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Pain assessment tools in cardiac surgery patients, challenges and perspectives: A review article

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Abstract

Introduction: Patients who undergo cardiac surgery stay in intensive care for the first hours or days after their operation and experience severe pain. Several pain assessment tools have been used in cardiac surgery patients, although none is especially designed for this subpopulation of patients.

Purpose: This narrative review explores the existing observational and behavioral tools for assessment of pain in adult cardio surgical patients

Methods: A literature review was conducted using the international databases Medline/PubMed, Scopus and Google Scholar. Only quantitative studies published in English language journals were included.

Results: The following pain assessment tools have been used in cardiac surgery patients in ICU: The Behavioral Pain Scale (BPS),Critical-Care Pain Observation Tool (CPOT),Non-Verbal Pain Scale (NVPS), Non-Verbal Pain Assessment Tool (NPAT), Faces, Legs, Activity, Cry and Consolability Scale (FLACC), Visual Analogue Scales (VAS), Numeric Rating Scale (NRS), as well as Verbal Descriptor Scale and its alternative, the Thermometer Pain Scale (TPS).

Conclusions: There is a scarcity of data on pain assessment of cardiac surgery patients in ICU. The existing pain assessment tools have considerable limitations. The creation of a new tool especially designed for cardiac surgery patients is strongly suggested.

Keywords: Pain; Assessment Tools; Cardiac Surgery Patients; Intensive Care Unit; Adults

1. Introduction

Patients who undergo cardiac surgery stay in intensive care for the first hours or days after their operation. The Society of Thoracic Surgeons (STS) defines “early extubation” as a 6-hour timeframe and considers intubation lasting over 24 hours as “prolonged intubation.” (STS, 2018). The recommended early extubation period, that is, within 6 hours post-procedure, in contrast to traditional extubation methods, has been linked to lower incidences of infections, renal failure, stroke, and mortality[1-2].

Open-heart surgeries are painful due to the incision in the sternum and harvesting of the internal mammary artery graft which is utilized in coronary artery bypass. Patients may suffer from prolonged chest pain which results in damage to the soft tissues and nerves in the chest wall. Additionally, during saphenous vein harvesting procedures, discomfort

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may be felt for several weeks post-surgery, influenced by the leg incision and swelling. Brachial plexus neuropathy may also manifest, depending on sternum retraction and the status of patients on the operating table.The pain from the chest tube and surgical incision is often characterized as “the worst pain,” “suffering” and “exhausting”[3-5].Inadequate respiratory function due to pain in cardiac surgery patients can lead to complications in both respiration and circulation. In a study of 213 patients who underwent sternotomy, all reported experiencing significantly more intense pain than they had anticipated prior to surgery; 49% reported severe pain even while at rest, 78% had issues with coughing, and 62% experienced intense pain during movement[6].

In the ICU, patients’ ongoing exposure to light and noise, along with features of psychological stress like limited perception and fear of death, can intensify their pain experience. Moreover, certain procedures in the ICU, such as cannulations, the insertion of endotracheal and chest tubes, and surgical cuts, activate patients' pain perception. During open-heart surgery, chest tubes are utilized in the initial days, and patients express significant pain in various ways while the chest tube is in place and when it is removed.Additionally, heart surgery patients experience intense pain during the aspiration of the endotracheal tube and the removal of chest tubes, particularly the pleural ones. Previous studies have shown that patients regarded the pain experienced in the ICU as one of the three most distressing factors they faced and as among the worst experiences of their lives. Nurses must evaluate pain using physiological indicators and patient behavior, as those in intensive care cannot communicate their pain and its intensity sufficiently, due to fluctuating consciousness levels and the presence of an endotracheal tube [7-9].

Due to the significant differences in pain experiences among individuals, evaluating and treating it can be challenging. When evaluating pain, it is essential to depend on patients' accounts of the pain severity first. In cardiac surgery, it's important to note that within the initial 48 hours, when pain is at its peak, patients are unlikely to express their pain verbally. The literature also suggests that pain assessment should involve patients responding with a straightforward “yes” or “no”[10]This method is effective when they can answer the question, but even such a basic response may not be feasible for individuals in the ICU. Additionally, two other factors contributing to insufficient analgesia are the neglect of pain and the absence of a scale that properly measures pain objectively, particularly in the case of cardiac surgical patients[5,11-12].

