Predictors of postoperative pain in 1,008 spine surgery patients

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Introduction

Study objective: To develop a predictive model of postoperative pain after spine surgery using a machine learning algorithm to integrate disparate classes of perioperative data

Introduction: Postoperative pain remains a major patient concern and interferes with recovery after surgery. While some perioperative factors correlate consistently with the severity of postoperative pain, the interrelatedness of these factors as well as patient selection bias make it difficult to identify modifiable factors that influence postoperative pain. Despite a plethora of studies reporting correlative findings, validated predictive models of postoperative pain are sparse. Here, we present a predictive and independently validated model of postoperative pain that included all collected patient data to provide relatively unbiased results.

Materials and methods

Methods: Patients who underwent spine surgery under general anesthesia in hospitals participating in the PAIN-OUT initiative from 2011-2013 were included for analysis (n=1008). This study used de-identified patient information and was IRB exempt. Using a randomly selected training cohort, an elastic net algorithm was used to create a predictive model of postoperative pain in the first 24h after surgery. The performance of this model was validated in an independent patient cohort and its stability was characterized through bootstrap modeling of factor selection. Additional linear regression analysis of the key factors selected by the predictive model identified modifiable perioperative factors that may influence postoperative pain.

Results/Case report

Results: Elastic net analysis generated a cross-validated predictive model of postoperative pain (r=0.34, p=8.9x10^{-15}). Of 30 potential factors, bootstrap modeling of factor selection identified 8 robust predictive factors. Stable factors included: sex, preoperative pain, duration of surgery, remifentanil use, ketamine use, non-opioid intraoperative pain medication use, volatile anesthetic use, and PACU morphine equivalent consumption. Linear regression analysis of key factors revealed their individual contribution to postoperative pain, while Bayesian network analysis revealed significant inter-dependence between several factors. Highlights from this analysis include a strong dependence of postoperative pain on the number of classes of non-opioid analgesics used during surgery (p=1.1x10^{-15}) and the use of intraoperative remifentanil (p=1.7x10^{-4}).

Discussion

Discussion: This is the first validated predictive model of postoperative pain in patients undergoing spine surgery using an agnostic and unbiased approach for factor selection. The factors identified in this model and their relative contribution to postoperative pain present opportunities for interventions to improve pain control in the future. For example, this study provides first quantitative evidence suggesting that the use of one non-opioid medication during surgery did not result in clinically meaningful pain relief, while the use of two non-opioid medications did (effect size > 30%). A second important finding is the fact that the model could not account for a significant portion of observed variance, indicating a need to identify novel factors contributing to postoperative pain. Our previous work suggests that patient-specific biological traits including a “pro-inflammatory” predisposition could explain a significant part of observed variance.

References

- Gaudilliere et al., Sci Transl Med 2014
- Fragiadakis et al., Anesthesiology 2015
Tables/images

Figure 1. Box plot of average postop max pain score with interquartile ranges vs the number of different non-opioid analgesic medications given intraoperatively (left), and vs the use of intraoperative remifentanil (right).

Disclosures

I declare that there are no conflicts of interest or support that may cause bias in my presentation.