The use of opioids for post-operative pain relief strikes a delicate balance between effective pain control and adequate respiratory function: too much analgesia often leads to respiratory depression and other complications. The introduction of patient-controlled analgesia (PCA) allowed for prompt pain control in the absence of direct involvement by a care provider. Unfortunately, widespread use of PCA did not eliminate opioid-induced respiratory depression (OIRD). One contributing factor is the fact that PCA protocols are generally based on standard dosing formulas, rather than being individualized based on information regarding opioid sensitivity and metabolism. Ongoing assessment of respiratory status and response to opioids could assist in creating patient-specific PCA protocols. Recently, a non-invasive respiratory volume monitor (RVM) that provides continuous, real-time, quantitative measurements of minute ventilation (MV), tidal volume (TV), and respiratory rate (RR) has become available. Previous studies have demonstrated accuracy of the RVM system and its utility in identifying patients that may be more opioid-sensitive, enabling dosage adjustment. Patients who exhibit low MV and sensitivity to opioids can be placed on a low-dose protocol or be put on a multi-modal pain management regimen. In this study, we used the RVM to monitor the respiratory status of non-intubated patients in the post anesthesia care unit (PACU), and examined the respiratory effects of standard-dose (using hydromorphone) vs. low-dose (using morphine) PCA protocols.

Figure 1: A non-invasive Respiratory Volume Monitor (RVM, ExSpiron, Respiratory Motion, Inc.) that provides continuous, real-time, non-invasive measurements of MV, TV and RR. Figure shows standard PadSet placement. One electrode is placed at the sternal notch, another is placed on the xiphoid and the third is placed on the right mid-axillary line at the level of the xiphoid.

Patients in the low-dose morphine group received similar overall opioid dosing as the standard dose hydromorphone group. The low-dose group used marginally less opioids (in terms of MME) when compared to the standard-dose hydromorphone group (7.4±0.8 vs. 5.5±0.5, p<0.05).

Figure 2: (A) Total opioid dose in the PACU. Patients in the low-dose group (blue, 1 mg hydromorphone per PCA button push) used a similar amount of opioids (by MME) compared to the standard-dose group (red, 0.2 mg hydromorphone per PCA button push) during their stay in the PACU (7.4±0.8 MME vs. 8.5±0.8 MME, p=0.3). (B) Number of PCA-administered opioid doses. Clearly, to achieve the same level of overall opioid dosing, patients in the low-dose group self-administered significantly more PCA doses than patients in the standard-dose group (7.4±0.8 vs. 5.5±0.5, p<0.05).

Interestingly, there were approximately twice as many patients in the low-dose group who pushed the PCA button and received opioids more than 10 times (13 vs. 25 patients, respectively, Figure 3 A vs. B).

Figure 3: The distributions of number of PCA doses used by patients under the standard-dose (A) and low-dose (B) protocols. The low-dose group had 2 times as many patients who pushed the PCA button more than 10 times (25 low-dose vs. 13 standard-dose patients).

Methods

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• RVM monitoring provides the potential to individualize pain management strategies. This would be an improvement over current methods that standardize dosing based on the “average” patient.
• Implementation of a broad, across the board, low-dose opioid protocol or change in specific opioid administered may not reduce total opioid use or reduce the incidence of OIRD. This group of patients appeared to compensate for lower PCA dosing by increasing the number of opioid doses that they self-administered. This may be associated with a decrease in patient satisfaction.
• For patients at-risk for respiratory depression, RVM monitoring may allow clinicians to more carefully titrate opioid dosing and employ a targeted low-dose opioid protocol, or consider using multi-modal pain relief therapy.
• For patients with adequate respiratory function (MV), clinicians may safely use a more aggressive and more effective opioid dosing strategy.

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