Evidence-based practical guideline for procedural pain management and sedation for burn pediatrics patients undergoing wound care procedures

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ABSTRACT

Background: Almost all children with burns experience pain as a result of a complex pathophysiologic process that is usually untreated, and up to 38% of all pediatric burn victims develop anxiety disorders due to pain after hospital admission. Hence, it is important to manage pain and anxiety in the care of burn victim children. The goal of this review was to develop an evidence-based guideline for procedural pain management and sedation for burned children undergoing wound care procedures.

Methodology: The review was reported according to Reporting Items for practice Guidelines in Healthcare (RIGHT) protocol. A search of literature was done from Cochrane review, PubMed, Google Scholar, Embase, web of science and Hinari database key words “pediatrics”, “children”, “burn”, “procedural wound care”, “wound dressing”, “non-pharmacological”, “analgesia”, “pain management” and “sedation” were used. Extraction and filtering of the results was determined based on the interventions, outcome, population, and methodological quality, and inclusion and exclusion criteria. Finally, 6 systematic review and meta-analysis, 1 observational study, and 16 randomized control trial Studies were appraised for quality, and conclusion was made based on their level of evidence and grade of recommendation.

Conclusion and recommendation: For effective management of procedural pain and accompanying anxiety during WCP in children, we recommend using non-pharmacological strategies as an adjunct with calculated dose of analgesics based on the children’s analgesic requirements. We also recommend ketamine-dexmedetomidine as an effective first-line analgesic-sedation, and ketamine-propofol, propofol-remifentanil, propofol-fentanyl, and ketamine-midazolam as useful sedative-analgesic-options.

1. Background

Burn injuries are among the top five most common causes of non-fatal pediatric injuries on the globe and the sixth greatest cause of mortality among 5–14 year old children in low and middle-income countries [1].

All children with burn injury experience pain, irrespective of the cause, degree, or depth of the burn [2]. Furthermore, the injury requires painful procedures such as wound debridement, frequent wound care, and surgery. The additional pain experienced following these procedures might cause adverse physiological, psychological, and emotional consequences. According to literatures, up to 38% of all pediatric burn patients develop anxiety disorders after being admitted to the hospital, and pain playing a significant role in the development of acute stress and post-traumatic stress disorder (PTSD) symptoms [3]. Therefore adequate and satisfying pain management is crucial for the pediatric population undergoing wound care procedures. However, the standard analgesia used within pediatric burn settings was inadequate in fulfilling children’s need and decreasing pain-related anxiety and distress. Study shows initial sedative strategies failed to sufficiently reduce the pain and anxiety in up to 50% of children [4].

The aim of this review was to develop a guideline for procedural pain management and sedation for children undergoing wound care procedures.

2. Method

The review was reported according to Reporting Items for practice...
Guidelines in Healthcare (RIGHT) protocol [5]. A systematic and hand search of literature was done from Cochrane review, PubMed, Google Scholar, Embase, web of science and Hinari databases. The search was performed using key words for PubMed and Cochrane [burn AND pediatrics OR children AND procedural OR wound care OR wound dressing OR non-pharmacological AND pain management OR pain relief OR analgesia] and by using full sentences search for Google scholar. Observational, interventional studies, meta-analysis and systematic review studies, full articles published from 2005 to June 2021 and articles written in English language were included in this review (See Fig. 1).

The results of the search engine were filtered based on the interventions, outcome, data on population, and methodological quality. Only articles involving wound care procedural pain management in pediatrics populations with burn injury with relevant outcomes were included, whereas articles without relevant outcomes, background burn pain management, major burn procedures and procedures other than burn wound care were excluded. After extraction and filtering with a patient population and exclusion criteria’s were done; 6 systemic review and meta-analysis, 1observational study, 16RCT and 1 outcome study were appraised for quality (See Table 1). Conclusion was made based on their level of evidence and grades of recommendations that adapted from oxford center for evidence based medicine (Table 1) (see Table 2).

