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## Management of Procedural Pain in Pediatric Burnt Patients: A Review

Haitham ELsayed Elsadek<sup>1\*</sup>

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### ABSTRACT

Burn injuries are the sixth leading cause of mortality globally and among the top five causes of injury in pediatrics. Therefore, this study aimed to review the methods and treatments for managing procedural pain in pediatric burnt patients, focusing on alleviating burning sensations effectively. Data were gathered from various electronic databases spanning 2015 to 2024 using keywords related to pain management, burn injuries, and intervention strategies. Utilizing frameworks like SPIDER, PICO, and ROBIS, 85 articles were selected for review, elucidating interventions, pain assessment criteria, and management guidelines. The review underscores the progress in effective therapies while aiming to determine the prevalence and treatment of procedural burn pain in pediatrics. Further, it encompasses treatment criteria, protocols, pharmacological and non-pharmacological interventions, and lifestyle modifications. This indicates that effective treatment options are progressing. This review concluded personalized, multimodal pain treatment methods for enhancing the health and efficiency of patients in vulnerable situations.

### INTRODUCTION

Burn injuries are among the five most common causes of pediatric injuries and the sixth leading cause of mortality in the world (Shiferaw *et al.*, 2022a). Almost all children with burns endure pain as a result of a complex pathophysiological process that is usually disregarded, and up to 38% of all pediatric burn patients develop anxiety disorders due to pain after hospital admission. All children who experience burn injuries experience pain, regardless of the cause, severity, or depth of the burn (Shiferaw *et al.*, 2022a). Further, the injury requires invasive therapies such as surgery, recurrent wound care, and wound debridement (Preston & Ambardekar, 2020). After these surgeries, there may be increased discomfort, leading to adverse physiological, psychological, and emotional consequences (Shiferaw *et al.*, 2022a). Discomfort and distress are significant contributors to the development of acute stress and symptoms of Post-Traumatic Stress Disorder (PTSD) (Unseld *et al.*, 2021). Therefore, it is vital to manage pain and anxiety in the treatment of burn pediatric patients.

Around 19% of all recorded burn cases in the United States involve those under five years old, with a majority occurring in their own homes (almost 73%) (Shank *et al.*, 2019). The majority of the population is Caucasian (59%), 20% African American, 14% Hispanic, 2.4% Asian, and 5% other ethnic groupings. Scalds and contact with hot objects are the primary causes of pediatric injuries, with 5.4% involving inhalation injuries (Shank *et al.*, 2019). There were indications of potential child abuse in 1861 cases. Mortality rates range from 0.6% for burns affecting

less than 10% of the Body Surface Area (BSA) to over 84% for burns affecting over 90% of BSA (Rajarajan, 2015). Around 200,000 children with burn injuries receive treatment in emergency rooms annually, with the majority being under six years old (Burgess *et al.*, 2022).

Furthermore, in the United Arab Emirates, pediatric burns account for 64% of all traumatic injuries in children under five years old and have an 8% death rate. Tea and hot water are the most common causes of burns in youngsters (Qureshi *et al.*, 2021). However, understanding the pathophysiological and pharmacological challenges associated with burn trauma is crucial for the successful treatment of pediatric patients with burn injuries (Jeschke *et al.*, 2020). Burn injuries are categorized based on the burn depth after the initial assessment. Topical treatment options include various options, such as debriding chemicals and dressings (Qureshi *et al.*, 2021). After the wound is healed, the patient is monitored at a clinic under the doctor's supervision, where dressings are regularly replaced. The dressing changes cause significant pain and discomfort to the child during wound cleaning, as well as anxiety (Qureshi *et al.*, 2021).

Burn-related tissue damage is considered a severe injury and a significant worldwide health crisis (Fagin & Palmieri, 2017). Patients with burns suffer from psychological and physical consequences as a result of their distress, which might result in long-lasting pain. Burn pain can be categorized into three types: background pain, breakthrough pain, and procedural pain (Fagin & Palmieri, 2017). Burns and related procedures can cause pain, anxiety, and itch in children, leading to relapse,

<sup>1</sup> Alzakra Hospital Dubai, Sheikh Zayed Rd, Al Barsha & Dubai Health Authority, Headquarters, Sheikh Ahmed Square, Al Jaddaf, Dubai, United Arab Emirates

\* Corresponding author's e-mail: [dr\\_hytham3000@yahoo.com](mailto:dr_hytham3000@yahoo.com)

delayed recovery, and increased healthcare costs (Geagea *et al.*, 2022). Inadequate treatment can cause chronic sensory alterations and psychosocial sequelae, increasing medication needs and negatively impacting children's well-being and quality of life. Post-burn itch, procedural pain, and state anxiety can prevent related consequences like post-traumatic stress disorder and their impact on families (Ramachandran *et al.*, 2017). Addressing these issues can prevent related biopsychosocial sequelae and enhance re-epithelization in children with burns (Wiechman, 2020). Treatment for these issues typically involves non-pharmacological and pharmacological interventions (Geagea *et al.*, 2022).

