JOURNAL OF NEPALESE SOCIETY OF CRITICAL CARE MEDICINE
A PEER REVIEWED, OFFICIAL JOURNAL OF NSCCM

ORIGINAL ARTICLE

Comparison of pain assessment by critical care pain observation tool and physiological variables in mechanically ventilated patients.

Batsalya Arjyal[1], M.D., F.I.P.M., F.I.C.C., Lalit Kumar Rajbanshi[1], M.D., E.D.I.C.M., F.I.C.M., Kanak Khanal[1], M.D., Dipesh Man Singh[2], M.D., F.I.C.A., Gunjan Regmi[1], M.D., Rakshya Sangroula[3], M.D.

[1] Department of Anesthesiology and Critical Care, Birat Medical College and Teaching Hospital, Biratnagar, Nepal
[2] Department of Cardiothoracic Cascular Anesthesia, Manmohan cardiothoracic vascular and transplant centre, Maharajgunj, Kathmandu, Nepal,
[3] Koshi Zonal Hospital, Rangeli Road, Biratnagar, Nepal.

Corresponding author:
Dr. Batsalya Arjyal, M.D., Assistant Professor
Department of Anesthesiology and Critical Care
Birat Medical College and Teaching Hospital,
Biratnagar, Nepal.
Email: batsalyaarjyal@gmail.com
Phone: 9813778200
https://orcid.org/0000-0001-6939-4544

ACCESS THIS ARTICLE ONLINE

View PDF

HOW TO CITE THIS ARTICLE IN VANCOUVER STYLE?

Arjyal B, Rajbanshi LK, Khanal K, Singh DM, Regmi G, Sangroula R. Comparison of pain assessment by critical care pain observation tool and physiological variables in mechanically ventilated patients. Journal of Nepalese Society of Critical Care Medicine. 2023 Jul;1(2): 10-15.

Submitted	: 24 June 2023
Accepted	: 29 June 2023
Published Online	: 9 July 2023
Conflict of Interest	: None
Source of Support	: None

ABSTRACT

Background and aims : Critically ill and mechanically ventilated patient cane experience mild to severe pain. Pain assessment in critically ill mechanically ventilated patient is challenging due to their inability to communicate. In these patients, pain is often underdiagnosed and undertreated contributing to increased morbidity and mortality. The Critical-Care Pain Observation Tool (CPOT) is a tool designed to assess pain in critically ill patient. This study compares the accuracy of CPOT and physiological variables of pain for assessing pain in mechanically ventilated, critically ill patients in Intensive Care Unit (ICU).

Methods : This quantitative observational study was conducted on critically ill mechanically ventilated patient. CPOT and physiological variables for assessment of pain were compared. The data of 120 samples were collected from 40 patients at three different time points (morning, evening and night) within 24 hours of ICU admission. Tracheal suctioning and patient positioning were considered as the two painful conditions in this study. Data were collected for CPOT and physiological variables (heart rate and blood pressure) at rest and at the time of these two painful procedures.

Results : There was a significant increment in physiological variables during the painful procedures. The CPOT score values also increased, coinciding with increase in physiological variables. There was statistically significant correlation between the increase in CPOT score and physiological variables.

Conclusion : The study demonstrates a significant correlation between the change in CPOT score and physiological variables in response to painful stimuli in mechanically ventilated critically ill patients.

Keywords: *Critical Care Pain Observational Tool, critically ill, intensive care unit, mechanically ventilated, pain, physiological variables.*

INTRODUCTION

International Association for Study of Pain (IASP) defines pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.[1]

Annually an approximate of five million patients are hospitalized in ICUs (Intensive Care Unit), among which 71% experience pain. Mild to severe pain was experienced by about 63% of the patients hospitalized in ICUs.[2]

Pain decreases the speed of recovery, quality of life, increases mortality rate and convalescence of patient who have undergone surgical operation.[3]

The physiological responses caused due to pain during various care procedures such as turning and physical therapy disrupt the ability of body to react positively to healing process. The stress responses to pain increases the heart rate, blood pressure, impairs the tissue perfusion.[4]

