

Comparison between Critical-Care Pain Observation Tool and physiologic indicators for pain assessment in the critically ill, mechanically ventilated adult patients

ABSTRACT

Background and Objectives: Pain assessment of nonverbal, critically ill patients continues to present a challenge in Intensive Care Unit (ICU). The Critical-Care Pain Observation Tool (CPOT) rates critically ill patients' pain based on clinical observation. In the present study, the accuracy of CPOT was compared with physiological indicators of pain in mechanically ventilated, critically ill patients.

Methods: This quantitative prospective observational study was conducted to assess pain in the critically ill, mechanically ventilated patients in comparison to physiologic indicators such as blood pressure and heart rate. A repeated measures design was chosen, and a sample size of 180 was taken from 60 patients with sepsis, acute exacerbations of chronic obstructive pulmonary disease, community-acquired pneumonia, and postsurgical patients in the ICU. The two painful procedures chosen were tracheal suction and patient positioning. The data were collected at rest, at tracheal suctioning, 20 min later at positioning of the patient, and final reading 20 min later. Three testing periods, each including 4 assessments for a total of 12 pain assessments with sixty patients, were completed during each patient's ICU course. A total of six assessments were done with the patient at rest and three each with pain stimulus of tracheal suctioning and patient positioning.

Results: There was a significant increase in both hemodynamic variables (systolic blood pressure and diastolic blood pressure) during painful procedures except for the heart rate during positioning. The correlation between the CPOT and Ramsay scale was negative and significant.

Conclusions: The present study provides evidence that the CPOT has good psychometric properties. It might prove useful for pain assessment in uncommunicative critically ill patients.

Key words: Critical-Care Pain Observation Tool; Intensive Care Unit; pain

Introduction

Pain assessment and its management is essential right of every patient. Various tools and instruments have been described in literature.^[1] Most of these tools require a patient response

for assessing pain severity. Pain experts agree that a patient's self-report of pain intensity is the most valid measure.

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PUNEET KHANNA, RAVINDER KUMAR PANDEY, CHANDRALEKHA CHANDRALEKHA, ANKUR SHARMA¹, NEHA PANGASA

Department of Anaesthesiology, Pain Medicine and Critical Care, All India Institute of Medical Sciences, New Delhi, ¹Department of Anaesthesiology, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India

Address for correspondence: Prof. Ravinder Kumar Pandey, E-18, Ayur Vigyan Nagar, Near Ansal Plaza, New Delhi-110049 India.
E-mail: ravindrapandey1972@gmail.com

However, this patient response for pain assessment may not be feasible in certain groups of patients such as critically ill patients and patients who are on mechanical ventilation. Critically ill patients are unable to communicate effectively for several reasons, including tracheal intubation, reduced level of consciousness, restraints, sedation, and administration of paralyzing drugs. Moreover, the inability to communicate verbally does not negate the possibility that an individual is experiencing pain. Thus, pain assessment for critically ill patients, especially for nonverbal patients, continues to present a challenge for clinicians and researchers.^[1]

Several pain scales have been used to document self-reporting of pain in intubated patients.^[2-5] In the absence of a patient's self-report, observable, behavioral and physiological indicators become important indices for the assessment of pain and are a common method of assessing pain. The hemodynamic variables of blood pressure and heart rate are the physiological indicators of pain. Pain behaviors can be markers of the existence, intensity, and causes of pain. Critical-Care Pain Observation Tool (CPOT)^[2] [Appendix 1] is a tool designed for critically ill patient and has four sections, each with different behavioral categories (facial expression, body movements, muscle tension, and compliance with the ventilator for intubated patients or vocalization for extubated patients).^[6] The CPOT had an acceptable reliability and validity in patients undergoing cardiac surgeries.^[7]

The aim of this prospective study was to compare the accuracy of CPOT with physiological indicators such as blood pressure and heart rate for pain assessment in critically ill patients who were sedated, tracheally intubated, and mechanically ventilated. We hypothesized that CPOT has sufficient accuracy to assess pain in the critically ill, mechanically ventilated patients in comparison to physiologic indicators such as blood pressure and heart rate and has the potential to significantly improve pain treatment practices.

