

Kangaroo Mother Care for Procedural Pain in Pre-term Neonates

a report by

Celeste C Johnston, RN, DEd, FCAHS,¹ Marsha Campbell-Yeo, RN, MN, NNP-BC² and Ananda Fernandes, RN, MScN³

1. Professor, McGill University, Montreal; 2. Neonatal Nurse Practitioner, Izaak Walton Killam (IWK) Health Centre, Halifax, Nova Scotia;

3. Co-ordinating Professor, Coimbra College of Nursing

Human mimicry of marsupial behavior in a healthcare context is known as kangaroo mother care (KMC), so-called because the infant is held skin-to-skin with the mother with no clothing between them. Skin-to-skin care (SSC) or kangaroo care (KC) involves holding a diaper-clad infant upright at a 60° angle between the mother's breasts. The technique was originally developed to use the mother as a means of keeping pre-term neonates warm in the absence of a sufficient number of incubators in Colombia,^{1,2} and it has now become accepted as a mode of care for pre-term neonates.³ Some studies have demonstrated KMC to be at least as good as conventional care in terms of survival rate.⁴⁻⁸ Other benefits, such as physiological stability,⁹⁻¹⁵ the establishment of exclusive breastfeeding,^{4,16,17} infant state transition,¹⁸ temperature^{11-15,19} self-regulation,²⁰ and even later development, have been reported.²¹⁻²³ Not surprisingly, KMC also promotes family bonding.^{1,21,24-26} Not all KMC studies are well-controlled or designed; however, the results are positive²⁷ and no adverse events have been reported,⁵ except one case in a tuberculosis-endemic setting.²⁸ While the duration of providing KC ranges from continuous around-the-clock holding as an alternative to incubator to shorter intermittent periods, this article will focus on its shorter-term use for pain.

Touch and Skin Contact

Touch is considered to be a vital component of KMC, and is known to be crucial to development and even survival.²⁹⁻³¹ From very early gestation, infants have built-in mechanisms for soothing and comfort,³² and all neonates are capable of perceiving and responding to biological and sensory stimuli.³³ Tactile awareness is one of the first senses to develop, and occurs in the fetus at seven to eight weeks' gestational age,³⁴ and psycho-neuro-endocrine development occurs mid-gestation at approximately 20 weeks.^{35,36} Gentle touch or stroking and massage have been reported to have positive effects on newborns. Infants have been shown to exhibit decreased levels of active sleep, motor activity, behavioral distress, and increased weight gain following gentle human touch³⁷⁻³⁹ and massage;^{40,41,42} however, in the extreme pre-term, massage has been less promising.^{38,43} Alterations in vagal tone—a marker for regulatory maturation—secondary to tactile stimulation has been associated with

diminished infant stress and improved regulation.^{41,44,45} Additionally, the release of hormones that promote homeostasis in the context of maternal touch have been documented.^{29-31,46,47} The comfort hormones—endorphins, oxytocin, and serotonin—have been associated with modulating pain response.⁴⁸⁻⁵²

Procedural Pain in the Neonatal Intensive Care Unit

The recognition that unmanaged pain in pre-term neonates has deleterious effects has been recognized for more than a decade.^{53,54} Even procedural pain, considered minor by care-givers, can result in immediate physiological instability,⁵⁵⁻⁵⁹ blunting of the display of behavioral cues,⁶⁰⁻⁶³ and even modification of the hypothalamic-pituitary-adrenal axis response.^{64,65} Despite this, numerous surveys have shown that procedural pain remains largely unmanaged.⁶⁶⁻⁶⁹ Some of these surveys are recent⁷⁰ and show little change in practice, despite guidelines that suggest the use of non-pharmacological interventions. Sucrose or sweet taste has been shown to be efficacious in many trials and is considered by some to be a standard of care.⁷¹ Reports of high doses over 24-hour periods have shown some negative outcomes, but within a certain limit repeated use of sucrose provides analgesia over time with no adverse events.⁷²⁻⁷⁵

