

OPIOID ADMINISTRATION AS PREDICTOR OF PEDIATRIC EPIDURAL FAILURE

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Background: Increasing use of regional analgesia in pediatric populations requires a better understanding of when analgesic techniques need revising or supplementation. This study was conducted to examine intra-operative opioid use as a predictor of post-operative epidural failure.

Methods: Retrospective chart review of patients having epidurals placed intra-operatively. 229 epidurals were placed during the study, with 75 excluded. Dosing and quantity of opioids used intra-operatively were compared to the primary outcome of epidural failure, as well as duration of infusions and pain scores.

Results: Opioid use was associated with increased epidural failure, particularly in less than 12 hours. However, no distinct point of certain epidural failure was found.

Conclusions: Opioid use after epidural loading correlates with increasing risk for epidural failure. Anesthesia providers should consider replacing or supplementing epidurals with increasing use of opioids.

Keywords: Epidural Analgesia, Epidural Anesthesia, Opioid Analgesics, Outcomes Assessment, Pediatrics.

Introduction

Reliable prediction of epidural failure in pediatric anesthesia is difficult, and testing of block adequacy is generally prohibited by placement after induction of general anesthesia. Changing physiologic parameters, such as blood pressure and heart rate, are used as substitute indicators of inadequate analgesia.

Unfortunately, there are multiple factors contributing to variation in vital signs during surgery, including stimuli outside of the surgical area, changing anesthetic levels, and tourniquet related discomfort. Many of these stimuli may lead to the use of intravenous opioids during anesthesia. However, this makes it difficult at times to determine the effectiveness of an epidural.

This uncertainty can lead to a patient emerging from anesthesia with an inadequately functioning epidural and inadequate intravenous analgesia. Additional information that might improve the ability to predict a failed block would improve patient care. The purpose of this study was to evaluate the hypothesis that opioid use after initiation (or 'loading') of an epidural block may correlate with the success or failure of an epidural.

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Methods

This was a prospective observational study of routine anesthetic care, without randomization or control groups. All anesthesia patients between 7/20/2010 and 5/20/2011 were screened for epidural placement as part of a pre-existing billing/review process within the Department of Anesthesiology & Pain Medicine at Seattle Children's Hospital after IRB approval and waiver of consent. In patients receiving epidurals both paper (anesthesia records) and electronic (Clinical Information System [CIS] and Pain service database) records were reviewed for information on epidural loading, intra-operative opioid use, pain scores and possible failure of epidurals.

Patients were excluded if they were admitted to the Neonatal ICU or under 6 months old, remained intubated at the end of procedure, underwent procedures expected to require more than an epidural for analgesia or when an epidural could not be evaluated during or after surgery. Examples of this last group would include epidurals being placed or removed at the end of a surgical procedure or unexpected changes in post-operative care unrelated to the epidural. Other exclusion criteria included being over 18 years of age, catheter dislodgement, and if an alternative pain scoring system was used.

The primary outcome variable epidural catheter failure was defined as epidural removal due to inadequate analgesia or the regular use of intravenous/enteral opioids in addition to the epidural infusion. Determination of inadequate analgesia was made by the acute pain service per their routine clinical practice on a case-by-case basis.

Quantity of opioid doses used intra-operatively was measured as either absolute number delivered, or doses per hour. The dose of opioids administered was measured as mcg/kg or mcg/kg/hour. All measures of opioid administration ignored opioids used prior to epidural loading, under the assumption that these were associated with induction of anesthesia. Secondary outcome measures included the first 24 hours of pain scores, and the duration of epidural infusion without removal or supplementation.

Spearman's rho was used for correlations between intra-operative opioid use and the outcome

measures of epidural failure, pain scores and infusion duration. A p value < 0.05 was considered statistically significant.

Results

After IRB approval and waiver of consent, 229 patients who had epidurals placed were identified. After exclusion criteria, patient ages ranged from 6 months to 18 years, with a mean of 8.3 years. Patient weights ranged from 4.49 to 108.2 kg, with a mean of 33.96 kg (Std Dev 23.9).

A total of 75 patients were excluded, most frequently for being under six months of age or postoperative care in the NICU (33 patients). Twenty two patients could not have their epidurals evaluated due to being placed or removed at the end of the procedure. Less common reasons for exclusion included being over 18 years of age (6 patients), catheter dislodgement (5 patients), remaining intubated (4 patients), procedures requiring more than an epidural for analgesia (3 patients) and post-operative seizures in a patient with a seizure disorder requiring a highly sedating regimen (1 patient). Due to the low use of opioids besides fentanyl, all comparisons using opioid dosing are based exclusively on those patients receiving only intra-operative fentanyl. The exception to this is binary state comparison of opioids used/ no opioids used.

