Heart & Lung 43 (2014) 6–12

Contents lists available at ScienceDirect

Heart & Lung

journal homepage: www.heartandlung.org

Care of Critically Ill Adults

Responses to noxious stimuli in sedated mechanically ventilated adults

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ARTICLE INFO

Article history:
Received 14 May 2013
Received in revised form
21 October 2013
Accepted 22 October 2013
Available online 15 November 2013

Keywords:
Sedation
Evaluation
Mechanical ventilation
Outcomes

ABSTRACT

Objective: To determine the effect of sedation on physiologic responses and comfort before, during and after a noxious stimulus (endotracheal tube suctioning).
Methods: The sample was a subset of a larger, longitudinal descriptive study, blood for endorphins and saliva for alpha-amylase were obtained before and after suctioning. Heart rate (HR), respiration rate (RR), oxygen saturation (SPO_2), and arm and leg actigraphy were continuously recorded.
Results: 67 subjects from medical and surgical ICUs were primarily deeply (37%) or mildly sedated (54%) prior to suctioning. Alpha-amylase increased post suctioning ($p = 0.04$); endorphins did not change ($p = 0.58$). Neither were modified by sedation. There were no changes in HR, RR or SPO2 post suctioning. Arm ($p = 0.007$) and leg actigraphy ($p = 0.057$) changed from baseline and depended on sedation level ($p = 0.0005$).
Conclusions: While a stress marker did increase during suctioning, only the measure of patient arm movement was significantly affected by sedation level.

The overall goals of sedation in the critical care setting are to provide physiologic stability and patient comfort.[1–4] The need for sedative therapy in mechanically ventilated (MV) patients in adult critical care settings is well established with 85% of intensive care unit (ICU) patients receiving sedation to promote patient comfort by attenuating the anxiety, pain, and agitation associated with mechanical ventilation.[2,3,5,6] For most critically ill patients, a strategy that ensures patient comfort while maintaining a light level of sedation is associated with improved clinical outcomes.[7–12] However, striving to ensure that patients are free from pain, agitation and anxiety may conflict with maintaining cardiopulmonary stability[13] since medications that enhance comfort and reduce agitation and anxiety may also contribute to cardiopulmonary instability. Although sedatives are among the most frequently prescribed drugs in intensive care,[14] the achievement and evaluation of optimal sedation remains a clinical challenge.

Sedative medications should reduce the physiologic stress of respiratory failure and improve the tolerance of invasive life support.[2,15–17] However, noxious experiences such as endotracheal tube suctioning[18–22] may produce stressful stimuli, even in the presence of sedation, resulting in increases in both beta-endorphin[23] and catecholamine blood levels, tachycardia and hypertension.[24] Although noxious experiences may be unavoidable in critical care, whether sedation ameliorates their negative effects has not been well examined and identification of strategies to reduce the stress response to critical illness is a priority.[25] Therefore, the specific aim of this study was to determine the effect of sedation on physiologic responses and comfort during and after a noxious stimulus, specifically, endotracheal suctioning (Fig.1).

Sources of support: National Institute of Nursing Research, R01 NR009506, Grap, M.J. (P.I.).
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0147-9563/$ – see front matter © 2014 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.hrtlng.2013.10.012

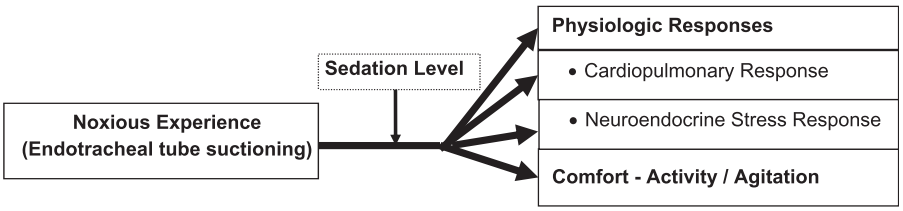

Fig. 1. Study model.

Methods

Setting and subjects

This study is a subset of a larger, prospective, 24 h, observational study conducted in a 779-bed tertiary care university medical center in 3 critical care units, Surgical Trauma ICU (STICU), Cardiac Surgery ICU (CSICU) and Medical Respiratory ICU (MRICU).[26] The specific aim of the larger prospective study was to describe the relationship among sedation, stability of physiological status, and comfort during a 24-h period in patients receiving mechanical ventilation. The larger study sample ($N = 176$) was drawn from all patients admitted to these ICUs who were intubated, MV, 18 years of age or older, and with an expectation of at least 24 h of mechanical ventilation. Patients were excluded who had a tracheostomy (rather than endotracheal intubation) since the discomfort associated with a tracheostomy tube may be different than that associated with an endotracheal tube (ETT),[27] received paralytics, had a chronic, persistent neuro-muscular disorders (such as cerebral palsy and Parkinson's disease) or had suffered head trauma or stroke as these would affect patient movement and study measurements. Subjects were recruited over a 2-year data collection period. The subset of 67 subjects for the study reported here were those who had an endotracheal tube (ETT) suctioning event during daytime hours when study research assistants were present, had venous access, and a hemoglobin level greater than 7.0 g/dL to reduce risks associated with lowering of hemoglobin levels with additional venous sampling.