The resulting hemodynamic instability following the pain is due to release of catecholamine and stress hormones. Pain also causes wound infection, impaired blood sugar, thromboembolic disorders, atelectasis, pneumonia, sepsis, cardiac ischemia, ventilator asynchrony in mechanically ventilated patient. It also causes emotional disorders, neuro hormonal changes, insomnia, delirium and impaired social function. All these conditions result in delayed recovery leading to prolonged hospitalization.[5]

30% of the total patients treated in ICU have significant pain at rest, while more than 50% have been noted to have significant pain during routine care like turning procedures. The repeated high intensity pain events in ICU might lead to increased risk of chronic pain syndromes.[6]

Pain should be effectively managed by decreasing pain intensity thereby improving the functionality. Cardiovascular instability, opioid dependency, and depression of spontaneous ventilation stop the physicians from adequately treating pain. Moreover, lack of knowledge on assessment of pain, treatment techniques and long-term benefit of effective pain management is very common.[7]

In addition to that reduced level of consciousness, sedation, restraints, tracheal intubation and use of paralyzing agents precludes critically ill patients to communicate effectively. All the factors contribute to difficulty in assessing and managing the pain.[8]

There are various scales to assess the pain, but, in non-communicating critically ill patient, pain scores are underestimated is revealed many studies.[9]

Critical-Care Pain Observation Tool (CPOT) (Table 1) has been designed to assess the pain The aim of this 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, tracheal intubated, and mechanically ventilated.

Table 1. Critical-Care Pain Observation Tool (CPOT):

Indicator	Score
Facial expression	
• Relaxed	0
• Tense	1
• Grimacing	2
Body movements	
• Absence of movements	0
• Protection	1
• Restlessness	2
Compliance with ventilator	
• Tolerating with ventilator	0
• Coughing but tolerating	1
• Fighting ventilator	2
Muscle tension	
• Relaxed	0
• Tense, rigid	1
• Very tensed	2

METHODS

This observational cross-sectional study was undertaken on 40 patients after obtaining approval of IRC (Institutional Review Committee). The total of 120 samples were recruited from critically ill mechanically ventilated patients admitted in ICU of Birat Medical College Teaching Hospital. The sampling technique used was convenience non probability sampling. The sample size was measured using standard deviation and effect size from the similar study conducted by Khanna P et al at AIIMS, India.[11]

The written informed consent was obtained from the eligible surrogate decision maker of the patient. Adults with age more than 16 years old, who were sedated, critically ill and mechanical ventilated were enrolled in the study. All the data were collected on the first day of intubation. The intubated patients were sedated with midazolam and fentanyl. The patients whose Richmond Agitation and Sedation Score (RASS) more than -3 were included in the study. The CPOT and physiological parameters were used as tools to access the patient during the painful stimulus.

These data were taken at three different points (morning, evening, night). The suctioning and position change were considered as painful stimulus for the study. No additional interventions were done during these routine care procedures. The data were collected for CPOT and physiological variables at rest (20 minutes before suctioning) then at suctioning and at rest (20 minutes before position change) then at the time of position change.

Data was filled in a preformed standard Performa. MS Excel was used for data entry and was analyzed by IBM SPSS version 23. The mass and standard deviation was used for continuous data while frequency and percentage was used for categorized data. The chi-square test was used for categorized variables, while Mann Whitney U test was used for the evaluation of continuous variables. A p value of < 0.05 was considered as significant.

Sample size estimation:

A similar study was conducted by Khanna P et al in 2018.[11] Standard deviation (SD) for heart rate after tracheal suctioning in the study was 20.

Effect size (d) = Mean difference of heart rate after tracheal suctioning and at rest = 111.1-102.6=8.5

In our study power of 80% and type 1 error of 5% were taken and through z table values 1.96 and 0.84 were derived.

Sample size = 2(SD) 2 (1.96+0.84)2/d2 = 2(20 X 20) (7.84)/ (8.5 X 8.5) = 86.80

A total of 120 samples was included in the study.

RESULTS

A total of 60 critically ill mechanically ventilated patients were screened for eligibility for study. Out of which only 40 were included in the study (Figure 2). Total of 120 data were drawn from the patients. All the data collected were on the first day of admission at three different times among morning, evening or night. The patient were sedated with midazolam and fentanyl so as to target RASS score around -3. The data were collected at rest (20 minutes before suctioning), at tracheal suctioning, at rest (20 minutes before positioning), at positioning.

