Minute Ventilation Prior to Opioid Dose as a Predictor of Opioid-Induced Respiratory Depression in the PACU

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Introduction

Postoperative opioid-induced respiratory depression (OIRD) can lead to severe morbidity or mortality. A variety of patient and perioperative factors have been associated with increased risk for OIRD. We have found that patients who have nursing-diagnosed OIRD during anesthesia recovery subsequently have higher rates of postoperative pulmonary complications. However, reliance on nursing staff has several limitations including subjective bias and periods of non-observation when caring for other patients. The EXSpiron 1Xi (Respiratory Motion, Waltham, MA) is a commercially available respiratory volume monitor (RVM) that relies on impedance based respiratory traces to accurately measure minute ventilation (MV), tidal volume and respiratory rate in non-intubated patients. This RVM can be used to identify episodes of OIRD. In this study we use the RVM to evaluate the ability of pre-opioid MV measurements to identify patients at risk for OIRD and we compare the predictive ability of pre-opioid MV with the predictive ability of commonly used parameters such as obstructive sleep apnea, body mass index, Charlson comorbidity Index, ASA status, age and sex as predictors of OIRD.

Material and methods

Impedance-based respiratory traces were acquired using an RVM in 107 non-intubated patients during their PACU stay following general anesthesia. Predicted MV (MVPRED) was calculated based upon gender and BSA for each patient. A "Low Minute Ventilation event" (LMVe) was defined as MV < 40% MVPRED sustained for at least 2 minutes. LMVe occurring within 30 minutes after administration of an opioid was used as a proxy for OIRD. Pre-opioid MV was defined as the average MV over the 5 minutes before opioid administration. Patients were classified "At-Risk" or "Not-At-Risk" for OIRD based on pre-opioid MV, as well as patient characteristics.

Results

Forty-five patients out of 107 (42%) received at least one opioid dose during anesthesia recovery (mean 1.23 Â± 0.62 hours). Of the 45 patients receiving opioids, 12 had obstructive sleep apnea, 24 had an ASA status > 2, 24 had a BMI > 30, and 9 were over the age of 70. Thirteen patients out of 45 (29%) experienced an LMVe within 30 minutes of an opioid dose. Figure 1 shows the receiver operating characteristic (ROC) curve for a classifier based on pre-opioid MV when stratifying patients "at risk" for OIRD. Using a threshold value of 70% MVPRED, sensitivity could be
maximized at a value of 1, while maintaining a specificity of 0.81 (Figure 2). Note that, the corresponding negative predictive value is 1 with a corresponding positive predictive value of 0.68. Similar analysis assessing the performance of other patient parameters yielded predictors with ROC curves similar to the performance of random classifier.

Conclusion

Postoperative OIRD is a potential cause of serious morbidity and mortality. Thus, developing a highly sensitive measure able to identify patients at risk for OIRD could play a crucial role in improving patient safety and targeting postoperative pain management. Preoperative patients risk classifications failed to produce classifiers that were simultaneously sensitive and specific regardless of threshold values. Noninvasive RVM can reliably provide accurate real-time continuous respiratory volume measurements and can identify patients at risk for OIRD earlier than traditional other measures. Continuous monitoring of MV can guide opioid-dosing regimens during anesthesia recovery. This technology should be assessed to determine if it can be used to lower the incidence of OIRD during anesthesia recovery.

Reference