Therefore, this study aimed to review the methods and treatments for managing procedural pain in pediatric burnt patients.

## LITERATURE REVIEW

Managing pain in burn patients is a challenging and intricate matter. There are various pharmacological and non-pharmacological methods or therapies to overcome anxiety and alleviate pain (Sine, 2019).

### Pharmacologic Pain Management

Procedural pain in children and adults is typically managed using sedation-analgesics, opioids, and non-steroidal anti-inflammatory drugs (NSAIDs) (Minardi *et al.*, 2012; Shiferaw *et al.*, 2022b). Narcotics and opioid receptor agonists have been used for treating severe burns in individuals of all age groups (Meyer III *et al.*, 2018). A study comparing oral morphine and intranasal fentanyl found no noticeable differences, suggesting INF at a dose of 1.4 mcg/kg 15 minutes before the procedure and OM at 0.1 ml every 5 minutes after the procedure. Oral trans-mucosal fentanyl citrate (OTFC) and intranasal fentanyl (INF) are as effective and favored for pain relief in pediatric burn patients during wound care (McPherson & Grunau, 2022). OTFC is a promising analgesic due to its rapid onset and simple administration. Non-opioid analgesics, such as acetaminophen and NSAIDs, are beneficial in treating burn pain due to their advantages and side effects (Pietsch *et al.*, 2023). A low-dose intravenous ketamine injection and oral paracetamol are cost-effective and feasible alternatives for treating pain during burn procedures, especially in rural and resource-limited areas (Dezfouli & Khosravi, 2020; Yang *et al.*, 2018).

### Procedural Analgesia-Sedation

Procedural analgesia-sedation is a technique used to prevent children from experiencing pain or recalling unpleasant medical procedures (Fagin & Palmieri, 2017). Pediatric procedural sedation involves a complex process for the child, parents, and medical workers (Grossmann *et al.*, 2019). A compliant, relaxed, pain-free pediatric is ideal for safe and successful sedation. Ketamine, which causes amnesia, analgesia, and sedation, can be administered intramuscularly, intranasally, orally, or rectally. Ketamine is considered safe and effective for procedural

analgesia in pediatrics (Grossmann *et al.*, 2019). Studies have focused on various mixtures of opioids, midazolam, dexmedetomidine, ketamine, and propofol to provide adequate pain relief and deep sedation for burned children undergoing wound care treatments (Drummond *et al.*, 2020; Meyer III *et al.*, 2018). Ketamine-propofol is a commonly used combination for pain relief and sedation during burnt care procedures in the operating room. Existing research evaluated that Ketamine-Propofol (KP) resulted in fewer respiratory incidents and enhanced child comfort (Cettler *et al.*, 2022). Both Ketamine-dexmedetomidine and propofol-opioids are equally safe and effective for providing deep sedation and pain relief in pediatric burn patients (Grossmann *et al.*, 2019).

### Anesthetic Management

The acute phase of a burn injury is the period from injury onset to wound healing (Anderson & Fuzaylov, 2014). Modern burn care success relies on a multidisciplinary team of anesthesiologists, intensivists, nurses, dietitians, rehabilitation therapists, and pulmonary care therapists (Woodson *et al.*, 2018). Understanding this interdisciplinary framework is crucial for effective anesthesia management. Surgical treatment often involves removing and grafting non-viable burn areas, which can harbor infections and compromise heart function (Woodson *et al.*, 2018). Severe burns require proper resuscitation for surgical procedures, and understanding their pathophysiological alterations is crucial for administering appropriate anesthetic treatment (Stapelberg, 2020). Pediatric patients with severe burn injuries necessitate anesthetic care from the outset of their resuscitation and persist for years during reconstructive operations (Fuzaylov, 2020). Anesthesiologists, with comprehensive knowledge of burn injury pathophysiology, can provide appropriate care and manage complications related to burn injuries and their treatment (Woodson *et al.*, 2018).