Environmental Context and Comfort for Alleviation of Pain

Infants have been shown to have cortical perception^{76,77} and 'memory' of pain, exhibited by both peripheral hypersensitization⁷⁸ and behavioral response.^{60,63,64,79} Recently, two studies using near-infrared spectroscopy (NIRS) to measure pain experience in pre-term infants, revealed that infants as young as 28 weeks of gestation exhibit cortical response during heel stick.^{76,77} Functional magnetic resonance imaging (MRI) of adults demonstrated that pain perception and inhibitory mediation appears to involve multiple areas of the brain, referred to as the 'pain matrix,'⁸⁰ and that perception and response can be mediated by visual cues and relational factors.⁸¹ Although not yet proved by neonatal neuroimaging, the assumption that neonates may also perceive and respond to pain and distress in a similar interlinked manner is highly plausible. We know that pain in newborns can be soothed with alterations in the environmental context and the provision of non-pharmacological interventions involving orogustatory, vestibulokinesthetic, and/or olfactory and tactile systems. Sweet-tasting solutions, breastfeeding, and non-nutritive sucking regulated through endogenous opiate and serotonin systems have been shown to diminish pain responses associated with procedural pain.^{71,82,83} Containment methods, such as swaddling and facilitated tucking, are thought to enhance regulation of the infant state and have also been shown to be beneficial.⁸² KMC or SSC provides a multisensory context encompassing elements of contact and containment, olfactory, and relational systems. Mothers have a unique role in the touch of their infant. It is now understood that infants recognize their mother through



Celeste C Johnston, RN, DEd, FCAHS, is a James McGill Professor in the School of Nursing at McGill University. She is Past Secretary of the Special Interest Group for Pain in Children of the International Association for the Study of Pain (IASP) and was elected Councillor of that association in 2008. Professor Johnston's research, funded mostly by the Canadian Institutes of Health Research (CIHR), is focused on pain in infants and children, and changing the practices of healthcare professionals related to pain management.

E: celeste.johnston@mcgill.ca

Table 1: Studies Examining the Effect of Kangaroo Mother Care on Pain Response

| Study | Subjects | Design and Intervention | Outcome Measures | Results in KMC |
|--------------------------------|---|---|--|--|
| Gray ⁹⁸ | 30 healthy full-term infants >37 WGA | Randomized controlled trial. 10–15 minutes KMC versus swaddled in crib | Duration of cry, grimacing, HR | Cry reduced by 82%, grimacing reduced by 65%, smaller increase in beats/minute during blood collection (8–10 versus 36–38) |
| Johnston ⁹⁹ | 74 pre-term infants (32–36 WGA) | Single-blind, randomized, cross-over trial. 30 minutes KMC versus swaddled in incubator | PIPP: facial actions, heart rate, oxygen saturation, gestational age, behavioral state | PIPP scores significantly lower by two points at 30, 60, and 90 seconds after lancing |
| Ludington-Hoe ¹⁰⁰ | 23 pre-term infants \leq 37 WGA (mean 31 WGA) | Randomized cross-over trial. Three hours of KMC versus three hours in incubator | Heart rate, respiratory rate, oxygen saturation, less crying, length of crying, behavioral state | Lower mean rise in HR from baseline to lance, during lance, and post procedure. No differences in respiratory rate and oxygen saturation. More time in quiet/sleep states. |
| Castral ¹⁰¹ | 59 pre-term infants (30–37 WGA) | Randomized controlled trial. 15 minutes KMC versus swaddled in incubator or crib | Facial action, NFCS score, behavioral state, duration of cry, heart rate | NFCS score significantly lower at heel lance (-1.140; p=0.23) and squeeze phase (-1.872; p<0.001) Cry reduction by 37.4%. No difference in HR. |
| Johnston ¹⁰² | 61 very pre-term infants (28–31 WGA) | Single-blind randomized cross-over trial. 15 minutes KMC versus swaddled in incubator | PIPP, time to recover (heart rate return to baseline), facial actions, HR, oxygen saturation | PIPP scores lower at 90 seconds (8.871 versus 10.677; p<0.001). Time to recover shorter (p<0.0000). Facial actions significantly fewer across the procedure. HR lower across the first 90 seconds. Oxygen saturation higher at 60 seconds. |
| Kostandy ¹⁰³ | 10 pre-term infants (30–32 WGA) | Randomized cross-over trial. 30 minutes KMC versus nested in incubator | Audible and inaudible crying (Anderson Behavioral State Scoring system) | Less combined crying time during heel stick (55 versus 96.2 seconds; p=0.001) and during recovery (5.8 versus 25.5 seconds; p<0.01). Inaudible cry was minimal in each phase, in both conditions 0–1.34 seconds. |
| De Sousa Freire ¹⁰⁴ | 95 pre-term neonates (28–36 WGA) | Randomized controlled trial. 15 minutes variation KMC versus oral glucose versus prone position in incubator | Behavioral state, HR variation, oxygen saturation, PIPP scores for facial actions | No difference in behavioral state, smaller variation in (p<0.0001) and HR in oxygen saturation (p<0.0012), lower scores for facial actions (p<0.0001). |
| Johnston ¹⁰⁵ | 90 pre-term infants (32–36 WGA) | Single-blind randomized cross-over trial. KMC with additional rocking, singing, and sucking versus KMC without additional stimulation | PIPP, time to recover | No significant differences in PIPP scores or time to recover significant, differences across sites. |

