharmacist's abbreviation ***'Rx'.***



	Pharmacokinetic Consideration in Children	Clinical Implication in Children
Absorption	• Higher cardiac output and lower tissue binding, resulting in higher rate of systemic absorption.	• Shorter duration of LA action • Increased risk of LAST
Distribution	• Neonates have higher extracellular fluid volume and higher volume of distribution. • Low plasma concentration of α1-acid glycoprotein (0.2–0.3 g/L at birth), reaching adult levels (0.7–1.0 g/L) by 1 year of age. This results in an increased unbound fraction of LA in the plasma.	• Higher dose requirement in neonates after a single injection of LA, but LA accumulates with repeated doses • Higher unbound free fraction of LA in plasma, increasing risk of LAST
Metabolism	• Lignocaine and bupivacaine are initially metabolized by CYP3A7. By 9 mo of age, they are metabolised by CYP3A4. • Ropivacaine and levobupivacaine are metabolised by CYP1A2 which is relatively immature until 3 y, with full development by 8 y	• Half-life of amide LA in neonates 3-8 times longer than adults; hence, have increased risk of systemic toxicity when used as an infusion
Clearance for LA bolus injection	• Up to 2 y: Cm and clearance of amide LA decreased after bolus injection, and elimination half-life prolonged • > 2 y: clearance and elimination half-life increase progressively and exceed that of adults before returning to adult levels during adolescence	Free fraction of LAs ↑ in infants
Clearance for continuous infusion	• AAG ↑ on POD 1 and 2 protects against LAST • AAG ↓on POD 3 resulting in ↑ free fraction • Thus, it is advised to stop LA infusion in infants after 48 h • Lignocaine: continuous infusion results in substantial decrease in intrinsic clearance, since lignocaine metabolism is impaired by its own metabolites • Clearance is rate limited for both bupivacaine and ropivacaine and primarily dependent on protein binding • Bupivacaine: clearance decreases by more than 40%, and risk of accumulation exists • Ropivacaine: clearance remains unchanged	• Lignocaine is unsuitable for continuous infusion • Chloroprocaine and ropivacaine are considered to be safer choices

RISK OF TOXICITY

PHARMACODYNAMICS

- Smaller nerves
- Immature myelination (completed by 10-12 y)
- Loose endoneurvium, less connective tissue
- Shorter distance between Ranvier nodes

Fast-onset and high-quality block

even with LOW CONCENTRATION

General principles of regional anaesthesia in children

F. Merella[1,*], N. Canchi-Murali[1] and V. Mossetti[2]

[1]Birmingham Children's Hospital, Birmingham, UK and [2]Regina Margherita Children's Hospital, Turin, Italy

BJA Education, 19(10): 342–348 (2019)

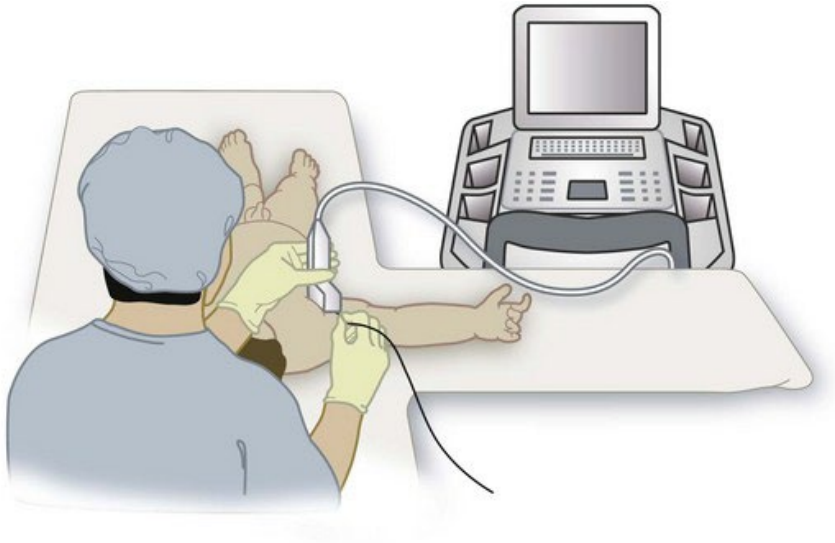
doi: 10.1016/j.bjae.2019.06.003
Advance Access Publication Date: 24 August 2019

Levo-bupivacaine&Ropivacaine

- Prolonged action
- Better cardiac toxicity profile

US-guided regional block

- Increases precision and success rate
- Faster onset
- Reduces the amount of LA
- Develops new blocks



The European Society of Regional Anaesthesia and Pain Therapy/American Society of Regional Anesthesia and Pain Medicine Recommendations on Local Anesthetics and Adjuvants Dosage in Pediatric Regional Anesthesia

Santhanam Suresh, MD, Claude Ecoffey, MD,† Adrian Bosenberg, MB, ChB, FFA(SA),‡ Per-Anne Lonnqvist, MD,§ Gildasio S. de Oliveira Jr, MD, MSCi,|| Oscar de Leon Casasola, MD,** José de Andrés, MD, PhD,†† and Giorgio Ivani, MD‡‡*

(*Reg Anesth Pain Med* 2018;43: 211–216)

High-level evidence is not yet available to guide dosage of LA used in regional blocks in children. The ASRA/ESRA recommendations intend to provide guidance in order to reduce the large variability of LA dosage currently observed in clinical practice.

- The performance of spinal anesthesia with ropivacaine can be performed in children with a dose of 0.5 mg/kg. (Evidence B3)

Caudal Block—Single Injection

The recent Pediatric Regional Anesthesia Network data reported a large variation in LA dose used in caudal blocks.[26] Indeed, the data suggest that approximately 25% of patients undergoing a caudal block received an LA dose with the potential to cause LA toxicity. Younger children seem to be at greatest risk of receiving a toxic dose. The volume injected should be modified to achieve a dermatomal level according to Armitage, that is, 0.5 mL/kg to achieve the sacral dermatomes, 1 mL/kg to achieve the lumbar dermatomes, and 1.25 mL/kg to reach lower thoracic dermatomes.[27] Some authors used more volume of diluted ropivacaine (0.15%): if the total dose is fixed, caudal analgesia with a larger volume of diluted ropivacaine provides better quality and longer duration after discharge than a smaller volume of more concentrated ropivacaine (0.125%).[28–31] In addition, ropivacaine undergoes slower systemic absorption from the caudal epidural space than bupivacaine; ropivacaine produces lower incidence of motor blockade in the early postoperative period than bupivacaine.

