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Painful procedures experienced by preterm newborns and evidence-based non-pharmacological methods

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Abstract

Preterm newborns are defined as babies born alive before 37 weeks of pregnancy are completed. Prolonged or frequent pain in the early stages of life can prevent the baby's behaviour, feeding patterns, adaptation to the outside world, as well as changes in brain development and adversely affect growth. Preterm newborns are known to be more sensitive to pain due to immature pain mechanisms. Therefore, preterm newborns need more support during painful procedures. The aim of this review is to provide information about the painful procedures encountered by preterm newborns in neonatal intensive care units and the evidence-based non-pharmacological methods for these painful procedures. This study used English–Turkish language articles and a search was conducted in PubMed, Scopus, Cochrane and Google Scholar, using a combination of key words like 'painful procedures', 'preterm newborn', 'non-pharmacological methods' and 'pain and newborn'. These terms are frequently used in non-pharmacological methods as well as pharmacological methods in pain relief. Non-pharmacologic methods used in pain management in preterm neonates are massage, kangaroo care, music, oral sucrose, pacifier, aromatherapy, swaddling, facilitated tucking, prone position, mother's touch, mother's voice and smell and breastfeeding method. Facilitated tucking, kangaroo care, swaddling, breast milk and oral sucrose are effective in heel blood collection and venous blood collection in newborns. It has been reported in the literature that the smell of glucose, breast milk, vanilla and lavender reduces pain. It is stated in the literature that breast milk, sucrose and kangaroo care used during the retinopathy of premature retinopathy reduces pain during and after the procedure. The aim of newborn pain management is to help reduce pain and help the baby cope with pain. Therefore, further research on evidence-based non-pharmacological methods is essential, and it is essential for all health professionals to be aware, know and practice non-pharmacological methods.

Keywords: Newborn, pain, non-pharmacological methods, preterm.

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1. Introduction

Preterm newborns are defined as babies born alive before 37 weeks of pregnancy are completed. There are sub-categories of preterm birth, based on gestational age (GA), extremely preterm (less than 28 weeks), very preterm (28–32 weeks) and moderate to late preterm (32–37 weeks) (World Health Organization, 2016). Specific receptors (nociceptors) to perceive the first pain impulses appear in the perioral region in the 7th week of intrauterine life, spreads to the rest of the face, palms and feet at 11 weeks, spreads to the arms and legs at 15 weeks and then to all cutaneous and mucous surfaces at 20 weeks (Akcan & Akbas, 2009; Anand & Hickey, 1987; Eroglu & Arslan, 2018). In summary, before the completion of the embryonic period, all of the afferent tracts are formed, except myelination. Even if neuronal differentiation and migration of the fetus develop early, myelinisation of pain pathways occurs over time (Dincer, Yurtcu & Gunel, 2011). Pain transmission in neonates is mediated by C-fibers (without myelins and slow conduction), which, therefore, is slow but uncontrolled, which may cause pain to be more severe in neonates than in older children and adults due to the immaturity of the inhibitory mechanisms that reduce pain. It is accepted that the anatomical and functional structures necessary for the transmission of pain in neonates have existed from the early embryonic period, they feel pain, remember painful stimuli, and then react more when they encounter the same stimuli (Eroglu & Arslan, 2018).

Newborns are exposed to an average of 5–10 invasive procedures daily for diagnosis and treatment (Aliefendioglu & Guzoglu, 2015). It is known that newborns are more sensitive to pain after invasive procedures due to immature pain mechanisms. Prolonged or frequent pain experience in the early stages of life can prevent the baby's behaviour, family infant interaction, feeding patterns, baby's adaptation to the outside world, as well as changes in the development of the brain and senses and affect growth negatively (Akcan, Yigit & Atici, 2009). In the preterm neonates, the pain-induced interventions should be identified and the pain symptoms should be closely monitored and appropriate intervention should be performed as soon as possible. Therefore, the pain behaviour of neonates, especially preterm neonates, should be monitored, evaluated and pain-controlled by evidence-based non-pharmacological methods should be effectively controlled.