### Treatment of Anxiety and Pain

Burn patients often experience severe pain and anxiety during treatment and recovery. Anxiety is closely linked to pain, especially after burns and during wound healing. Stress and pain can exacerbate discomfort (Fagin & Palmieri, 2017). Children's unique physiological, psychological, and anatomical characteristics make it challenging to treat anxiety and discomfort (Fagin & Palmieri, 2017). Burn injuries can also affect the efficacy and clearance of drugs, complicating pain management and sedation. The aim is to limit discomfort, but complete pain relief during procedures may not be possible (Fagin & Palmieri, 2017). Combining opioid analgesics with anti-anxiety drugs is the most common method, as narcotic analgesics do not provide full pain relief (Helander *et al.*, 2017). Moreover, tranquilizers are frequently prescribed to patients to alleviate anxiety and discomfort caused by side effects like nausea, vomiting, bleeding, or respiratory issues, but they are time-consuming and costly (Seyyed-Rasooli *et al.*, 2016).

## Non-Pharmacological Treatment for Burn Pain Management

### Distraction and Multimodal Distraction

A distraction strategy can be employed by directing children's focus on neutral stimuli instead of suffering or distress. For distraction tactics to be effective, the patient must attentively focus on them to redirect their attention from the unpleasant input (Van Ryckeghem *et al.*, 2018). Examples include virtual reality, music distraction, computer/iPad distraction, cartoon distraction, and interactive gaming (Meyer *et al.*, 2018). Another form of distraction method is known as multimodal distraction (MMD), which involves the use of a specially designed handled device that engages children through various sensory inputs such as movement, touch screen, vibration, vision, and sound, without requiring a headset (Meyer *et al.*, 2018).

### Virtual Reality and Cartoon Distraction

Virtual reality (VR) utilizes goggles or helmets to offer high-resolution, three-dimensional visuals and sounds to patients undergoing a procedure (Claudio & Maddalena, 2014). This non-invasive cognitive distraction technique effectively diverts patients' attention and diminishes their pain perception, reducing pain intensity (Pancekauskaitė & Jankauskaitė, 2018). Moreover, to reduce pain intensity, pediatric patients can be facilitated through entertainment strategies such as animated cartoons via smartphones or televisions (Zhicai Feng *et al.*, 2018; Z. Feng *et al.*, 2018).

### Hypnosis

Hypnosis is a non-pharmacologic method used to manage pain and anxiety in children with burn injuries (Chester *et al.*, 2016). It involves deep breathing, muscle relaxation, and direct hypnotic suggestions (Provençal *et al.*, 2018). A randomized controlled trial by Chester *et al.* 2018 and a study by Milling *et al.* 2021 confirmed the efficacy of medical hypnosis in alleviating pain and distress in pediatric burn cases (Chester *et al.*, 2018; Milling *et al.*, 2021). However, non-pharmacological approaches can help manage burn pain when used alongside regular pharmaceutical care (Eijlers *et al.*, 2019). Existing literature demonstrated that virtual reality and distraction effectively reduced pain perception and distress during procedures (Fardin *et al.*, 2020; Farzan *et al.*, 2023; Scheffler, Koranyi, Meissner, Strauss, *et al.*, 2018).

### Anxiety and Stress Reduction Techniques

Non-pharmacologic therapy should be used to reduce anxiety in children in intensive care units (ICU) (Ismail *et al.*, 2019). This includes environmental adjustments such as minimizing noise, ensuring proper lighting for a healthy sleep-wake cycle, allowing time for rest and sleep to maintain a natural rhythm, scheduling procedures during the day, ensuring comfortable positions with cushions, and monitoring fluid intake and feeding can enhance

comfort (Kudchadkar *et al.*, 2022). In addition, a family member's presence can also help alleviate anxiety and stress associated with burning pain (Ali, 2015). However, establishing a regular schedule can reduce fear and increase the child's sense of security. Comfort can also be given by providing facilities such as earplugs, eye masks, noise reduction, and darkness (Baarslag *et al.*, 2017). Play specialists can also offer personalized diversion therapy to manage pain, fear, and distress in pediatric and burn intensive care units. These strategies can help children maintain their routines, self-perception, and sense of normality (Fagin & Palmieri, 2017).