3. Discussion

1. Pediatrics pain assessment

Pain assessment is vital for effective pain management. There are three fundamental modes of pain assessment in the pediatric population: Self-report, behavioral/observational and physiological. Some of popular example of self-reporting pain assessment methods are Faces Pain Scale revised (FPS-R), Visual Analog Scale (VAS) and Numeric Rating Scale (NRS), while behavioral/observational aspect is mainly assessed by FLACC (face and leg, activity, cry, and consolability) scale.

![PRISMA Flow diagram](image-url)

NOTE: Taken From; Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021; 372:n71. https://doi.org/10.1136/bmj.n71.
The studies included in the guideline.

| SNo | Author/Year          | Study                                                                 | Population  | Sample size and design | Findings of the studies                                                                 | LOE |
|-----|----------------------|-----------------------------------------------------------------------|-------------|------------------------|----------------------------------------------------------------------------------------|-----|
| 1   | Heijden et al., 2018 | Assessing and addressing the problem of pain and distress during WCP in south African pediatric patients with burns | Pediatric   | 150, Observational     | There is a correlation between age and COMFORT-B scores                               | 2C  |
| 2   | Dezfooli et al., 2020 | Systematic review of the effective factors in pain management in children. | Pediatric   | 20 articles            | both pharmacological and non-pharmacological treatment methods are effective in relieving and reducing a range of pediatric pain diseases, | 1A  |
| 3   | Borland, 2005        | Intranasal fentanyl is an equivalent analgesic to oral morphine in pediatric burns for dressing changes: | Pediatric   | 24, RCO                | No significant difference between INF and OM                                             | 2b  |
| 4   | Yang C et al., 2018  | Efficacy and feasibility of opioids for burn analgesia: An evidence-based qualitative review of randomized controlled trials. | Pediatric and adult | 9RCT()                | OTCF and INF were equivalent, or preferable, to oral morphine, hydromorphone, and oxycodone in providing analgesia for burn WCP in pediatric. | 1C  |
| 5   | Werunga K et al., 2011| Use of combined paracetamol and low dose ketamine in pain control during change of dressings in burn patients. | Pediatric   | 73%, Pediatrics, and adults | Reduced FLACC and VAS pain score after administration of oral Paracetamol combined with the low dose intravenous Ketamine | 2C  |
| 6   | Seol TK et al., 2015 | Propofol-ketamine or propofol-remifentanil for deep sedation and analgesia in pediatric patients undergoing burn dressing changes. | Pediatric   | 50, RCT                 | No significant differences. Both the pk and PR combinations were effective for sedation and analgesia of children undergoing burn WCP. | 1c  |
| 7   | Campolat DG et al., 2012| Ketamine-propofol vs ketamine-dexmedetomidine combinations in pediatric patients undergoing burn dressing changes. | Pediatric   | 30, RCT                 | No statistically significant differences. KD combination can be considered as an excellent alternative for pediatric wound dressing changes | 1c  |
| 8   | Tson et al., 2007    | Propofol-ketamine vs propofol-fentanyl combinations for deep sedation and analgesia in pediatric patients undergoing burn dressing changes. | Pediatric   | 32, RCT                 | no statistically significant difference on effectiveness of both group, but KP was better in terms of patient discomfort | 1c  |