1.1. Preterm newborns

According to the World Health Organisation, 15 million newborns are preterm prematurely (from 20 to 37 weeks) each year (World Health Organization, 2016). According to other data, 13 million newborns are born preterm each year in the world (Beck et al., 2010). Preterm births are at the top of the deaths of children under 5 years of age (World Health Organization, 2016). Despite improvements and improvements in neonatal care, cerebral palsy, learning disabilities and respiratory diseases are approximately 20% in preterm newborns (Beck et al., 2010). These preterm neonates need special care and treatment to achieve the goal of reducing child mortality in the 21st century (United Nations, 2013). In order to reduce infant mortality, national and international special care and treatment, especially for preterms, is required.

1.2. Definition of pain

The International Association for the Study of Pain defines pain as 'tissue damage or potential tissue damage or sensory and emotional experience identified during such damage'. It is also said that pain is a universal experience (Kuru et al., 2011). The Joint Commission on Accreditation of Healthcare Organisations describes pain as the fifth sign of life that should be monitored in medical care. As it can be understood from this definition, we should accept pain as a component of life signs, such as fever, pulse and blood pressure (Conk & Basbakkal, 2013).

1.3. Physiology of pain in newborn

The transmission of pain in the newborn is provided by C-fibers within the peripheral nerves that provide unmyelinated and slow conduction. With these fibers providing slow and uncontrolled transmission, pain transmission causes the newborn to feel pain more severe than the adult (Aliefendioglu & Guzoglu, 2015).

Studies have shown that pain is felt from intrauterine life. In a study in the literature, it was found that the baby's ability to respond to pain developed during the 20th and 24th weeks of pregnancy during intrauterine life (Reyes, 2003). According to another data, preterm newborns are thought to have the ability to respond to pain at post conceptional 26th weeks (Merskey, 1991).

1.4. Behavioural and physiological responses to pain

Pain symptoms in neonates are grouped as behavioural (showing different body movements, crying, facial expression, body tone) and physiological symptoms (heart rate, respiratory rate, increase in blood pressure, metabolic and hormonal changes) (Ball & Bindler, 2010; Ballweg, 2007; Curry, Brown & Wrona, 2012).

1.5. Pharmacological treatment methods

Pharmacological methods are the most commonly used methods to improve or prevent pain in newborns. However, many analgesics used in the treatment of pain have many negative effects. For example, opioids may have side effects, including drowsiness. In addition, the use of spontaneous breathing in patients may cause respiratory depression (Taddio, 2002). In newborns, various pharmacological methods, including opioids, acetominophen and topical anesthetics, are used for interventional pain. The pharmacological methods used to alleviate the pain of the newborn are reported to have significant side effects, such as respiratory distress, changes in oxygen saturation, apnea, bradycardia, hypotension, partial airway obstruction and hypersalivation (Anand et al., 2004). The pharmacological methods used for analgesia and sedation in pain control in newborns are monitored for possible side effects and it is considered safe to use them in appropriate doses and time. The pharmacological methods for pain treatment are expressed stepwise as follows:

1. In the first step, topical anesthetic cream or gels (lidocaine-prilocaine, liposomal lidocaine, amethocaine, tetracaine) are used.
2. In the second step, acetaminophen or non-steroidal anti-inflammatory agents (acetaminophen, propacetamol) are used.
3. In the third step, slow intravenous infusion of opiate is carried out (fentanyl, morphine, alfentanil, remifentanil).
4. In the fourth step, local anesthetics are used (lidocaine, bupivacaine, ropivacaine).
5. In the fifth step, deep sedation or general anesthesia (fentanyl, morphine, ketamine, alfentanil, anesthetic or sedative) is applied (Hall, 2012).