Several pain assessment tools have been developed for critically ill patients and some widely used tools for pain assessment in other clinical settings (VAS, NRS) have also been tested in ICU patients. These tools can be either one-dimensional or multidimensional. Unidimensional scales consist of a one-dimensional (behavioral reactions, for instance) and may take into account one (like facial expressions) or several domains (facial gestures, physical actions, and vocalizations). On the other hand, multidimensional scales assess two or more pain aspects (actions, bodily reactions) and possess multiple domains across each dimension [13-14]Some of themhavebeen implemented for cardiac surgery patients, although they are not especially designed for this subpopulation of patients. The purpose of this review was to examine the existing observational and behavioral tools for assessment of pain in adult cardiac surgical patients.

2. Methods

A descriptive review of the international literature on the subject was carried out. The key words and phrases used in the search in various combinations were: Pain, assessment tools, intensive care unit, cardiac surgery patients, adults, questionnaires, nurse. The international databases Medline/PubMed, Scopus and Google Scholar were searched.Only quantitative studies published in English language journals were included.

3. Results

The pain assessment tools tested in ICU cardiac surgery patients are presented in Table 1 in italics, among other pain instruments used in critically ill patients. The following pain assessment tools have been used in cardiac surgery patients in ICU: The Behavioural Pain Scale (BPS),Critical-Care Pain Observation Tool (CPOT),Non-Verbal Pain Scale (NVPS), Non-Verbal Pain Assessment Tool (NPAT), Faces, Legs, Activity, Cry and Consolability Scale (FLACC), Visual Analogue Scales (VAS), Numeric Rating Scale (NRS), as well as Verbal Descriptor Scale and its alternative, the Thermometer Pain Scale (TPS) have been implemented in ICU cardiac surgey patients. Among them, the most frequently used was the CPOT. Other frequently utilized pain intensity measurements include the Numerical Rating Scale (NRS) and the Visual Analogue Scale (VAS), whereas the Behavioral Pain Scale (BPS) serves as an alternative method for evaluating pain in patients who are sedated and on mechanical ventilation[15,14,16,11].

The Critical-Care Pain Observation Tool (CPOT) is designed to assess pain in adult patients admitted to the ICU, regardless of their ability to communicate verbally [39]. The tool consists of four components: facial expressions, body movements, muscle tension, and adherence to a ventilator in intubated individuals or vocalization in non-intubated individuals. This tool has a scoring range of 0-2 for each item, leading to an overall score between 0 and 8[17-22].

The Behavioral Pain Scale was designed to assess pain in intubated patients and includes three domains: facial expression, arm movement, and adherence to mechanical ventilation, each one rated from 1 to 4. The sum of the lowest scores is 3 (no pain), while the highest score is 12 (maximum pain)[22-23].

VAS is a one-dimensional assessment tool featuring a horizontal or vertical line measuring 100 millimeters, with its ends marked by perpendicular lines containing descriptions. It is carried out using one-time sheets of paper, a pen, and a ruler [8]. The Numerical Rating Scale (NRS) is a numeric divided form of the VAS (ICC = 0.802, after one hour) 3, 6. This scale is typically rated from 0 to 10 and includes user guidelines, enabling respondents to categorize the result using numerical values. It may vary from 0 to 5, 0 to 20, or 0 to 100, and can be positioned either vertically or horizontally [24].

The Faces, Legs, Activity, Cry and Consolability Scale (FLACC)was originally developed to assess pain in children with cognitive impairments. Each element of the tool is assigned a score between 0 and 2, leading to a total score range of 0-10 across the five components[25-26].

Non-Verbal Pain Scale (NVPS) , which was originally designed based on FLACCconsists of 5 elements for assessing pain: facial expression, activity (movement), and guarding within the behavioral category, along with a physiological segment from the original NVPS version, which includes physiological item I (blood pressure, heart rate, respiratory rate) and physiological item II (pupil size, skin color and temperature, sweating). Each item is assigned a score from 0 to 2, using a pain scale that goes from 0 (no pain) to 10 (maximum pain)[27,16].