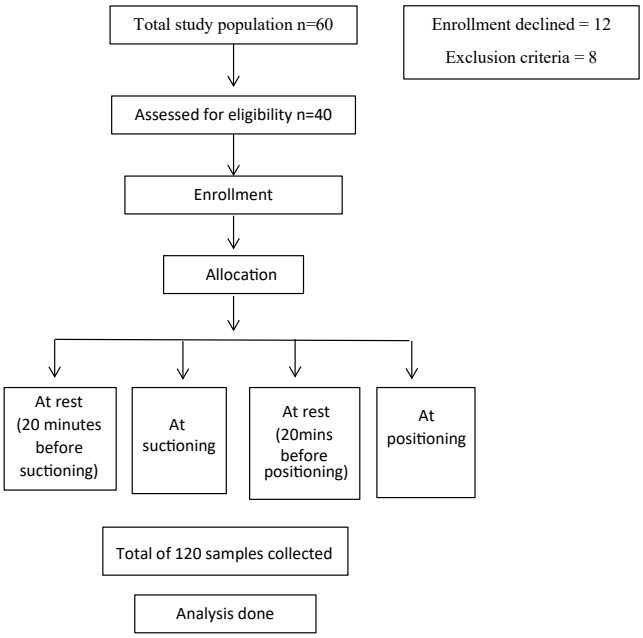

Figure 2: Consort diagram.

Table 1: Patient demographic data

Parameters	Values
Age	50.925±20.26 (mean± standard deviation)
Sex	
Male	29
Female	11
Ramsay Sedation Score	3.2±1.5 (mean ±standard deviation)
Diagnosis	
Sepsis	26
Cardiac failure	W5
Post laparotomy	3
Poisoning	5
Ectopic pregnancy	1

The demographic data was not statistically significant. The mean Ramsay Sedation Score was 3.2±1.5. These data are demonstrated in Table no 1.

The mean value of systolic blood pressure at rest was 115.07±17.54 mm of Hg while on tracheal suctioning, it increased to 122.80±16.91 mm of Hg. This shows significant correlation.

The mean value of diastolic blood pressure at rest was 67.57±11.431 mm of Hg which increased to 73.78±12.004 mm of Hg at tracheal suctioning projecting statistically significant correlation

The increment in mean value of heart rate from 108.07±23.9 to 114.23±23.42 /min suggests significant correlation statistically at rest and tracheal suctioning respectively.

The CPOT values also demonstrate statistically significant correlation when the mean values increase from 0.56±0.96 to 1.93±1.27 at rest and tracheal suctioning respectively.

These data are demonstrated in the below table no 2.

Table 2: Physiological variables and Critical-Care Pain Observation Tool at rest and at tracheal suctioning.

	SBP (mm of Hg)	DBP (mm of Hg)	HR (/mins)	CPOT
At rest	115.07 ± 17.24	67.57 ± 11.431	108.07 ± 23.9	0.56 ± 0.96
At tracheal suctioning	122.80 ± 16.91	73.78 ± 12.004	114.23 ± 23.42	1.93 ± 1.27
P value	<0.001	<0.001	<0.001	<0.001

Values are expressed as mean± Standard deviation, SBP-systolic blood pressure, DBP-diastolic blood pressure, HR-heart rate, CPOT-Critical-Care Pain Observation Tool

Similarly, the mean value of systolic blood pressure increases from 117.12±17.946 mm of Hg to 123.78±17.603 mm of Hg suggesting statistically significant correlation at rest and at positioning respectively.

The mean value of diastolic blood pressure increases from 63.69±11.699 mm of Hg to73.49±11.211 mm of Hg suggesting statistically significant correlation at rest and at positioning respectively.

The increment in mean value of heart rate from 107.39±22.906 /min to 111.23±25.191/min suggests significant correlation statistically at rest and positioning respectively.

The mean value of CPOT score increased from 0.72±1.063 to 1.67±1.103 suggesting statistically significant correlation at rest and positioning respectively.

