Accuracy of Respiratory Rate Using an Acoustic Respiration Monitor.
Macknet M., Allard M. Kimball-Jones P., Rook J., Applegate R. *Proceedings of the 2010 Annual Meeting of the American Society Anesthesiologists.* A1146.

Introduction

While respiratory rate is recognized as a reliable early indicator of physiological deterioration, it is also prone to errors in measurement and documentation when done at the patient bedside. Capnography is often used to monitor respiration in the OR and PACU but has limitations that can induce errors in data acquisition. A respiratory rate monitoring technology has been recently introduced that uses a bioacoustic sensor placed on the neck (Rainbow Acoustic Monitoring: RAM, Masimo, Irvine, CA). This study compares the accuracy of respiratory rate from the acoustic monitoring technology and capnography to respiratory rate derived from the manual counting of breaths from audio and waveform data.

Methods

IRB approved prospective data collection and algorithm development and validation study. After informed consent, 115 patients were enrolled from the PACU (n=105) and post-surgical wards (n=10). An adhesive acoustic sensor (RAS 125 Rev A) was placed on the neck and connected to a Rad-87 Pulse CO-Oximeter with RAM. A nasal cannula was connected to either a CapnoStreamTM 20 capnograph (CS20, Oridion, Needham, MA) or a CAS 750 capnograph (CASMED, Branford, Connecticut). All devices were connected to a computer for continuous data recording and subsequent analysis. Manual counts of respiratory rate were determined by retrospective analysis of the data collected. A trained observer listened to the acoustic sounds while manually viewing acoustic and capnograph waveform files. The observer manually tagged all breaths and respiratory rate was automatically generated from this tracing. Bias, precision and accuracy root mean square (A_{RMS}) were calculated for each method by comparing to the respiratory rate of the manual scoring method.

Results

Patients were monitored from 5 to 107 minutes. The average duration of monitoring was 53 (CS 20) and 45 (CAS 750) minutes. Respiratory mean respiratory rate was 14 bpm and ranged from 0 to 41 bpm. Acoustic monitoring demonstrated similar accuracy to the Capnostream 20 EtCO2 for respiration rate estimations compared to manual counting of breaths. The Cas750 had significantly lower accuracy than either of the two other devices.

Discussion

Accurately determining respiratory rate can be very challenging in a clinical environment. Manually counting each respiration using audio and waveform data provided a very accurate respiratory rate from which to compare acoustic monitoring and capnography. Other methods were explored; however, these were not well tolerated in the clinical setting. The algorithm developed allowed acoustic monitoring to provide similar accuracy for respiratory rate estimations compared to commercially available capnography equipment. Acoustic monitoring may also be better tolerated by patients and

easier to use for clinical staff than capnography as some patients do not tolerate the presence of the nasal cannula needed for this technology. This technology should be further studied to establish the potential to improve patient safety in clinical care settings.

Method	Monitoring time (min)	Bias (bpm)	Precision (bpm)	A_{RMS} (bpm)
RAM acoustic	6431	0.4	2.7	2.7
Capno20 EtCO2	4506	0.3	2.8	2.8
CAS750 EtCO2	1925	5.3	9.5	10.8