Evidence-based conclusions and clinical advice

- Ropivacaine 0.2% (2 mg/mL) or levobupivacaine/bupivacaine 0.25% (2.5 mg/mL) is recommended for the performance of caudal blocks in children and should not exceed 2 mg/kg ropivacaine or 2.5 mg/kg bupivacaine or levobupivacaine. (Evidence B2)

Lumbar or Thoracic Epidural

Similarly to caudal anesthesia, the use of ropivacaine 0.2% or levobupivacaine/bupivacaine 0.25% is common for lumbar or thoracic epidural in children.[32–34] A dose of 0.5 mL/kg is usually used for lumbar epidural initial loading (0.3 mL/kg thoracic epidural initial loading) and 0.25 mL/kg for subsequent "top-up" in order to obtain intraoperative analgesia. The building properties of the epidural space are important and prevent a rapid rise in concentration. The maximum dose usually used is 1.7 mg/kg ropivacaine and 1.7 mg/kg levobupivacaine bupivacaine.[35]

Evidence-based conclusions and clinical advice

- The use of LAs for lumbar or thoracic epidural in children should not exceed a dosage of 1.7 mg/kg of ropivacaine, bupivacaine, or levobupivacaine. (Evidence B3)

Continuous Infusion Epidural Anesthesia

Epidural infusions of ropivacaine provided satisfactory pain relief in neonates and infants younger than 1 year. As plasma concentrations of unbound ropivacaine are not influenced by the duration of the infusion, ropivacaine can be safely used for postoperative epidural infusion for 48 to 72 hours. Levels of unbound ropivacaine were higher in the neonates than in the infants, but well below threshold concentrations for central nervous system toxicity in adults, that is, greater than or equal to 0.35 mg/L.[35] In the first weeks of life, ropivacaine infusion should be used with more caution. Because of concerns about toxicity due to accumulation of amide LAs in infants and young children, chloroprocaine could be an alternative.[36]

Evidence-based conclusions and clinical advice

- The performance of continuous epidural anesthesia with bupivacaine/levobupivacaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.4 mg/kg per hour for children older than 1 year. (Evidence B3)
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- The performance of continuous epidural anesthesia with chloroprocaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.5 mg/kg per hour for children older than 1 year. (Evidence B3)

Single-Injection LA Dosage for Peripheral Nerve and Fascial Plane Blocks

The introduction of ultrasound-guided regional anesthesia has increased the use of peripheral nerve blocks in children during recent years.[37–39] Nonetheless, few publications have addressed the pharmacodynamics of LAs in children.[6] In addition, pharmacokinetic properties of LAs significantly differ between different types of blocks.[40]

Many studies have examined dose responses of single peripheral nerve blocks in pediatrics.[41–43] Nonetheless, dosages have been examined in very few block types by more than 1 study, and this limits the reliability of the findings.[6] Intercostal nerve blocks are known to have the greatest rate of reabsorption and therefore the highest potential risks of LA systemic toxicity.[44,45] Conversely, higher LA dosages (2.5 mg/kg) used for intercostal nerve blocks have resulted in plasma levels below potential toxic levels.[46]

Evidence-based conclusions and clinical advice

- The performance of ultrasound-guided upper-extremity peripheral nerve blocks (eg, axillary, infraclavicular, interscalene, supraclavicular) in children can be performed successfully and safely using a recommended LA dose of bupivacaine, levobupivacaine, or ropivacaine of 0.5 to 1.5 mg/kg. (Evidence B2)
- The performance of ultrasound-guided lower-extremity peripheral nerve blocks (eg, femoral, sciatic, popliteal, adductor canal) can be performed successfully and safely using a recommended LA dose of bupivacaine or ropivacaine of 0.5 to 1.5 mg/kg. (Evidence B2)
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Continuous Infusion … and Fascial Plane Blocks

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Evidence-based conclusions and clinical advice

- Continuous infusion of LA for peripheral nerve and fascial plane blocks can be safely and successfully performed with

Caudal Block-Single Injection

of receiving a toxic dose. The volume injected should be modified to achieve a dermatomal level according to Armitage, that is, 0.5 mL/kg to achieve the sacral dermatomes, 1 mL/kg to achieve the lumbar dermatomes, and 1.25 mL/kg to reach lower thoracic dermatomes.[27] Some authors used more volume of diluted ropivacaine (0.15%): if the total dose is fixed, caudal analgesia with a larger volume of diluted ropivacaine provides better quality and longer duration after discharge than a smaller volume of more concentrated ropivacaine (0.125%).[28–31] In addition, ropivacaine undergoes slower systemic absorption from the caudal epidural space than bupivacaine; ropivacaine produces lower incidence of motor blockade in the early postoperative period than bupivacaine.

Evidence-based conclusions and clinical advice

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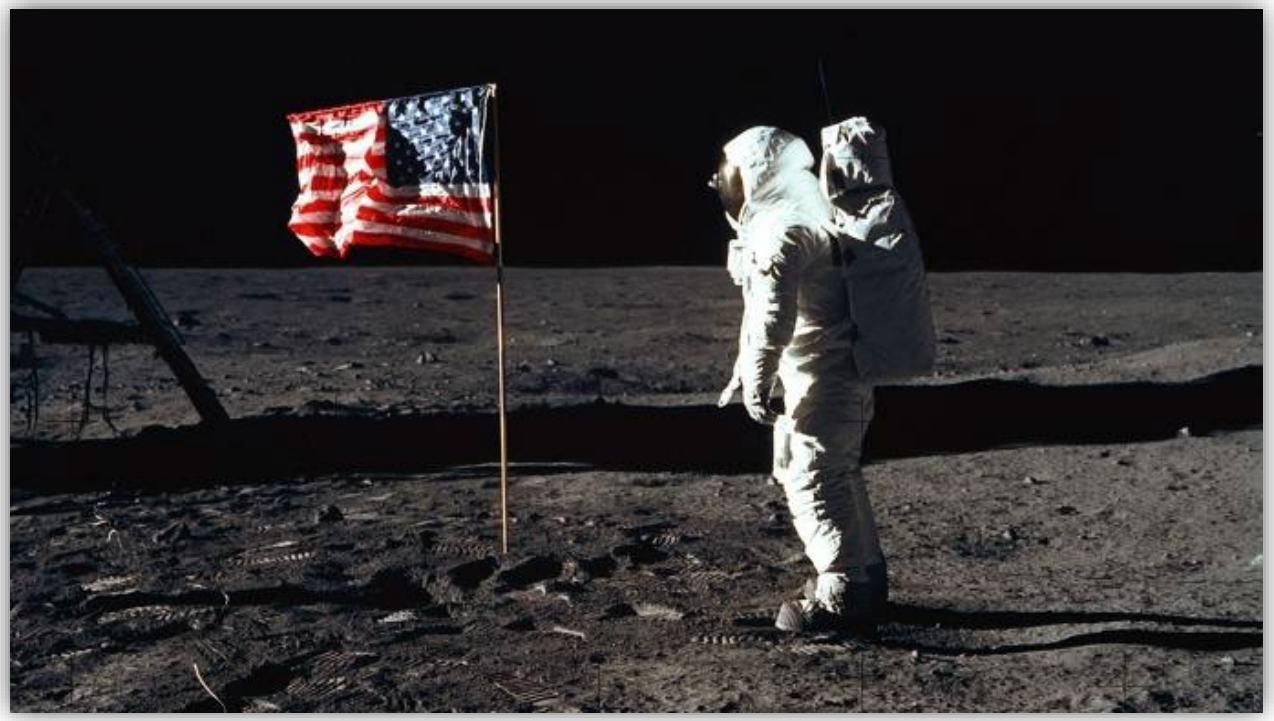