| 9   | Noramburna C et al., 2013| Oral ketamine and midazolam for pediatric burn patients: prospective, randomized, double-blind study. | Pediatric   | 60, RDBs                | Oral midazolam and ketamine combination provides better analgesia than oral midazolam, codeine, and acetaminophen combination rectally administered ketamine (6 mg/kg) and midazolam (0.5 mg/kg) provides optimal analgesic-sedation and pain relief | 1c  |
| 10  | Grossmann B et al., 2019| Rectal ketamine during pediatric burn wound dressing procedures: a randomized dose-finding study. | Pediatric   | 90, RDFS                | VR is an effective distraction to reduce pain and anxiety.                               | 1a  |
| 11  | Miller K et al., 2009| Multi-modal distraction. Using technology to combat pain in young children with burn injuries. | Pediatric   | 80, RCT                 | VR significantly reduces pain and anxiety.                                             | 1a  |
| 12  | Miller K et al., 2011| A novel technology approach to pain management in children with burns: | Pediatric   | 40, RCT                 | VR is an effective distraction to reduce pain and anxiety in children undergoing a wide variety of medical procedures. | 1a  |
| 13  | Heijden MJE et al., 2018| Can live music therapy reduce distress and pain in children with burns after wound care procedures? | Pediatric   | 150, RCT                | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1c  |
| 14  | Scapin S et al., 2018| Virtual Reality in the treatment of burn patients: A systematic review. | Pediatricadolescent | 34, RCT | VR is an effective distraction to reduce pain and anxiety in children undergoing WCP. | 1a  |
| 15  | Eijlers R et al., 2019| Systematic review and meta-analysis of virtual reality in pediatrics | Pediatricadolescent | 17, RCT | VR is an effective distraction to reduce pain and anxiety in children undergoing a wide variety of medical procedures. | 1a  |
| 16  | Khadra C et al., 2018| Projector-based virtual reality dome environment for procedural pain and anxiety in young children with burn injuries: a pilot study. | Pediatric    | 15, pilot RCT | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1c  |
| 17  | Chester SJ et al., 2016| Effectiveness of medical hypnosis for pain reduction and faster wound healing in pediatric patients undergoing hydrotherapy: | Pediatricadolescent | 66, RCT | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1c  |
| 18  | Chester SJ et al., 2018| Efficacy of hypnosis on pain, wound-healing, anxiety, and stress in children with acute burn injuries | Pediatricadolescent | 62, RCT | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1c  |
| 19  | Bures-Nader et al., 2017| Computer tablet distraction reduces pain and anxiety in pediatric burn patients undergoing hydrotherapy. | Pediatricadolescent | 30, RCT | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1b  |
| 20  | Das DA et al., 2005 | The efficacy of playing a virtual reality game in modulating pain for children with acute burn injuries | Pediatricadolescent | 9, RCT | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1b  |
| 21  | Chan EA et al., 2007 | Application of a virtual reality prototype for pain relief of pediatric burn in Taiwan. | Pediatricadolescent | 8, RCT | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1b  |
| 22  | Feng Z et al., 2018 | Application of animated cartoons in reducing the pain of dressing changes in children with burn injuries | Pediatricadolescent | 54, RCT | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1b  |
| 23  | Hadouš H et al., 2021| Non-pharmacological Management of Burn-related Pain and Distress in Children: | Pediatricadolescent | 5R, MA | VR is acceptable and feasible intervention for procedural pain management in young burned children undergoing WCP | 1b  |
Physiologic parameter uses vital sign of patients such as heart rate for assessment of pain. However, self-report is considered the gold standard for older children [6–9] (See Tables 3 and 4, and Fig. 3).

