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/ PAIN SCALE of CRITICAL-CARE PAIN OBSERVATION TOOL (CPOT) for MECHANICALLY VENTILATED ADULTS in ICU: A SYSTEMATIC REVIEW Nur Hidayati*) Magister of Nursing - Universitas Airlangga Email: deyyacutez@gmail.com ABSTRACT Introduction: Critical care pain observation tool (CPOT) is one of the behavior pain scale frequently used to detect pain in a critical patients with non verbal method.

Objectives: To assess validity, specificity, and sensitivity of CPOT in detecting pain to critical adult patients in ICU unable to communicate his pain. Method: Article searching from database; Google scholar, Ebsco, Science Direct, Elsevier, Medline, CINAHL, SpringerLink, and proquest ranging from 2006 to 2016. Results: There are 16 reviewed international journals; 11 articles dealing with CPOT, 3 CPOT & BPS articles, 1 CPOT & NVPS-R article, and 1 CPOT & FLACC & PINR article.

Conclusions: This systematic review is less strong to recommend the use of CPOT universally. However in general CPOT can be used to measure pain scale in mechanically ventilated adult patients in ICU either conscious or unconscious. Further study is needed by using RCT and more accurate criterion validity.

Keywords: critical-care pain observation tool, critically ill adults, intensive care unit INTRODUCTION Critically ill patients frequently complain pain and uncomfortable state during his care in ICU. Approximately 50% patients complain pain ranging from moderate to severe, either during rest or routine procedures. The pain is caused by a number of factors; pathological conditions, surgical procedures, medical procedures, and nursing interventions such as; repositioning

and suctioning. Pain is subjective. Self report is the main standard used to assess pain, but self report can not be necessarily obtained.

many patients treated in ICU find it difficult to verbalized the pain because they use mechanical ventilator, are sedated/ under analgesia, or suffer from altered LOC. Inadequate Pain management can result in impaired physiological and psychological condition such as unstable hemodynamic and delirium (Bourbonnais, et.al., 2016; Li, et.al., 2014; & Rijkenberg, et.al, 2015). Assessment is the first important stage in pain management.

Assessment of pain in critically ill patients on intubation, sedation, and unable to communicate their need verbally is still a challenge. Unfortunately, measurement of acute pain is frequently inaccurate, so management to relieve pain is also inadequate. No pain assessment tools universally accepted is used in all intensive care units.

Therefore more accurate pain assessment tools are needed and the validity and reliability must be tested. CPOT is observational rating scale designed by Gellinas, et.al. (2006) to measure pain in patients treated in icu unable to communicate it verbally. CPOT has 4 indicators; facial expression, body movement, muscle tension, and compliance with ventilator (for intubated patients) or vocalization (for extubated patients) (Linde, et.al., 2013, Lee, et.al., 2013 & Bourbonnais, et.al., 2016).

CPOT is used due to limitation of tool behavioral pain assessment (BPS & the post anesthesia care unit behavioral pain rating scale) in which BPS consist of 3 components; facial expression, upper limb movement, and compliance with ventilation, while in CPOT muscle tension category is added both BPS and CPOT are used to assessed body movement, but additional muscle tension needs peer evaluation (Linde, et.al., 2013).

The Objectives of this review is to review validity, specificity, and sensitivity of CPOT in measuring pain scale in critically ill adult patients in ICU using ventilator either conscious or unconscious, intubated or nonintubated. METHOD Literature Search Systematic review was initiated with article search in electronic databases including Google Scholar, Ebsco, ScienceDirect, Elseiver, Medline, CINAHL, Elseiver, SpringerLink and ProQues by using PICO frameworks including critically ill adult population, critical care pain observation tool intervention, compared with behavioral pain scale (BPS, FLACC, PINR, NVPS-R, and sensitivity outcomes and specificity of using CPOT in measuring pain scale.

The searching obtains 37 full text articles subsequently strictly selected. It then produced 16 journals which were critically reviewed. Study Selection Criteria The articles are confined to the use of CPOT in critically ill adults treated in ICU published in English in the past 10 years (2006-2016). The article searching is not specified on certain designs due to the lack of available study.