For the primary outcome measure of epidural failure there were a significant number of measures that showed significant correlations. No use of opioids after epidural loading was negatively associated with epidural failure in less than 12 hours (-0.239 p=0.005), and epidural failure at any time (-0.221 p=0.009). The hazard curve for opioid use is illustrated in Figure 1. Opioid use measured as the number of doses administered during the procedure (number of doses) correlated with epidural failure in less than 12 hours (0.244 p=0.006) and at any time (0.306 p=0.001), while opioid use measured as number of doses/hour correlated with epidural failure in less than 12 hours (0.272 p=0.002) and at any time (0.207 p=0.02). The hazard curve for number of doses/ hour is illustrated in Figure 2. Opioid use measured as mcg/Kg correlated with epidural failure in less than 12 hours (0.324

Fig. 1

Showing the cumulative hazard of epidural failure by groups of patients who received intra-operative opioids and those who did not

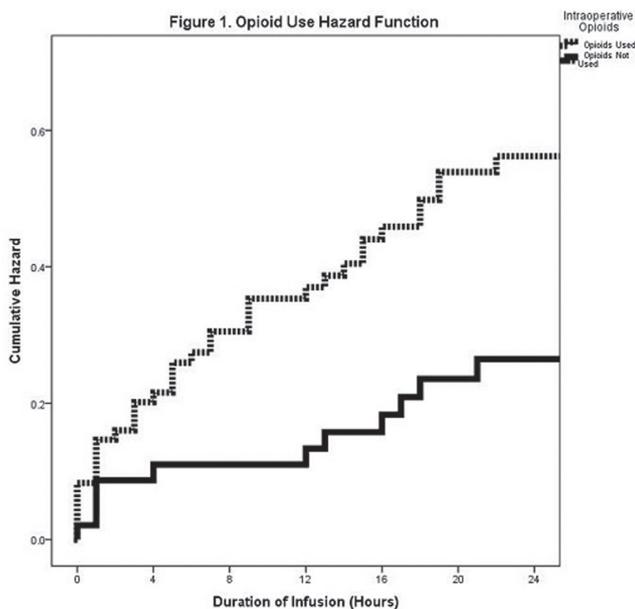


Fig. 2

Showing the cumulative hazard of epidural failure grouped by fentanyl doses per hour.

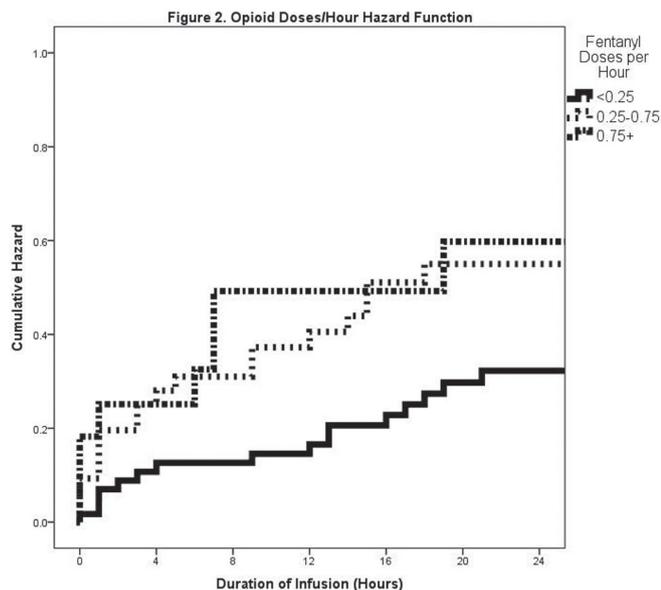


Fig. 3

Showing the cumulative hazard of epidural failure grouped by fentanyl dosing in micrograms/ kilogram/hour.

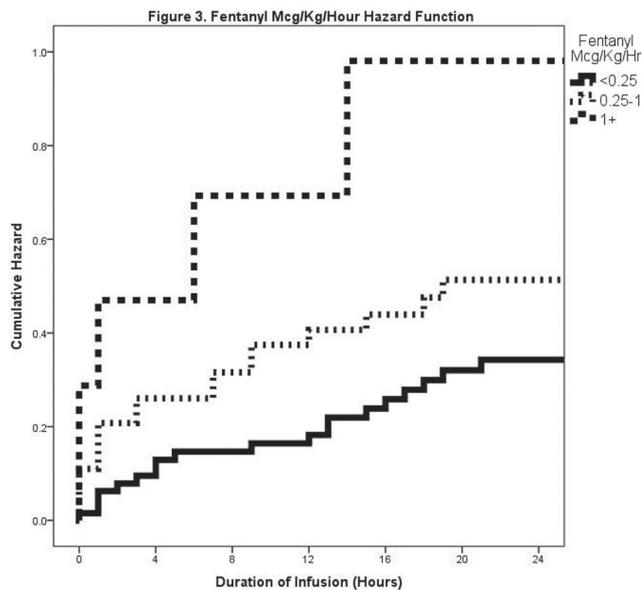
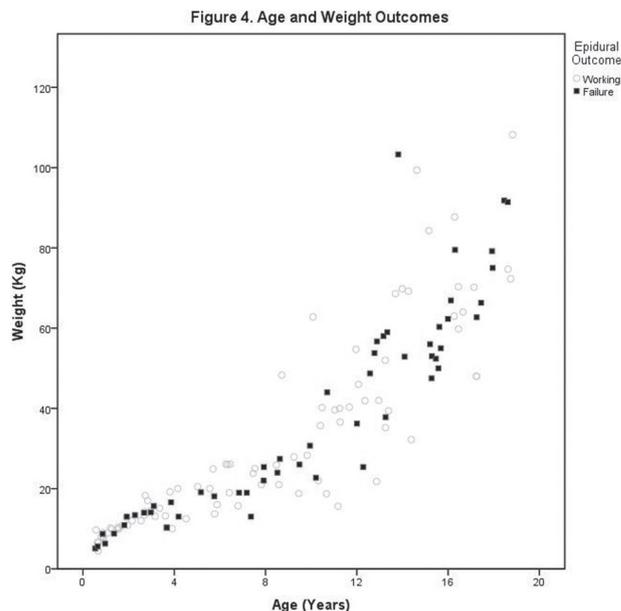