1.6. Non-pharmacological treatment methods

Non-pharmacological methods utilise environmental, behavioural and pharmacological approaches by activating the 'gate control mechanism' which prevents the sensation of pain from the central nervous system (Melzack & Wall, 1965). All interventions to control pain without medication are called non-pharmacological methods. Non-pharmacological methods used to reduce the perception of pain increase the effectiveness of drugs used with analgesics (Derebent & Yigit, 2008).

Non-pharmacological methods are preferred because they are easy to apply and inexpensive, reduce the need and side effects of drug administration. Massage, kangaroo care, music, sucrose, pacifier, aromatherapy, wrapping, nesting, prone position, shaking, maternal touch, maternal voice

and smell, individualised developmental care, breastfeeding and fetal position are among the non-pharmacological methods used in pain management in newborns (Yigit, Ecevit & Altun Koroglu, 2018).

As pain management in newborns becomes a need, pain non-pharmacological interventions for pain increase over time. Studies have suggested many non-pharmacological interventions, such as oral sucrose (Cignacco et al., 2012; Nimbalkar, Sinojia & Dongara, 2012), fetal position (Cignacco et al., 2012), non-nutritious sucking (Liaw et al., 2013), breastfeeding, wrapping (Ho, Ho, Leung, So & Chan, 2016), breast milk (Rosali et al., 2014) and kangaroo care to reduce the pain of newborns.

1.7. Heel blood collection and evidence-based non-pharmacological treatment methods

Newborn screening programme is routinely carried out for hepatitis B vaccine, vitamin K injection, blood sugar monitoring and detection of metabolic diseases in newborns who are in the process of adapting to the extra uterine environment. Within the scope of the newborn screening programme, the heel blood sample is taken from the capillary and is considered the most painful blood sampling attempt. Studies show that taking heel blood plays an important role in invasive procedures applied to the newborn. The process of taking blood from the heel, which leads to tissue destruction in the first days of life, is one of the attempts to cause pain in healthy newborns. The pain that occurs in the heel blood removal process has negative consequences in both short and long term, which further increases the importance of pain management in the heel blood removal process (Cong, Ludington-Hoe, McCain & Fu, 2009; Joffe, Cohen, Bearden & Welkom, 2009; Taddio, Katz, Ilersich & Koren, 1997; Walter-Nicolet, Annequin, Biran, Mitanchez & Tourniaire, 2010).

When we look at the studies carried out to reduce pain during the heel blood removal process, Corff, Seideman, Venkataraman, Lutes and Yates (1995) observed that the position of the fetus and the fetal position during the heel blood collection from preterms at 25–35 weeks of gestation evaluated the effect of position on pain and fetal position in effectively reducing the baby's behavioural and physiological responses to pain. Huang, Tung, Kuo and Ying-Ju (2004) examined the fetal position and the effect of arson on pain during the heel blood collection from preterm babies at 25–36 weeks of gestation and reported that it was effective in reducing pain in two positions, but the mean pain score of infants in fetal position was lower. Cignacco et al. (2012) evaluated the effect of fetal position and oral sucrose on pain during the application of heel blood from preterm at 24–32 weeks of gestation and reported that pain decreased more than oral sucrose administration in newborns given only fetal position, and pain decreased even more when both methods were applied together (Cignacco et al., 2010).

Johnston et al. (2003) evaluated the effect of kangaroo care on pain when heel blood was taken from preterms at 32–36 weeks of gestation and found that pain was reduced effectively after heel blood collection. Ho and Ho (2012) examined the effect of wrapping on pain perception before, during and after heel blood collection in preterm newborns. They found that the pain score averages of newborns who were wrapped before, during and after the procedure were significantly lower during the procedure than those who were not wrapped. Tantapong (2000), in his study of newborns at 32–35 weeks of gestation, examined the effect of wrapping on pain perception in heel blood retrieval and reported that the pain scores of newborns wrapped in heel blood retrieval were lower than those of non-wrapped newborns. Nishitani et al. (2009) found that newborns who smelled their own mother's breast milk while taking heel blood had less pain than newborns who smelled other mother's milk and formula milk. In line with these studies, non-pharmacological methods can be said to be effective in reducing the pain of newborns before, during and after the heel blood removal process.