Brit. J. Anaesth. (1969), **41**, 1016

AGEING AND EPIDURAL DOSE REQUIREMENTS

Segmental spread and predictability of epidural analgesia in youth and extreme age

BY

P. R. BROMAGE

Spread of block is predictable.

- **Spiegel** spinal column height-based formula Volume for T10 block (ml) = $\left\{4+\left(\frac{D-15}{2}\right)\right\}X13/20$
- **Bromage&Schulte-Steinberg** age x 0.1 ml/n° dermatomes
- **Takasaki** body weight-based formula Volume for T10 block (ml) = [(body weight in kg x 0.078)-0.17] x 13

Dr Edward Nigel Armitage

the provision of improved facilities for extended postoperative recovery.

Caudal block in children

E.N. Armitage (Brighton)

Very few children presenting for surgery are in pain preoperatively. Many of the younger ones are unaware that there is anything the matter with them; they therefore naturally regard postoperative pain as unnecessary and unjust.

Caudal block has been found valuable for pain prevention in children since it is free from the disadvantages which limit its use in adults. In children, a caudal, performed under light general anaesthesia, is successful in over 98% of cases, is suitable for surgery from the umbilicus downwards, and takes less than 1 min to perform.

The sacral cornua are the important landmarks and, with the child's hips flexed to 90°, the cornua are found to lie in line with the long axis of the femur. Once the needle has penetrated the sacro-coccygeal ligament, it is not re-angled or advanced further into the sacral extradural space lest a blood vessel is damaged.

There are two causes of failure with paediatric caudals. The first is anatomical, and with experience and careful attention to the landmarks, this is rare. The second cause may be termed 'functional', that is, failure to obtain a satisfactory block even when the needle is correctly placed. Failure is then almost always due to low dosage—doses in common use are too low to give successful blocks in every child.

The following dosage scheme, using 0·25% plain bupivacaine, is effective and avoids the need for calculating the number of segments to be blocked: block of sacral nerves (e.g. for circumcision) 0·5 mg/kg, block to lower thoracic nerves (e.g. for inguinal herniotomy) 1 ml/kg, and block to mid thoracic nerves (e.g. for orchidopexy or umbilical herniorrhaphy) 1·25 ml/kg. When this regime results in a volume of local anaesthetic greater than 20 ml, the bupivacaine concentration is reduced to 0·19%. This avoids the unpleasant sensation of lower limb weakness and heaviness which may otherwise result. It is well known that children are very tolerant of local analgesics in the extradural space. There have been no signs or symptoms of local anaesthetic toxicity in over 1100 cases, and samples taken for plasma bupivacaine analysis have always shown levels below 1·2 μg/ml.

The technique is applicable over a wide range of paediatric surgery. Pain prevention extends well into the postoperative period. Quick recovery of consciousness, due to light levels of general anaesthesia, is an additional advantage.

Grossly abnormal sacral anatomy, bleeding tendencies and local sepsis are contra-indications to the technique.

Anaesthesia, 1979, Volume 34. pages 390–434

Is there a place for regional anesthesia in pediatrics ? — Yes !

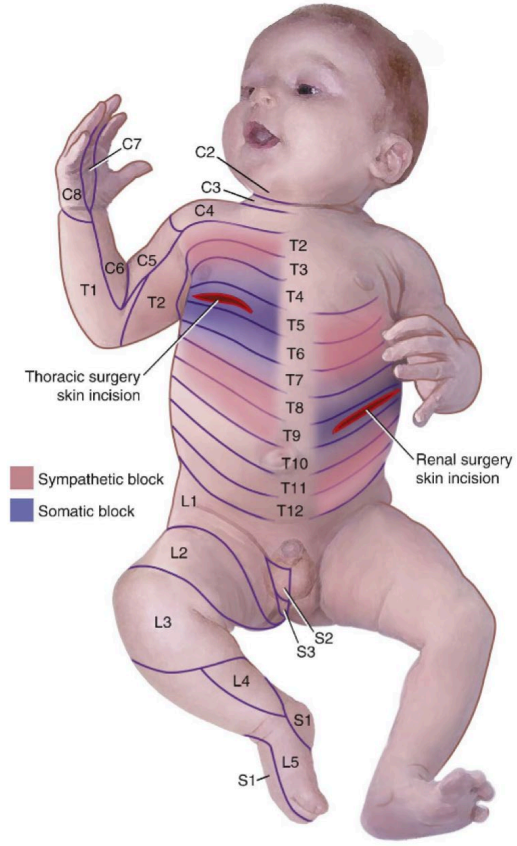
E. N. ARMITAGE

(Acta Anaesth. Belg., 1988, 39, 191-195).

