Assessment of Postoperative Pain in Infant
A Literature review

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Abstract

Pain is a subjective as well as personal experience, and there are no objective tests exist to measure it. Assessment is the initial step of the nursing process; therefore, it is essential to assess pain accurately among infants in the postoperative environment to have better pain management. Nurses are the health practitioners in the front line to understand the suffering and pain of the patients, giving them greater responsibility to perform on their observations. Hence, the purpose of the thesis is to provide knowledge on the pain assessment methods in infants in the postoperative environment with a research question of how nurses assess postoperative pain in infants.

The search for the data was conducted in January 2019. During the thesis process, an inductive qualitative content analysis was chosen to gain updated facts and data.

The research methodology is followed by the review of literature, with inductive qualitative data analysis. Four databases searched for data retrieval. These included; Laurea FINNA, ProQuest Central, Science direct, and Sage premier. A total number of 6 articles from the year 2015-2019 were selected.

Four main themes as the methods of assessment of postoperative pain in infants were derived from the data analyzed which include; performing history taking through proxy reporting, identifying other potential causes of pain, observing infant's pain responses and using appropriate pain assessment tools.

In a nutshell, the imparted knowledge from the thesis will surely provide knowledge on assessment methods among the health care professionals working with infants in the postoperative environment through assisting them in making decisions in clinical sectors. The knowledge of assessment helps to make better planning and interventions in the nursing career.

Since only a few academic databases were used in data collection, recommendations are aimed at health care professionals in general for furthermore research regarding the topic which could lead to even more effective pain assessment in infants in the postoperative department.

Keywords: Infant, postoperative pain, postoperative pain assessment

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1 Introduction

Pain is defined by International Association for the Study of Pain (IASP) as an unpleasant sensory and emotional experience which is often associated with actual or potential injuries, but subjectively and multidimensional in its perception. It is a common sensation experienced by all human beings and expressed in a certain way (Xavier et al. 2018).

In reference to Xavier et al. (2018),Pain is standardized by the Joint commissions on Accreditation of Healthcare Organizations (JCAHO), as the fifth vital sign, which should be prioritized in care, and its evaluation should be done through behavioural scales that allow the measurement of the intensity of the pain, including its location and possible changes in functional limits.
Post-operative pain is referred to as physiological and psychological distress, which may hinder post-operative recovery through the development of chronic post-surgical pain due to increased sadness (Nielsen et al. 2007). Messer et al. (2010), describes post-operative pain as a good example of acute pain as it usually exists a couple of days after the surgery. Naturally, surgical procedures cause pain and are the common reason for postponed admission and the longer stay in hospitals.

According to Barker and Wilson (2014), post-operative neonates are exposed to potentially painful experiences from repeated noxious stimuli, multiple painful experiences from repeated noxious stimuli, multiple procedures, and postoperative care routines. Pain is a negative and stressful experience for hospitalized neonates, with research signifying that infants, therefore, experience altered pain responses later in life. Premature infants exposed to early and ongoing painful stimuli during the neonatal period are particularly susceptible to impaired brain development as evidenced by reduced white and grey matter on magnetic resonance imaging (MRI) (Barker and Wilson, 2014).

Xavier et al. (2018), says that approximately 45% of the patients search for the health services for pain control as the main complaint. In the operative period, it is present due to the surgical procedure itself and /or to the presence of pre-existing diseases, with acute pain in this period being the most predominant form of pain. Therefore, pain should be measured using an accurate assessment tool that recognizes the quantity and/or quality of one or more of the dimensions of the patients' experiencing pain (Christie et al. 2018).

In accordance with Erikson and Campbell-Yeo (2019), many authors have studied the implementation and planned pain assessment in clinical practice, and the outcomes are very discouraging. A prospective cohort study in 243 neonatal intensive care units from 18 European

countries found that only 32% of the 6,648 infants received at least one assessment of continuous pain and that only 10% had received daily pain assessment. Some countries have come further, e.g., a Dutch study showed that most of the NICU-patients had at least one pain assessment during their hospital stay (Erikson and Campbell-Yeo, 2019).

Similarly, the percentage of units that have reported implementation and used of structured pain scales varied between countries from 6 to 88%. From the report, it showed that USA, 81% has used pain assessing tool as mandatory for assessing pain in paediatrics and the studies conducted in Europe show that nurses may not be consistently assessing pain as they may not always believe children when they report pain and may not treat pain adequately (Erikson and Campbell-Yeo 2019; Threne et al. 2015).

(Twycross and Collis 2012, cited in Threne et al. 2015), says that even though there are well-validated tools available for assessing children's pain, more than half of the hospitalized children experience unrelieved pain which implies that either the available tools are not being used or the pain not being treated adequately. The postoperative pain in patients existed consistently high over the past two decades, which shows that the factor responsible for inadequate pain management may be due to poor pain assessment. (Hoogervorst-Schilpaical et al. 2016).

Thus, Woragidpool et al. (2018), suggests that it is vital for the improvement of the situation in the clinical setting to reduce pain exposures, encourage accurate pain assessment, and promote pain-relieving interventions for infants who are considered as the vulnerable patient population.

2 Key Concepts Definitions

2.1 Pain

According to the Merriam Webster med dictionary (2005), it defines pain as "a state of physical, emotional, or mental lack of well-being "or "a physical, emotional, or mental discomfort which ranges from mild uneasiness or dull distress to acute and sometimes unbearable agony''.

The North American Nursing Association (NANDA) has described the pain as a Nursing Diagnosis taxonomy that arises due to aggressions that affect the cells of the organism leading to the release of the prostaglandins and the increase of the sensitivity and causing the nerve endings captures the painful stimuli (Xavier et al. 2018).

In reference to Gyland et al. (2012), researcher Fillingrim has proposed the biopsychosocial model of pain, which presents three major dimensions: biomedical, psychological, and sociocultural. The biomedical dimension includes pathology, injury, and nociceptive factors. The

psychological dimension includes anxiety, depression, cognitive, and behavioural factors. Similarly, the sociocultural dimension includes the factors of age, race, sex, income, education, and social factors. Hence, all these definitions work to emphasise the fact that pain is complex, multidimensional, subjective, and personal (James et al. 2013).