1.8. Venous blood collection and evidence-based non-pharmacological treatment methods

Newborns in the neonatal intensive care unit (NICU) are exposed to numerous invasive procedures during their stay. Among these invasive procedures, venous blood collection is the most common procedure since blood samples are taken for the analysis of the newborn. It is stated that newborns

are more sensitive to pain after invasive procedures due to immature pain mechanisms (Caglayan & Balci, 2014).

Looking at the studies on pain management, Efe and Savaser (2007) reported 25% glucose during entering the vein in newborns and Beken et al. (2014) reported that 30% glucose was not effective when entering the vein but was effective in reducing pain after interference. Some studies investigated the effects of odours on pain during entering the vein. Bartocci et al. (2001) found that the scent of breast milk, Cignacco et al. (2007) found that the scent of vanilla and Razaghi, Sadat Hoseini, Aemmi, Mohebbi and Boskabadi (2015) found that the scent of lavender were effective in reducing pain.

As a result, it shows that non-pharmacological methods have a positive effect on pain relief during venous blood collection in newborn.

1.9. Endotracheal aspiration procedure and evidence-based non-pharmacological treatment methods

Endotracheal aspiration, which is one of the most painful interventional procedures carried out by nurses in the NICU, is defined as the mechanical cleaning of the secretions in the lung by an artificial airway (American Association for Respiratory Care, 2010). Endotracheal aspiration is required all newborns younger than 27 weeks of age, where 80% of newborns are 27–30 weeks old and about 30% of newborns are 30–32 weeks old (Mueller et al., 2003). The research showed that newborns not only feel and understand pain during endotracheal intubation, but also respond intensely to pain (Kucuk Alemdar & Guducu TufekcI, 2018).

Endotracheal aspiration negatively affects the physiological parameters: comfort, sleep, development and length of hospital stay of the newborn (Anand, 2000). Axelin, Salantera and Lehtonen (2006) examined the effect of fetal position on pain during endotracheal aspiration in preterm newborns and found that babies whose fetal position was given by their parents had significantly lower pain than routine position. Sener Taplak (2017) found that fetal position, smell of breast milk and white noise did not have an effect on reducing pain during endotracheal aspiration process, but fetal position, smell of breast milk, and white noise was more effective in recovery of preterm newborns after the procedure. Kucuk Alemdar and Guducu TufekcI (2018) in the study before, during and after the endotracheal aspiration procedure to listen to the newborn maternal heart sounds and preterms pain and relief levels were evaluated. Infants who heard maternal heart sounds during aspiration as a result of the intervention found that they had a lower pain score than the babies in the control group.

The results of the studies show that non-pharmacological methods used during endotracheal aspiration will be used as a reliable method for reducing pain in preterm newborns.

1.10. Retinopathy of prematurity (ROP) and evidence-based non-pharmacological treatment methods

Neonatal ROP is a pathophysiologic condition with unknown pathogenesis due to abnormal proliferation of retinal vessels (Koc, Bas, Ozdek, Ovali & Basmak, 2018). Low birth weight and GA are the two most important risk factors for ROP (Metres, 2014). According to the American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus and the American Academy of Pediatrics Association of Department of Ophthalmology, birth weight < 1,500 g or GA less than 30-weeks scan should be carried out for the eyes of all newborns and birth weight of 1,500–2,000 g or 32 weeks of gestation between ROP recommends that newborns should be tested for over (Sun, Lemyre, Barrowman & O'connor, 2010). Early recognition of premature retinopathy, timely and appropriate treatment, prevents vision loss, contributes to the child's developmental process and improves the quality of life (Koc et al., 2018).

