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Research article

Factors affecting pain assessment scores in patients on mechanical ventilation

Yumi Ito[a,*], Koji Teruya[b], Hiroshi Kubota[c], Tomoko Yorozu[d], Emiko Nakajima[a]

[a] Department of Nursing, Faculty of Health Sciences, Kyorin University, Tokyo, Japan
[b] Department of Public Health, Faculty of Health Sciences, Kyorin University, Tokyo, Japan
[c] Department of Cardiovascular Surgery, School of Medicine, Kyorin University, Tokyo, Japan
[d] Department of Anesthesiology, School of Medicine, Kyorin University, Tokyo, Japan

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ABSTRACT

Objective: To determine how respiratory status and other aspects of the patients' condition affect pain assessments.
Methods: Pain was assessed in 20 patients aged ≥20 years who underwent cardiovascular surgery, and required postoperative mechanical ventilation in an intensive care unit using the Behavioral Pain Scale (BPS). A BPS score of ≥6 (pain) versus <6 (no pain) was the dependent variable for determining the effect on pain.
Results: Multiple logistic regression analysis showed that in 99 observations made at rest, pre- and post-turning and pre- and post-tracheal suctioning, the BPS score was significantly affected by gender, the Acute Physiology and Chronic Health Evaluation (APACHE) II score, Richmond Agitation–Sedation Scale score, $PaCO_2$, and HCO_3^-.

The associations between BPS scores and APACHE II scores and HCO_3^- demonstrated that pain results from biological responses to invasion. Increases in $PaCO_2$ affecting only the total BPS score suggests that $PaCO_2$ is associated with other pain responses, regardless of respiratory status.
Conclusion: The BPS score was significantly associated with disease severity and ventilatory capacity, demonstrating a need to examine pain assessment methods tailored to the severity of underlying disease, degree of respiratory failure and other aspects of individual patient's condition for effective pain management.

Implications for Clinical Practice

- The Behavioral Pain Scale (BPS) score is significantly affected by gender Acute Physiology and Chronic Health Evaluation II score, Richmond Agitation–Sedation Scale score, and $PaCO_2$, and HCO_3^- values.
- Given that the severity and degree of respiratory insufficiency were significantly related to the BPS score, the necessity of considering a pain assessment method that takes into account the patient's condition during mechanical ventilation was suggested.
- By clarifying the pain assessment method based on the patients' condition, we could administer analgesia more appropriately and contribute to early withdrawal from mechanical ventilation among critically ill patients.

Introduction

For patients with a severe disease who require mechanical ventilation, it has recently been recommended that in order to reduce the duration of ventilation, excessive administration of sedatives should be avoided and sedation should be maintained at a level

* Corresponding author at: Department of Nursing, Faculty of Health Sciences, Kyorin University 6-20-2 Sinkawa Mitaka–shi, Tokyo 181-8611, Japan.
E-mail address: yumito@ks.kyorin-u.ac.jp (Y. Ito).

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Table 1
Behavioral Pain Scale.

Item	Description	Score
Facial expression	Relaxed	1
	Partially tightened (e.g., brow lowering)	2
	Fully tightened (e.g., eyelid closing)	3
	Grimacing	4
Upper limbs	No movement	1
	Partially bent	2
	Fully bent with finger flexion	3
	Permanently retracted	4
Compliance with ventilation	Tolerating movement	1
	Coughing but tolerating ventilation for most of the time	2
	Fighting ventilator	3
	Unable to control ventilation	4

Payen et al. (2001).

that is light enough to enable patients awakening during the daytime (Girard et al., 2008). These recommendations have made it more important to appropriately assess patients' levels of pain and plan pain management. However, in patients whose general condition is unstable, such as severe respiratory failure, sedation needs be prioritised (Reade and Finfer, 2014) and the maintenance of a light sedation level is difficult. In such cases, an objective evaluation of the patient's pain is necessary. In order to do so, the Clinical Practice Guidelines for the Management of Pain, Agitation, and Delirium in Adult Patients in the Intensive Care Unit ("PAD Guidelines"), published by the American College of Critical Care Medicine in 2013, recommend the use of the Behavioral Pain Scale (BPS) or Critical-Care Pain Observation Tool (CPOT) (Barr et al., 2013). In light of the publication of the PAD Guidelines, the Japanese Society of Intensive Care Medicine published the Japanese Clinical Practice Guidelines for the Management of Pain, Agitation, and Delirium in Adult Patients in the Intensive Care Unit ("J-PAD Guidelines") in 2014 (Japanese Society of Intensive Care Medicine J-PAD Guidelines Production Committee, 2014). These guidelines recommend the application of the BPS and CPOT for the assessing pain in critically ill patients. Although a complete Japanese version of the CPOT does not exist, a Japanese version of the BPS was introduced as a scale for assessing pain during mechanical ventilation (Table 1) (Japanese Society of Respiratory Care Medicine, 2007).