2.1.1   Classification of pain:

According to Young (2016), ''Pain can be neuropathic from damaged or compressed nerves typically describes as burning or tingling, or it can be nociceptive. Nociceptive pain results from inflammatory mediators released because of tissue injury and can be somatic, from the skin and soft tissue pain receptors and typically described as sharp, stabbing, or throbbing, or visceral, from visceral organ receptors and typically described as dull, cramping, or aching." Traditionally, on the basis of assessing pain, three types of neonatal pain have been discussed which are: acute/procedural pain, acute/prolonged pain (including post-operative pain), and chronic pain (Erikson and Campbell-Yeo,2019).

Acute pain is often the result of injury or disease and is generally improved with healing and rest. It comes upon with a wide variety of clinical situations (e.g., postoperative, trauma and medical illness) and It is also increasingly common to find patients with chronic pain complaints in an acute setting also. Acute pain is generally considered nociceptive pain, but it can be neuropathic pain or a combination (McCormick and Law,2016). The postoperative pain is an excellent example of acute pain as it is normally limited to a couple of days (Avian et al. 2016).

According to McCormick and Law (2016), chronic pain is pain that lasts for over 3 months, and neuropathic pain is more common in chronic pain states, due to peripheral and central sensitization.

2.1.2   Consequences of Untreated Pain

According to Avian et al. (2016), significant pain without appropriate analgesia will not only cause great physical, psychological and hormonal stress response but will also produce a ''pain memory." Wong (2014), says the perception and response to pain develop with every painful experience. Among premature children who experience repeated painful exposures as a result of hospitalization, procedures, and surgeries during the neonatal period results disruption in the normal structural and functional neurological development of pain-coping pathways. When exposed to noxious thermal and mechanical stimuli, the motor response to pull away, known as the "withdrawal reflex" is stimulated at a reduced threshold; as a result infant experience heightened pain response (e.g., hyperalgesia, allodynia) to subsequent stimuli (Peters et al. 2005, cited in Wong 2014).

Furthermore, AMA (2010), cited in Wong (2014), describes that the heightened postoperative pain response (or "wind-up effect"), increased duration of pain, reduced pain threshold, and reduced pain tolerance can initiate different maladaptive behaviours among children such as separation anxiety, insomnia or sleep disturbances, postoperative anxiety, eating difficulties aggression towards authority, temper tantrums, apathy, and withdrawal syndromes. Moreover, a painful event in childhood has caused the patient to be fearful, anxious, and unresponsive to future health encounters and treatments (Fortier et al. 2010, cited in Wong, 2014). Therefore, in order to raise the quality of care in daily paediatric practice, pain assessment should be an integral part of every child's health care system with the target to prevent suffering and long-term effects of untreated pain (AMA 2010, cited in Wong 2014).

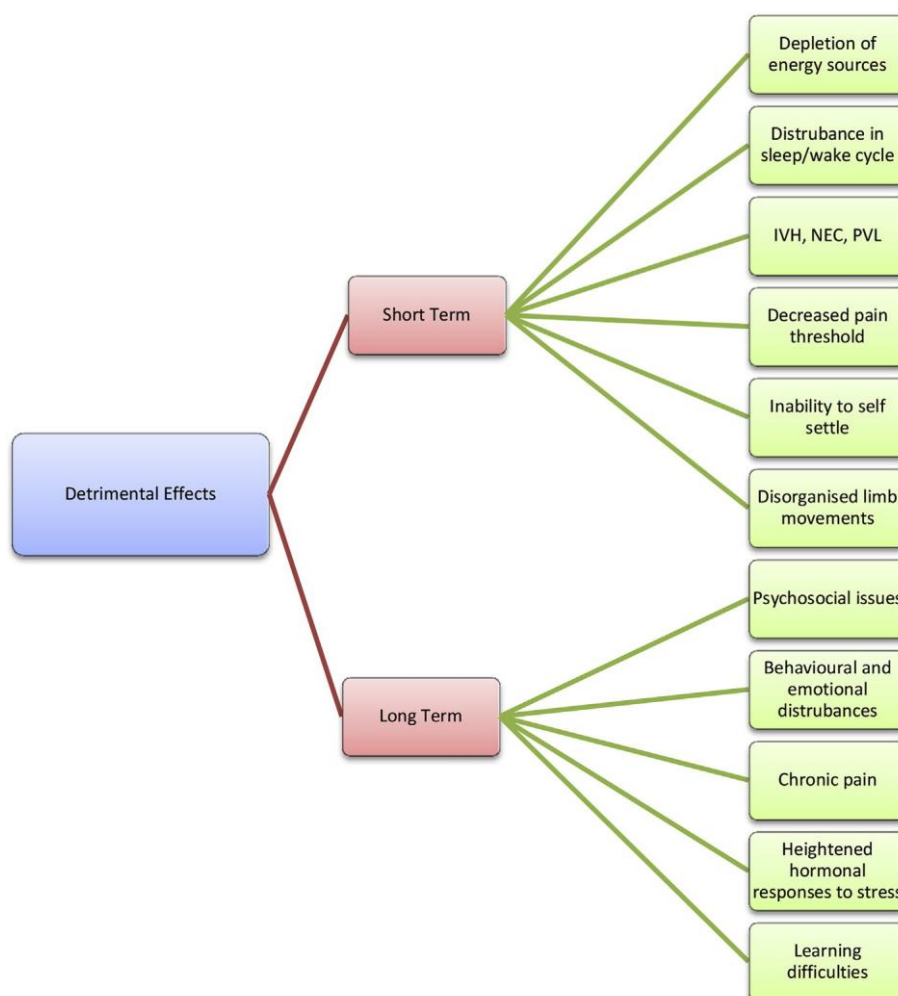M. Capolingua, F.J. Gill / Journal of Neonatal Nursing 24 (2018) 218 -224

Figure 1 Deleterious effects of premature infant pain

2.2   Infants

According to Nursing Child Assessment Satellite Training (NCAST, 2014), the infancy period begins from the newborn to 12 months age, and during this period, generally, infants' physiques develop significantly. In 0-3 months, an infant can hold head up, push up, move arm and legs. Infant shows curiosity with the environment, follow eyes with the things. He/she able to response the voice of parents and mostly remain calm and may shock fingers. In 4-6 months, an infant can grasp, roll over, reach the object, play with feet. He/she can make the response to love and affection with both hands and eyes, able to move eyes side by side, easily recognize the familiar people, express emotion and feelings. Infant can smile and try to show pain, hunger with crying. In 6-9 months, an infant can roll over both direction, push head, may stand with the support of others, bring things to mouth. He/she is able to express joy and pain with voice, response with own name, and even enjoy with his or her own sound or voices. In 9-12 months, an infant is able to form sitting, crawling, standing, pulling, walking, putting things mouth, etc. He or she is able to copy gestures, names, find out the things, shaking head and hand for the expression of yes or no, etc. (NCAST 2014).