### Massage and Aromatherapy

Non-pharmacological therapies are used to reduce the reliance on analgesics and mitigate their adverse effects. This indicates that the cycle of pain and anxiety decreases through massage. Massage is the application of pressure and movement to soft tissues to achieve therapeutic results like comfort, healing, and restoration (Najafi Ghezleleh *et al.*, 2017). Traditional massage enhances oxygen uptake. However, massage can stimulate cell division, which helps the body flush out waste and become more detoxified, which promotes relaxation and mental clarity (Miri *et al.*, 2023; Seyyed-Rasooli *et al.*, 2016). Further, to increase blood flow to the soft tissues during massage, the following five techniques are used (Gasibat & Suwehli, 2017; Mobilizations, 2015);

- Effleurage
- Petrissage
- Friction
- Tapotement
- Vibration

Aromatherapy is an alternative therapy that uses plant extracts from various parts of plants, such as flowers, leaves, stems, fruits, seeds, and roots. It is commonly used in inhalation and massage therapy, with lavender oil extract being a popular choice due to its sedative properties (Rafii *et al.*, 2020). Chamomile oil, with its strong analgesic and anti-inflammatory properties, can be used during massages to enhance immunity (Rafii *et al.*, 2020). Aromatherapy massage is a popular supplementary therapy in nursing due to its user-friendly nature, affordability, and non-invasive characteristics (Seyyed-Rasooli *et al.*, 2016). The practice involves various manipulations, such as rubbing, squeezing, stroking, deep massage, and vibrating motions. Massage can alleviate fear, promote closeness and safety, and improve communication between nurses and patients. Aromatherapy massage involves gradually absorbing aromatic herbal oils and volatiles through the skin, lasting 10 to 30 minutes (Ayik & Özden, 2018). The oils and volatile compounds deliver medicinal advantages such as sleepiness, pain relief, muscle relaxation, and fever reduction. Studies showed that using aromatherapy oils in combination with massage has a greater soothing effect than massage without oils (Rafii *et al.*, 2020).

**Music Therapy**

Music stimulates calm in patients by impacting the central nervous system and redirecting focus away from pain (Mofredj *et al.*, 2016). Music has a direct impact on the desired alterations in an individual’s emotions and behavior, especially in therapeutic environments or high-pressure situations (van der Heijden *et al.*, 2018). Music intervention involves the regular utilization of music to support, sustain, and enhance both physical and well-being. The major focus of this intervention is believed to be the selection of a popular piece of music (Altenmüller & Ioannou, 2016; Najafi Ghezleji *et al.*, 2017).

**Computer-Tablet Distraction**

A computer tablet, also referred to as a tablet, is a prevalent technological distraction device (Scheffler, Koranyi, Meissner, Strauß, *et al.*, 2018). Pediatric patients can use a touchscreen to access movies, cartoons, music, games, books, puzzles, comics, audio-video stories, and more. Medical professionals use tablets to manage procedures and stress-related needs, such as surgery preparation (Scheffler, Koranyi, Meissner, Strauß, *et al.*, 2018). Engaging children in age-appropriate activities reduces their susceptibility to distractions. However, tablets are increasingly used in pediatric clinics due to their versatility and user-friendly nature (Scheffler, Koranyi, Meissner, Strauß, *et al.*, 2018).

**MATERIALS AND METHODS**

**Search Strategy**

To execute this review, recent research and review articles/publications based on pain management in pediatric burnt patients were considered. The focus of the investigation revolved around the effectiveness of managing pain in treating the burning sensations in patients. Data was gathered from electronic databases: Google Scholar, PubMed, Publon, Web of Science, NCBI, Hindawi, National Library of Medicine, ResearchGate, MEDLINE, EMBASE database, Science Direct, Scopus, Cochrane Central Register of Controlled Trials (CENTRAL), and BioMed.

For this study, we searched the literature for articles addressing the causes, prevalence, and treatments. Studies were selected from different years ranging between 2015 to 2024 using keywords ‘pain,’ ‘pediatric pain,’ ‘procedural pain,’ ‘pain management,’ ‘burning pain management,’ ‘treatments for burnt areas,’ ‘procedural wound care,’ ‘wound dressing,’ ‘analgesics,’ ‘sedatives,’ ‘distraction techniques,’ ‘non-pharmacological interventions,’ ‘pain intensity,’ ‘adverse effects,’ ‘burn injury,’ ‘pain assessment,’ and ‘intervention strategies.’ Search keywords were combined using proximity operators (NEAR, NEXT, WITHIN) and boolean (AND, OR) operators. Table 1 indicates the data selection strategy for the review.

