Background: Noninvasive capnography is not routinely available on portable transport patient monitors but can be useful in respiratory monitoring of spontaneously breathing patients during transport, especially when sedation is administered. We describe an assembled setup of face mask capnography. The purpose of this study was to assess the feasibility and performance of an assembled face mask capnography setup using common transport equipment for invasive monitoring.

Methods: Using a transport monitor with an invasive capnography channel and a mainstream inline capnometer, we assembled a standard oxygen face mask to function as a noninvasive capnogram and tested its performance on 17 healthy adult volunteers. The study assessed the quality of the resultant capnography waveform and with variables such as simulated apnea and head positioning.

Results: We were able to show that the assembled noninvasive capnography setup provided adequate waveform in all test subjects and that it reliably triggered the apnoea monitor alarm when respirations were less than 6 breaths/min.

Conclusions: An assembled noninvasive capnography setup is feasible using common portable monitoring devices. It can display capnographic waveforms and allow visual representation of simulated apnoea.

Introduction

Sedation given to manage agitation during air medical transport can be challenging to safely monitor and noninvasive capnography provides a valuable continuous monitoring modality of both airway patency and ventilation. In the air medical setting, it is not uncommon for sedated patients to be positioned in a manner on the aircraft stretcher that does not always allow adequate respiratory assessment during all phases of flight. Pulse oximetry will only provide late warning of airway obstruction. Furthermore, in the noisy air medical environment, it may be difficult to hear signs of respiratory distress and airway obstructive sounds such as stridor or gagging. It is possible that a sedated patient can suffer acute laryngospasm with no effective alveolar oxygen delivery yet still display chest wall movement and normal pulse oximetry. Capnography is the only monitoring modality that will provide immediate alert to such an airway crisis. It is also the modality that will provide the fastest alert to apnea, well before pulse oximetry. This descriptive pilot study assesses the feasibility of an assembled face mask capnography setup.

Methods

Seventeen healthy volunteers were selected from the workforce of Royal Flying Doctor Service Cairns base. Ethics approval from the local review board was gained. Written informed consent was obtained from all subjects. We used a Welch Allyn Propaq Encore transport monitor (Welch Allyn, Inc., Beaverton, Oregon) and Protocol Systems Inc mainstream inline capnometer (Protocol Systems, Inc., Beaverton, Oregon) with an endotracheal tube adapter (Figs. 1 and 2). Taking a standard non-rebreather oxygen face mask, we cut a hole through the side vent and inserted the tube adapter with an attached capnometer (Fig. 2). A brand new adapter and face mask were used for each subject. The capnogram waveform was divided into baseline phase 1, phase 2, and phase 3 for the purpose of the study (Fig. 3).

We tested the waveform produced under several variables for each subject. We asked the subjects to change their head position into fully neck flexed and extended as well as laterally flexed and rotated to both the right and left in turn. Finally, we asked subjects to simulate apnea by holding their respiration for at least 10 seconds.

Results

End-Tidal Carbon Dioxide measurements

The end-tidal carbon dioxide reading with an assembled face mask was 36 to 41 with an average of 33.8 (Fig. 4).

Position of the Head

This was measured with 4 to 6 L/min of oxygen flow and kept in the following positions: head flexed forward, head...
extended upward, and head extended toward the right or left. In all 3 phases of the waveform, there were insignificant artifacts produced in all positions tested with no obvious significant change to the overall shape and height of the tracings obtained (Fig. 5).

**Simulated Apnea**

All subjects who simulated apnea by breath holding for at least 10 seconds triggered an apnea alarm on the Propaq monitor (Fig. 6).
Discussion

The main purpose of the study was to test if we could get a reliable waveform by using the assembled face mask capnography. Assembled capnography setups have been described previously. The capnography method used was easily assembled and easily reproducible. It was also noticed that the apnea alarm triggered promptly as the rate was decreased less than 6 breaths/min, which could lead to immediate alert in a real clinical setting. The waveform was maintained well with the varying head positions with minimal artifacts.

Although this assembled setup is not formally clinically tested, it shows the feasibility of such an assembly of common transport equipment and practically may add an important monitoring modality to the patient requiring sedation during air medical transport who is not intubated. The visual waveform of the capnography trace produced by this setup in healthy volunteers is adequate to detect simulated apnea, and in the noisy cabin setting of air medical retrieval, early visual alerts of apnea or airway obstruction may assist clinicians better than auditory alarms.

Limitations

This setup was not compared with standard commercial noninvasive capnography systems, so we cannot conclude it would perform similar to such approved systems. A study comparing commercial systems with this assembled one is recommended before applying the assembled setup into clinical use. The modification of the oxygen face mask will alter its performance in delivering inspired oxygen concentration, and this needs to be taken into account on a case by case basis.

Conclusions

An assembled noninvasive capnography setup is feasible using common portable monitoring devices and can display adequate waveforms.

References