Pediatric caudal dosage *

Lumbosacral block	0.5 ml/kg
Thoracolumbar block	1 ml/kg (T8-T10)
Mid-thoracic block	1.25 ml/kg (T4-T6)

* Drug concentrations :
0.25% bupivacaine for volumes up to 20 ml
0.19% bupivacaine for volumes over 20 ml



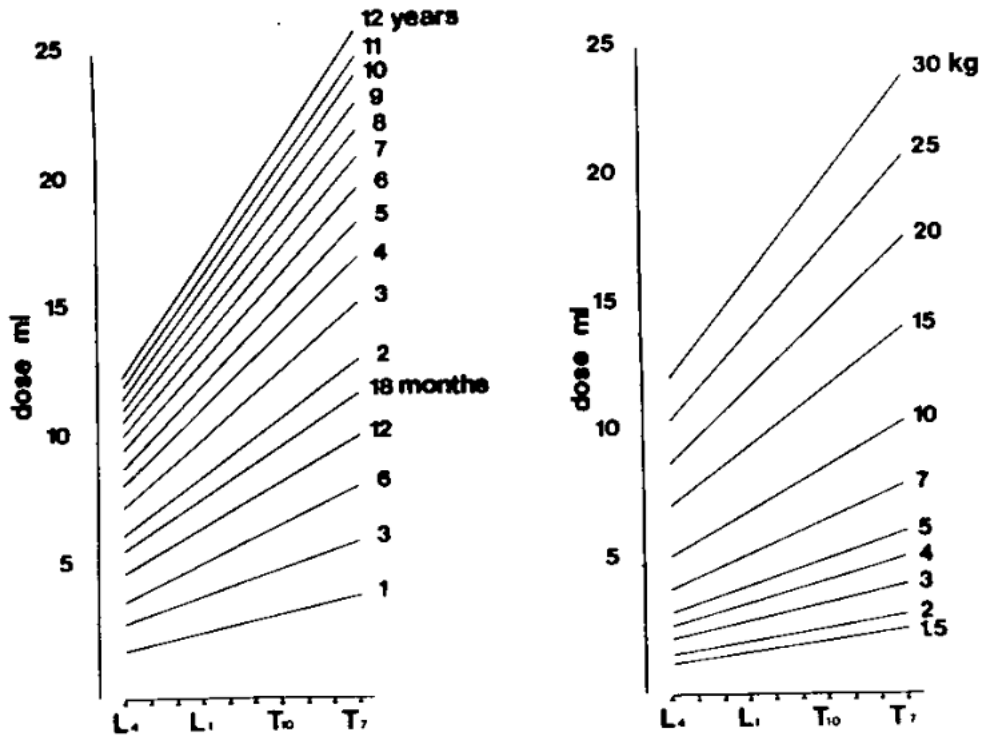
«Two factors affect the success of the block in children. Firstly, the **DOSE** must be large enough to ensure an adequate block in every case, since a caudal is a single-injection technique and increments cannot be given if the initial dose is too small. Secondly, it is important to choose a **CONCENTRATION** of local anesthetic which produces only the desired sensory effect and which leaves the motor system unaffected. Children become very distressed if they cannot move their legs or if they have severe paresthesiae, so when the calculated **VOLUME** is greater than 20 ml, the bupivacaine should be diluted from 0.25% to 0.19%.»

Anaesth Intens Care (1986), **14**, 140-144

The Spread of Caudal Analgesia in Children: A Mathematical Model

P. BUSONI* AND T. ANDREUCCETTI*
Department of Anaesthesia, Ospedale Pediatrico 'A Meyer,' Firenze, Italy

There are four different possibilities to avoid too large **DOSAGE**: further **DILUTION** of the drug while keeping the **VOLUME** as calculated; maintenance of light general anaesthesia; insertion of a catheter in the sacral canal and finally, the performance of epidural rather than caudal blockade.