**Table 1:** Data Selection Strategy

Years	Search Engines	Keywords
2015- 2024	Google Scholar	Pain
	PubMed	Pain Management
	NCBI	Burning Pain Management
	Hindawi	Treatments for Burnt Areas
	BioMed	Managing Strategies
	Web of Science	Burning Pain Management
	MEDLINE	Analgesics
	EMBASE	Distraction Techniques
	ScienceDirect	Non-Pharmacological Interventions
	Scopus	Burn Injury
	Cochrane Central Register of Controlled Trials (CENTRAL)	Intervention Strategies

A systematic search of databases was conducted to identify pertinent publications. Subsequently, the text words present in the title, abstract, and index keywords of the articles were examined and analyzed. Afterwards, a comprehensive search was conducted across all databases utilizing the identified keywords, index terms, and MeSH terms for MEDLINE. Furthermore, a thorough search on PubMed, Google Scholar, and Google databases was conducted to identify new studies on pain management. The search terms were found in titles and abstracts, and the entire texts of the articles were available. This strategy

serves as a concise overview. Consequently, the contents of the material provided do not thoroughly address the management and prevention of burning pain. However, the priority was given to incorporating the most significant and relevant studies.

**Quality Assessment Frameworks**

The SPIDER framework was employed to determine which studies to include in this review, as shown in Table 2. The PICO model was also used to evaluate databases, as shown in Table 3.

**Table 2:** SPIDER Framework

<b>Sample</b>	<b>Pediatrics, Newborns, Infants, Global.</b>
Phenomenon of Interest	Procedural pain management in pediatric burnt patients and impact of burning on pediatrics quality of life.
Inquiry	Strategies and interventions for managing pain.
Design	Review of already published articles using Search engines.
Evaluation	Treatments effect on procedural pain management.
Research Type	Case reports, controlled studies, cohort studies, prospective randomized studies and analyses, systematic reviews, meta-analyses, scoping reviews, and qualitative analysis.

**Table 3:** PICO Model

<b>PICO</b>	<b>Search strategy</b>
Population	Pediatrics, Infants, Newborns
Intervention	To improve pain management among burnt pediatrics and to introduce various managing strategies to overcome the conditions. pharmacological interventions (e.g., analgesics, sedatives), non-pharmacological interventions (e.g., distraction techniques, virtual reality), or a combination.
Comparison	Comparing different types of interventions or strategies for procedural pain management.
Outcome	To overcome the effect of burning and pain in pediatrics and bring improvement with advanced procedures and safety measures in treating the conditions associated with this. It may also include pain intensity scores, physiological responses to pain (heart rate, blood pressure), duration of the procedure, adverse effects of interventions, and overall satisfaction with pain management.

**Inclusion Criteria**

The titles were filtered based on the following criteria for addition and exclusion, rather than their relevance to the study. We exclusively selected studies that have already been published and peer-reviewed. These studies were reviewed in order to better understand the research criteria.

- All research written in English that has been published in peer-reviewed journals was included for evaluation..
- Studies describing the importance of nursing strategies were included.
- Studies related to care were included.
- Studies on interventions for burn care were also included.
- Reviews of recent developments in burning pain treatment were focused on.
- Studies related to precautions during treatment and management were also considered.
- The research focused on assessing diagnostic standards as another area of interest.
- Studies exploring various non-pharmacological methods for pain management, including virtual reality, analgesics, sedatives, and diversionary strategies, were considered.
- A case report, a case report with review literature, a review of the literature, a retrospective cohort study, review articles, and a case-control study were all included in the study.

**Exclusion Criteria**

The exclusion criteria involve;

- Only papers written in English were taken into consideration.

- Studies that solely focused the science of burning were not included.
- Studies not aimed on improving monitoring and therapy were not included in the review.
- The objective was unrelated to procedural pain management.
- Studies focused on procedural pain management in pediatric patients without burn injuries were not considered.
- Studies investigating interventions not directly related to procedural pain management in burn care.
- Studies without relevant comparisons or not comparing different types of interventions for procedural pain management.
- Studies lacking predefined findings’ supporting data.
- Studies included adult participants were excluded.

The review did not include studies whose titles were relevant to the investigation but whose material was unrelated.

**Data Extraction**

The two authors reviewed and chose to include all reviews independently using the PICO methodology, as indicated in Table 3. The researchers extracted and sorted the sample size, study type, duplicates, full-text articles, and empirical studies using Microsoft Excel and a standardized data extraction form, making the review approach practicable. The author, the year of publication, and the total number of studies are examples of variables. The ROBIS technique was utilized by the two reviewers to evaluate the methodological qualities. The demographic, research selection procedure, inadequate data, time period, and location were among the assessed sources of bias.

