Use of Respiratory Acoustic Monitor for Postoperative Monitoring in Children

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Background

Current postoperative respiratory monitoring uses pulse oximetry, transthoracic impedance (TI) and manual counting of the respiratory rate (RR). The Rainbow Acoustic Monitoring (RAM) (Figure1) provides noninvasive and continuous RR measurements using an adhesive sensor applied on the lateral neck. The primary aim is to compare the accuracy of the RAM to the measurements of the RR provided by manual counting and by TI. Secondary aims evaluated the tolerance to the RAM, and an analysis of the alarms recorded by each device.

Methods

After IRB approval and informed consent obtained, 62 post-tonsillectomy or receiving IV PCA pediatric patients (ages from 2 to 16 years old) were recruited. Patients were stratified by weight (10 to 20 kg, 20 to 40 kg, and over 40 kg). Patients were admitted for overnight continuous monitoring. A RAM sensor was placed on the patients' neck to detect RR and regular ECG pads recorded RR based on the TI. Manual counting of the RR was done at constant intervals and recorded simultaneously with the RR measurements by RAM and by TI. The presence of alarms was recorded by clinical observation. The source of the alarm was identified and verified as a true or false alarm. Data were summarized using mean (SD) or median (IQR) for continuous variables and frequency and percent for categorical variable. To assess accuracy of RR measurements by RAM and by TI in comparison with manual counting, a repeated measures ANOVA analysis was performed. A mixed model ANOVA procedure was used to estimate correlation between different RR measures.

Figure 1

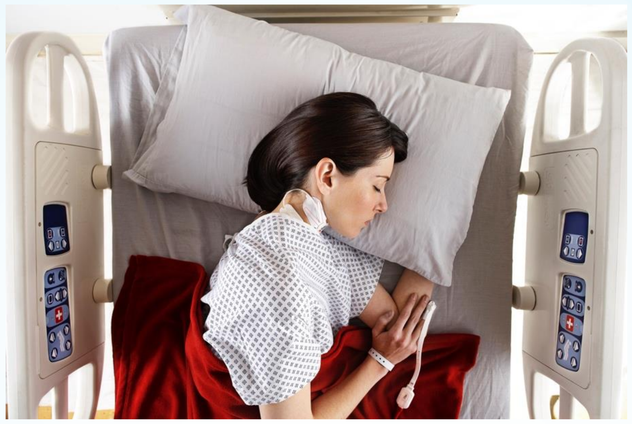

Table 1

	Manual vs. RAM mean (sd)	Manual vs. TI mean (sd)	RAM vs. TI mean (sd)
Average Difference	0.17 (6.81) 95% CI: -0.77, 0.44	1.39 (10.63) 95% CI: -2.34, -0.44	1.53 (10.72) 95% CI: -2.48, -0.57
Proportion of difference ≥ 4 bpm	11% 95% CI: 0.08, 0.14	22% 95% Ci: 0.18, 0.27	23% 95% CI: 0.18, 0.29

Table 2

Respiratory monitoring	Number of alarms	Average number of alarms per patient	Number of false alarms	Average false alarms per patient	Number of patients with at least one alarm	Number of patients with at least one false alarm	Average number of alarms per 2 hour episode	Average number of false alarms per 2 hour episode
RAM	98	1.58 +/- 2.49	11	0.18 +/- 0.71	36 (0.58)	6 (0.1)	0.19 +/- 0.77	0.02 +/- 0.25
TI	178	2.87 +/- 4.32	62	1.00 +/- 2.78	43 (0.69)	19 (0.31)	0.35 +/- 1.58	0.12 +/- 0.99

Results

We enrolled 58 post tonsillectomy patients and 4 patients on intravenous PCA with a mean age of 6.5 yo, a mean weight of 35.3 kg and a mean BMI percentile of 76.6 +/- 30.8. A polysomnography study with a diagnosis of severe OSA was present in 43% of the post-tonsillectomy children. The other post-tonsillectomy patients had a presumptive diagnosis of OSA. The average monitoring time per patient was 15.9 hours. The ANOVA analysis showed that the mean RR of the three measurement methods was different (p= 0.0255). Specifically, manual RR measurements were significantly different than TI measurements of RR (p=0.0066), but were not significantly different than RAM measurements of RR (p=0.8077). The degree of correlation between RR measurements by RAM and manual counting was 0.5851 and that between TI monitor and manual counting was 0.4898. The mean differences in RR and the proportion of time with a difference of the RR measurements of more than 4 breaths per minute are presented in Table 1. The tolerance to the RAM was 0.87. A total of 276 alarms were detected with a mean of 4.45 alarms per patient. The analysis of alarms is showed in Table 2.

Conclusion

Respiratory rate measurements with RAM provide better accuracy than TI using manual counting as the reference method. The incidence of false alarms was higher for the TI. RAM improves respiratory monitoring during the postoperative care of pediatric patients.