Early Warning of Respiratory Depression Can be Used to Reduce False Alarms

Voscopoulos C1, Freeman J2, George E3, Hein T3

1University of Hawaii, Honolulu HI; 2Respiratory Motion Inc., Waltham MA; 3Massachusetts General Hospital, Harvard Medical School, Boston MA; 4University of Texas, Dallas TX

Methods

In the 240 patients, 80 “Low SpO2” alarm conditions were recorded. Of them 62 (78%) were “False Alarms” (<2min). The remaining 18 “Desaturation Events”, 25 patients had only “False Alarms”, in 8 patients desaturation events were considered to be “False Alarms”. Only 1 event longer than 3 minutes was recorded. We defined SpO2 less than 90% as “Low SpO2”, which triggered an alarm. Having “Low SpO2” for less than 2 minutes was defined as a “False Alarm”. “Unsafe MV” was defined as MV less than 40% MV_PRED.

Results

In the 240 patients, 80 “Low SpO2” alarm conditions were recorded. Of them 62 (78%) were “False Alarms” (<2min). The remaining 18 “Desaturation Events” were preceded by “Unsafe MV” by an average of 16.7±4.6 min (mean ±SEM) and the level of “Unsafe MV” was strongly correlated with the time before an SpO2 alarm sounded (r=0.77, p<0.05, Figure 3). While MFAANOVA found no difference in the demographics of the populations with real desaturation events versus “False Alarms” (p>0.2 for height, weight, age, BMI, sex), the length of stay in the PACU for the group with “True Desaturation” events was significantly longer (176±9 min v. 134±18 min, p<0.05).

Equipment and Population: After obtaining written informed consent, monitoring data were collected from 240 extubated patients (none had an endotracheal tube) in the PACU following elective joint replacement surgery under either general or spinal anesthesia (130 females, 110 males; age: 66.8±10.3 yrs; BMI: 29.6±5.7 kg/m²). Respiratory data were recorded continuously from an RVM (ExSpirion, Respiratory Motion, Waltham, MA) via an electrode PadSet placed on the thorax (Figure 1). Simultaneously, SpO2 data were recorded at 1-min intervals.

Metrics: “Predicted” MV (MV_PRED) and “Percent Predicted” (MV_PRED/MV_RATIO x100%) were calculated for each patient. MV_PRED was calculated using standard body surface area (BSA) formulas: BSA X 4 (men); BSA x 3.5 (women). MV_PRED represents adequate MV during quiet respiration in awake, non-intubated patients. We defined SpO2 less than 90% as “Low SpO2”, which triggered an alarm. Having “Low SpO2” for less than 2 minutes was defined as a “False Alarm”. “Unsafe MV” was defined as MV less than 40% MV_PRED.

Statistics: Multifactor analysis of variance (MFAANOVA) was used to evaluate differences in clinical populations including differences in patient demographics between different groups. Unpaired one-sided t-tests were used to compare measurements across groups. Pearson correlations were used to evaluate intra-variable dependencies including the correlation between the severity of respiratory depression and the delay in registered desaturation. All analyses were performed in MATLAB R2021b (Mathworks, Natick, MA).

Conclusions

• Improvements in SpO2 monitoring equipment and conservative use of alarm limits have decreased false alarms; yet, this study showed that >90% of SpO2 alarm conditions in the PACU were most likely false.

• Continuous MV monitoring can be used to reduce false alarms in the PACU. More importantly, continuous MV monitoring gives advanced warning of developing respiratory depression. Early detection of desaturation leads to reduced severity of respiratory depression.

• RVM has the potential to improve patient safety and satisfaction and reduce the length of stay in the PACU associated with a true desaturation event.

• As respiratory depression is often caused by opioids, apnea, and other factors, continuous MV monitoring provides advanced warning and early point-of-care data for caregivers to modify opioid dosing or institute other interventions to prevent progression of respiratory depression to the point of true desaturation and severe compromise.

Contact: Jenny Freeman, MD: jefreeman07@gmail.com