Although according to the culture and perception of authors there are many different classificational stages of growth and development of children, in this thesis ''infant" means a child from birth to till one year of old considering neonates (0-1months of age) and all the preterm and full-term babies to till one year of age.

2.3   Postoperative pain

Postoperative pain is the pain which is the normal response by patients to surgical wound and which is caused by delayed recovery and discharge after surgery in which risk is increased by the infection of wound and respiration or cardiovascular complications. Improper management of postoperative pain leads to reduce the satisfaction of patients and increases the mortality and morbidity, and it also adds the economic burden to the patients. Postoperative pain that becomes intractable and continues, called Chronic Postsurgical Pain (CPSP) which can have a significant effect on the normal life of the patients' daily activities such as disturbing of sleep, effective mood, etc. (Lovich-Sapola et al. 2015).

Pogatzki-Zahn et al. (2007) define postoperative pain as an incisional pain, which is also a unique and common form of acute pain. In reference to Gupta et al. (2010), postoperative pain is often considered as an acute pain because of surgical injury with an inflammatory reaction and is a combined constellation of several unpleasant sensories, emotional and mental experience which is precipitated by the surgical trauma.

2.4 Postoperative Pain in Infants

Postoperative pain is often a new experience for young children. Moreover, the complexity of interpreting and verbalizing pain may be further complicated by unfamiliar postoperative sensations from general anaesthesia, surgical site discomfort, and disorientation among paediatric groups (Wong 2014).

The field of anesthesia and operation are an unfamiliar environment for children as well as the postoperative pain in paediatric has remained untreated because of the difficulty of pain assessment. Even though pain is often regarded as the inevitable consequence of the operation, its control or management is vital to improving both clinical outcomes and patient comfort. Postoperative pain control is started with the assessment of pain and the efficacy and safety of analgesics techniques in pediatric patients (Lee and Jo 2014).

According to Erikson and Campbell-Yeo (2019), ''all infants, even those considered to be healthy, undergo painful procedures immediately after birth and throughout infancy period as a part of routine preventive practices.'' Exposure to pain and repeated painful procedures is even higher among sick and preterm new-born infants because of their medical condition and mostly as a result of the care and treatment received. According to numerous studies, it is shown that 10-15 hospitalized neonates undergo painful procedures daily, both in industrialized and developing countries often without any pain relief measures (Erikson and Campbell-Yeo,2019).

2.5 Postoperative Pain Assessment in Infants

Assessment is considered as the first step in pain management, which is also the complex and critical element (Habich at al. 2012). According to Rodriguez et al. (2016), the precise and complete assessment of pain results in the optimal management of pain. Thus, a comprehensive approach is required as the way a child perceives pain is the outcome of biological, psychological, social, cultural, and spiritual factors. As pain is the subjective experience, the ideal way to reply it is through self-report, but among the non-verbal population, many signs should be observed, including physiological and behavioural changes. To know whether the child has pain or not, pain intensity must be evaluated based on behavioural, physiological, and self-report methods (Rodriguez et al. 2016).
Wong (2014), suggests that one may simplify pain in a linear model where a nociceptive stimulus, described by location, frequency, and intensity, initiates a unique painful sensation. In response, there are verbal expressions as well as physiological responses that are influenced by a person's characteristics. These external signals can be observed, recorded, interpreted, and assessed (Wong, 2014). Hence, the review of the above literatures shows that infants' pain can be assessed, but there is lacking systematic assessment of pain in infants in the postoperative setting.

3   The purpose statement and research question

Purpose: The purpose of the thesis is to describe the methods used by nurses to assess post-operative pain in the infant.
Research question: How do nurses assess postoperative pain in infants?

4   Methodology

4.1   Principle of Literature Review

The method chosen for this bachelor's thesis is a literature review. A literature review is an identification and systematically organization of the concepts from the relevant literature. In general, it is the process of penetrating the currently existing and earlier literature in the particular fields and in doing so, it is possible to find out the gap or to identify the areas in which further research would be beneficial (Rowley & Slack 2014). The purpose or importance of reviewing literature are many, and primarily, it forces a writer to gather possible more information to be clear in a chosen topic. It will help in the learning process and will strengthen the writing as strong as what should be and not to be and establish prior knowledge. Similarly, it demonstrates the readers that the author has a vivid understanding of the topic. By reviewing all the previous literature, the strength and weaknesses of the literature will become more apparent and which assist not only to find or form the particular research question but also help to form the argument for the further research (Denny & Tewksbury 2012).

During the data search, research on pain assessment in infants within the postoperative setting was found to be extremely limited. Hence, an inductive content analysis was considered to be the best approach for data analysis.

4.2   Data Search and screening

The data retrieval process was done electronically using databases that were accessible from the Laurea University of Applied Sciences. Four databases were initially identified: Laurea FINNA, ProQuest Central, Science direct, and Sage premier. Laurea FINNA is a search portal for the electronic database of Laurea UAS. ProQuest Central is also an electronic source which brings together, mostly used available databases which are to generate the most comprehensive, distinct, and suitable multidisciplinary research database. ScienceDirect is a large database of scientific and medical research. SAGE premier is an academic and professional publisher of high quality of content each year in various topics.

These databases were accessed through electronic portal libguides. The search was conducted in January 2019. The search words used were infant, postoperative pain, and pain assessment. Data search was conducted in all four databases using the same search words and combinations. The following table describes the inclusion and exclusion criteria.

Table 1 Original search words and inclusion and exclusion criteria

Search words used with different combinations	Infant and pain assessment, postoperative pain and infant and pain assessment method, postoperative pain and infant and pain assessment, infant and acute pain assessment, postoperative or acute or surgical pain and pain assessing or measuring methods or techniques.
Inclusion criteria	➢ Articles in English language. ➢ Scholarly reviewed articles. ➢ Articles published from 2015-2019. ➢ Articles that support the purpose statement and the research question. Articles those focused on the assessment of postoperative pain in infants or paediatrics. ➢ Free of charge articles that don't require the fund to access.
Exclusion criteria	➢ Articles those not in English language. ➢ Non-academic databases were excluded. ➢ Articles published before 2015. ➢ Articles that do not respond to the research question were excluded. ➢ Articles requiring the fund to access were excluded. ➢ Articles that do not focus on the assessment of postoperative pain in paediatrics.