Key variables and their measurement

Sedation

The Richmond Agitation Sedation Scale (RASS) is a 10 point scale, ranging from −5 (unarousable) to 0 (calm and alert) to +4 (combative), based on observations of specific patient behaviors.[28] This scale is used widely in critical care, demonstrates excellent interrater reliability and criterion, construct, and face validity. It is the first sedation scale to be validated for its ability to detect changes in sedation status over consecutive days of ICU care, against constructs of level of consciousness and delirium, and correlated with the administered dose of sedative and analgesic medications.[28,29] The RASS was found to have the highest physiometric score of all sedation scales included in a recent review.[3] The RASS served as our baseline measure of sedation prior to suctioning. Based on our previous work, and the RASS descriptions, a RASS of −5, −4, or −3 was categorized as moderate/deeply sedated, a −2, −1 or 0 as alert/mildly sedated and a +1, +2, +3, or +4 was categorized as restless/agitated.[28,30] To determine the effect of all levels of sedation including a RASS level of alert, all subjects regardless of RASS level, were included.

Physiologic response

Cardiopulmonary response. This response was measured as heart rate (HR), oxygenation (respiratory rate [RR], hemoglobin saturation of oxygen [SPO_2]). Heart rate data were acquired every second using the Criticare Systems Scholar II monitor (Criticare Systems, INC, Waukesha, WI), using a Type I, three electrode ECG sensors, which were stored in the computer via serial port connection. Respiratory rate information was documented for every breath and was acquired from the ventilator through a NICO® Cardiopulmonary Monitor device (Respironics, Parsippany, NJ) then stored to the computer via serial port connection. The SPO_2 waveform from the NICO® monitor was obtained from a finger oximetry sensor. The analog SPO_2 signal was then sampled and stored on the PC at a rate of 125 Hz using a Biopac™ Systems (Goleta, CA) MP-150 data acquisition system. The stored SPO_2 data were averaged into 1 s intervals and then time-synchronized with the respiratory, HR and actigraphy data into a single text file.

Neuroendocrine stress response. Serum beta-endorphin and salivary alpha-amylase levels are markers of the stress response and were selected because they reflect central nervous system response (beta-endorphin) and sympathetic nervous stimulation (salivary alpha-amylase), can be reliably measured, and have been used successfully in critically ill populations.[31,32] Blood samples were drawn after a 30 min period without stimulation (i.e., no physical stimulation and the subject appeared restful) and within 1 min after ETT suctioning. Each 3 ml sample was collected in a tube containing EDTA and Trasylol and immediately placed on ice; plasma was separated by refrigerated centrifugation, and frozen at −70 °C within 1 h of collection. Beta-endorphin was assayed by commercially available radio-immunoassay (RIA) kit (IBI Products, Hamburg, Germany), which demonstrates excellent specificity and is able to quantify beta-endorphin in ranges expected in this clinical study.

Salivary alpha-amylase was measured using a parotid sample of saliva and was collected by plain (non-citric acid) cotton salivettes (Sarstedt Inc, Newton, NC), the preferred method of collection for this biological marker.[32] Saliva samples were obtained at the same times that blood samples for beta-endorphin were drawn. With the head of bed elevated at least 45°, the salivette was placed in the buccal pocket of the subject's oral cavity, where it remained for 2 min. The salivette was then sealed in its transport tube and delivered to the laboratory. Saliva samples were frozen at −20 °C in order to precipitate mucins and to preserve stability. Prior to analysis, samples were thawed completely, vortexed, and centrifuged. Salivary alpha-amylase was quantified by a commercially available assay kit (Salimetrics, State College, PA) which utilized a chromagenic substrate to demonstrate the enzymatic action of alpha-amylase. The amount of α-amylase activity present in the sample is directly proportional to the increase in spectrophotometric absorbance.

Comfort

Patient comfort is a goal of sedation use. While analgesics are used specifically for pain relief, sedation together with analgesia may be required in the critically ill adult to alleviate pain and distress associated with surgical and other invasive or diagnostic procedures, to improve the efficacy of mechanical ventilation, and to alleviate the distress associated with acute illnesses, that is, to improve overall patient comfort. In the mechanically ventilated adult, it is often difficult to distinguish pain from anxiety, agitation