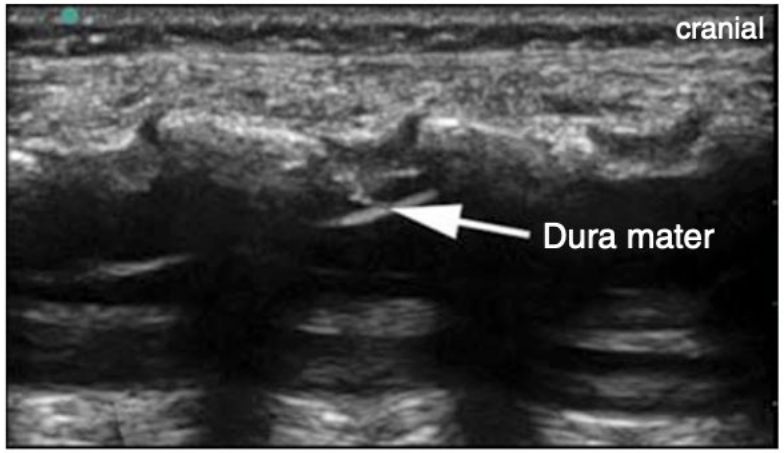


ORIGINAL ARTICLE

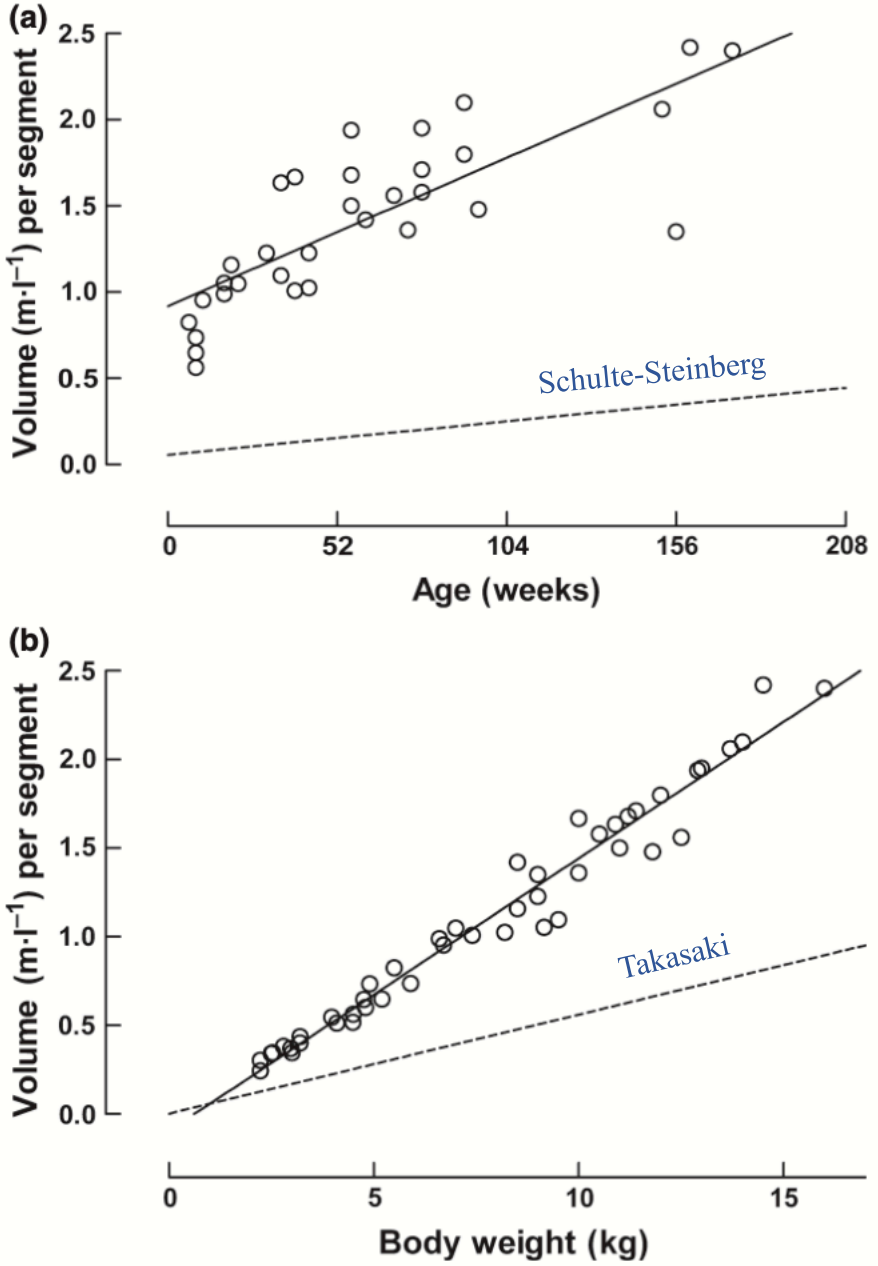
Pediatric Anesthesia **21** (2011) 121–127

Segmental distribution of high-volume caudal anesthesia in neonates, infants, and toddlers as assessed by ultrasonography

Märit Lundblad[1], Per-Arne Lönnqvist[2], Staffan Eksborg[3] & Peter Marhofer[4]



«The cranial spread of LA as assessed by immediate ultrasound visualization was found to be in poor agreement with previously published predictive equations that are based on cutaneous dermatomal testing.»



British Journal of Anaesthesia **108** (4): 675–81 (2012)
Advance Access publication 6 February 2012 · doi:10.1093/bja/aer513

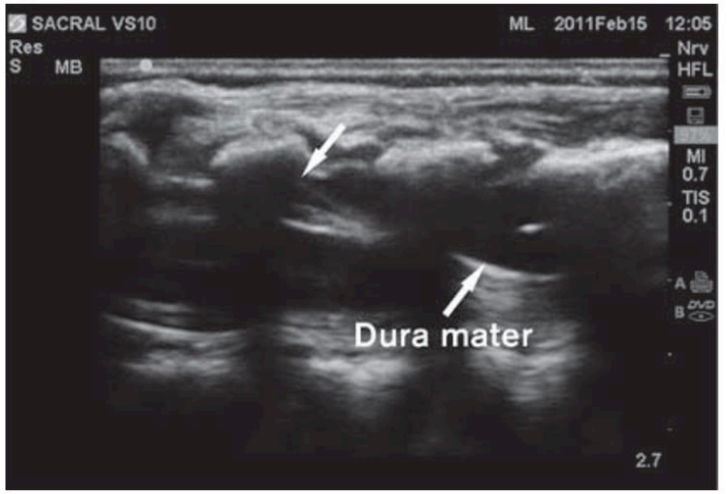
BJA

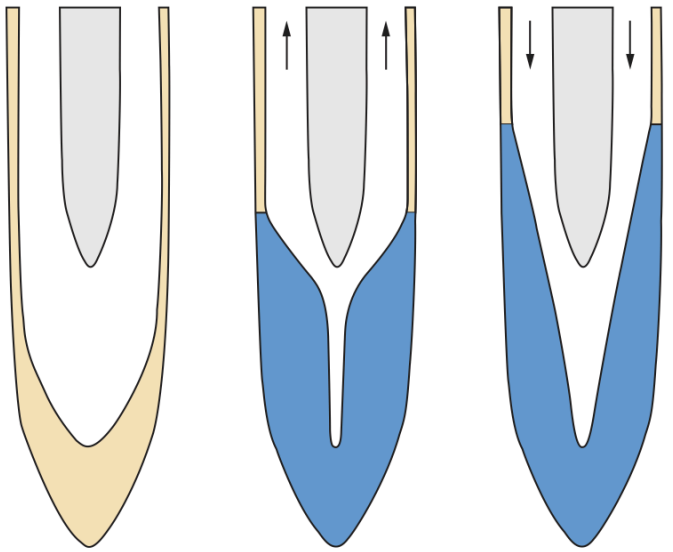
Secondary spread of caudal block as assessed by ultrasonography

M. Lundblad[1]*, S. Eksborg[2] and P. A. Lönnqvist[3]

Results. The median ultrasound-assessed cranial spread was Th10 and Th8 at 0 and 15 min, respectively, and the sensory level at 15 min was Th4. The caudal injection was initially found to compress the terminal part of the dural sac, later followed by a partial re-expansion as epidural pressure was returning towards pre-injection values. An intrasegmental redistribution from the dorsal to the ventral compartment of the epidural space was also observed.

Conclusions. Two separate patterns of secondary spread of caudal block could be observed, being horizontal intrasegmental redistribution and longitudinal cranial spread. The observed bi-directional movement of cerebrospinal fluid (coined 'the CSF rebound mechanism') does explain a major part of the difference between the initial ultrasound-assessed cranial level and the final level determined by cutaneous testing.