These data are demonstrated in Table no. 3

Table 3: Physiological variables and Critical-Care Pain Observation Tool at rest and patient positioning

	SBP (mm of Hg)	DBP (mm of Hg)	HR (per min)	CPOT
At rest	117.12 ± 17.95	63.69 ± 11.70	107.39 ± 22.91	0.72 ± 1.06
After positioning	123.78 ± 17.60	73.49 ± 11.21	111.23 ± 25.19	1.67 ± 1.10
P value	<0.001	<0.001	<0.001	<0.001

Values are expressed as mean Standard deviation, SBP-systolic blood pressure, DBP-diastolic blood pressure, HR-heart rate, CPOT-Critical-Care Pain Observation Tool

Table 4: Pearson correlation of physiological variables and critical care pain observation tool

	Pearson correlation
Change in systolic blood pressure at suctioning	0.92
Change in systolic blood pressure at positioning	0.95
Change in diastolic pressure at suctioning	0.87
Change in diastolic pressure at positioning	0.94
Change in heart rate at suctioning	0.95
Change in heart rate at positioning	0.92
Change in CPOT at suctioning	0.61
Change in CPOT at positioning	0.69

Since the Pearson correlation coefficient for all the data lies between values ± 0.5-±1 it mean that there is a strong correlation.

DISCUSSION

Pain assessment and management in critically ill patient contributes to standard quality care in ICU. A multidisciplinary approach to assessing and managing pain in non-verbal critically ill mechanically ventilated case requires validated measures.

Inability of a patient to communicate verbally makes it difficult for clinicians to obtain self-report of pain. Pain assessment is further hampered by level of consciousness, use of sedatives presence of endotracheal tubes, mechanical ventilation and ICU environment. It has also been noted that severity of pain is often not appreciated and thus undertreated.[12,13]

The results drawn from our study suggest that correlation between the hemodynamic parameters namely blood pressure and heart rate were statistically significant.

Noxious stimuli generated during many standard ICU care procedures trigger nociception process leading to release of catecholamine. This further leads to increase in heart rate, blood pressure, respiratory rate.[14]

The clinicians have observed that there is a variation of 10-20% in physiological variables similar to the study conducted by Terai et al. who in their study demonstrated that heart rate, blood pressure increase significantly during painful procedures.[15]

These data are comparable with our study, wherein the heart rate and blood pressure increased during the tracheal suctioning and positioning in comparing to the rest.

In a study published in Taiwan by Huei-juin chen et al. it was mentioned that various scholars and researchers recommend heart rate and blood pressure as cue for assessment of pain. They also mentioned that values of blood pressure and heart rate were significantly higher during the suctioning. Furthermore they concluded that there is no significant correlation between heart rate, blood pressure and self-report of pain intensity. They suggest the need of assessment tool for accurately accessing the pain.[16]

However, Bakshi SG, Kulkarni AP pointed out challenges in pain assessment in patients admitted in ICU due to altered mentation, sedation, ventilators suggesting inaccuracy of use of hemodynamic parameters as an indicator for pain.[17]

During the painful procedures, Qingdong Li et al in their study showed significant increment in CPOT score in compared to rest. The detected change in CPOT indicate its usefulness in determining pain. They further testified that blood pressure, heart rate also increased during the painful procedures whereas it was stable at pre-procedure time. Their result emphasized that if a patient is exposed to painful procedures, the changes in physiological indicators and CPOT may be helpful in the assessment.[18]

In our study we observed that CPOT shows statistically significant difference during painful procedures in compared to rest. A strong correlation was noted.

The data produced in similar study conducted by Gomarverdi S et al. it was observed that CPOT showed significant difference ($p < 0.001$) between pain procedures and resting position. Similar to our study, they considered changing position, mouth wash suctioning and physiotherapy as painful procedures. They further added that CPOT is a good tool for capturing changes to pain response in unconscious ICU-admitted patients.[19]

In a study conducted in AIIMS hospital India by Punnet Khanna et al. it was demonstrated that CPOT is a reliable tool for assessing pain in critically ill mechanical ventilated patient. Similar to our study, the CPOT score and hemodynamic changes were increased during painful procedures. They stated that the change in CPOT testifies the capacity of this tool to detect and discriminate pain and provide evidence for validity of the tool.[11]

On noting the CPOT scores at rest and painful routine procedure in critically ill patient in our ICU, it was observed that CPOT changes where similar to change in heart rate and blood pressure. The values also correlate significantly. This similarity suggests that CPOT can be a reliable tool for pain assessment.

