

CLINICAL INVESTIGATION

Local anaesthetic dosage of peripheral nerve blocks in children: analysis of 40 121 blocks from the Pediatric Regional Anesthesia Network database

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Abstract

Background: The knowledge regarding appropriate dosage of local anaesthetics for peripheral nerve blocks in children is very scarce. The main objective of the current investigation was to evaluate dosing patterns of local anaesthetics in children receiving peripheral nerve blocks across multiple paediatric hospitals in the USA. We also sought to estimate the incidence of local anaesthetic systemic toxicity.

Methods: This is an observational study using the Pediatric Regional Anesthesia Network (PRAN) database. Data on every peripheral nerve block in patients aged <18 years placed from April 1, 2007 to May 31, 2015 were examined as a subset of the PRAN protocol. Data were examined for the type and dose of local anaesthetic and for the presence of local anaesthetic systemic toxicity.

Results: In total, 40 121 peripheral nerve blocks in children were analysed. Individual analyses of block type demonstrated large local anaesthetic dose variability with a five- to 10-fold spread depending on the block type. Two patients developed local anaesthetic systemic toxicity, resulting in an estimated incidence (95% CI) per blocks performed of 0.005% (0.001–0.015%). None of the patients had any short- or long-term complications or sequelae.

Conclusions: We detected a large variability in the local anaesthetic dosing practices for peripheral nerve blocks in children across multiple hospitals in the USA. Nonetheless, the risk of local anaesthetic systemic toxicity was very low. Due to the lack of dose findings studies, our results suggest the need to develop practice guidelines to minimize variability of regional anaesthesia practices in children.

Keywords: nerve; block; dose; children

The use of single-shot peripheral nerve blocks has become an important strategy in the anaesthetic management of children undergoing surgical procedures.^{1–4} Although single-shot peripheral nerve blocks have been commonly used in

the paediatric population, very few data are available on the effectiveness and/or safety of single-shot peripheral nerve blocks in this population.^{5,6} In addition, classic pharmacologic dose finding studies are very scarce in the paediatric regional

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Editor's key points

- Large clinical databases (e.g. Pediatric Regional Anesthesia Network) can answer clinically relevant questions including safety issues
- Local anaesthetic dose varied up to 10-fold for the same peripheral nerve blocks
- Systemic toxicity was low, with an incidence of 0.005%, with no resultant long-term harm
- Clinical guidelines could be informed by this to reduce variability in practice

anaesthesia literature.^{7–9} Moreover, no practice guideline is currently available to guide clinical practitioners on the appropriate dose of local anaesthetics for single-shot nerve blocks in children.

Studies on implementation science have revealed that many factors are responsible for variations in clinical practice.^{10–12} Factors such as lack of practitioner knowledge, insufficient process time, resistance to adoption, and organizational barriers are often targeted as quality improvement initiatives to minimize variation of clinical practice.^{13–16} In circumstances where no evidence-based medicine is available (e.g. local anaesthetic for peripheral blocks in children), the development of a learning collaborative can generate data that can help guide clinical practice.^{17,18}

The main objective of the current investigation was to evaluate dosing patterns of local anaesthetics in children receiving peripheral nerve blocks for surgical procedures across multiple paediatric hospitals in the USA. In addition, we sought to estimate the incidence of local anaesthetic systemic toxicity in the same patient population.

Methods

Approval for data collection was obtained from the local Institutional Review Board of each individual site participating in the Pediatric Regional Anesthesia Network (PRAN). All centres were granted waivers of informed consent by their review boards because the data had no identifiers and were collected during the course of routine patient care. The study protocol was also approved by the PRAN publication committee.

PRAN is a multicentre project to collect information prospectively about paediatric regional anaesthetic techniques and complications. Currently, the PRAN database has 20 participating sites, with over 100 000 regional anaesthesia procedures recorded, and is audited regularly for accuracy and completeness. PRAN centres and local primary investigators are listed in [Appendix 1](#). Details of the PRAN database, audits, and methodology have been previously reported.^{19–22}

Data on every peripheral nerve block in patients aged <18 years placed from April 1, 2007 to May 31, 2015, all available audited data as of February 29, 2016 were examined as a subset of the PRAN protocol.