- The performance of spinal anesthesia with ropivacaine can be performed in children with a dose of 0.5 mg/kg. (Evidence B3)

Caudal Block—Single Injection

The recent Pediatric Regional Anesthesia Network data reported a large variation in LA dose used in caudal blocks.[26] Indeed, the data suggest that approximately 25% of patients undergoing a caudal block received an LA dose with the potential to cause LA toxicity. Younger children seem to be at greatest risk of receiving a toxic dose. The volume injected should be modified to achieve a dermatomal level according to Armitage, that is, 0.5 mL/kg to achieve the sacral dermatomes, 1 mL/kg to achieve the lumbar dermatomes, and 1.25 mL/kg to reach lower thoracic dermatomes.[27] Some authors used more volume of diluted ropivacaine (0.15%): if the total dose is fixed, caudal analgesia with a larger volume of diluted ropivacaine provides better quality and longer duration after discharge than a smaller volume of more concentrated ropivacaine (0.125%).[28–31] In addition, ropivacaine undergoes slower systemic absorption from the caudal epidural space than bupivacaine; ropivacaine produces lower incidence of motor blockade in the early postoperative period than bupivacaine.

Evidence-based conclusions and clinical advice

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Lumbar or Thoracic Epidural

Similarly to caudal anesthesia, the use of ropivacaine 0.2% or levobupivacaine/bupivacaine 0.25% is common for lumbar or thoracic epidural in children.[32–34] A dose of 0.5 mL/kg is usually used for lumbar epidural initial loading (0.3 mL/kg thoracic epidural initial loading) and 0.25 mL/kg for subsequent "top-up" in order to obtain intraoperative analgesia. The bupivacaine properties of the epidural space are important and patient a rapid rise in concentration. The maximum dose usually is 1.7 mg/kg ropivacaine and 1.7 mg/kg levobupivacaine bupivacaine.[35]

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Continuous Infusion Epidural Anesthesia

Epidural infusions of ropivacaine provided satisfactory pain relief in neonates and infants younger than 1 year. As plasma concentrations of unbound ropivacaine are not influenced by the duration of the infusion, ropivacaine can be safely used for postoperative epidural infusion for 48 to 72 hours. Levels of unbound ropivacaine were higher in the neonates than in the infants, but well below threshold concentrations for central nervous system toxicity in adults, that is, greater than or equal to 0.35 mg/L.[35] In the first weeks of life, ropivacaine infusion should be used with more caution. Because of concerns about toxicity due to accumulation of amide LAs in infants and young children, chloroprocaine could be an alternative.[36]

Evidence-based conclusions and clinical advice

- The performance of continuous epidural anesthesia with bupivacaine/levobupivacaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.4 mg/kg per hour for children older than 1 year. (Evidence B3)
- The performance of continuous epidural anesthesia with ropivacaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.4 mg/kg per hour for children older than 1 year. (Evidence B3)
- The performance of continuous epidural anesthesia with chloroprocaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.5 mg/kg per hour for children older than 1 year. (Evidence B3)

Single-Injection LA Dosage for Peripheral Nerve and Fascial Plane Blocks

The introduction of ultrasound-guided regional anesthesia has increased the use of peripheral nerve blocks in children during recent years.[37–39] Nonetheless, few publications have addressed the pharmacodynamics of LAs in children.[6] In addition, pharmacokinetic properties of LAs significantly differ between different types of blocks.[40]

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Evidence-based conclusions and clinical advice

- The performance of ultrasound-guided upper-extremity peripheral nerve blocks (eg, axillary, infraclavicular, interscalene, supraclavicular) in children can be performed successfully and safely using a recommended LA dose of bupivacaine, levobupivacaine, or ropivacaine of 0.5 to 1.5 mg/kg. (Evidence B2)
- The performance of ultrasound-guided lower-extremity peripheral nerve blocks (eg, femoral, sciatic, popliteal, adductor canal) can be performed successfully and safely using a recommended LA dose of bupivacaine or ropivacaine of 0.5 to 1.5 mg/kg. (Evidence B2)
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Caudal Block-Single Injection

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1 ml/kg max 20 ml

- The performance of spinal anesthesia with ropivacaine can be performed in children with a dose of 0.5 mg/kg. (Evidence B3)

Caudal Block—Single Injection

The recent Pediatric Regional Anesthesia Network data reported a large variation in LA dose used in caudal blocks.[26] Indeed, the data suggest that approximately 25% of patients undergoing a caudal block received an LA dose with the pote... to cause LA toxicity. Younger children seem to be at g... of receiving a toxic dose. The volume injected sh... fied to achieve a dermatomal level according... ge, that is, 0.5 mL/kg to achieve the sacral derm... mL/kg to achieve the lumbar dermatomes, and 1.2... g to reach lower thoracic dermatomes.[27] Some authors... more volume of diluted ropivacaine (0.15%): if the tot... se is fixed, caudal analgesia with a larger volume of dilu... opivacaine provides better quality and longer duration after... charge than a smaller volume of more concentrated ropivac... e (0.125%).[28–31] In addition, ropivacaine undergoes slower systemic absorption from the caudal epidural space than bupivacaine; ropivacaine produces lower incidence of motor blockade in the early postoperative period than bupivacaine.

Evidence-based conclusions and clinical advice

- Ropivacaine 0.2% (2 mg/mL) or levobupivacaine/bupivacaine 0.25% (2.5 mg/mL) is recommended for the performance of caudal blocks in children and should not exceed 2 mg/kg ropivacaine or 2.5 mg/kg bupivacaine or levobupivacaine. (Evidence B2)

Lumbar or Thoracic Epidural

Similarly to caudal anesthesia, the use of ropivacaine 0.2% or levobupivacaine/bupivacaine 0.25% is common for lumbar or thoracic epidural in children.[32–34] A dose of 0.5 mL/kg is usually used for lumbar epidural initial loading (0.3 mL/kg thoracic epidural initial loading) and 0.25 mL/kg for subsequent "top-up" in order to obtain intraoperative analgesia. The buffering properties of the epidural space are important and prevent a rapid rise in concentration. The maximum dose usually used is 1.7 mg/kg ropivacaine and 1.7 mg/kg levobupivacaine and bupivacaine.[35]

Evidence-based conclusions and clinical advice

- The use of LAs for lumbar or thoracic epidural in children should not exceed a dosage of 1.7 mg/kg of ropivacaine, bupivacaine, or levobupivacaine. (Evidence B3)

Continuous Infusion Epidural Anesthesia

Epidural infusions of ropivacaine provided satisfactory pain relief in neonates and infants younger than 1 year. As plasma concentrations of unbound ropivacaine are not influenced by the duration of the infusion, ropivacaine can be safely used for postoperative epidural infusion for 48 to 72 hours. Levels of unbound ropivacaine were higher in the neonates than in the infants, but well below threshold concentrations for central nervous system toxicity in adults, that is, greater than or equal to 0.35 mg/L.[35] In the first weeks of life, ropivacaine infusion should be used with more caution. Because of concerns about toxicity due to accumulation of amide LAs in infants and young children, chloroprocaine could be an alternative.[36]

Evidence-based conclusions and clinical advice

- The performance of continuous epidural anesthesia with bupivacaine/levobupivacaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.4 mg/kg per hour for children older than 1 year. (Evidence B3)
- The performance of continuous ...idural anesthesia with ropivacaine can be performed with ... of 0.2 mg/kg per hour for children younger than 3 months... per hour for children between 3 months and 1 yea... g per hour for children older than 1 year. (Evide... chloro- ... for ... between 3 months and ... dren older than 1 year. (Evide...