During the data search process, it was noticed that using infant and postoperative pain assessment as the search words, the inclusion criteria gave limited results in regard to the research question of the thesis. The publication year limitation starting from 2015 was chosen as the previous dated articles during the review process had similar themes in context with the latest articles. Therefore, the search word list was modified, and the publication year time limit was chosen from 2015 in order to get more relevant and recent data.The modified search provided more accurate results regarding postoperative pain in infants. Finally, six articles for the literature review were selected for the thesis.

The final data search is represented in the table below.

Table 2 Final data search

Database	Search words	Limita-tions	No, of hits	Articles eligible based on headings	Articles eli-gible based on ab-stracts and full text	Articles fully read and se-lected for liter-ature review
Laurea FINNA	Postopera-tive or surgi-cal or acute pain AND as-sessment techniques or methods AND infant or pediatric	2015-2019 Full text	333	50	8	3
Science Direct	Postopera-tive pain AND infant AND pain as-sessment methods	2015-2019 Full text	152	25	10	1
ProQuest Central	Postopera-tive pain AND Infant AND pain as-sessment	2015-2019 Full text	129	22	15	1
SAGE Premier	Infant AND Acute pain assessment	2015-2019 Full text	61	20	12	1

Six articles were selected in total for the literature review.

4.3   Critical Appraisal of Data

Young and Solomon (2015), define that critical appraisal is a methodological process applied to recognize the research articles' weaknesses and strengths for assessing the validity and usefulness of the research finding. The most essential elements of the critical appraisal are

the appropriate evaluation of the study design mostly for the research question as well as a systematic assessment of the methodological key features of the design.

Thus, Critical data appraisal has been understood as the application of the evidence-based rules to assess and study the data, the perfection of methods and technique, the conclusion as well as ethical maintenance and following are the drawn-up assessment question taken for the literature review articles (Young and Solomon, 2015).

- Is the research evidence-based?
- Does the study add anything new?
- Was the study design suitable for the research question?
- Is the study question relevant?

Table 3 Data Appraisal of the article used in the thesis

Authors, Year of publication, Country	Title/Name of belonging articles	Purpose of the Study	Article type	A critical appraisal based on questions formed
Linda A. Hatfield and Elizabeth A.Ely, 2015, USA	Measurement of Acute Pain in Infants. A review of Behavioural and Physiological Variables. The article belongs to (SAGE premier)	This article's aim was to evaluate the evidence regarding the physiologic and behavioural changes that correctly assess and measure the acute pain response of the infants.	Qualitative Research article.	This research article was much relevant to the research question, and the content of this piece of work matches the purpose of this research. The articles describe observing infants pain responses and identifying the needs for pain assessment.
Alexandra Beltramini, Kolia Milojevic, and Dominique Pateron, 2017, Germany	Pain Assessment in Newborns, infants, and Children. (Science Direct)	The article's main purpose was to review the available pain scales for children from birth to adolescence and to propose a synthesis of the reliable tools to use based on the pain context.	Qualitative Research article	The research article was compatible with the research question. This research describes the different pain scales for different contexts in paediatrics. Thus, found effective and relevant for research.
Lisa Joestlein, 2015, USA	Pain, Pain, Go Away! Evidence-Based	This article's aim was to provide an overview of		The article was found to be relevant to the research question and was effective as

	Review of Developmentally Appropriate Pain Assessment for Children in a Postoperative Setting. (Laurea Finna)	developmentally appropriate pain assessment tools in the postoperative paediatric orthopaedic patients.	Qualitative research article.	the article provided evidence-based information for assessing postoperative pain in infants.
Rabecca Saul, Judy Peters and Elizabeth Bruce, 2016, U.K	Assessing acute and chronic pain in children and young people (ProQuest Central)	The purpose of this article was to discuss the fundamental principles of assessing pain in children and young people.	Peer review article.	The article was found to be relevant and provides evidence-based information to the related topic of assessing post-operative or acute pain in children. The article gives a framework for the assessment of postoperative pain in children, thus, showing its relevance.
Manaporn Chatchumi, Ampaporn Namvongprom, Henrik Erikson and Monir Mazaheri, 2016, Sweden	Thai Nurses' experiences of postoperative pain assessment and its influence on pain management decisions. (Laurea Finna)	This article's aim was to describe Thai nurses experiences of pain assessment in the surgical ward through the survey.	An explorative cross-sectional study. Qualitative Research Article	The article's aim was found to be relevant in accordance with the research question. The article gives information on how Thai nurses performed pain assessment among postoperative patients.
Beatriz Marques, Cardos JM, Silva MJ, 2019, Portugal	Post-operative Pain assessment methods for Infants and Young Children: A Review (Laurea FInna)	This article's aim was to review the most commonly used pain assessment tools in postoperative settings and find their advantages and limitations.	Review Article	The content of this article was relevant to the research question as the article provides information on different contextual pain assessing tools in infants and young children.

5 Qualitative Content Analysis

The framework approach toward this review was qualitative content analysis.
Hsieh and Shannon (2014), describe that the content analysis is largely applied in the qualitative research method. Currently, there are three different approaches of content analysis, which are conventional, directed, or summative, and all these approaches are applied to describe the meaning from the content of the article or text. According to Chron (2019), Inductive content analysis is the method of the content analysis in the qualitative research where researcher applies to form the theory and find out the themes by studying or recording the printed material and documents. As from its name, inductive content analysis refers to inductive reasoning, where the emerging themes from the raw data are examined and compared (Chron 2019). Thus, this method was the most appropriate choice for interpreting the data.

During the data analysis process, all the chosen articles were first reviewed thoroughly based on the research question, 'How do nurses assess postoperative pain in infants?' In reference to the research question, all the emerged important themes from the reviewed articles were highlighted and were combined into the table in order to identify similar or distinct patterns within the data. Finally, continuing the analysis process as a result of findings, four key categories were formed as the answers to the research question.