Table 1 Pain assessment tools used in the intensive care unit*

Instrument*	**Score**
Critical care pain observational tool (CPOT)	Each domain: 0-2 Total score: 0 (no pain) to 8 (most pain)
Behavioral pain scale (BPS)	Each domain: 1-4 Total score: 3 (no pain) to 12 (most pain)
Nonverbal pain assessment tool (NPAT)	Each domain: 0-2 Total score: 0 (no pain) - 10 (most pain)
Verbal Descriptor pain Scale (VDS) and Thermometer Pain Scale (TPS)	A thermometer-like diagram indicates levels of pain. Total score: 0-1 no pain, 2-3 mild, 4-5 uncomfortable, 6-7 severe, 8-9 very severe, 10 unbearable pains
Numeric Rating Scale (NRS)	A whole number scale, total score: 0 – 10, 0 being no pain and 10 being very severe pain
Visual Analogue Scale (VAS)	A continuous scale from 0-10 on a 10 cm ruler, with zero pain being on one end and the most severe pain on the other.
Nonverbal pain scale (NVPS)	Each domain: 0-2 Total score: 0 (no pain) to 10 (most pain)
Face, legs, activity, Cry, consolability (FLACC)	Each item: 0-2 Total score: 0 (no pain) to 10 (most pain)
Behavioral pain assessment tool (BPAT)	Eight dichotomized behavior items: present or absent
Escala de conducts Indicadora dolor (ESCID)	Total score: 0 (no pain); 1-3: mild-moderate pain; 4-6: Moderate-severe pain; >6: very intense pain
Behavioral pain rating scale (BPRS)	Total score: 0 (no pain) to 12 (most pain)
Pain assessment and intervention Notation	Total score: 0 (no pain) to 10 (most pain)

(PAIN) algorithm	
Multidimensional objective pain assessment tool (MOPAT)	Behavioral dimension: 0 (none) to 3 (severe) Physiologic dimension: 0 (no change) or I (change)

*All the scales presented in the tables have been used for pain assessment in ICU patients. Scales in italics have been tested in cardiac surgery patients

The Non-Verbal Pain Assessment Tool (NPAT)was created and launched in 2010 to evaluate pain in individuals unable to express themselves verbally[28]NPAT has been researched in individuals admitted to internal intensive care, general surgery, cardiac, and thoracic surgery departments. The first edition of this tool consists of five items, where each scored between 0 and 2, with 0 indicating the lowest score and 10 the highest score. The instrument comprises emotion (appropriate reaction to a circumstance), movement (alteration in body placement and positioning), verbal cues (patient vocalizations aside from speech), facial cues (face expressions), and positioning/guarding (body responses indicating a defense of the body against external contact).

In Verbal Descriptor Scale, (VDS), pain intensity is ranked in 5 stages, from mild to unbearable. The patient is asked to choose the appropriate one among these categories. TPS is a visual representation of pain intensity, typically using a thermometer-like diagram to indicate levels of pain, ranging from "no pain" to "worst possible pain". 0-1 is no pain, 2-3 is mild, 4-5 is uncomfortable, 6-7 is severe, 8-9 is very severe, and 10 is unbearable pain. It's a type of verbal descriptor scale that helps individuals quantify their pain experience [11].

4. Discussion

Cardiac surgery patients usually remain intubated in intensive care for the initial few hours following their procedure. Within the initial hours, when pain is at its peak, patients are unlikely to express their pain verbally. However, after extubating, pain assessment might involve patients responding not only with a straightforward “yes” or “no”, but also those who can describe their pain characteristics. Unfortunately, there is no pain assessment tool designed especially for these patients and the existing scales exhibit considerable limitations. Moreover, they have not been adequately tested in cardiac surgery patients.

Examining the drawbacks of the tools tested in cardiac surgery patients, sampling, reliability and innate limitations are major concerns. Of note, in most studies, the number of participants is usually < 100 patients, and in some studies, < 50 patients have been evaluated, while in many cases the smaple include mixed populations of critically ill patients [26,17].

Two of the most widely used pain assessment tools in various clinical settings is VAS and NRS. Nevertheless, when applied in ICU patients these tools exhibit considerable limitations [29,11].

