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PAIN ASSESSMENT IN CRITICALLY ILL PATIENTS ACROSS LOW-RESOURCE INTENSIVE CARE UNITS; SYSTEMATIC REVIEW.

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Abstract
Assessment of pain in critically ill patients (CIPs) in low-resource intensive care units (ICUs) is vital but challenging because of limited infrastructure and training. This review focuses on the epidemiology, causes, necessities, and outcomes of pain assessment in low-resource settings. At rest, pain is experienced in 33-61% of CIPs, of whom 10-33% report moderate to severe pain, with underlying conditions, invasive processes, and psychological variables contributing the strongest considerations. Uncontrolled pain prolongs mechanical ventilation, raises morbidity, and makes it more costly. The gold standard, self-reporting, is not possible due to sedation or ventilation, and it requires validated instruments, such as the Critical Care Pain Observation Tool (CPOT) and Behavioral Pain Scale (BPS). Such cost-efficient instruments have credibility among non-communicative patients and can be applied to low-resource ICUs. Inconsistent practices, cultural barriers, and incomplete documentation, however, impede their application. Educational interventions, including CPOT training and organizational support, enhance compliance. Consistency of pain measurement lowers ventilation time, delirium, and chronic pain, improving living standards. CPOT and BPS, as well as training and policy change, enable low-resource

countries to improve patient pain management and outcomes. The review highlights the need for scalable solutions that are accessible to all, providing equitable care in resource-scarce ICUs.

Keywords: Pain assessment, Pain, Critically ill patients, Low-resource settings, CPOT, BPS.

Introduction

In intensive care units (ICUs), critically ill patients (CIPs) endure a lot of pain. Pain in CIPs is often described as unpleasant sensory and emotional experience tied to actual or potential tissue damage. It often stems from their underlying conditions, invasive treatments, or routine care in ICUs [1]. Low-resource settings often experience this issue due to shortage of trained staff and poor infrastructure. These constraints often lead to under-recognition of pain, which can compromise patient care and outcomes [2]. CIPs frequently endure 33% experience pain at rest, and 10% report pain ranging from moderate to severe [3]. Unrelieved pain triggers a cascade of stress responses, including tachycardia, hypertension, increased myocardial oxygen demand, hypercoagulability, immunosuppression, and persistent catabolism [1]. These physiological effects can prolong ICU stays, increase morbidity, and elevate mortality risks, highlighting the need for effective pain assessment [1]. In low-resource settings, where 50% of countries lack published ICU data, the burden of critical illness amplifies these challenges, often leaving pain management neglected [4].
Proper assessment of pain is the key to successful pain management, but CIPs may lack the ability to self-report, either being sedated, in delirium, or on mechanical ventilation [5]. Self-reporting as the gold standard is not feasible for many patients, causing underestimation of pain severity, particularly in sedated patients [6]. In non-verbal patients, validated behavioral tools such as Critical Care Pain Observation Tool (CPOT) and Behavioral Pain Scale (BPS) will provide reliable alternatives [1, 6]. One such tool is the CPOT, which measures facial expressions, body movements, muscle tension, and ventilator compliance, with a sensitivity of 76.5% and a reliability (kappa 0.80-0.90, making it applicable in ICUs as well [5]. Although BPS is also slightly less sensitive, it is popular due to its ease of use [7].

The practice of pain assessment is inconsistent in low-resource countries, with only 38.2% of nurses having adequate skills, as observed in Ethiopian studies [8]. Adequate care is hindered by limited training, cultural barriers (e.g., patients being reluctant to report pain), and insufficient documentation (47.2% of nurses reported pain scores) [8]. Pain assessments in such settings have not been fully explored, and most ICUs do not have standardized procedures or even access to pain medication [5]. The review aims to address these gaps by examining the current state of pain measurement in low-resource ICUs, with a focus on identifying the most appropriate methods that require minimal resources and training, as well as resource-effective approaches.