### Risk of Bias – Assessment Tool

ROBIS (Risk of Bias in Systematic Reviews) criteria were also used to reduce the risk of bias to some extent because they examine both the risk of bias in a review and (when applicable) the review’s relevance to the research problem. The four steps in the design of ROBIS were defining the scope, analyzing the evidence, having a face-to-face meeting, and piloting the tool. Levels of concern

ranging from low to high or uncertain were seen for each phase 2 area, as well as the percentage of reviews with high or low bias risk (Whiting *et al.*, 2016).

As shown in Figure 1, the use of signaling questions in conjunction with a domain-based approach aligns with the most recent methods for estimating the risk of bias tools. The opinion of an extra reviewer was sought in order to settle disputes.

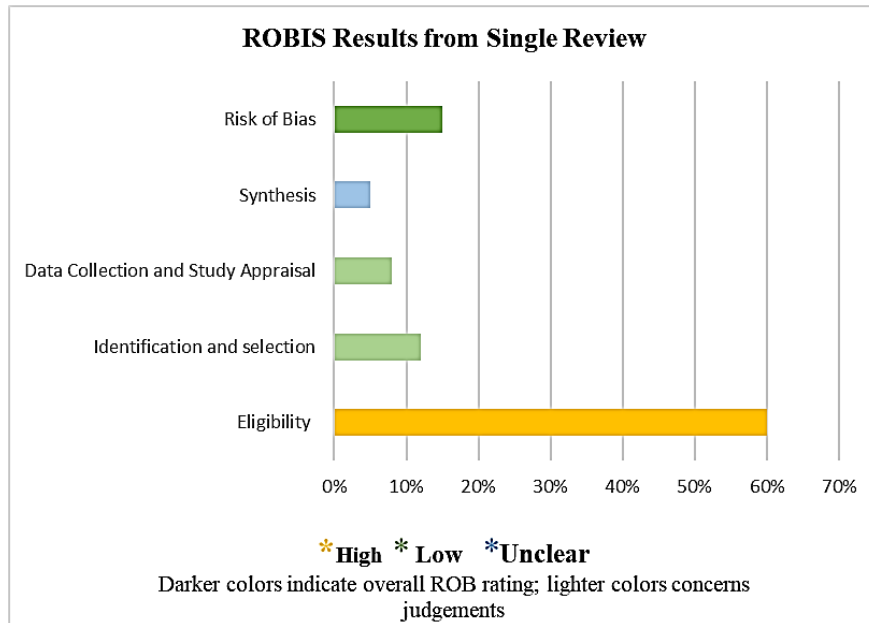


Figure 1: ROBIS Results

Fig. 1 illustrates the graphical representation of the ROBIS findings from a single review. The risk of bias phase assessment is displayed in the final part, which is shaded darker. The colored segments represent the issues for each phase 2 ROBIS domain.

Additionally, the study purpose, study design, study outcomes, justification by results, study limits, ethical approval, participant informed consent, funding, and study relevance were all taken into consideration by the two reviewers who conducted the risk assessment. To reduce the possibility of bias, the third reviewer’s viewpoint was also considered. The study’s purpose, relevance to the study, its findings, conclusions, ethical approval, and informed consent were at low risk, unclear for its limitations, design and outcomes, and high risks for funding.

### DISCUSSION

Burn injury is a common cause of illness and death in children, majorly with scald damage (42%), followed by flame (29%), and contact (10%) (Preston & Ambardekar, 2020). Non-accidental burns and inhalation injuries increase short-term mortality risk (Saeman *et al.*, 2016). Burn injuries in children are associated with higher long-term mortality, especially when the size of the burn is larger (Kazis *et al.*, 2018). However, pediatrics who receive care from burn treatment centers with experience had

lower fatality rates, although there is significant variability in management approaches (Preston & Ambardekar, 2020).

Burns are severe traumas caused by prolonged contact with thermal, chemical, electrical, or radioactive materials, causing tissue damage. Over 25% of hospital admissions are for children, primarily aged 0-15 (Zwierello *et al.*, 2023). Burn injuries involve a complex pathophysiological process that results in both localized and systematic damage (Kaddoura *et al.*, 2017). Patients with burn injuries affecting 30% or more of their total body surface area (TBSA) often suffer systemic repercussions due to the release of catecholamine’s and cytokines (Kaddoura *et al.*, 2017). The initial phase, known as burn shock, is triggered by fluid moving into the third space, resulting in hypovolemia (Cartotto *et al.*, 2022). Burn injuries have serious short-term and long-term effects that result in high levels of illness and death, demanding careful monitoring and assessment at all stages of a pediatrics treatment (Preston & Ambardekar, 2020).