From 16 articles, 11 articles measure CPOT, 3 articles compare CPOT & BPS, 1 article compares CPOT & NVPS-R, and 1 article compares CPOT & FLACC & PINR. The selected sample is patients treated in ICU. Study on medical file and or nurses are excluded. Figure 1. Search algorithm Level Of Evidence The strength of the study is measured based on level of evidence Wood & Haber (2010) divided into 7 levels. / Figure 2.

Level of Evidence based on Wood & Haber (2010) RESULTS Study Design Articles reviewed include; 2 observational - prospective study, 1 prospective observational cohort, 2 descriptive-correlational design, 1 non randomized prospective study, 7 repeated measures design, and 3 descriptive design. According to the level of evidence, 16 articles are in 4-6 levels from 7 level of evidence, level 4 (12 articles) & level 6 (4 articles).

Characteristic of Participant Study reviewed deriving from 7 countries; Canada (7 studies), Korea (1 study), China (2 studies), Spain (1 study), USA (3 studies), Netherland (1 study), and Italy (1 study). All studies were carried out in critically ill adults (age =16 years old and =18 years old) includes; General ICU (all cases), Cardiac ICU (Cardiac surgery), Medical ICU, Neurosciences ICU (Brain injury, stroke, aneurysm, & TBI), and Neuro Surgical ICU (traumatic or neurosurgery, vascular, brain surgery).

Sensitifty and Specificity Gelinas, et.al. (2009) used repeated - measures design to evaluate sensitivity & specificity CPOT on 105 intubated critically ill patients post cardiac surgery able to hear and see. Pain scale measurement was done during rest (pre - exposure), during turning (Exposure), and 20 minutes after (post exposure).

The patient's self - report of pain was taken while the patients on intubation and extubation. The result reveals that pre exposure CPOT has 47,2% sensitivity and 82,9% specificity; exposure 86% sensitivity, 78 % specificity, and 84,5% accuracy; while post exposure sensitivity and specificity is 63% and 97,4% respectively. Varquez, et.al.

(2011) used prospective descriptive study to compare CPOT with patient's physiological response before, during, and post repositioning

on 96 critically ill patients which included medical cases (21) and surgical cases (75). The measurement reveal facial expression is an indicator which significantly increased compared with baseline condition (without stimuli), followed by body movement, compliance with ventilator, and muscle tension. Total mean in CPOT during turning on surgical patients = 2,02, medical patients = 1,80.

CPOT cutoff score > 3 with sensitivity = 66,7% and specificity = 83,3% Li, et.al. (2014) used repeated - measures design on 63 conscious & ventilated critically ill patients able to hear and understand Chinese and stable. Pain scale measurement with CPOT was done during rest, pre and post turning & NIBP.

The results revealed CPOT cut off score (> 2) with 80,8 - 89,4% sensitivity and 73,3 - 81,8 % specificity. Joffe, et.al. (2016) used repeated - measures within subject prospective design to measure reliability and validity CPOT on 79 critically ill patients with brain injury (stroke, aneurysm, tumor, TBI, etc). Measurement was done pre & post 2 procedures (non painful / gentle touch & painful procedure turning).

Self report of pain was obtained by having the patients give verbal affirmation (Yes/No) or nod by using Faces Pain Thermometer scale 0-10. Measurement reveals CPOT cut off score = 2 with 90% sensitivity and 67% sensitivity. Severgnini, et.al. (2016) used observational - prospective study on 101 critically ill patients conscious ventilated patients (41), unconscious ventilated patients (60).

This study measured pain by using CPOT & BPS 1 minute before, during, and 20 minutes after procedures (turning, suctioning, medications, repositioning, & catheter management). The measurement revealed that BPS was more specific (91,7%) than CPOT (70,8%), but BPS was less sensitive (62,7%) compared with CPOT (76,5%). Combination of both tools produced better sensitivity value (80,4%).

