**Non-Invasive Respiratory Volume Monitoring to Quantify Respiratory Depression Following Benzodiazepine Administration**

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**Introduction:** The administration of benzodiazepines before general surgery is common and can cause reduction in respiratory effort; however continuous, non-invasive, objective monitoring of the effects of benzodiazepines on respiratory status is not routinely available. Respiratory status is difficult to assess with existing monitoring technology, putting patient safety at risk. A novel non-invasive respiratory volume monitor (RVM), that provides continuous, real-time accurate measurements of minute ventilation (MV), tidal volume (TV) and respiratory rate (RR), was used to quantify the effects of benzodiazepines, specifically midazolam, on the respiratory status in spontaneously breathing patients.

**Methods:** Continuous digital respiratory traces were collected from 30 adult general surgery patients who were sedated but spontaneously breathing using an impedance-based RVM (ExSpiron, Respiratory Motion Inc., Waltham, MA). Eleven of these patients (58 ± 19 years (range 20-81 years), average BMI 27.7) received 2.0 mg of midazolam at least 20 minutes prior to induction of anesthesia. Minute ventilation (MV) tidal volume (TV), and respiratory rate (RR), were calculated from 30 second segments within the continuous digital RVM data. Respiratory parameters were evaluated in the 10 minutes before and after the first administration of 2mg midazolam. One patient had an idiosyncratic response to the medication. Ten patients were analyzed as a group and one patient was analyzed separately.

**Results:** Following the administration of midazolam, the group MV’s and TV’s decreased an average of 19% ±7% and 16% ±5%, respectively (mean ±sem, p<0.01 for both) and RR remained essentially unchanged (decrease of only 3% ±8%, p>0.3). In the younger half of the cohort (45±16 years), the decreases in MV and TV were not significant, only 6%±3% and 8%±5%, respectively. In contrast, the older half of the cohort (72 ±8 years) displayed four-fold greater MV and TV decreases (32±11%, p<0.05 and 25±6% p<0.05), when compared to the younger cohort, p<0.01, Figure 1).

**Discussion:** Objective, non-invasive, continuous monitoring of minute ventilation, tidal volume and respiratory rate using RVM provides a valuable depiction of respiratory hypoventilation related to the administration of benzodiazepines, not demonstrated by other methodologies including pulse oximetry and RR monitoring alone. Respiratory volume monitoring can help uncover potentially life-threatening hypoventilation in elderly patients. Additional studies are ongoing support these findings and to quantify changes in respiratory status following administration of other anesthetic medications.
Figure 1: Analysis of respiratory depression following administration of 2mg of midazolam. Percent reduction in minute ventilation (MV), tidal volume (TV), and respiratory rate (RR) for all patients (yellow), younger patients (green), and older patients (red).