All single-shot nerve blocks performed between April 1, 2007 and August 31, 2014 (i.e. all available audited data) were analysed. This data set was further narrowed to include only blocks performed with a sample size >300 in order to obtain precise estimations of local anaesthetic dosages per individual block.

Data extracted for the current project included: (1) patient characteristics and anthropometrics (age, sex, weight); (2) the patient's state of consciousness at the time of the block

(awake, sedated, or anesthetized with or without neuromuscular blockade); (3) technology used to place the block; (4) whether a test dose was given; (5) the type and dose of local anaesthetic administered; (6) local anaesthetic systemic toxicity, as defined by the American Society of Regional Anesthesia (e.g. presence of seizure, agitation, muscle twitching, coma, tinnitus, dizziness, arrhythmias)^{23,24}; and (7) other complications. Any identified complication or adverse event was followed until the complication was resolved. Every complication and adverse event, rather than a selected sample, was audited at each site prior to its entry to the database.

Normally distributed data are reported as means and standard deviation and were analysed using independent t-test. Non-normally distributed interval and ordinal data are reported as median, range or interquartile range (IQR), and were analysed using the Mann–Whitney U-test. Categorical variables were presented as counts and were evaluated using Fisher's exact test. The 95% CI for the local anaesthetic dosages and local anaesthetic systemic complication was calculated using Jeffreys' method. The coverage properties of that method are similar to others, but it has the advantage of being equal-tailed (e.g. for a 95% CI, the probabilities of the interval lying above or below the true value are both close to 2.5%). A two-tailed P-value <0.05 was used to reject the null hypothesis. Data were analysed by the corresponding author using STATA version 13 (Stata Corp, College Station, Texas, USA).

Results

There were 42 178 peripheral nerve blocks placed in children and 40 121 met inclusion criteria. Of these, 2057 blocks were excluded because the sample size was <300 per individual block. Demographic and block characteristics of patients are presented in [Table 1](#). The majority of blocks were placed while the patient was under general anaesthesia, 37 505 out of 40 121 (93%) blocks. Ropivacaine was the most common used local anaesthetic, 23 799 out of 40 121 (59%) blocks.

Individual analyses of block type demonstrated large local anaesthetic dose variability; five- to 10-fold spread depending on the block type ([Table 2](#)). Two patients developed local anaesthetic toxicity, resulting in an estimated incidence (95% CI) of local anaesthetic toxicity per blocks of 0.005% (0.001–0.015%). Details of block performance in the cases of local anaesthetic toxicity are presented in [Table 3](#).

The concomitant use of ultrasound and nerve stimulator for block placement was reported in the majority of blocks, 30 019 out of 40 121 (75%). The concomitant use of ultrasound and nerve stimulator for block placement increased over the duration of the study years with 176 out of 555 (32%) blocks placed with ultrasound and nerve stimulator in 2007 compared with 3112 out of 3672 (85%) in 2015, $P<0.001$. In contrast, the use of nerve stimulator alone decreased from 56 out of 311 (18%) blocks in 2007 to 36 out of 338 (11%) in 2015, $P<0.001$. There was no difference in local anaesthetic volume when ultrasound was used for femoral blocks, median (IQR) of 0.30 (0.22–0.39) ml kg⁻¹ compared with the lack of ultrasound use, median (IQR) 0.31 (0.23–0.38) ml kg⁻¹, $P=0.30$.

When blocks were performed with bupivacaine, the use of epinephrine as a block adjuvant was associated with greater local anaesthetic doses, median (IQR) of 0.83 (0.50–1.28) mg kg⁻¹ compared with blocks that were not performed with epinephrine as an adjunct, median (IQR) of 0.62 (0.36–0.97) mg kg⁻¹, $P<0.001$. Similarly, when blocks were performed with ropivacaine, the use of epinephrine as a block adjuvant was associated

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