2. Pediatrics Procedural Burn pain management

Systematic review of 20 articles on procedural pain management concludes that both pharmacological and non-pharmacological approach are effective in relieving and reducing a pain in a wide range of pediatric disease and painful procedures.

An effective procedural burn pain management plan should include both pharmacologic and non-pharmacologic modalities. LOE = 2a.

3.1. Pharmacologic pain management

Depending on the severity of the pain sedation-analgesics, opioids and Non-steroidal Anti-inflammatory drugs (NSAIDs) are the most commonly used pharmacologic agent for procedural pain management in both children and adults [10].

Narcotics/opioid receptor agonists/have been commonly used for many years in the treatment of severe burn pain in all age groups [11]. A comparative study of intranasal fentanyl (INF) and Oral morphine (OM) demonstrated no significant difference and recommended the uses of 1.4 mcg/kg INF 15 min prior to the procedure followed by 0.1 mL (15 mcg) every 5 min after procedure as an alternative agent or in combination to oral morphine in the pediatric population [12]. LOE = 2b

Similarly a review done by Yang et al. which evaluated efficacy and feasibility of different types of opioids and routes of administrations concluded that oral trans-mucosal fentanyl citrate (OTFC) and INF are equally effective and preferable, to oral morphine (0.1 mg/kg), hydromorphone (60 mcg/kg), and oxycodone (0.1–0.2 mg/kg) in providing analgesia for burn pediatric patient undergoing wound care. Because of its fast acting and easy to administer effect OTFC appeared to be a promising analgesic in reducing burn wound procedural pain [13]. LOE = 1a

Both oral trans-mucosal fentanyl and intranasal fentanyl are preferable than oral morphine, hydromorphone, and oxycodone, as they are easy to administer, provide alternative route of administration in case of difficult cannulation due to burn injury. In addition, they have lesser side effects and faster onset of action.

A range of non-opioid analgesics are advantageous for treating burn pain since their advantages and side effect profiles differ from opioid analgesics. Non-narcotic analgesics include acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs).

Werunga et al. concluded that the combination of oral Paracetamol (20 mg/kg) and low dose intravenous Ketamine (1 mg/kg) is effective and cheap alternative that can be applied to control burn procedural pains, especially in remote and low resource settings [14]. LOE = 2c.

3.2. Non-pharmacological adjunct for burn pain management

3.2.1. Distraction

Distraction technique can be achieved by diverting the attention of children from the procedure, pain or thoughts of pain/distress to a more neutral stimulus [15]. Effective distraction methods require substantial attention by the patient, resulting in the shifting of attention away from the painful stimulus. Distraction technique includes, virtual reality, multimodal distraction, music distraction, computer/iPad distraction, cartoon distraction, interactive gaming [15–17].

3.2.2. Multimodal distraction (MMD)

Multimodal distraction (MMD) is another form of a distraction technique that administered through multimodal distraction device which is a customized hand held technology that is interactive for the children through touch screen, movement and multisensory feedback including auditory, visual and vibration without use of headset.

A RCT study done by Miller K et al. supports the use of MMD as both a procedural preparation and distraction tool by showing reduced pain scores in those children accessing MMD compared to the control (18). LOE = 1c.

Another study also shows MMD protocol reduces pain experiences of young children undergoing burn care procedures. In addition to minimizing pain and distress, this innovative technology reduces treatment length and pain adverse events, and may have an impact on reducing days to healing, providing evidence of clinical efficacy and utility [16]. LOE = 1c.

3.3. Computer based distraction

A RCT study done by Burns NS et al. on computer tablet distraction concluded that distraction techniques with the use of a tablet computer decreases pain and anxiety of pediatric burned patients during hydro-therapy procedures [15]. LOE = 2b

3.4. Music based distraction

The effectiveness of musical therapy has also been evaluated on achieving distraction and relaxation and helping processing of the traumatic experience. Yet, the findings are not supporting to use it for wound care procedures. For instance, a randomized controlled clinical trial study demonstrated the ineffectiveness of live musical therapy to reduce distress and pain associated with painful burn wound care in young children, rather distressed infants lean towards seeking proximity to their caregiver or parents. However, this study also indicated that children older than 5 years music is statistically significant to decrease distress on the self-reported FACES scale (p = 0.05) than those in the control group [18]. LOE = 1c.

3.5. Virtual reality

Virtual reality (VR) is a noninvasive cognitive distraction technique that permits patients to immerse or involve into a computer-generated world through the use of goggles or helmets that deliver high resolution, three-dimensional sight and sounds to patients during a procedure in order to provide significant distraction and reduction in pain intensity through manipulation of pain perception mechanism (7).

A Systematic review and meta-analysis, based on 14 RCT studies for pain and 7RCT studies for anxiety in 2019, revealed VR is an effective tool to reduce patient-reported pain and anxiety during a range of medical procedures. In this analysis the effect of VR on pediatric pain was found to be significant when observed by health caregivers or
supportive finding on efficacy and effectiveness of hypnosis is needed in order to be recommended for wound care procedures.