The BPS assesses pain based on facial expression, upper limb movements and compliance with mechanical ventilation. Payen, who developed the BPS, compared BPS scores during tracheal suctioning and mobilization with BPS scores at rest, thus verifying the scale's reliability (Payen et al., 2001).

Studies have been conducted to verify the reliability and validity of the BPS since its development (Al Darwish et al., 2016). However, considering that pain is one of the important signs of a biological response in a critically ill patient subjected to particularly invasive surgery or trauma (D'Arcy and Burns, 2014), no study has been conducted on the BPS that incorporate the relevance of treatment factors, such as disease state and mechanical ventilation.

Therefore, this study was conducted to clarify how the disease state and severity, including the respiratory state of the patient, affect the BPS.

Methods

Participants and setting

The subjects were patients who were hospitalised in the intensive care unit (ICU) of a university hospital in Tokyo Prefecture between May 30 and September 15, 2013. These subjects, who were aged ≥20 years, underwent cardiovascular surgery and required postoperative mechanical ventilation in the ICU. As burn and trauma patients are not accommodated in this ICU, they were not included as subjects. Owing to the possibility of quadriplegia, we excluded one patient with a diagnosis of cranial nerve disease as a subject to avoid potential differences in behavior expression related to pain (Payen et al., 2001). We ended our observation once patients were able to verbally communicate with us.

Ethical considerations

The present study was approved by the Institutional Review Board of the Faculty of Health Sciences at Kyorin University (Approval No: 25-1) and the Institutional Review Board of the Faculty of Medicine and Clinical Epidemiology at Kyorin University (Approval No: 374). Potential subjects and their families received an explanation of the study from the surgeon prior to surgery. Patients who provided consent were included in this study.

Consent was obtained by presenting a written document detailing the voluntary nature of participation, right to withdraw from the study at any time, and protection of privacy. All patient names were coded to preserve anonymity.

Data collection

Pain was assessed with the BPS at rest as well as pre- and post-turning, and pre- and post-tracheal suctioning. Assessments at rest were conducted at times during which the arterial blood gas analysis results could be obtained. In addition to basic information, such as gender, clinical diagnosis, underlying disease and operative procedure; evaluation items obtained from medical records consisted of the following: Acute Physiology and Chronic Health Evaluation (APACHE) II, Sequential Organ Failure Assessment (SOFA) severity and Richmond Agitation–Sedation Scale (RASS) scores; mechanical ventilation mode; patient information obtained from the mechanical ventilator (minute ventilation, airway pressure, respiratory rate); arterial blood gas analysis values (pH, PaO_2, $PaCO_2$, HCO_3^-, SaO_2); haemodynamics (blood pressure, heart rate); types and dosages of analgesics and sedatives used and type of artificial airway.

Data analysis

We performed multiple logistic regression analysis to determine how factors obtained from patient data affect BPS scores. A BPS score of ≥6 versus <6, which represents the presence versus absence of unbearable pain in the PAD Guidelines (Barr et al., 2013), was used as the dependent variable. Independent variables consisted of gender (male vs. female); APACHE II, SOFA, and RASS scores; minute ventilation, airway pressure, and respiratory rate; pH, PaO_2, $PaCO_2$, HCO_3^-, and SaO_2 values; and blood pressure and heart rate. Variables were selected using backward elimination performed with a likelihood ratio test. The goodness of fit of the model was assessed with the Hosmer–Lemeshow test. Statistics were analysed using SPSS Statistics 19, with the level of significance set at 5%.

Results

Subject characteristics

All 20 subjects underwent cardiovascular surgery. Three patients were diagnosed with diabetes as an underlying disease, whereas one patient was undergoing renal dialysis treatment for chronic renal failure. The 20 subjects comprised 14 men and 6 women aged 72.8 ± 10.2 years (mean ± standard deviation), with a duration of mechanical ventilation of 6.5 ± 8.2 days, and an APACHE II score of 18.9 ± 6.1; only one subject underwent tracheostomy

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