### Classification of Burns

The severity of burn injuries is determined by assessing the TBSA affected and the depth of the burn (Brekke *et al.*, 2023). Adult TBSA is often determined using the rule of nines, while children use the Berkow method to calculate burn size based on the area of burn on a specific

body part (Tocco-Tussardi *et al.*, 2018). Major burn injuries in children include full-thickness burns exceeding 10% of the TBSA, and partial thickness burns exceeding 20% in infants (Giretzlehner *et al.*, 2021), burns affecting critical areas, inhalation, chemical or electrical burns, or burns in individuals with significant pre-existing medical conditions (Rice & Orgill, 2021). There are four categories of burns determined by the extent of the damage:

- First-degree burns cause redness and inflammation in the outer layer of the skin, often causing discomfort and healing without surgery.
- Second-degree burns extend from the epidermis into the dermis, causing discomfort characterized by redness, swelling, blistering, and requiring surgical excision and grafting.
- Third-degree burns have a leathery texture, affecting the dermis and epidermis, potentially leading to white, brown, or black discoloration.
- Fourth-degree burns penetrate deeply into muscles, bones, and tissues, causing significant agony and necessitating excision and grafting for healing (Dries & Marini, 2017).

### Mechanism of Burn Pain

Acute burn injuries cause pain in peripheral nociceptors, sensory neurons transmitting signals to the brain and thalamus (Santiago *et al.*, 2020). Repetitive stimulation can cause hyperalgesia, reducing neuron thresholds and increasing sensitivity to future stimuli (Santiago *et al.*, 2020). C fibers and dorsal horn neurons are not fully formed before postnatal life, and infants have lower pain thresholds. Major burn injuries trigger a local and systemic inflammatory response syndrome, releasing mediators like complement, histamine, serotonin, cytokines, and prostanooids (Lee & Neumeister, 2020).

### Pain Assessment in Pediatrics

Three primary approaches of pain assessment in pediatric patients are; self-report, behavioral or observational, and physiological measures (Laures *et al.*, 2019). Comprehensive evaluation is essential for successful pain management in these individuals. However, self-reporting is a crucial element in the pediatric population (Cohen *et al.*, 2020; Jaaniste *et al.*, 2019). Three major self-reporting methods for pain assessment include the Faces Pain Scale-Revised (FPS-R), Visual Analog Scale (VAS), and Numeric Rating Scale (NRS). Behavioral and observational evaluations play an important role (Lundeberg & Lundeberg, 2013; Shimoji & Aida, 2021), which is typically facilitated by measurements such as FLACC (Face, Legs, Activity, Cry, Consolability) (Babl *et al.*, 2012). Additionally, physiological indicators such as heart rate and other vital signs are utilized for pain assessment (Gosnell & Thikkurissy, 2019). Despite the various methodologies used for evaluation, self-report is considered as a gold standard, particularly for older children (2-5 years) (Pancekauskaitė & Jankauskaitė, 2018).

### Multifaceted Dimension of Pain Experience

There are multiple components to the experience of pain that can be evaluated independently and may be influenced differently (Scheffler, Koranyi, Meissner, Strauß, *et al.*, 2018);

- A sensory component (intensity of pain)
- An affective component (unpleasantness of pain)
- A cognitive component (time spent focusing on the pain)

### Treatment and Management Guidelines

Burn injuries are considered one of the most tragic events a person can endure while quantifying pain remains challenging (Foster, 2014). Treatment for burn injuries includes debridement, daily wound care, surgery, and extended physical therapy to alleviate the intense and persistent pain experienced by patients (Drummond *et al.*, 2020). Managing burn pain is inherently challenging due to the intricate structure and dynamic alterations caused by repeated treatments and manipulations of painful lesion sites (Ahuja *et al.*, 2016). Burn centers need to adopt a systematic approach to manage burn pain, despite evidence of inadequate treatment and varied practice standards over the past twenty years (Rowan *et al.*, 2015). It is crucial to differentiate between pain and anxiety, ensuring patients are comfortable, alert, and focused. Burn pain should be promptly addressed, involving an IV line, resuscitation, and administering opioids. Opioids may be combined with adjuncts like benzodiazepines to manage pain (Carey *et al.*, 2021). However, regularly assessing patient's pain and anxiety levels using established metrics is recommended (Yastı *et al.*, 2015). It is crucial to educate staff, patients, and families on burn-related pain and its harmful consequences. The educational program should address addiction and pain communication through pain scales (Nosanov *et al.*, 2020). A personalized treatment plan considers individual opioid effectiveness and drug tolerance development (Foster, 2014). The Joint Commission on Accreditation of Healthcare Organizations and physical speciality groups outline patient monitoring levels, especially for those needing increased sedation and analgesia. The burn care team must prioritize addressing burn-related pain in all patient care aspects (Carrougher *et al.*, 2020; Pruskowski *et al.*, 2020).