Overall, Non-pharmacological interventions in treating burn pain are useful when used as supplementation to pharmacological standard care. In most of non-pharmacological interventions children with a cognitive, intellectual, or physical impairment that affect speech or memory are excluded because those intervention needs focused attention, and visual and auditory involvement [9,20]. Meta-analysis of studies on non-pharmacological intervention involving distraction, virtual reality, relaxation and hypnosis in children undergoing painful burn management procedures demonstrated distraction and virtual reality as effective non-pharmacological interventions in reducing the pain perception and distress for children undergoing painful burn WCP [22]. LOE = 1a From non-pharmacologic interventions we recommend to use either virtual reality and multimodal distraction techniques as first line adjunct for procedural pain management in children with burn injury undergoing painful wound care procedures. LOE = 1a; GOR = A.

4. Procedural analgesia-sedation

Procedural analgesia-sedation has been used by combination of analgesic, amnestic, and anxiolytic agents to prevent children from feeling pain or remembering painful procedures [23]. Studies on procedural analgesic-sedation on pediatrics age group mainly focused on varying combination of propofol, ketamine, dexmedetomidine, midazolam and opioids to provide adequate analgesia and deep sedation for burned children undergoing WCP [24-27].

4.1. Ketamine-propofol

Propofol (1.2 mg/kg) – ketamine (1 mg/kg) is among commonly practiced combinations which provide ascertained effective analgesia and sedation for burned children undergoing WCP in operating room. Comparative studies shows ketamine-propofol (KP) has better child comfort and lesser respiratory events when compared with PR and PF [25,26]. LOE = 1c.

4.2. Propofol-opioids

Two comparative RCT studies demonstrated that Propofol–Remifentanil and Propofol-Fentanyl combinations were equally safe and effective for analgesia and deep sedation during WCP in pediatric burn patients [25,26]. LOE = 1c.

4.3. Ketamine-dexmedetomidine

Randomized clinical trial (RCT) of 60 pediatrics patients aged between 8 and 60 months and with second-degree burns study found that both the ketamine-propofol and ketamine-Dexmedetomidine combinations are effective for sedation and analgesia during dressing changes in pediatric burn patients. The ketamine-dexmedetomidine combination
(with dose of dexmedetomidine 0.5 to 1 mcg/kg) provided effective sedation and hemodynamic stability without respiratory complications [24]. LOE = 1c.

4.4. Ketamine-midazolam

Prospective RCT study on oral ketamine and midazolam on 60 children 1–5 years old undergoing WCP conclude that combination of oral midazolam (0.5 mg/kg) and ketamine (5 mg/kg) provides better analgesia than the combination of oral midazolam (0.5 mg/kg), codeine (1 mg/kg), and acetaminophen (10 mg/kg) in children with burns undergoing wound care [27]. LOE = 1c Another study in 90 children revealed rectally administered ketamine (6 mg/kg) and midazolam (0.5 mg/kg) during burn WCP provides optimal analgesia-sedation and pain relief [28]. LOE = 2b

Based on current available evidences when sedation and analgesia is indicated, we recommend ketamine-dexmedetomidine combination as a first line intervention for safe sedation and analgesia for young pediatrics patients undergoing wound care procedures after burn injury. We also recommend ketamine-propofol or propofol-remifentanil or propofol-fentanyl or ketamine-midazolam as good alternatives for sedation and analgesia in burn children undergoing WCP. GOR = B.

5. Conclusion and recommendations

Pain can be effectively assessed by COMFORT-B and FLACC scale in preverbal children and by Faces Pain Scale-Revised (FPS-R) in older children undergoing WCP. Pain and anxiety in pediatrics patients undergoing wound care procedures are well managed and highly satisfying when analgesic medications are used in combination with non-pharmacologic interventions as shown in Fig. 2.

We recommend to use non-pharmacologic approach as adjunct to a calculated dose of standard pharmacological analgesics according to children’s analgesic requirement for children undergoing wound care procedures after burn injury. But in case when sedation is indicated, we recommend ketamine-dexmedetomidine combination as a first line intervention.

Limitations and challenges

Although this practical evidence based guideline is the first of its kind (specific for burn pain as far as our search covers) it has its own limitations and challenges. One of the challenges and limitations of this review is the scarcity of literatures with high level of evidence specifically for pain assessment for burnt pediatrics undergoing wound care procedures. We tried to overcome these challenges by using available literatures.