Fig. 4

Showing the distribution of failed and successful epidurals distributed by patient age and weight in kilograms.



$p < 0.001$), between 12 and 24 hours (0.191 $p = 0.035$) and at any time (0.282 $p = 0.001$). When measured as mcg/Kg/Hr, opioid use correlated with epidural failure in less than 12 hours (0.284 $p = 0.002$) and at any time (0.232 $p = 0.009$). The hazard curve for opioids measured in mcg/Kg/Hr is illustrated in Figure 3.

The secondary outcome of pain scores had

fewer correlations. The first post-operative pain score correlated only with opioid use measured as mcg/Kg (0.185, $p = 0.035$), but the third post-operative pain score correlated with opioids measured in mcg/kg, mcg/kg/Hr, and number of doses administered (0.205 $p = 0.022$, 0.180 $p = 0.043$, and 0.186 $p = 0.038$ respectively). Age only correlated with the 5th and

6th pain scores (0.214 $p=0.013$ and 0.201 $p=0.019$ respectively). Similarly, weight correlated with the 5th and 6th pain scores (0.219 $p=0.01$ and 0.195 $p=0.024$ respectively). Figure 4 illustrates the age and weight distribution, with epidural failures and successes.

Discussion

Intra-operative opioid use did correlate with epidural failure, particularly within the first 12 hours. Post-operative pain scores were not as well correlated with opioid use. The failure of epidurals in the first 12 hours supports the idea that opioid use intra-operatively is often masking the sympathetic response to surgical stimulation, i.e. pain.

Perhaps the strongest statistical predictor is opioids measured as mcg/Kg, with correlations to epidural failure in less than 12 hours, between 12 and 24 hours and at any time. The cumulative hazard of 1 before 16 hours at a fentanyl dose of 1 mcg/kg/hour suggests this may be the clearest indicator of epidural failure for clinical practice.

The relative lack of correlation between post-operative pain scores and opioid use is not surprising. Strong correlation would seem surprising to the authors, given the inherent variability in pain score in and between individuals, as well as the fact that rarely are epidurals used without adjuncts (acetaminophen, or non-steroidals) at Seattle Children's. Additional variability in pain scores of 'working' epidurals can come from insufficient infusion rates and changes in activity.

No report was found in the literature of using opioid administration to predict success or failure of regional analgesia. There have been prior attempts, with limited success, using other techniques. Non-invasive attempts have included changes in baseline heart rate¹, monitoring skin temperature², and plethysmography³. Unfortunately, these techniques do not report successful coverage of the surgical area specifically¹⁻³, or require special equipment². More invasive measures have included evaluation of anal sphincter tone⁴ and papillary response to electrical stimulation⁵. These techniques require special equipment⁵ or were only evaluated at the end of surgery⁴.

The findings of this study demonstrate another avenue for evaluating epidural success and failure, but do not provide definitive criteria for predicting epidural failure. No opioid administration was negatively associated with failure, but even in that group there were epidural failures. How many of these failures were due to factors within anesthesia staff control (poor placement choices, unrealistic expectation of epidural coverage, etc.) or generally out of their control (patchy blocks, one sided blocks, catheter migration) cannot be evaluated. Given the variable nature of surgical interventions and anesthetics administered to the subjects of this study, we believe these results are broadly applicable to other pediatric populations.

This study had several potential limitations, including the observational design. Lack of information on patient gender, specific surgical procedures and epidural placement locations limited some avenues of analysis, while variations in anesthetic practice were not controlled for. These data points may have provided further analysis, but that is uncertain given the subject group size. The limited data set was chosen with the intention to maximize applicability to general pediatric anesthesia practice.

Not requiring systemic opioids for management during anesthesia is a predictor of a successful epidural. Each use of systemic opioids adds to the risk of a failed epidural as well. Unfortunately, only the relatively high dose of 1mcg/kg/hour fentanyl produced a clear indication of failure. Future studies can examine this issue with specific surgical types, such as orthopedic procedures and abdominal procedures (with the contribution of visceral responses being examined) or specific epidural regimens (such as thoracic placement). Perhaps a larger study population will be able to identify a specific point of significantly increased risk for failure, directing anesthesia care providers to address analgesic inadequacy before the patient leaves the operating suites.

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