Search Methodology

To identify relevant literature for this review, we conducted a comprehensive search of electronic databases spanning 2015 to 2024, utilizing PubMed, EMBASE, Cochrane Library, and Web of Science without language restrictions. The search strategy employed nine key terms to ensure all pertinent studies addressing the review's objectives were captured: "pain assessment," "critically ill patients," "intensive care unit," "low-resource settings," "low-income countries," "behavioral pain scale," "critical care pain observation tool," "pain management," and "ICU outcomes." In agreement between the authors, we included studies of any design focusing on adult critically ill patients managed in ICUs, provided they offered relevant data on pain assessment, its challenges, or outcomes in low-resource settings. Reviews were also included if they provided current and applicable insights. Studies involving pediatric or neonatal populations were excluded to maintain focus on adult ICU patients.

Epidemiology of Pain in CIPs

According to research, the annual prevalence of CIPs admitted to ICUs is more than five million with an average stay of 3.8 days [1]. Estimates suggest that 33% to 61% of ICU patients experience pain at rest, while 10% to 33% report moderate to severe intensity [2]. Procedural pain is even more common, affecting up to 80% of patients during interventions such as endotracheal suctioning, turning, or catheter insertion [1, 9]. Unmanaged pain in CIPs leads to severe clinical and economic consequences. It contributes to prolonged mechanical ventilation, extending ICU stays and increasing healthcare costs [1, 7]. Physiologically, unrelieved pain triggers stress responses such as tachycardia, hypertension, and immunosuppression, which elevate morbidity and mortality risks [6]. Furthermore, persistent pain in the ICU is linked to post-ICU chronic pain, thus diminishing long-term quality of life [1]. A prospective study in Ethiopia found that nearly 23.93% of ventilated ICU patients experienced unacceptable (significant) pain at rest. The study also noted that unmanaged pain was associated with factors such as female gender, surgical admission, and anxiety, while combining opioid and non-opioid analgesics reduced pain severity [10].

In low-resource settings, cultural challenges and a lack of data further worsens this problem. Approximately 50% of low- and middle-income countries lack published ICU data [4]. Other factors, such as patients' inability or reluctance to explain pain also play a pivotal role. This reluctance, combined with staff shortages and limited training, creates significant barriers to accurate assessment and timely treatment [2, 4].

Causes of Pain in CIPs

One of the major contributors of pain among CIPs is underlying medical and surgical conditions. Medical conditions such as sepsis, trauma, or acute pancreatitis cause inflammatory or ischemic pain due to tissue damage and systemic inflammation [1, 6]. Surgical patients often experience post-operative incisional pain, exacerbated by wounds, drains, or invasive devices [11]. These conditions are common in both high and low-resource settings, but more pronounced in low-resource ICUs, where the availability of analgesics and modern diagnostics may delay the course of pain and complicate its management [4].

In ICUs, mechanical ventilation also causes significant pain. Endotracheal tubes cause discomfort in patients due to direct airway irritation, and ventilator dyssynchrony, where the patient's breathing pattern does not sync with the ventilator, leading to physical and emotional distress [1, 12]. Dyssynchrony in low-resource ICU settings can be complicated by older ventilators and inadequate staff training, aggravating pain and complicating care [4]. Furthermore, acute illness can lead to delirium and weakness of the muscles, which increases awareness of pain and makes patients more susceptible to pain. ICU-acquired weakness, caused by systemic inflammation, lack of activity, and neuromuscular imbalance, is prevalent and prolongs mechanical ventilation and recovery period. Such weakness makes normal movement painful and adds to the cycle of pain and sedation [3, 4, 7, 8].

Psychological factors further complicate pain in CIPs. Emotional distress, anxiety, and a feeling of loss of control into the ICU environment increase the perception of pain, particularly in non-communicative patients [13]. Hypermetabolism, which contributes to hyperglycemia, lipolysis, and protein catabolism, further delays wound healing and predisposes to infection when induced by unrelieved pain [6]. Moreover, pain compromises immune response by inactivating natural killer cells and lowering cytotoxic T-lymphocyte numbers, which lead to long-term pain and chronic complications [13]. These physiological and psychological consequences are comparable to those that occur in developed settings, although in low-resource countries, healthcare infrastructure and cultural norms of under-reporting pain are a compounding factor [5].

Need for Pain Assessment in ICU

Pain assessment is essential to CIPs in ICUs to achieve optimal results, especially in low resource settings where pain management is not given due attention. Poor pain management and outcome are associated with poor outcome in terms of prolonged mechanical ventilation, ICU stay, increasing morbidity, and mortality rate [1, 2]. These complications emphasize the need for conducting systematic pain assessment to advance patient treatment and alleviate healthcare demands, even within resource-limited settings such as within Pakistan.