The following are the available themes in the review, which are illustrated in the figure below:
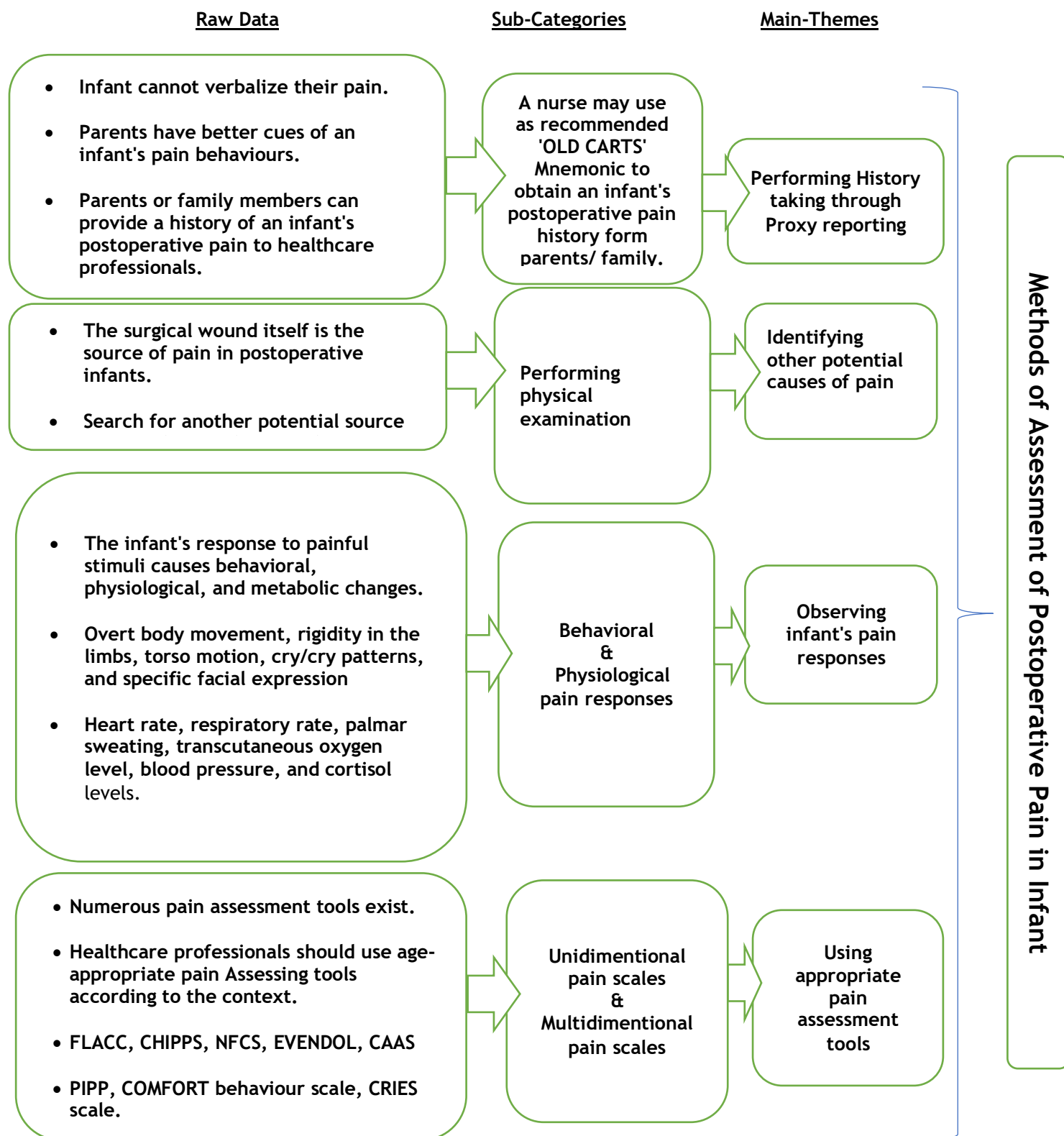
Raw Data	Sub-Categories	Main-Themes

- Infant cannot verbalize their pain.
- Parents have better cues of an infant's pain behaviours.
- Parents or family members can provide a history of an infant's postoperative pain to healthcare professionals.

A nurse may use as recommended 'OLD CARTS' Mnemonic to obtain an infant's postoperative pain history form parents/ family.

Performing History taking through Proxy reporting

- The surgical wound itself is the source of pain in postoperative infants.
- Search for another potential source

Performing physical examination

Identifying other potential causes of pain

- The infant's response to painful stimuli causes behavioral, physiological, and metabolic changes.
- Overt body movement, rigidity in the limbs, torso motion, cry/cry patterns, and specific facial expression
- Heart rate, respiratory rate, palmar sweating, transcutaneous oxygen level, blood pressure, and cortisol levels.

Behavioral & Physiological pain responses

Observing infant's pain responses

- Numerous pain assessment tools exist.
- Healthcare professionals should use age-appropriate pain Assessing tools according to the context.
- FLACC, CHIPPS, NFCS, EVENDOL, CAAS
- PIPP, COMFORT behaviour scale, CRIES scale.

Unidimentional pain scales & Multidimentional pain scales

Using appropriate pain assessment tools

Methods of Assessment of Postoperative Pain in Infant

Figure 2. Illustration of the data analysis process

6   Literature review findings

According to Joestlein (2015), the American Society for Pain Management Nursing (ASPMN), in its position statement recommends, using the modified Hierarchy of Pain Assessment Techniques in paediatrics which are stated below:

1. Obtain self-report
2. Search for potential causes of pain
3. Observe patient behaviour
4. Elicit proxy reporting (family members, parents, unlicensed caregivers, professional caregivers) of Pain and Behaviour/Activity Changes).

The above-mentioned techniques can be used as the template for assessing postoperative pain in infants in the following ways.

6.1   Performing History taking through Proxy reporting

According to Marques et al. (2019), self- report is considered as the gold standard for pain assessment in children who could verbalize. In infants who cannot verbalize their pain, proxy reporting is considered (Saul et al. 2016).

Beltramini et al. (2017), says while infants cannot verbalize the pain themselves, often parents help the caregiver to assess an infant's unusual behaviour as parents have enough time to observe the infant's response to pain. Similarly, Saul et al. (2016) also add in many circumstances, and parental involvement might assist the child in providing an accurate history to the nurses. For taking the detailed history to assess pain in children or young persons, Saul et al. (2016) suggest the simple mnemonic 'OLD CARTS' which may be adopted by caregivers to act as a memory aid to assess acute pain in paediatrics.

