Respiratory Pause Detection and False Alarms from Capnography and Acoustic Monitoring in Procedure Related Sedation

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Background

Performance of many procedures in adults and children is facilitated by procedure related sedation (PRS). While many studies support the overall safety of PRS, concern remains regarding the potential for serious complications. Respiratory complications including respiratory depression and oxygen desaturation during PRS may be frequent and can result in significant morbidity.[1,2] Closed claim analysis[3] suggests better monitoring could prevent about 1/3 of liability cases. Respiratory events are identified as the leading mechanism of injury during PRS. Clearly, continuous patient monitoring with high sensitivity for detection of critical events is essential. However, excessive false alarms can distract providers.[4] This study compares true and false positives (false alarm rates) of respiratory pauses reported by two monitors of respiratory function during PRS.

Methods

IRB approved observational study. After written informed consent, adults scheduled for PRS during GI or interventional radiology patients received standard monitoring. Respiratory rate was monitored by both acoustic respiratory monitoring (RRa; Rad-87 Pulse CO-Oximeter, sw 7805, with acoustic respiration sensor, rev C; Masimo Corp, Irvine CA), and nasal cannula capnometry (EtCO2; Capnostream 20, Covidien, Bedford, MA). Monitoring data was continuously recorded to a computer for subsequent analysis. PRS clinicians were blinded to both devices. A research clinician retrospectively reviewed acoustic and capnography waveform and sound files for each event when either monitor reported a respiratory pause (0 respiration rate for ≥15 sec) to validate identification of respiratory pauses by each monitor. The number of respiratory pauses reported by each device and verified by retrospective analysis as true positive or false positive was determined and a t-test for proportions was conducted to determine if differences were significant, with $p<0.05$ considered significant. The positive predictive value was calculated. Agreement between the monitors was assessed using Bland Altman analysis (Matlab 7.5.0342, Mathworks, Natlick, MA).

Results

Fifty patients completed the study; 5 were excluded from analysis due to technical issues. During a total of 2086.7 monitored minutes, 226 respiratory pauses were reported by at least one monitor. 26 patients had at least one respiratory pause. The number of respiratory pauses reported by each method and verified as true positive or false positive is shown (Table). Bland Altman bias was 0.5 and limits of agreement -7.6 to 8.6 breaths per minute (Figure).

Conclusion

Respiratory pauses were common during PRS. Limits of agreement between acoustic and capnometry respiratory rate were wider than reported for facemask capnometry.[5] Acoustic respiratory monitoring detected more true events and had fewer false alarms. Compared to nasal cannula capnometry, acoustic respiratory monitoring may be a superior monitor of respiration during procedural sedation.

References

1 Curr Opin Anaesthesiol. 2010; 23:523
2 Anesth Analg. 2009; 108:795
3 Curr Opin Anaesthesiol. 2009; 22:502
4 Anesth Analg. 2011;112:78
5 Br J Anaesth. 2012;108:872
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Patient Characteristics n = 45				
Age years			57 ± 13	
Gender number F; M			28; 17	
Weight kg			79.7 ± 18.7	
Height cm			167.1 ± 10.0	
Body mass index kg/m^2			28.6 ± 6.0	
Procedure type number Gastroenterology number Interventional Radiology			28 17	
Detected respiratory pauses		Retrospective Analysis		
	Reported, n	Clinician Verified as True Positive, n (%)	Clinician verified as False Positive, n (%)	PPV %
RRa	101	78 (77)	23 (23)	77*
$EtCO_2$	166	49 (30)	117 (70)	30

Table: patient characteristics and performance of respiratory monitors in adult patients undergoing procedure related sedation for GI or Interventional Radiology procedures. Results are shown as mean ± standard deviation or count. RRa = acoustic respiratory rate; $EtCO_2$ = end tidal CO_2. PPV = positive predictive value. Acoustic respiratory rate had better PPV than $EtCO_2$ $p<0.001$

Figure 1

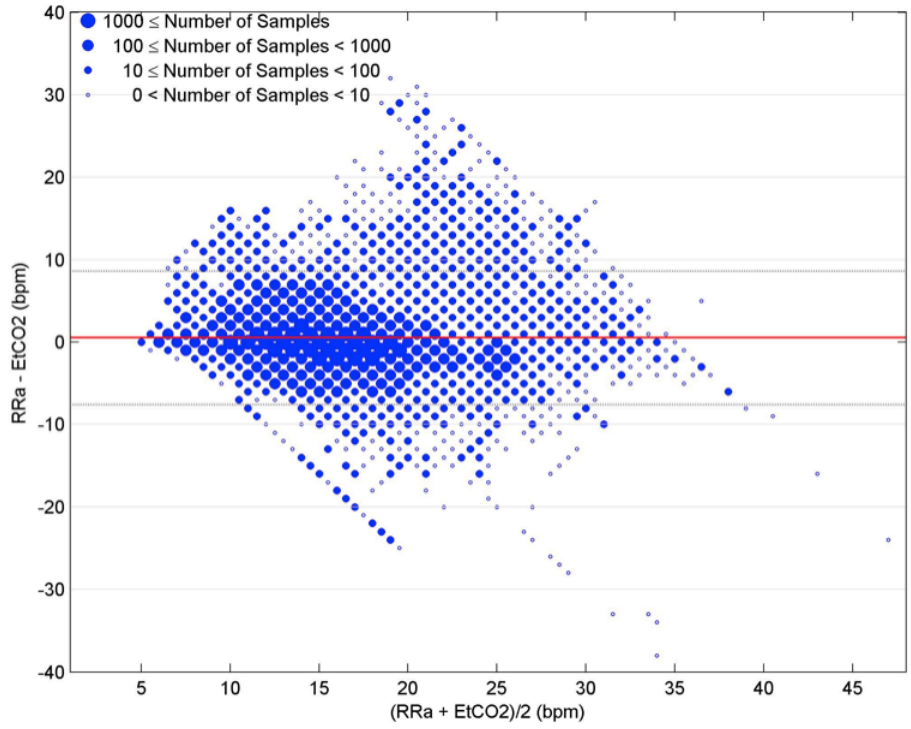

Figure 2