WGA = weeks' gestational age; HR = heart rate; KMC = kangaroo mother care; GA = gestational age; NFCS = Neonatal Facial Coding System; PIPP = premature infant pain profile.

various sensory modalities such as olfactory^{84–87} and auditory.⁸⁸ Both term and pre-term infants have olfactory memory. Not only do they show preference for their own mother's amniotic fluid and breastmilk, but also this recognition has been shown to reduce crying during maternal separation and pain response during heel stick.^{86,89–92} Interestingly, olfactory recognition of a familiar smell can elicit a similar comforting response,^{91–93} indicating both memory and ability to learn, recall capacity, and have emotional connections even in young, very pre-term infants.

Kangaroo Mother Care for Procedural Pain

Given the results of KMC studies, which showed physiological stability and the release of 'comfort' hormones, it was not surprising that investigators would consider KMC as a means of comfort for procedural pain. Supporting this was, the increase in the practice of KMC in NICUs,^{94,95} as well as mothers reporting the loss of parental role and the pain the child underwent as the most stressful aspects of an NICU admission of their child.^{96,97} Allowing mothers to practice KMC as a comfort measure for procedural pain had the potential of decreasing the pain of the infant as well as restoring the maternal role of comfort. The first study by Gray et al. was carried out on full-terms.⁹⁸ The first study testing KC for pain reduction with pre-term neonates was in 2003,⁹⁹ and has been followed by six other studies (see *Table 1*).^{100–105}

Is Kangaroo Mother Care for Procedural Pain Acceptable to Mothers and Nurses?

As can be seen in *Table 1*, KMC has been shown in well-controlled studies to be consistently efficacious in decreasing procedural pain in neonates, even the very young. There has been some concern that mothers may find it difficult to hold their infants in the KMC position while the child undergoes a painful procedure. In the studies that we conducted, we asked mothers how they felt about performing KMC during a painful procedure. A majority of mothers (80%) expressed positive feelings after using the KC method during the heel lance. All but two of the 173 mothers said that they would wish to use KMC again in spite of some apprehension beforehand, and would recommend it to other mothers as a way to help reduce their infant's pain. Mothers verbalized feelings of higher self-control and actualization of the parental role, a finding that is in keeping with a previous study examining KMC and attachment.^{106,107} KMC as a non-pharmacological means to diminish pain appears to play a dual purpose by creating an opportunity for mothers to regain their parental role, a frequently cited area of distress.⁶⁵ Of course, mothers who were very uncomfortable with KMC at all or for procedural pain did not participate in these studies. However, the refusal rate in those studies was fairly low (28%), and only 49% of those who refused reported their reason for not doing so was discomfort with the idea of KMC for procedural pain.

Conclusions

KMC appears to be a safe and efficacious method to decrease procedural pain in neonates. With eight well-conducted studies consistently showing positive results, there is now sufficient evidence to set it as a standard of care. Recent guidelines from the American and Canadian Pediatric Societies Fetus and Newborn Committees¹⁰⁸ have included it as an option for procedural pain management, and other reviews have recommended it.^{82,109} Questions still remain about its efficacy over repeated episodes, and if it necessarily has to be

maternal KC or if other people could substitute as effectively. The combination of KMC and sucrose may prove even more efficacious than either alone, and would not interfere with KMC. ■

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