(Adapted from Fergusson 2008, cited in Saul et al. 2016)

'OLD CARTS' mnemonic for taking pain history
O- Onset: when did the pain begin? Was there a triggering event?
L-Location: where is the main focus of the pain? Is there pain anywhere else?
D-Duration: how long has the pain lasted? Was it immediate or gradual? Is it intermittent or reoccurring?
C-Characteristics: describe the pain. Is it sharp, dull, stabbing, aching, tingling, numb? Does it change?
A-Associated symptoms: are there other symptoms associated with the pain, such as nausea, vomiting, weakness, fatigue, breathlessness?
R- Relieving and aggravating factors: what makes the pain better? What makes the pain worse?
T-Treatment: what medications or non-pharmacological methods to reduce pain have already been tried to reduce the pain?
S-Severity: how severe is the pain? What is the intensity?

6.2 Identifying other potential causes of pain

Joestlein (2015), describes that the surgical site is an obvious source of pain, but an assessment for other causes should not be stopped for example pain from positioning intraoperatively for long periods can also be the other potential source of pain. Incorrect positioning after surgery can create stress on the surgical site. Similarly, surgical appliances such as braces, knee immobilizers, and casts can rub or put pressure on other body parts that cause pain in areas other than the surgical site. For example, flexible nails protruding out of the affected bone, in the orthopaedic surgical cases can also be the cause for pain. Sometimes complications from surgery and even non-invasive blood pressure monitoring can also be the cause of pain in postoperative infants (Joestlein 2015).

Chatchumni et al. (2016), says that the nurses conducted physical examinations to assess postoperative pain by searching any potential causes and complications of surgery. Nurse's conducted physical examinations through abdominal examination and noted any abdominal distention, the presence or absence of pain, any bleeding from the wound, the condition of the bladder if it was full and so on. Thus, it was done in order to determine the other potential causes of pain (Chatchumni et al. 2016).

6.3 Observing infant's pain responses:

According to Beltramini et al. (2017), during the child development, a child gains the ability to recognize the pain stimulus, locate it, quantify it and finally verbalize its painful sensation as pain induces behavioural, physiological and metabolic changes. Below is the description of the physiological and behavioural responses to pain in infants.

6.3.1 Infant's behavioural pain responses:

Hatfield and Ely (2015), describes that the behavioural pain response in infants includes overt body movements (withdrawal), rigidity in the limbs, torso motion, cry/cry patterns, and specific facial expressions. In response to painful stimuli, the child has an avoidance of eye-contact, locking of gaze or drifting away. The crying/vocalization has a longer duration, changes in quality; fussiness, 'silent cry.' Observing an infant's facial expression shows the presence of, e.g., brow bulge, eye squeeze, nasolabial furrow, open lips, horizontal mouth stretch, vertical mouth stretch, lip purse, taut tongue and/or chin quiver. Similarly, the effects of painful stimuli in infant show presence and duration of avoiding or more indistinct limb movements like fisting or finger playing. There is an increase or decrease in muscle tone and variation in sleep/ activity/waking state, ranging, for example, from quiet sleep to quite awake and active awake for crying and agitated (Hatfield and Ely 2015).

Hatfield and Ely (2015), says that preterm and the term neonates exhibit unpredictable, imprecise, disorganized, and weak behavioural responses to pain as they have immature neural

pathways. Thus, with the maturing of neural pathways, older infants and toddlers exhibit more precise, more organized, and stronger behavioural responses to pain and may have the ability to modulate pain more effectively. Hence, as term infants are more likely to show facial expressions than preterm infants, the use of facial activities as a valid and reliable indicator of pain depends on the gestational age of infants (Stevens et al. 2007, cited in Hatfield and Ely 2015). According to Marques et al. (2019), behavioural signs, including facial expression, were appeared to be the most important signs for healthcare professionals to recognise pain in infants.
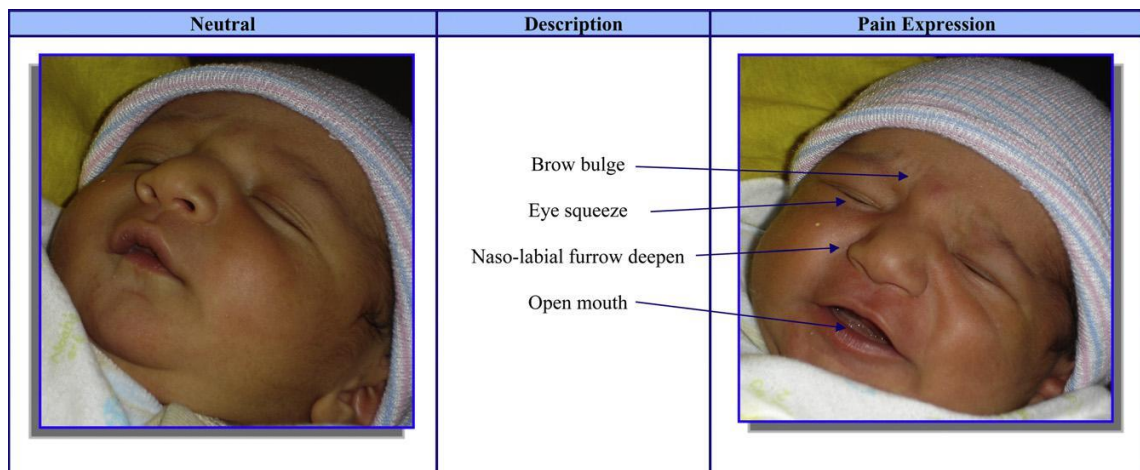

Neutral	Description	Pain Expression

Brow bulge
Eye squeeze
Naso-labial furrow deepen
Open mouth

Figure 3. Facial Expression Correlated with Pain by Arif-Rahu et al. 2012.

6.3.2 Physiological pain responses:

In reference to Hatfield and Ely (2015), physiological responses include heart rate, respiratory rate, sweating of Palmer, transcutaneous oxygen levels, cortisol level, and blood pressure. Infant's physiological responses to painful stimuli show the increase or decrease blood pressure, tachycardia or bradycardia, decrease in oxygen saturation level, increase or decrease in respiratory rate or presence of apnea, changes in skin colour as red or pale and change in metabolic and hormonal levels.

In accordance to (APA 2012, cited in Saul et al. 2016), measurement of vital signs, including heart rate, blood pressure, and respiratory rate, are not recommended for use as sole indicators of pain as they are raised at times of stress. Similarly, Beltramini et al (2017) also explains, when child is in pain behavioural, physiological and metabolic changes occur, in the same way, the facial expressions, bodily movements and physiological changes can also occur when a child has hunger, fear, anxiety, and cold which makes recognizing pain responses in infants even more complex. Moreover, the process of obtaining physiologic measures such as heart rate and blood pressure, which requires special equipment may irritate the infants, altering the behavioral responses with pain.