A large proportion of CIPs, particularly those who are sedated or intubated, are unable to express pain in a verbal or measurement-based manner [2, 6]. Although physiological signs, e.g. changes in heart rate or blood pressure, can be an indicator of pain, they are not specific and can be caused by a variety of pathologies that frequently occur in CIPs, including sepsis or hypoxia [12]. The use of these indicators alone is inadequate to conduct proper pain assessment. This renders them unreliable, especially in low-resource ICUs with minimal diagnostic tools [1, 2].

The American Society for Pain management Nursing (ASPMN) addresses such issues by proposing a 4-step guided methodology of pain assessment in CIPs [14]. First, healthcare professionals must strive to get the self-reported pain, when possible, because it is the gold standard [5]. Second, in non-communicative patients, pain can be measured on basis of observable indicators like facial expressions or body movements using validated behavioral scales of pain, e.g., the CPOT or BPS [5, 6]. Third, observations made by family members or caretakers regarding the usual pain behaviors of the patient might prove useful. Lastly, in cases of suspected but unconfirmed pain, analgesic trial must be commenced and reassessment conducted to determine the effectiveness [14].

Pain Assessment in ICU

The basic rule of pain assessment in the ICU is very simple: check with the patient first, monitor them when they are unable to inform you. Self-reporting is the best measurement to assess pain and is regarded as the gold standard when the patients can communicate or understand [6]. The Numeric Rating Scale (NRS) and the Visual Analog Scale (VAS) are the most frequently used self-report tools. The NRS requires the patients to describe their level of pain by using a scale of 0 (no pain) to 10 (worse pain possible), with verbal or visual clues provided in the case of the non-speaking patient who is nevertheless interactive [1, 6, 15]. As an example, the Numeric Pain Rating Scale-Visual Component (NRS-V) uses large font sizes, with 0 representing “no pain” and the “extreme pain” being 10, thus being understandable even by ICU patients with limited communication skills [1, 6]. VAS, on the other hand, involves a 10 cm line, where patients indicate their level of pain with one end marked as “no pain” and the other end as the “worst pain imaginable.” A score is assigned by measuring the distance to the end of no-pain, providing a continuous scale [6].

In low-resource ICUs, however, they are not used. It is because CIPs tend to be sedated or ventilated and unable to self-report, or there are insufficient trained staff to administer them [4]. In such cases, clinicians are forced to use behavioral pain scales. The two most validated and reliable tools to accomplish this purpose are the CPOT and the BPS [5]. The CPOT is a structured tool explicitly administered to patients in the ICU who are not able to self-report, measuring four domains: facial expression (e.g., grimacing, scored 0-2), body movements (e.g., restlessness, scored 0-2), muscle tension (e.g., resistance to movement, scored 0-2), and ventilator compliance in patients who are intubated (e.g., coughing, scored 0-2) or vocalization in non-intubated patients (Table 1). Scores range from 0 to 8, with a threshold of >2 indicating significant pain [16]. Its structured scoring system allows nurses to systematically observe behavioral cues, which is critical in low-resource ICUs where staff training is often limited. The CPOT’s simplicity and low cost make it feasible for implementation in settings like Pakistan, though its effectiveness depends on consistent training to ensure reliable application [2, 7].

Table 1: CPOT for Pain Assessment

Component	Scoring	Use in Low-Resource Settings
Facial Expression	0 = Relaxed, neutral 1 = Tense 2 = Grimacing	• Easily observable by trained staff. • Requires minimal training and no equipment, ideal for low-resource ICUs [5, 6]
Body Movements	0 = No movement 1 = Protective (e.g., guarding) 2 = Restless	• Simple to assess without technology [7].
Muscle Tension	0 = No resistance 1 = Resistance to movement 2 = Strong resistance	• Requires only physical examination. • Cost-effective for ICUs with limited tools [5].
Ventilator Compliance	0 = Tolerating ventilator 1= Coughing, alarms triggered 2 = Fighting ventilator	• Applicable in low-resource ICUs with basic ventilators. • No additional equipment needed [6].
Total Score	Range: 0–8	• High sensitivity and reliability [8].