CPOT when compared to Behavioral pain score showed fair to good interrater reliability however has superior properties on discriminant validation in assessing pain. On painful stimuli both the scores had increased results. This was proposed by S. Rijkenberg et al. in mechanically ventilated critically ill patient who were unable to self-report pain.[20]

In a study conducted to evaluate pain and outcome in critically ill patient in a Greek ICU, it was noted that Behavioral Pain Score and CPOT successfully assessed pain. They also stated that increased pain correlated with worse outcome and may improve with administration of extra analgesia.[21]

Moreover CPOT was awarded higher acceptability rating by the nurses despite giving comparable rating for feasibility for the two tools.[22]

In critically ill post-operative heart surgery patient higher reliability was noted in CPOT in compared to nonverbal pain scale. It demonstrated moderate to high correlation between the two scale but higher with CPOT.[9]

Celine RN et al. in their study compared conscious patient to unconscious patient and CPOT score. They stated that CPOT score during painful procedure was higher in conscious patient. The increase in CPOT score and physiological indicators during the turning supported the validity of the tool. They reported a sensitivity of 66.7% and a specificity of 83.3% for the CPOT.[23]

One of the limitations of our study is that we did not calculate the specificity and sensitivity of the CPOT score. One of the study suggested higher specificity of CPOT during all times (painful stimuli and no exposure) while sensitivity was high only during painful stimuli.[24]

Despite this, we can suggest that CPOT can be used as a reliable tool for assessing pain in the critically ill mechanically ventilated patient, since the data obtained from the study are convergent with the previous studies.

Limitation of the study:

We did not compare the CPOT tool with other tools available. We did not calculate specificity and sensitivity of the tool.

CONCLUSION

We conclude that there is a significant correlation between the change in CPOT score and physiological variables in response to painful stimuli in mechanically ventilated critically ill patients.

Acknowledgements

We would like to thank all the participants, medical officers, paramedics, and specially nursing staffs of Birat Medical College and Teaching Hospital who selflessly helped us during the course of study. We would also like to thank Dr. Nabaraj Koirala and team for supporting and guiding us during preparation of this manuscript.

REFERENCES

1. International Association for the Study of Pain. IASP Taxonomy; 1994. Available from: http://www.iasp-pain.org/Education/content.aspx?ItemNumber=1698.
2. Payen JF, Bru O, Bosson JL, et al. Assessing pain in critically ill sedated patients by using a behavioral pain scale. Crit Care Med 2001;29:2258-62 [PubMed | Google Scholar | DOI]
3. Ahlers SJGM, van Gulik L, van der Veen AM, et al. Comparison of different pain scoring systems in critically ill patients in a general ICU. Crit Care. 2008;12:R15 [PubMed | Google Scholar | DOI]
4. Sohn A, Garrett DO, Sinkowitz-Cochran RL, et al. Prevalence of nosocomial infections in intensive care unit patients: results from the first national point-prevalence survey. J Pediatr. 2001;139:821–7. [PubMed | Google Scholar | DOI]
5. Shahriari M, Golshan A, Alimohammadi N, Abbasi S, Fazel K. Effects of pain management program on the length of stay of patients with decreased level of consciousness: A clinical trial. Iranian J Nursing Midwifery Res. 2015;20:502-7 [PubMed | Google Scholar | DOI]
6. Chanques G, Sebbane M, Barbotte E, Viel E, Eledjam JJ, Jaber S. A prospective study of pain at rest: incidence and characteristics of an unrecognized symptom in surgical

and trauma versus medical intensive care unit patients. Anesthesiology. 2007;107:858–60. [PubMed | Google Scholar | DOI]