In opposition, Hatfield and Ely (2015), suggests physiologic variables are valuable sources of providing objective measures of pain, but they should be used together with behavioral parameters without biasing one of them because physiologic variables have low specificity and can be altered by other non-painful stimuli such as fatigue, hunger, stress or distress. Hence, Hatield and Ely (2015), explains the previous studies which emphasize the interrelationships between the systems that respond to pain and the systems that create physiologic stability, physiologic variables, alone, cannot confirm the existence or absence of pain. Thus, Hatfield and Ely(2015),supports the research for using both behavioral variables and physiological variables for identifying pain responses in infants by supporting the use of physiologic variables of heart rate and oxygen saturation and the use of behavioural variables of facial expressions and body movements as the indicator of pain responses to assess acute pain in infants.

6.4   Using appropriate pain assessment tools

Hatfield and Ely (2016), says combining both physiological and behavioural responses to obtain a composite picture of pain in infants is part of the rationale for multidimensional scales. When pain therapy interventions mitigate the behavioural pain response without parallelly managing the physiological pain response, an infant's pain is being under controlled, and the infant is exposed to the detrimental effects of the physiological response to pain (Holsti and Grunau 2007, cited in Hatfield and Ely 2015).

According to Beltramini et al (2017), ''the ideal pain assessment tool would be sensitive and free from bias; have good internal consistency, good interrater reliability, and good construct and discriminant validity; and be easy to understand and use for all children and for all types of pain in all clinical settings." None of the scales has all these attributes, and very few scales possess both strong validity criteria and are polyvalent. The scales have been validated according to a specific methodology, and each has specific psychometric properties. The context and the quality of the validity criteria depend upon the reliability of the tool which guides the caregiver in choosing the correct tool (Beltramini et al. 2017).

Infant's postoperative pain assessment tools can be categorised either multidimensional or unidimensional. Unidimensional tools include either physiological aspect or behavioural aspects. Multidimensional tools include both physiological and behavioural variables.

6.4.1   Unidimensional pain assessment tools.

Four different behavioural scales and one physiological scale in association with other novel tools for recording physiological variables have been emerged from the reviewed findings to assess postoperative pain in infants.

6.4.1.1 Behavioural pain scales

    i.   FLACC scale

The FLACC scale comprises of five behavioural categories: face, legs, activity, cry, and consolability. These responses are observed over 1-5 minutes with the pain score of 0-10. It has been validated in children aged 2 months to 7 years (Saul et al. 2016). The FLACC scale has been proven to be a good measurement tool in a recent study exhibiting excellent sensitivity and sensibility (Marques et al. 2019).

    ii.   Neonatal facial coding system (NFCS)

Originally, The Neonatal Facial Coding System (NFCS) was validated with 10 facial expression items for acute pain in preterm and term newborns and infants up to age 18 months. It was further simplified to only four facial expression items, which include: brow bulge, eyes squeeze, nasolabial furrow, and open lips. The tool is easy to use, reliable, fast, and results are reproducible (Beltramini et al. 2017).

    iii.   Evaluation Enfant Douleur (EVENDOL)

The Evaluation Enfant Douleur (EVENDOL) scale has validated for procedural pain and acute pain in the children age group from 0 to 7 years in an emergency setting, in out-of-hospital emergency medicine, and in postoperative care. It has four behavioural items, including verbal expression, facial expression, postures, movements, and one item related to the environment, which includes, for example, interested in people. Health professionals should note everything observed, even if they think the symptoms are not due to pain but to fear, fatigue, or illness. It is easy to use, reliable and is not influenced by hunger, fever, or fear (Beltramini et al. 2017)

    iv.   Children and Infants Postoperative Pain Scale (CHIPPS)

The CHIPS scale is multivalent and assesses all infants younger than age 1 year and also has also been validated for postoperative pain in children age 0 to 5 years. It includes only behavioural items (Beltramini et al. 2017). The four behavioural items are crying, facial expression, trunk's posture, legs' posture, and motor restlessness, which of each can be scored from o to 2 points. Also, the tool takes only fifteen seconds for observation. It has been validated in the postoperative period for newborns, toddlers, and young children (Marques et al. 2019).

6.4.1.2 Physiological pain measurement tools:

    i.   Cardiac Analgesia Assessment Scale (CAAS)

The CAAS scale comprises four indicators based on physiological factors, which include: pupillary size, heart rate, blood pressure, and respiratory and motor responses. This scale is consistent in reflecting pain over time and is useful, especially when evaluating an invasively ventilated patient subjected to high doses of sedatives and muscle relaxants (Marques et al. 2019).

6.4.1.3   Tools which record physiological variables

Biofactors translating autonomic nervous system responses, such as ECG, Photo Plethysmography (PPG), Electrodermal Activity (EDA), Galvanic Skin Response (GSR), Surgical Pleth index (SPI), Pupillary Dilating Reflex (PDR) and skin temperature for instance, have been studied for measuring pain in children during painful procedures, general anaesthesia or postoperative period suggesting a combination of physiological parameters of pain with behavioural parameters to produce a better outcome (Marques et al. 2019).

i.   Infrared thermal imaging

(Marques et al. 2019) states that Infrared thermal imaging can be helpful in analysing thermic variations in pain processing, mostly in neuropathic pain. This tool can measure not only superficial skin temperature but also its in-depth variations. It has proven to obtain good results, combining normal thermographs with altered temperature patterns in patients under painful stimuli.

ii.   Analgesia Nociception Index (ANI)

The ANI base itself on calculating heart rate variability through a continuous ECG analysis which correlates with parasympathetic activity. The ANI scale is both easy and quick to use, and it is translated by the ranging number from 0 to 100, where 0 means absence of analgesia and 100 absence of pain, both as an average value for a period of time or as an instant measure (Marques et al. 2019).

According to Marques et al. (2019), a study done by researcher Funcke has shown promising results regarding Analgesia Nociception Index (ANI), Surgical Pleth Index (SPI) and Pupillary Dilating Reflex (PDR), finding them highly sensitive and specific for assessing pain. Even though the experiment was done among adults during general anaesthesia, the findings can be applied to children in postoperative settings as these factors imply a good correlation between noxious stimuli (Marques et al. 2019).