The management of burn pain in children can be enhanced by developing personalized treatment protocols that consider individual characteristics, burn severity, and cultural factors. Long-term outcome studies are needed to assess the long-term effects of pain management methods on pediatrics. Age-specific studies should be conducted to understand pain changes in newborns and young children. Interdisciplinary training for healthcare providers working with pediatric burn patients is recommended, and increased public awareness about burn injuries and management strategies can improve treatment compliance.

## CONCLUSION

In conclusion, this review found that pediatrics often suffer burn injuries, which can be treated in outpatient clinics through pharmacologic and non-pharmacologic interventions or require collaboration between pediatricians and regional burn programs for acute and long-term care. The review demonstrated that patients experience unmanageable physical and psychological pain, urging medical professionals to examine burn patients and establish a multidisciplinary pain management team. To apply safe and effective pain management strategies, this team may include surgeons, critical care specialists, anesthesiologists, nurses, psychologists, and social workers. It also highlights perspectives and suggestions for future research to address this significant clinical issue.

## LIMITATIONS AND STRENGTHS

- The review highlights the importance of personalized, multimodal pain treatment methods for vulnerable patients' health and efficiency. However, potential limitations include limited generalizability, publication bias in outcome measures, resource intensiveness, lack of long-term data, and variability in patient response.
- Excluding non-peer-reviewed sources may result in the omission of valuable insights.
- In contrast, the review has several strengths as a comprehensive search strategy, complex methodology, and quality assessment tools like ROBIS, PICO model, and SPIDER framework were used.
- It covers various treatments like non-pharmacological methods, procedural analgesia-sedation, pharmacological interventions, and anesthetic care.
- The review emphasizes clinical consequences, interdisciplinary anesthetic delivery, and pain management methods for pediatric burn care professionals.

## Contribution of Knowledge

This review explored the treatment of burn pain in pediatrics using both pharmaceutical and non-pharmaceutical methods. Quality evaluation tools like PICO model, SPIDER framework, and ROBIS were employed. It provided a comprehensive understanding of burn pain's sensory, emotional, and cognitive components. The review on procedural pain management in pediatric burn patients contributes by providing insights into effective interventions and tailored approaches for managing pain in this specific population. It helps inform clinical practice, identifies research gaps, and promotes patient-centered care. Overall, the review enhances understanding of procedural pain management in pediatric burn patients and guides efforts to improve their pain relief outcomes and overall quality of care.

## Novelty

This review demonstrated pediatric burn pain treatment through several interventions and provided management guidelines and insights on pain assessment tools, emphasizing the need for personalized strategies to

improve care. The novelty in this topic lies in its focus on procedural pain management specifically in pediatric burnt patients. While pain management in pediatric populations and burn care are well-studied areas, the intersection of these two domains may present unique challenges and considerations. Understanding effective methods and treatments tailored to this specific demographic could contribute to improving the quality of care and outcomes for pediatric burn patients. Additionally, exploring novel interventions or approaches specifically targeted at managing procedural pain in this population could represent a novel contribution to the field of pediatric pain management.

## Research Gap

Research on burn pain management in children is limited, mainly focusing on evaluating therapies but not integrating them into personalized treatment plans. The research gap in procedural pain management for pediatric burn patients includes a lack of high-quality evidence, standardized protocols, and studies on understudied interventions. Additionally, age-specific considerations, long-term outcomes, patient-centered outcomes, and cost-effectiveness analyses are lacking. Closing these gaps could improve pain management and overall care for pediatric burn patients undergoing procedures. This review covered various aspects of the treatment and management of procedural pain in burnt pediatric patients. Future research can assess lasting effects and understanding of cultural and environmental factors. However, addressing these gaps will improve the specialization and effectiveness of pain management strategies, leading to better patient outcomes.

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