Regarding VAS, certain individuals might encounter difficulties comprehending and utilizing the scale. When photocopying, the dimensions and ratios of the scale can be altered, resulting in consistent inaccuracies. Moreover, implementing VAS takes time and should be carried out by individuals without physical or motor impairments [30,29].In contrast to the VAS, the NRS offers the benefit of being verbally administered with easier scoring.Nonetheless, there are limitations regarding the clinical use of the NRS. Inconsistencies in clinical administration can result in either an overestimation or underestimation of pain. Other limitations are non-normal distribution and fluctuations in NRS scores among subjects over short time periods[31].

Innate limitations are also present in pain assessment tools designed for critically ill patients [15,14,16]. In the case of BPS there is an absence of a practical definition for certain items like upper limb movement, which may be interpreted variably by nurses. On the other hand, the CPOT, which has only been investigated in patients without an endotracheal tube following heart surgery, even though this item aims to evaluate pain in intubated patients unable to communicate their discomfort. There are also limitations in NVPS. Some parameters (e.g. pupillary dilation and sweating) are not standardized, while in behavioural items, the expression of a smiley state or normal position of body and hands may be misleading Regarding NPAT, there are concerns about responsiveness, satisfaction, sensitivity, and specificity of the tool [28,32].

According to the findings of the present review, CPOT is suggested in clinical practice for unconscious patients and the VDS/NRS for conscious patients who can express themselves verbally. Nevertheless, the validity and reliability of the aforementioned tools have to be evaluated in further studies.

The rather limited data on the pain issue in cardiac surgery patients could be attributed to challenges faced by nurses when using pain assessment scales in ICU patients, including "forgotten priority, "organizational barriers,"attitudinal barriers" and "barriers to knowledge".Additionally, the innate limitations of the scales and the absence of a pain assessment tool designed especially for cardiac surgery patients may further discourage nurse from incorporating these tools in daily routine [14].

A hybrid pain assessment tool including items appropriate for both verbal and non -verbal evaluation and comprising consolability domain might be more suitable for cardiac surgery patients in ICU. The consolability domain reflects the patient's reaction to interaction with the observer through verbal and/or tactile stimuli and has proven useful and reliable in other pain behavioral scales, such as FLACC in pediatric patients and PAINAD in patients with advanced dementia [33]. This domain was included in a relatively new pan assessment tool, the behavioral indicators of pain scale or ESCID from its acronym in Spanish, as a useful tool for assessing pain in mechanically ventilated and unable to self-report critically ill adult patients [34-35]. This questionnaire has not been tested yet in cardiac surgery patients. The creation of a new pain assessment scale suitable for Cardiac surgery patients is strongly recommended.

Using behavioral and observational pain assessment tools for cardiac surgery adult patients in an intensive care unit is crucial for effective pain evaluation and prompt management. In individuals receiving open-heart surgery, failure to promptly diagnose and manage pain can lead to severe complication and extended hospitalization duration. It is essential to train and familiarize nurses in intensive care units with behavioral and observational methods for assessing pain in this group of patients.

5. Conclusion

Pain assessment in adult cardiac surgery patients remains challenging due to sedation, mechanical ventilation, delirium, and communication barriers. Across available tools, behavioral scales such as CPOT and BPS demonstrate the most consistent performance in the ICU setting, while numeric rating scales are appropriate only when patients can reliably self-report. Evidence supports routine nurse-led screening at rest and during procedures, combined with protocolized analgesia and regular reassessment, to reduce pain intensity and procedure-related distress. However, heterogeneity in study methods, small samples, and limited external validation—particularly in postcardiac surgery cohorts—constrain generalizability. Moving forward, multicenter studies should compare tools head-to-head in cardiac surgery populations, define clinically meaningful change thresholds, and integrate pain measures with sedation, delirium, and hemodynamic/respiratory parameters in electronic workflows. Implementation research and staff training are equally critical to ensure timely assessments and equitable pain management. Ultimately, improving tool selection and real-time use will enhance patient comfort, reduce complications, and support safer, more efficient ICU care.

Compliance with ethical standards

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Disclosure of Conflict of Interest

The authors declare no conflicts of interest.

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