7. De Pinto M, Dagal A, O'Donnell B, Stogicza A, Chiu S, Edwards WT. Regional anesthesia for management of acute pain in the intensive care unit. Int J Crit Illn Inj Sci. 2015;5:138-43. [PubMed | Google Scholar | DOI]
8. Cade CH. Clinical tools for the assessment of pain in sedated critically ill adults. Nurs Crit Care. 2008;13:288-97. [PubMed | Google Scholar | DOI]
9. Marmo L, Fowler S. Pain assessment tool in the critically ill post-open heart surgery patient population. Pain Manag Nurs. 2010;11:134-40. [PubMed | Google Scholar | DOI]
10. Gélinas C, Fillion L, Puntillo KA, Viens C, Fortier M. Validation of the critical-care pain observation tool in adult patients. Am J Crit Care. 2006;15:420-7 [PubMed | Google Scholar | DOI]
11. Khanna P, Pandey RK, Chandralekha C, Sharma A, Pangasa N. Comparison between critical-care pain observation tool and physiologic indicators for pain assessment in the critically ill, mechanically ventilated adult patients. Saudi J Anaesth 2018;12:384-8 [PubMed | Google Scholar | DOI]
12. Hamill-Ruth RJ, Marohn ML. Evaluation of pain in the critically ill patient. Crit Care Clin. 1999;15:35-54. [PubMed | Google Scholar | DOI]
13. Shannon K, Bucknall T. Pain assessment in critical care: what have we learnt from research.

    Intensive Crit Care Nurs. 2003;19:154-62. [PubMed | Google Scholar | DOI]
14. McCance K.L., Huether S.E. Pathophysiology-E-book: The biologic basis for disease in adults and children. 8th ed. Elsevier Health Sciences, New York 2018.
15. Terai T, Yukioka H, Asada A. Pain evaluation in the intensive care unit: observer-reported faces scale compared with self-reported visual analog scale. Reg Anesth Pain Med. 1998;23(2):147-51. [PubMed | Google Scholar | DOI]
16. Chen HJ, Chen YM. Pain Assessment: Validation of the physiologic indicators in the ventilated adult patient. Pain Manag Nurs. 2015;16:105-11. [PubMed | Google Scholar | DOI]
17. Bakshi SG, Kulkarni AP. Ignorance may be Bliss (for Intensivists), but not for ICU Patients! Indian J Crit Care Med. 2019;23(4):161–2. [PubMed | Google Scholar | DOI]
18. Li Q, Wan X, Gu C, et al. Pain Assessment Using the Critical-Care Pain Observation Tool in Chinese Critically Ill Ventilated Adults. J Pain Symptom Manag. 2014;48:975-82. [PubMed | Google Scholar | DOI]
19. Gomarverdi S, Sedighie L, Seifrabiei MA, Nikooseresht M. Comparison of two pain scales: Behavioral pain scale and critical-care pain observation tool during invasive and noninvasive procedures in intensive care unit-admitted patients. Iranian J Nursing Midwifery Res. 2019;24:151-5. [PubMed | Google Scholar | DOI]
20. Rijkenberg S, Stilma W, Endeman H, Bosman RJ, Oudemans-van Straaten HM. Pain measurement in mechanically ventilated critically ill patients: Behavioral Pain Scale versus Critical-Care Pain Observation Tool. J Crit Care. 2015;30:167-72. [PubMed | Google Scholar | DOI]
21. Kontou P, Kotoulas SC, Kalliontzis S, et al. Evaluation of Pain Scales and Outcome in Critically Ill Patients of a Greek ICU. J Pain Palliat Care Pharmacother. 2023;37:34-43. [PubMed | Google Scholar | DOI]
22. Topolovec-Vranic J, Gélinas C, Li Y, et al. Validation and Evaluation of Two Observational Pain Assessment Tools in a Trauma and Neurosurgical Intensive Care Unit. Pain Res Manag. 2013;18:e107-14. [PubMed | Google Scholar | DOI]
23. Gélinas C, Johnston C. Pain Assessment in the Critically Ill Ventilated Adult: Validation of the Critical-Care Pain Observation Tool and Physiologic Indicators. Clin J Pain. 2007;23:497-505. [PubMed | Google Scholar | DOI]
24. Gélinas C, Harel F, Fillion L, Puntillo KA, Johnston CC. Sensitivity and Specificity of the Critical-Care Pain Observation Tool for the Detection of Pain in Intubated Adults After Cardiac Surgery. J Pain Symptom Manag. 2009;37:58-67. [PubMed | Google Scholar | DOI]