Fig. 2. Flow chart of procedural pain management and sedation guideline for burn children during wound care.
Fig. 3. FACES Pain rating scale.

Ethics approval and consent to participate

Not applicable.

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Author’s contributions

SM and AS contributed to study conception, design, data collection, and performed statistical analysis. SM, AS, AG and AS contributed on interpretation of the result, writing up and preparation of the manuscript. All the authors read the manuscript and approved the final submission.

Guarantor

Simeneh Mola.

Consent for publication

Not applicable.

Availability of data and material

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of competing interest

There is no competing interest.

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Not applicable.

Abbreviations

| Acronym | Description |
|---------|-------------|
| WCP     | wound care procedures |
| PTSD    | Post traumatic stress disorder |
| LOE     | level of evidence |
| GOR     | grade of recommendation |
| PR      | Propofol-Remifentanil |
| PF      | Propofol-fentanyl |
| PK      | Propofol-ketamine |
| KD      | ketamine-Dexmedetomidine |
| OTFC    | oral trans-mucosal fentanyl citrate |
| VR      | virtual reality |
| MMD     | multimodal distraction |
| RCT     | randomized clinical trial |
| RCO     | randomized cross over |
| FLACC   | face, leg, activity, cry, consolation |
| FPS-R   | faces pain scale revised |
| NPI     | non-pharmacologic intervention |