The BPS is another validated tool that evaluates three domains: facial expression (e.g., relaxed to grimacing, scored 1-4), upper limb movements (e.g., no movement to fully bent, scored 1-4), and ventilator compliance (e.g., tolerating ventilation to fighting ventilator, scored 1-4) (Table 2). Scores range from 3 to 12, with higher scores indicating greater pain intensity [1, 2, 7]. Although less sensitive than CPOT, BPS is straightforward and widely used due to its focus on observable behaviors [2]. The BPS is particularly valuable in mechanically ventilated patients, where ventilator asynchrony can signal discomfort. In low-resource settings, its ease of use is an advantage, but its reliance on fewer domains may miss subtle pain indicators compared to CPOT, especially in deeply sedated patients [17].

Table 2: BPS for Pain Assessment

Component	Scoring	Use in Low-Resource Settings
Facial Expression	1 = Relaxed 2 = Partially tightened 3 = Fully tightened 4 = Grimacing	• Easily observable by trained staff. • Requires minimal training and no equipment, ideal for low-resource ICUs [5, 6]
Upper Limb Movement	1 = No movement 2 = Partially bent 3 = Fully bent 4 = Permanently retracted	• Simple to assess, feasible in settings with limited staff and resources [8].
Ventilator Compliance	1 = Tolerating movement 2 = Coughing but tolerating 3 = Fighting ventilator 4 = Unable to control ventilation	• Applicable in low-resource ICUs with basic ventilators [6].

Total Score	Range: 3-12	• Moderate sensitivity [5]

Outcomes and Interventions for Pain Assessment in ICU

Systematic pain assessment significantly improves clinical outcomes for CIPs. Regular application of tools like CPOT allows selective analgesia, which shortens mechanical ventilation and ICU stays. Research indicates that pain assessment among ICU patients correlates with decreased mechanical ventilation time and ICU length of stay. One such intervention was the implementation of a pain management algorithm, which significantly decreased ventilation time and ICU length of stay compared to a control group of insurance assessment [18]. Pain assessment also mitigates the occurrence of delirium, a common complication in ICUs, because it allows clinicians to modify sedation and analgesia. This reduces the chances of excessive sedative use that usually results in cognitive impairment [1]. Simple tools, such as CPOT, enable an accurate way to seek optimal analgesia and minimize adverse events, even where resources are limited [1, 4].

The assessment of pain is cost-efficient, especially in low-resource ICUs. Tools, such as CPOT, minimize healthcare expenditure by decreasing the mechanical ventilation and ICU time needed to treat complicated conditions [18]. They are convenient in low-budget environments since they can operate in low-resource settings [4, 8]. The adoption of such tools can streamline resource utilization and promote effective care delivery.

Education interventions are important aspects of enhancing pain assessment in low-resource settings. In Pakistan, a 6-hour CPOT training resulted in a substantial improvement in the knowledge base of nurses with an initial pre-test score of 57.83±11.86, improving to 67.43±12.96 ($p < 0.01$) [7]. These programs, which require limited resources, can be executed by low-resource ICUs and updated with in-service training and continuous professional development to address knowledge gaps [8]. Translating tools like CPOT into local languages improves access and uptake. Pain assessment is also enhanced by organizational support and clinical supervision models. Structured training and audits included in the SafeCare model have enhanced commencement of pain assessment protocols in low-resource conditions [11]. Organizational support enhances effective pain assessment practices, increasing the likelihood of implementation twice, as accountability and resource allocation thrive in supportive environments [8]. Low-resource ICUs can standardize care by incorporating interventions like policy requirements to use CPOT and BPS, thereby enhancing patient outcomes consistently.

Conclusion

Proper pain assessment of critically ill patients is essential to low-resource ICUs, where pain is frequently unaddressed because of limited resources and training constraints. Tools, such as CPOT and BPS, provide accuracy and an affordable means to determine pain, minimize complications, and improve patient outcomes. Targeted interventions, such as staff training programs and organizational support, can improve practices despite current issues, like cultural barriers and staffing shortages. With a focus on simple and accessible tools and policy changes, low-resource countries can make equitable care a reality by promoting the best pain management, shorter stays in intensive care units, and a higher quality of life in patients.

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