Non-pharmacological methods such as swaddling, teat giving, sucrose, sterile water, fetal position, kangaroo care, breast milk and individualised developmental care are used to reduce pain during ROP

examination (Taplak & Erdem, 2018). Mitchell et al. (2004) and Gal (2005) evaluated the effect of 24% sucrose and sterile water on reducing pain during ROP examination using the PIPP scale and found that repeated doses of sucrose were effective in reducing pain. Rosali et al. (2014) evaluated the effect of swaddling, pacifier, proparacaine and breast milk with PIPP in reducing pain during and after ROP examination. They found that the use of breast milk is an effective method to reduce pain both during and after the procedure. Taplak and Erdem (2017) compared the effects of breast milk and sucrose on pain reduction during ROP examination to PIPP scores and found that the group receiving breast milk was higher than those in the group receiving sucrose. Padhi et al. (2015) in his prospective study examined the effect of kangaroo care in reducing pain during ROP examination and found that kangaroo care was effective in reducing pain.

Considering all these studies carried out nationally and internationally, it was concluded that non-pharmacological methods are used frequently during and after the ROP examination.

1.11. The importance of neonatal Intensive care nurse in pain management

NICU is a special nursing branch that provides continuous care, care and monitoring of risky newborns for 24 hours, critical thinking, communicating well with team members and using the technical equipment in the unit (Yildiz, 2008). According to the nurse identifying newborns in Turkey, the neonatal nurse is a nurse who plays an important role in ensuring the adaptation of newborns to the external environment, healthy growth and development, breastfeeding, protection from diseases and maximising health in line with their professional nursing roles. Additionally, the neonatal nurse is a someone who can evaluate the baby extensively and interpret the clinical signs and symptoms, evaluate with the family, determine the care needs of the newborn and plan the appropriate care according to the evidence-based information and communicate with the newborns and their relatives. In addition to all these roles, the neonatal nurse is also a nurse who can provide training and consultancy and have the ability to communicate and collaborate well with team members in a team approach (Resmi Gazete, 2011).

Non-pharmacological methods, one of the pain management strategies, include resistance to change, lack of knowledge and lack of time (Conk & Basbakkal, 2013). Therefore, appropriate guidelines for daily clinical practice involving painful procedures in neonates need to be prepared. In these guidelines, the situations in which non-pharmacological methods should be used, application diagrams indicating how they are used, their effects and the points to be considered in their use should be clearly stated. Despite this, in a study conducted by Cirik and Efe (2018) with 1,450 paediatric nurses, more than half (58.8%) of nurses expressed that they did not consider complementary health approaches to be the nurse's responsibility. In addition, nearly half of the nurses said they did not question whether families had used these methods on their children. Nurses are required to attend regular trainings about pain and non-pharmacological / pharmacological pain treatment methods in children and their clinics. However, all members of the team are responsible for pain relief by pharmacological and non-pharmacological methods.

2. Conclusions and recommendations

Preterm newborn are exposed to a lot of pain in the NICU. Preterm neonates are known to be more susceptible to pain due to immature pain mechanisms. Therefore, healthcare professionals working in the NICU should play an important role. These roles and responsibilities are listed below.

Additionally, the aim of preterm neonatal pain management is to help reduce pain and help the baby cope with pain. Therefore, further research on evidence-based non-pharmacological methods is essential and it is essential for all health professionals to be aware, know and practice non-pharmacological methods.

Recommendations for health professionals to reduce the pain experienced by preterm newborns at NICU;

- Follow evidence-based practices and studies for pain in the newborn,
- Provide the newborn with an appropriate position for the infant during invasive procedures,
- Observe physiological changes hormonal and behavioural responses of newborn,
- Evaluate pain-related changes continuously and comparatively,
- Neonatal intensive care should reduce environmental stimuli (loud noise, sudden and jarring movements in the area where the newborn sleeps, lights, etc.),
- Evaluate the care plan continuously using pharmacological and non-pharmacological methods in time for pain
- Correct misconceptions about pain and their thoughts through education.

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