References

[1] https://www.who.int/news-room/fact-sheets/detail/burns.
[2] M. Gandhi, C. Thomson, D. Lord, S. Enoch, Management of pain in children with burns, Int. J. Pediatr. 10 (2010), 825657.
[3] D. Preston, A. Ambardkar, The pediatric burn: current trends and future directions. Anesthesiol. Clin. 38 (3) (2020) 517-530.
[4] Jennifer K. Hansen, Jordan Voss, Hammad Ganatra, Travis Langner, Prabhakar Chalise, Shaun Stokes, Dhaval Bhavsar, Anthony L. Kovac, Sedation and analgesia during pediatric burn dressing change: a survey of American burn association centers, J. Burn Care Res. 40 (issue 3) (May/June 2019) 287–293, https://doi.org/10.1093/jbcr/irz023.
[5] Y. Chen, K. Yang, A. Marusić, A. Qaseem, J.J. Meerpoohl, S. Flottorp, E.A. Ali, H. J. Schinemann, E.S. Chan, Y. Falck-Viitas, F. Ahmed, A reporting tool for practice guidelines in health care: the RIGHT statement, Ann. Intern. Med. 166 (2) (2017, Jan 17) 128–132.
[6] A. Bayat, R. Ramalaiah, S.M. Bhananker, Analgesia and sedation for children undergoing burn wound care, Expert Rev. Neurother. 10 (11) (2010) 1747–1759.
[7] G. Paskauskaite, L. Jankauskaite, Paediatric Pain Medicine: Pain Differences, Recognition and Coping Acute Procedural Pain in Paediatric Emergency Room, vol. 54, 2018, 6.
[8] R. Sreep, S. Ratnapalan, S. Schneeweis, Pain in children: assessment and nonpharmacological management, Int. J. Pediatr. 2010 (2010), 474838.
[9] Z. Feng, Q. Tang, J. Lin, Q. He, C. Peng, Application of animated cartoons in reducing the pain of dressing changes in children with burn injuries, Int. J. Burns Trauma 8 (3) (2018) 106.
[10] L. Faucher, K. Furukawa, Practice guidelines for the management of pain, J. Burn Care Res. 27 (5) (2006) 659–668.
[11] S.M.M. Dezfouli, S. Khosravi, Systematic review of the effective factors in pain management in children, Pak. J. Med. Health Sci. 14 (2) (2020) 1236–1243.
[12] M.L. Borland, R. Bergesio, E.M. Pascoe, S. Turner, S. Woodger, Intranasal fentanyl is an equivalent analgesic to oral morphine in paediatric burns patients for dressing changes: a randomised double blind crossover study, Burns 31 (7) (2005) 831–837.
[13] C. Yang, X-m Xu, G-e He, Efficacy and feasibility of opioids for burn analgesia: an evidence-based qualitative review of randomized controlled trials, Burns 44 (2) (2018) 241–248.
[14] K. Werungu, S. Khainga, P. Musau, M. Emarah, M. Emarah, Use of combined paracetamol and low dose ketamine in pain control during change of dressings in burn patients, East Afr. Med. J. 88 (3) (2011) 101–103.
[15] S. Burns-Nader, L. Joe, K. Piont, Computer tablet distraction reduces pain and anxiety in pediatric burn patients undergoing hydrotherapy: a randomized trial, Burns 43 (6) (2017) 1203–1211.
[16] K. Miller, S. Rodger, B. Kipping, R.M. Kimble, A novel technology approach to pain management in children with burns: a prospective randomized controlled trial, Burns 37 (3) (2011) 395–405.
[17] K. Miller, S. Rodger, S. Buco, K. Greer, R. Kimble, Multi-modal distraction. Using technology to combat pain in young children with burn injuries, Burns : J. Int. Soc. Burn Injuries 36 (2009) 647–658.
[18] M.J.E. van der Heijden, J. Jekel, H. Rode, S. Cox, J. van Rosmalen, M.G. Hunink, et al., Can live music therapy reduce distress and pain in children with burns after wound care procedures? A randomized controlled trial, Burns 44 (4) (2018) 823–833.
[19] R. Ejlers, E.M. Utens, L.M. Staals, P.F. de Nijs, J.M. Berghmans, R.M. Wijnen, et al., Meta-analysis: systematic review and meta-analysis of virtual reality in pediatrics: effects on pain and anxiety, Anesth. Analg. 129 (5) (2019) 1344.
[20] S.J. Chester, Z. Tyack, A. De Young, B. Kipping, B. Griffin, K. Stockton, et al., Efficacy of hypnosis on pain, wound-healing, anxiety, and stress in children with acute burn injuries: a randomized controlled trial, Pain 159 (9) (2018) 1790–1801.
[21] S.J. Chester, K. Stockton, A. De Young, B. Kipping, Z. Tyack, B. Griffin, et al., Effectiveness of medical hypnosis for pain reduction and faster wound healing in pediatric acute burn injury: study protocol for a randomized controlled trial, Trials 17 (1) (2016) 1–11.
[22] H. Hadouh, S. Alrzu, M. Kassab, A.N. Roy, Non-pharmacological management of burn-related pain and distress in children: a systematic review and meta-analysis study, Sys. Rev. Pharm. 12 (3) (2021) 423–438.
[23] A. Fagin, T.L. Palmieri, Considerations for pediatric burn sedation and analgesia, Burns Trauma 5 (2017) 28.
[25] T.K. Seol, J.K. Lim, E.K. Yoo, S.W. Min, C.S. Kim, J.Y. Hwang, Propofol–ketamine or propofol–remifentanil for deep sedation and analgesia in pediatric patients undergoing burn dressing changes: a randomized clinical trial, Pediatr. Anesth. 25 (6) (2015) 560–566.

[26] Z. Tosun, A. Esmooglu, A. Coruh, Propofol–ketamine vs propofol–fentanyl combinations for deep sedation and analgesia in pediatric patients undergoing burn dressing changes a, Pediatr. Anesth. 18 (1) (2008) 45–47.

[27] C. Norambuena, J. Yañez, V. Flores, P. Puentes, P. Carrasco, R. Villena, Oral ketamine and midazolam for pediatric burn patients: a prospective, randomized, double-blind study, J. Pediatr. Surg. 48 (3) (2013) 629–634.

[28] B. Grossmann, A. Nilsson, F. Sjöberg, L. Nilsson, Rectal ketamine during paediatric burn wound dressing procedures: a randomised dose-finding study, Burns 45 (5) (2019) 1081–1086.