Methods

A repeated measures design was chosen for this quantitative prospective observational study. A sample size of 180 from 60 patients in the Intensive Care Unit (ICU) at AIIMS, New Delhi, was recruited for the study after Institutional Ethics Committee approval. Adult patients (more than 16 years of age) of either sex, who were tracheally intubated and who required mechanical ventilation and sedation in the ICU at AIIMS, New Delhi, were recruited for the study on the 1st day of tracheal intubation. The consent was taken from eligible patients' relatives after explaining the study protocol. Patients were excluded if

they were quadriplegic; receiving neuromuscular blocking medications; or had a peripheral neuropathy, pregnancy, and morbid obesity; received medical treatment for chronic pain; had a left ventricular ejection fraction <0.25; had preexisting psychiatric or neurological problems; had a dependence on alcohol or drugs; or had complications after surgery (e.g., hemorrhage and delirium).

The patient received sedation as per institutional protocol using morphine and midazolam infusions. The patients' sedation levels were assessed using the Ramsay scale.^[8] The Ramsay scale rates sedation level on a scale from 1 to 6. The level of sedation was kept as Ramsay Sedation score of >3. After recruitment, all patients were assessed for pain using a physiological monitor (arterial blood pressure and heart rate) and CPOT at three time points (morning, afternoon, and night). At each of these time points, evaluation of the CPOT and the physiological variables was made at rest and during painful procedures to appreciate the CPOT responsiveness. The two painful procedures chosen were tracheal suction and patient positioning (defined as movement during shifting of the patient in bed). They were selected because their painful characters had been demonstrated in several previous studies and because they were part of the routine care that was normally planned for the patients. These both procedures were done simultaneously. During these assessments, no additional interventions or procedures were performed. The data were collected at rest, at tracheal suctioning, 20 min later at positioning of the patient, and final reading 20 min later.

This was a pilot study of sixty patients to assess the relation of CPOT and physiological parameters in response to painful activity. There is no published literature to assess for formal sample size, and hence, a sample size of 60 was considered as the sample of convenience. The statistical test was applied to the observed parameters. The data are summarized as mean \pm standard deviation. The correlations between the studied parameters were analyzed using Pearson's correlation coefficient. $P < 0.05$ was considered statistically significant.

Results

Three testing periods, each including 4 assessments for a total of 12 pain assessments with sixty patients, were completed during each patient's ICU course. A total of six assessments were done with the patient at rest and three each with pain stimulus of tracheal suctioning and patient positioning. Patient characteristics are shown in Table 1. Patients were sedated with midazolam and morphine with

a mean sedation score of 3.57. Analgesia was maintained with morphine, fentanyl, and paracetamol as per patients' requirement. There was a significant increase in both hemodynamic variables during painful procedures except for the heart rate during positioning [Tables 2 and 3]. The correlation between the CPOT and Ramsay scale was negative and significant [Figure 1]. There was no significant correlation among the CPOT scores and physiological variables, except a change in diastolic blood pressure during patient positioning ($P = 0.039$) in the present study [Table 4].

Discussion

Appropriate pain assessment is an important part of quality care for critically ill patients, and use of validated measures of pain could aid in the evaluation of multidisciplinary pain management techniques for nonverbal critically ill patients. Pain is a stressor that produces a sympathetic stimulation. Tachycardia, change in arterial blood pressure, diaphoresis, and change in pupillary size are physiological variations which can help to detect pain among patients with impaired mental status.^[9] Puntillo *et al.*,^[10] in a study of patients having difficulties with verbal communication (mechanically ventilated or having been tracheal extubated <4 h), showed that the most frequently noted physiological indicators of pain were increased heart rate and increased arterial blood pressure.

In the present study, heart rate and arterial blood pressure increased significantly during painful procedures. These results coincide with the observations of clinicians who generally associate pain with a variation from 10% to 20% in physiological variables.^[11]

Physiological indicators lack specificity in the ICU and can be influenced by many medications (vasopressors, adrenergic blockers, antiarrhythmic, sedative drugs, etc.) and pathological conditions (sepsis states, shock, hypoxia, and fear).^[9] Moreover, no significant correlation was found among the CPOT scores and the two physiological variables in our study.