It concluded that specificity of CPOT during the painful procedure was between 67 - 97,4% and sensitivity 66,7 90 %. While BPS revealed 91,7% specificity and 62,7% sensitivity. Sensitivity of CPOT was lower during the pre exposure (47,2%) and post exposure 63%, but it had higher specificity than pre exposure 82,9% & post exposure 97,4% (Gelinas, et.al., 2006). Validity Discriminant validity Score of CPOT during nociceptive procedure (mean score=1.93, SD 1.41) is higher than non nociceptive procedure (mean score 0.27, SD 0.64) or (t= -9.01 to - 15.96, p< 0.001).

There is no significant different of discriminant validation of CPOT

before and after gentle touch (Wilcoxon = - 1.00, $p=0.32$), but the score is higher during turning than preturning (Wilcoxon= -7.06, $p<0.01$). Criterion validity There is significant relationship between patient's self-report of pain and CPOT score; in patient's self-report pain CPOT score is 1.62 - 3.65; in patient's denying pain CPOT score is 0.49-2.11. In addition, there is moderate positive correlation between self - report of pain and CPOT during turning (0.64, $r_s=0.48$, $p <0.01$) (Gelinias, et.al., 2006; Gelinias, 2009; Benites, et.al., 2014; Severgnini, et.al., 2016; & Joffe, et.al., 2016).

Review shows that CPOT and BPS are both reliable and valid with good criterion and discriminant validity to measure pain on either intubated or non intubated patients supported by criterion validity score of BPS is $r_s=0.56$, $p<0.0001$ and Spearman correlation of CPOT and BPS ($r=0.951$, $p<0.001$). Criterion validity between CPOT & FLACC is 0.87-0.92, but FLACC is less appropriately used on ill adults. Criterion validity of CPOT & NVPS-R is significantly higher during turning than NIBP (CPOT $p=0.019$, NVPS-R $p=0.025$), but NVPS-R has weaker inter-rater & concurrent validity than CPOT. CPOT & PINR have lower correlation (0.50-0.69) than CPOT & BPS.

DISCUSSION Review shows that CPOT increased during painful procedure and immediately decreased within 10-20 minutes. It because the basis that CPOT increases during painful procedure it is assumed that the change of score results from manipulation turning or ETT/TT suctioning procedure increases pain while rest, oral care, gentle touch, NIBP measurement are less painful procedure.

CPOT is applied on mechanically ventilated patients conscious or unconscious. CPOT is more complete than BPS because muscular movement of arms and legs are not measured in BPS. Facial expression and ventilator compliance are measured in both tools. CPOT is more sensitive than BPS, but is less specific than BPS.

According to Liu & Herr (2015) both CPOT and BPS are valid and reliable to measure pain on intubated or non intubated patients because CPOT and BPS increased significantly during painful procedure, in which both have strong correlation (Spearman correlation analysis $r=0.951$, $p<0.001$). CPOT & BPS significantly increased as well (2 digits) between rest and turning (Rijkenberg, et.al., 2014). CPOT & BPS shows good criterion validity (BPS $r_s=0.56$, $p<0.0001$; CPOT $r_s=0.48$, $p<0.0001$), Severgnini, et.al. (2016) found that combination of CPOT & BPS procedures better sensitivity (80.4%) in measuring pain.

CPOT diterapkan pada pasien mechanically ventilated sadar maupun tidak sadar. CPOT lebih lengkap dibandingkan BPS karena muscular

movement pada lengan dan kaki tidak ada di BPS. Sedangkan facial expression dan ventilator compliance ada pada kedua tools. CPOT lebih sensitif dibandingkan BPS namun kurang spesifik dibandingkan BPS.

Menurut Liu & Herr (2015) CPOT & BPS sama – sama reliable dan valid untuk mengukur nyeri pada pasien intubated maupun non-intubated karena CPOT & BPS meningkat signifikan selama painful procedure dimana keduanya memiliki korelasi yang kuat (Spearman correlation analysis $r=0.951$, $p<0.001$). CPOT & BPS juga meningkat secara signifikan (2 angka) antara istirahat dan turning (Rijkenberg, et.al., 2014).