Single-Injection LA Dosage ... Fascial Plane Blocks

The introduction of ultras... has increased the use of periphe... locks in children during recent years.[37–39] Nonetheless, few publications have addressed the pharmacodynamics of LAs in children.[6] In addition, pharmacokinetic properties of LAs significantly differ between different types of blocks.[40]

Many studies have examined dose responses of single peripheral nerve blocks in pediatrics.[41–43] Nonetheless, dosages have been examined in very few block types by more than 1 study, and this limits the reliability of the findings.[6] Intercostal nerve blocks are known to have the greatest rate of reabsorption and therefore the highest potential risks of LA systemic toxicity.[44,45] Conversely, higher LA dosages (2.5 mg/kg) used for intercostal nerve blocks have resulted in plasma levels below potential toxic levels.[46]

Evidence-based conclusions and clinical advice

- The performance of ultrasound-guided upper-extremity peripheral nerve blocks (eg, axillary, infraclavicular, interscalene, supraclavicular) in children can be performed successfully and safely using a recommended LA dose of bupivacaine, levobupivacaine, or ropivacaine of 0.5 to 1.5 mg/kg. (Evidence B2)
- The performance of ultrasound-guided lower-extremity peripheral nerve blocks (eg, femoral, sciatic, popliteal, adductor canal) can be performed successfully and safely using a recommended LA dose of bupivacaine or ropivacaine of 0.5 to 1.5 mg/kg. (Evidence B2)
- The performance of ultrasound-guided fascial plane blocks (eg, rectus sheath, transversus abdominis plane block, fascia iliaca) can be performed successfully and safely using a recommended LA dose of bupivacaine or ropivacaine of 0.25 to 0.75 mg/kg. (Evidence B1)

Continuous Infusion LA Dosage for Peripheral Nerve and Fascial Plane Blocks

Very limited data are available regarding plasma levels associated with continuous infusions through peripheral nerve block catheters in children. Safety data regarding both short- and long-term uses of continuous infusions have been published, using different LAs and infusion rates, including the use of ambulatory infusions following hospital discharge.[47] No incidence of local anesthetic systemic toxicity was observed during these infusions, and no neurologic complications were noted. Nonetheless, dose-ranging studies addressing efficacy of continuous LA infusions in children are rarely available.[48]

Evidence-based conclusions and clinical advice

- Continuous infusion of LA for peripheral nerve and fascial plane blocks can be safely and successfully performed with

Lumbar/Thoracic Epidural

Similarly to caudal anesthesia, the use of ropivacaine 0.2% or levobupivacaine/bupivacaine 0.25% is common for lumbar or thoracic epidural in children.[32–34] A dose of 0.5 mL/kg is usually used for lumbar epidural initial loading (0.3 mL/kg thoracic epidural initial loading) and 0.25 mL/kg for subsequent "top-up" in order to obtain intraoperative analgesia. The buffering properties of the epidural space are important and prevent a rapid rise in concentration. The maximum dose usually used is 1.7 mg/kg ropivacaine and 1.7 mg/kg levobupivacaine and bupivacaine.[35]

0,5 ml/kg

Evidence-based conclusions and clinical advice

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Continuous Infusion Epidural Anesthesia

Ropivacaine 0.1% - Bupivacaine/L-bupivacaine 0.125%

0.2 mg/kg/h for children < 3 months
0.3 mg/kg/h for children 3 months and 1 year
0.4 mg/kg/h for children > 1 year.

Peripheral & Fascial Plane Blocks

Caudal Block—Single Injection

The recent Pediatric Regional Anesthesia Network data reported a large variation in LA dose used in caudal blocks.[26] Indeed, the data suggest that approximately 25% of patients undergoing a caudal block received an LA dose with the potential to cause LA toxicity. Younger children seem to be at greatest risk of receiving a toxic dose. The volume injected should be modified to achieve a dermatomal level according to Armitage, that is, 0.5 mL/kg to achieve the sacral dermatomes, 1 mL/kg to achieve the lumbar dermatomes, and 1.25 mL/kg to reach lower thoracic dermatomes.[27] Some authors used more volume of diluted ropivacaine (0.15%): if the total dose is fixed, caudal analgesia with a larger volume of diluted ropivacaine provides better quality and longer duration after discharge than a smaller volume of more concentrated ropivacaine (0.125%).[28–31] In addition, ropivacaine undergoes slower systemic absorption from the caudal epidural space than bupivacaine; ropivacaine produces lower incidence of motor blockade in the early postoperative period than bupivacaine.

Evidence-based conclusions and clinical advice

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Evidence-based conclusions and clinical advice

- The performance of continuous epidural anesthesia with bupivacaine/levobupivacaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.4 mg/kg per hour for children older than 1 year. (Evidence B3)
- The performance of continuous epidural anesthesia with ropivacaine can be performed with a dose of 0.2 mg/kg per hour for children younger than 3 months, 0.3 mg/kg per hour for children between 3 months and 1 year, and 0.4 mg/kg per hour for children older than 1 year. (Evidence B3)
- The performance of continuous epidural anesthesia with procaine can be performed with a dose of 0[illegible] children younger than 3 months, 0.3[illegible] between 3 months and 1 year, a[illegible]our for children older than 1 year. (Evid[illegible]

Single-Injection LA [illegible]or Peripheral Nerve and Fascial Plane Bloc[illegible]

The introducti[illegible]trasound-guided regional anesthesia has increased the u[illegible]eripheral nerve blocks in children during recent years.[37–39] [illegible]etheless, few publications have addressed the pharmacody[illegible]cs of LAs in children.[6] In addition, pharmacokinetic prope[illegible] of LAs significantly differ between different types of block[illegible]

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Evidence-based conclusions and clinical advice

- Continuous infusion of LA for peripheral nerve and fascial plane blocks can be safely and successfully performed with

Single-Injection

Ropivacaine 0.2%/L-bupivacaine-0.25%

US-guided Limb peripheral blocks **0.3-0.5 ml/kg**

US-guided Fascial plane blocks **0.1-0.3 ml/kg**

- ✓ Bilateral/Combined Blocks
- ✓ Lower concentration in neonates/infants
- ✓ Higher concentration (up to 0.375%) in older children

Continuous Infusion

Ropivacaine 0.1%-0.2% - Bupivacaine/L-bupivacaine 0.125%

0.1-0.3 mg/kg/h

Review Article

The Role of Interfascial Plane Blocks in Paediatric Regional Anaesthesia: A Narrative Review of Current Perspectives and Updates

Anesthesiology Research and Practice, 2020.

