Measuring behaviors of dyssynchronous patient ventilator interaction

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Background/Significance

Synchronous patient-ventilator interaction is essential in achieving optimal oxygenation and ventilation in critically ill patients. While recent studies show that patient ventilator dyssynchrony (PVD) is highly prevalent in the intensive care unit, it is difficult to quantify. Nurses often assess PVD using a non-empirical approach, and clinical behaviors of dyssynchrony are not standardized. A literature review revealed that PVD is associated with agitation, facial and respiratory behaviors and there is little empirical description of cardiopulmonary changes: tachycardia, tachypnea, decreased oxygen saturation and increased intrinsic positive end expiratory pressure. Describing PVD will assist clinicians in early and accurate detection of dyssynchrony, which may lead to reduction in risks associated with mechanical ventilation and sedation.

Specific Aim

The primary aim of this study is to identify the behavioral and biological markers of PVD.

Methods

A specific list of PVD behaviors was tested and refined during a pilot study. Videography is being used in the current study to capture agitation, facial and respiratory behaviors of PVD for 1.5 hours per subject. A video camera is connected to the computer with The Observer XT 7.0 software installed (Noldus computer) through a firewire cable. The Noldus computer is then connected to the data acquisition system, Biopac (Model MP 150), along with a synchronizing cable to send synchronization signals to the Biopac system. The Biopac software is configured to record the signals in a separate channel from physiological data. Video recorded data are coded for the refined behaviors using The Observer XT (Noldus Information Technology, Wageningen, The Netherlands). The physiological data is later exported from the Biopac system and imported into The Observer XT. It can then be viewed in synch with video after data coding of behavior and airway pressure/flow- time waveforms.

Patient ventilator dysynchrony is identified through physiological signals, ventilator airway pressure- time and flow- time waveforms. These waveforms are obtained through a pneumotachometer connected to the subject's ventilator circuit (Non-Invasive Cardiac Output Cardiopulmonary Management system [NICO], Respironics, Model 7300, Wallingford, CT) and sent to the Biopac for synchronization. Waveform data are being analyzed for the occurrence of PVD based on Nilsestuen and Hargett, 2005 [1]. Morphological changes in the waveform data are also coded using The Observer XT to represent three major categories of dyssynchrony, trigger, flow and termination. Trigger dyssynchrony has four subcategories: missed inspiratory effort, missed expiratory effort, failure to trigger and double trigger. Termination trigger has two subcategories: premature and delayed termination.

The respiratory markers of physiological instability from PVD are obtained from the NICO using pulse oximetry for oxygen

Figure 2. *Photograph of Biopac cart (right) with NICO and Criticare Scholar in patient room next to ventilator (left) (Photo courtesy of Anne Hamilton, Project Director of SAVE study)*

saturation and the pneumotachometer for respiratory rate and end tidal carbon dioxide. Cardiac physiologic instability is being measured by heart rate obtained from cardiac electrodes placed on the subject and connected to Criticare Scholar III (Criticare Systems, Inc., Waukesha, WI) heart monitor. All cardiopulmonary measures are then sent to the Biopac for time synchronization (See Figure 2 for diagram of Biopac cart).

Results

The Observer XT will allow for successful coding of both videotaped behaviors and physiologic signals of airway pressure and flow. Viewing behavior and the ventilator waveforms simultaneously provides the ability to describe actual subject behaviors of PVD with a standardized measure. It also provides the ability to detect possible time delays from a dyssynchronous event to a real-time behavior change, which has not been described. Therefore, this method will provide the capability to describe the natural history of PVD at a level that has not yet been disseminated Using this method, we will also be able to categorize the behaviors that occurred during different types of dyssynchrony. Coding of the airway pressure- time and flow- time waveforms to describe PVD will provide a convenient application to interface with analysis of subject behavioral data.

References

1. Nilsestuen, J.O. & Hargett, K.D. (2005). Using ventilator graphics to identify patient ventilator asynchrony. Respiratory Care, 50, 202-234.

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