CPOT & BPS menunjukkan good criterion validity (BPS $r_s=0.56$, $p<0.0001$; CPOT $r_s=0.48$, $p<0.0001$), Severgnini, et.al. (2016) menemukan bahwa kombinasi CPOT & BPS menghasilkan sensitifitas yang lebih baik (80.4%) dalam mengukur nyeri. Although CPOT has lower specificity than BPS, CPOT is more reliable than other tools.

Discriminant validation of BPS is less supportive because score also increased during nonpainful procedure. FLACC is less appropriately used in ill adults, this tool is more appropriately used in ill infants. CPOT & NVPS-R increased during turning instead of NIBP, but the inter-rater & concurrent validity is weaker than CPOT.

CPOT & PINR have lower correlation than other tools. Viewed from validity standards, CPOT has moderate positive correlation with patient's self – report of pain during turning (0.64, $p<0.01$) in which CPOT score during patient's reporting pain 1.62-3.65 and patient's denying pain 0.49-2.11 (Gelinias, 2006; Gellinas & Arbour, 2009; Benites, et.a.,

2014; & Joffe, et.al., 2016). From nurses' point of view, >90% nurses support the use of CPOT due to its clarity, understand ability, and easiness to fill in. More than 70% nurses agree that CPOT is helpful in nursing clinical practice and is recommended to be routinely used (Gelinias, 2010). CPOT is still recommended to be used in ICU viewed from sensitivity, validity, and nurses' recommendation as long as no more accurate tool is invented.

Limitations This Systematic review is in level 5 from 7 level of evidence because 16 articles which were reviewed are in level 4-6; it is therefore, less stronger to refer to. The samples of 23 – 257 critically ill adults (11 studies $n<100$ & 5 studies $n> 100$) without randomising is considered less stronger to be generalized. CPOT measurement is subjective to operator (nurses) and is not objective.

The ability of nurses in understanding the measuring technique and how to determine the score affects CPOT score. Muscle tension can not be measured on patients physically unable to respond such as quadriplegia, paraplegia, or neuromuscular disorder. Specificity of CPOT during painful procedure is lower than during nonpainful procedure.

Moreover, CPOT can only detect that patients complain pain, but it can detect how severe the pain is. CONCLUSIONS In General CPOT can be used to measure pain on mechanically ventilated ill adults (conscious or unconscious) in ICU for all cases. CPOT has positive correlation with self - report pain, is more sensitive than other tools, but less specific than BPS.

This systematic review is not strong enough to recommend the universal use of CPOT. However, CPOT is still recommended to be used in ICU as long as no better tool is available. There is a need for further research with RCT and more objective and accurate validity standard.

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APPENDIX – 1 Description of Critical-Care Pain Observation Tool
Indicator APPENDIX - 2 No

However, the tool needs to be further validated in different populations of critically ill patients.

Criterion validation, CPOT scores were related with the patient's self reports of pain ($p=0.001$)

>70% the nurses mentioned that CPOT was helpful for nursing practice & recommended its use routinely

The agreement percentages were between 97% - 100% (excellent degree of agreement)

(2013) CPOT & NVPS-R ICU In Toronto – Ontario Canada

(2014) CPOT ICU In China

The CPOT was valid instrument for pain assessment in Chinese critically ill ventilated adults

For rater 1, ICCs for NIBP & turning 0.85 ($p<0.001$) & 0.82 ($p<0.001$).

For rater 2, ICCs for NIBP & turning 0.92 ($p<0.001$) & 0.90 ($p<0.001$)

The median BPS score between rest & oral care showed a significant increase of 1 point, whereas the median CPOT score remained unchanged

Inter-rater reliability of BPS was .955, with 0.939 & 0.977 for intubated & nonintubated

Criterion validation: CPOT correlated with patient's self report of pain intensity during turning (0.64, $p<0.01$)

(2016) CPOT & BPS General ICU At Ospedale di Circolo Fondazione Macchi Varese Italy

CPOT & BPS showed a good criterion and discriminant validity ($p<0.0001$)

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