However, the correlation between the CPOT and Ramsay scale was negative and significant. The logical direction of the association is the higher the sedation level, the lower the ability to express painful behaviors. In the present study, the CPOT total was higher during the procedures but was not statistically significant. The change in CPOT scores testifies to the instrument's capacity to detect and discriminate pain and provides the evidence that the CPOT is a measure of pain assessment.

This analysis has shown that behavioral indicators can be a valid and reliable measure of pain. Few studies have evaluated

pain behaviors in the ICU and identified specific procedural pain behaviors such as grimacing, rigidity, wincing, shutting of eyes, verbalization, and clenching of fists. However, in one

Table 1: Patient demographic profile (n=180)

Parameters	Values
Age (year)	43.7±19.3
Weight (kg)	60.6±13.9
Sex	
Male	100
Female	80
Mean Ramsay sedation score	3.6±1.6
Diagnostic categories	
Sepsis	16
Postoperative	21
COPD	6
CAP/aspiration/ARDS	8
Others	9

Values expressed as mean±SD. SD: Standard deviation; COPD: Chronic obstructive pulmonary disease; CAP: Community acquired pneumonia; ARDS: Acute respiratory distress syndrome

Table 2: Study parameters: Physiological variables and Critical-Care Pain Observation Tool at rest and during tracheal suctioning (n=180)

Parameters	SBP	DBP	HR	CPOT
Rest	117.7±19.9	72.2±11.8	102.6±20.2	1.05±1.261
After tracheal suctioning	128.2±20.6	81.1±11.9	111.1±20.0	1.20±1.508
<i>P</i>	<0.001	<0.001	<0.001	0.307

Values expressed as means±SD. CPOT: Critical-Care Pain Observation Tool; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate; SD: Standard deviation

Table 3: Study parameters: Physiological variables and Critical-Care Pain Observation Tool at rest and patient positioning (n=180)

Parameters	SBP	DBP	HR	CPOT
Rest	119.6±20.0	75.7±12.2	108.9±77.5	1.07±1.280
After patient positioning	130.6±20.8	83.4±12.3	112.8±20.3	1.16±1.369
<i>P</i>	<0.001	<0.001	0.517	0.525

Values expressed as means±SD. CPOT: Critical-Care Pain Observation Tool; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate; SD: Standard deviation

Table 4: Correlation between Critical-Care Pain Observation Tool and physiological parameters (n=180)

Group	Pearson correlation	Significant (two-tailed)
Change in SBP (patient positioning)	0.068	0.365
Change in SBP (tracheal suctioning)	0.014	0.847
Change in DBP (patient positioning)	0.154	0.039*
Change in DBP (tracheal suctioning)	0.124	0.098
Change in HR (patient positioning)	0.014	0.852
Change in HR (tracheal suctioning)	0.058	0.438

*Correlation is significant at the 0.05 level, SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate

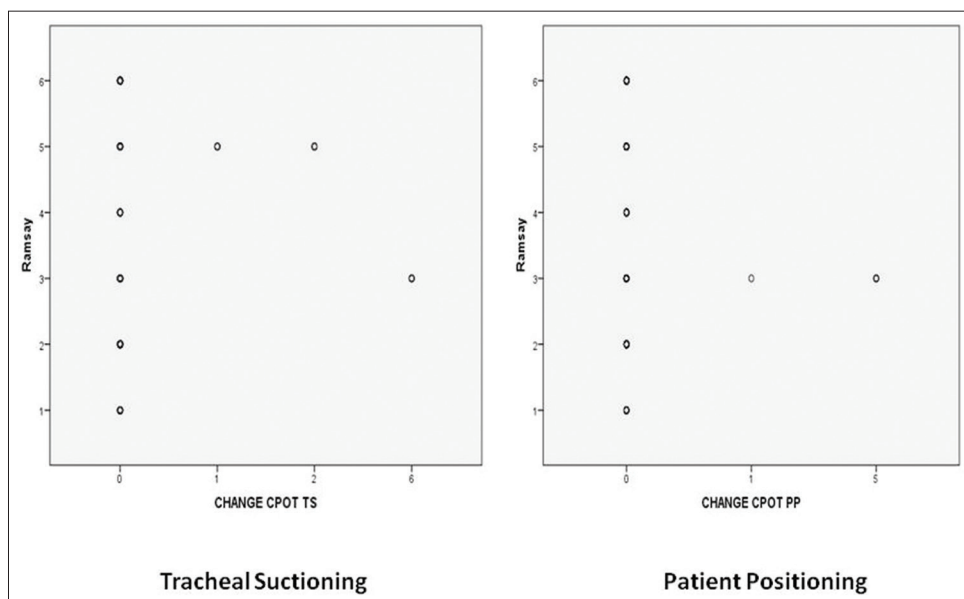


Figure 1: Correlation between Ramsay Scale and Critical-Care Pain Observation Tool during tracheal suctioning and positioning

study, the patients were awake and could measure their pain with a numeric rating scale.^[12]

Facial expression, which contributed to the pain rating in our study, is a sign found in various works measuring both acute pain and chronic pain. Prkachin^[13] has suggested that four facial fractions carry the bulk of facial information about pain: lowering the brow, tightening and closing of the eyelids, wrinkling of the nose, and raising the upper lip. He has also provided evidence of the existence of a universal facial language of pain. The facial scales, which are especially useful for measuring pain in infants and children, highlight the value of this type of signal.

In our study, movement contributed as much as facial expression to the pain rating. Compliance with mechanical ventilation had an effective contribution to pain assessment. The reason could be that this subscale might be affected by some factors unrelated to pain, such as hypoxemia, bronchospasm, and mucous plugging, which can lead to coughing and some fighting of the ventilator.

In addition to these psychometric properties, the CPOT showed good feasibility, as the average time of assessment was only 4 min. The short time required will make the CPOT suitable for everyday clinical use.

This study has two limitations. First, one aspect of the validation process has not been addressed, namely, the criterion validity (validity of the CPOT in comparison with another validated pain scale). Second, we could have compared the CPOT to subjective rating of the

level pain by an independent rater (a nurse) on a visual analog scale.

Despite these limitations, this study was innovative in several aspects. First, the use of the CPOT was based on previous research of others as well as on descriptive data from preliminary studies^[14-16] that led to the selection of the behavioral indicators. Second, the relationship between intubated patients' self-reports of pain and behavioral indicators was explored. Finally, data were obtained from patients at different levels of consciousness. Future studies will have to include more patients.

Conclusions

We conclude that the present study provides evidence that the CPOT has good psychometric properties. This tool might prove useful to measure pain in uncommunicative critically ill patients and to evaluate the effectiveness of analgesic treatment and adapt it. Further studies are required to determine whether the use of this scale can really improve management of pain in the ctical care setting.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Appendix

Appendix 1: Critical-Care Pain Observation Tool

Indicator	Score	Description
Facial expression	Relaxed, neutral - 0	No muscle tension observed
	Tense - 1	Presence of frowning, brow lowering, orbit tightening and levator contraction or any other change (e.g., opening eyes or tearing during nociceptive procedures)
	Grimacing - 2	All previous facial movement plus eyelid tightly closed (the patient may present with mouth open or biting the endotracheal tube)
Body movements	Absence of movements or 0 normal position	Does not move at all (does not necessarily mean absence of pain) or normal position (movements not aimed toward the pain site or not made for the purpose of protection)
	Protection - 1	Slow, cautious movements, touching or rubbing the pain site, seeking attention through movements
	Restlessness/agitation - 2	Pulling tube, attempting to sit up, moving limbs/thrashing, not following commands, striking at staff, trying to climb out of bed
Compliance with the ventilator (intubated patients)	Tolerating - 0 ventilator/movement	Alarms not activated, easy ventilation
	Coughing but tolerating - 1	Coughing, alarms may be activated but stop spontaneously
	Fighting ventilator - 2	Asynchrony: Blocking ventilation, alarms frequently activated
Muscle tension Evaluation by passive flexion and extension of upper limbs when patient is at rest or evaluation when patient is being turned	Relaxed - 0	No resistance to passive movements
	Tense, rigid - 1	Resistance to passive movements
	Very tense or rigid - 2	Strong resistance to passive movements or incapacity to complete them
Total	8	