Type of block	Targeted nerves	Surgery/indication
PEC blocks and serratus anterior block	Medial (C8-T1) and lateral pectoral (C5-C7), long thoracic nerve (C5-C7)	Thoracotomy and thoracoscopic procedures, breast surgeries, insertion cardiac resynchronization device, nuss procedures, and traumatic rib fractures
Rectus sheath block	T7-T12	For surgeries with midline abdominal incision
Transversus abdominis block	Lower six thoracic (T7-T12) and first lumbar nerve (L1)	Laparotomy, laparoscopic surgeries of the abdominal wall Provides only somatic analgesia
Ilioinguinal/ iliohypogastric block	Iliohypogastric and ilioinguinal nerves arising from L1	Inguinal hernia repair, orchiopexy, and hydrocele repair
Quadratus lumborum block	Lateral QLB-L1 Anterior QLB-T4-L1 Posterior QLB-T4-L1	Lateral QLB provides analgesia for abdominal surgeries below the umbilicus Anterior and posterior QLB provides both somatic and visceral analgesia for abdominal surgeries above and below the umbilicus
Erector spinae block	Spread to anterior and posterior rami in craniocaudal direction depending on the site of injection	Found to be effective in various thoracic, breast, and abdominal surgeries

REVIEW ARTICLE

Adjuncts should always be used in pediatric regional anesthesia

Per-Arne Lönnqvist[1,2]

Table 1. Neuroaxial blocks in children – suggested adjuncts and doses

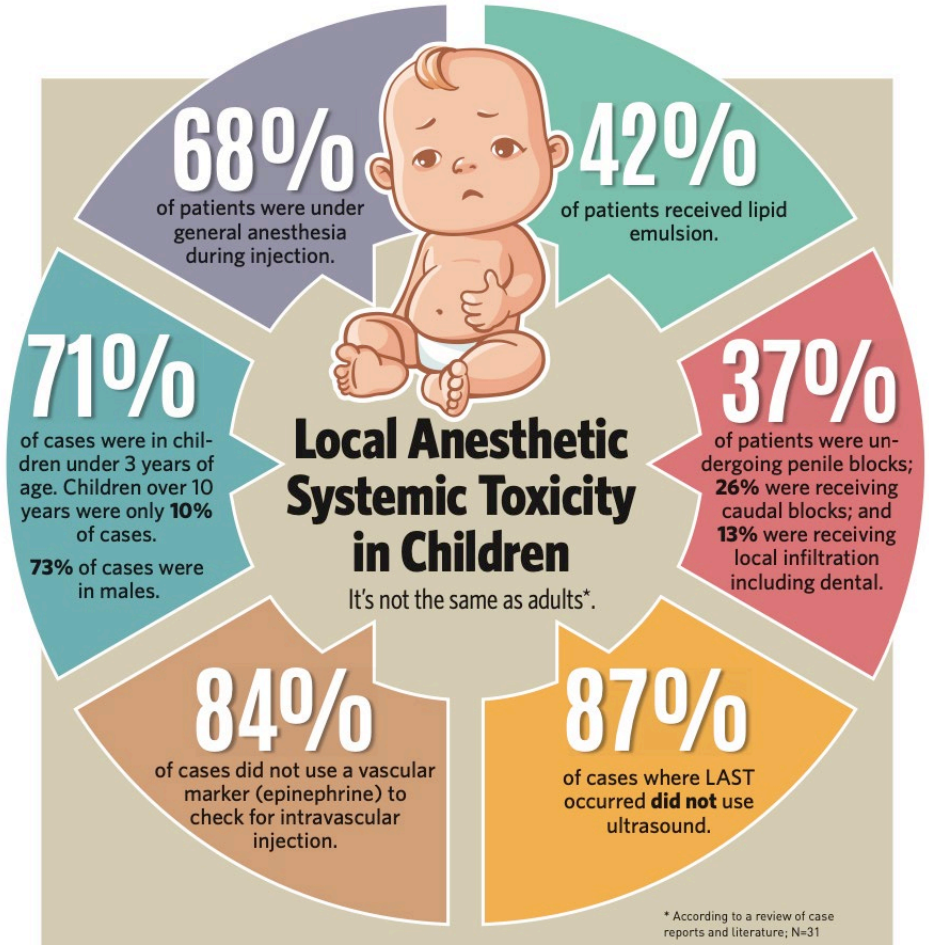
Spinal block (ex-premature babies – neonates)	Clonidine 1 μg kg^{-1}
Caudal block (ex-premature, neonate, infant)	Clonidine 1 μg kg^{-1}
Caudal block >1 year of age	S-ketamine 0.5 μg kg^{-1}; Clonidine 1–2 μg kg^{-1} (special indications: morphine 33–50 μg kg^{-1})
Continuous epidural block with acceptable catheter tip location	Clonidine >0.1 μg kg^{-1} h^{-1}
Continuous epidural block with suboptimal catheter tip location	Morphine 33–50 μg kg^{-1} as intermittent injection 1–3 times per day

Adjuvant Drugs

- Efficacy (duration&quality block)
- Known mechanism of action
- Appropriate safety profile
- Available as a preservative-free

Preservative-free clonidine 1-2 mcg/kg

THE BEST RECIPE



- Selection of the patient (high-risk group)
- Choice of LA and additives
- Use the lowest effective concentration
- Strict adherence to dosing guidelines
- Use US for peripheral and fascial blocks
- Equipment&Monitoring
- Avoid conditions that predispose to LAST (hypoxemia, hypercarbia, acidosis…)
- Be prepare if something goes wrong (Lipid Rescue)

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