6.4.2   Multidimensional pain assessment tools

From the reviewed findings, three multidimensional tools for assessing postoperative pain in infants have emerged and discussed below:

    i.   Premature infant Pain Profile (PIPP)

The PIPP has been assured in term and preterm new-borns for acute pain and procedural pain. It consists of three items, including facial expression and two items on variations in physiological constants. The pain threshold is weighted by gestational age and quality of sleep. The observation time is prolonged, so the assessment can be optimized by video re-cording, and it requires knowledge of the infant's usual behaviour (Beltramini et 2017).

    ii.   COMFORT Behaviour scale.

The COMFORT Behaviour Scale is used to monitor excess sedation in children from birth to ad-olescence, intubated ventilated or unconscious children in intensive care units, and in the postoperative setting. It assesses prolonged acute pain, discomfort, and distress. It includes eight items (with three physiological items). This scale is not reliable with paralysis. Because of the nonspecific variations of these features, a version without the blood pressure and heart frequency items was created, which is reliable and easier (Beltramini et al. 2017).

    iii.   The Crying requires increased oxygen administration, Increased vital signs, Ex-pression, Sleeplessness (CRIES) scale:

Beltramini et al. (2017), describes the crying requires increased oxygen administration, in-creased vital signs, expression, sleeplessness. (CRIES) the scale has been validated in new-borns from 32 weeks gestational age to age 6 months. It has 10 points (similar to Appearance, Pulse, Grimace, Activity, and Respiration-APGAR scoring). This scale is valid until 72 hours post-surgery and exhibits excellent interobserver reliability (Marques et al. 2019).

In cross-validation of the above-mentioned tools currently, EVENDOL and CHIPS are the most reliable tools in infants for assessing postoperative pain and are polyvalent (Beltramini et al. 2017, Marques et al. 2019).

7   Discussion:

The modified hierarchy of pain assessment techniques mentioned in the article by Joestlein (2015) has provided the framework for the research findings thus, resulting in four main methods of assessment of postoperative pain in infants which are: performing history taking through proxy reporting, identifying other potential causes of pain, observing infant's pain re-sponses and using appropriate pain assessment tools.

In a non-verbal population like infants, it has always been challenging for the health profes-sionals to assess postoperative pain where self-report is not possible, which was considered as

the standard gold method of assessing pain. Hence, to facilitate communication of pain between infants and the health professionals age-appropriate tools and have been applied frequently.

Marques et al. (2019), revealed that although behavioural pain scales are the frequently used pain assessing tools by healthcare providers, these tools are time-consuming and require a good education on the related topic by health care providers. Likewise, there is no unique observation method for pain assessment across all ages and contexts. Thus, the lack of a global cut-off point from a pain scale for pain treatment has kept patients at risk of overmedication or undertreated pain with severe consequences (Marques et al. 2019). Hence, Saul et al. (2016), suggest that it is vital for all healthcare professionals to be familiar with the principles of choosing suitable pain assessment tools to accurately and consistently assess pain in a variety of settings since no single tool is suitable for use in all the children.

Chatchumni et al. (2016), identified that the nurses assessed postoperative pain by judging the patient's appearance and mobility and through objective measures, for example, by taking vital signs. In addition, nurses tended to rely heavily on routines and structures and regarded competence as an individual concern, which means that they did not share their knowledge with any other staff. This approach did not foster collegial competence development, which was an important component of an evidence-based paradigm.

Joestlein (2015) revealed within the article that in addition to the difficulty assessing pain due to the patient's development ages, other factors for example medications used intraoperatively and patient anxiety, family members' and nurses' beliefs about pain could affect the assessment process of pain postoperatively. Likewise, the family member who have negative attitudes about pain medication, especially narcotic pain medication, may affect their assessment of children's pain in a postoperative setting. Hence, in the case of proxy reporting, eliminating fears of addiction, overdose, and existing side effects lead to better pain reporting and communicating from family members (Joestlein 2015).

In addition, Chatchumni et al (2016), identified that the quality of pain assessment has depended heavily on the individual nurse's experience, as well as their level of knowledge and competence which was noticed through variation in pain assessment skills and difference in the interpretation of patient pain among skilled nurses and the assistant nurses.

8 Limitations

The following literature review is limited with six articles that were selected from different online databases available to the students of Laurea University of Applied Sciences. Some of the scientific articles that seemed good and relevant to the study but were not accessible or need funds to open, therefore, were excluded for the research purpose. In addition, although

the researcher had tried best to extract top quality articles, the English language inclusion criteria might have limited the research. Even though the data in the chosen articles were consistent, the broader aspects of pain assessment methods among infants in the postoperative setting were limitedly described. Finally, some of the reviewed evidence-based articles were taken for the thesis, which could be another limitation.

9   Trustworthiness and Ethical Considerations

The trustworthiness of the study mentions the level of confidence or assurance in data collection and methods for using the reliability in a study. In every study, certain rules should be established and methods essentials for the study so that the reader can consider worthy achievement (Pilot & beck 2014, cited by Connelly 2016). There are certain criteria that are trusted by many qualitative researchers, and these criteria are confirmability, dependability, credibility, transferability, and authenticity (Guba & Lincoln 1914, cited by Connelly 2016). The ethical considerations and its significance in any scientific research have to be respected. Holloway and Wheeler (2013), defines that the validity, reliability, and integrity of the research finding depends strongly on ethical rules and principles. Thus, ethics are the norms and values for distinguishing between right and wrong and acceptable and unacceptable behaviours during the process of research which needs to be respected thoughout the research process.

During the research, the literature review has respected and followed the general principles of scientific research. Throughout the review process, Laurea's referencing guidelines were applied. To prevent the ethical violation, plagiarism was avoided by paraphrasing and using related citations.

10   Conclusion and Further Research Recommendation

The findings from the research reveal the methods assessing postoperative pain in infants in the postoperative environment and provide more knowledge to the nurses regarding the topic. The finding has evidence that they will benefit the health professional working with infants in the postoperative environment. It is very important for the nurses to understand the assessment methods for assessing pain in infants as nurses are the first to feel and notice discomfort arising to the client. Finally, the imparted knowledge from the thesis will surely provide knowledge on assessment methods among the health care professionals working with infants in the postoperative environment through assisting them in making decisions in clinical sectors. The knowledge of assessment helps to make better planning and interventions in the nursing career.

Since only a few academic database articles were used in data collection, recommendations are aimed at health care professionals in general for furthermore research regarding the topic

which could lead to more effective assessment of postoperative pain in infants. Further research could be conducted to explore how nurses assess postoperative pain in infants in Finland using the methods of questionnaire and interviews.

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12   Figures

13   Tables