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Effects of Skin-to-Skin Contact on Autonomic Pain Responses in Preterm Infants

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Abstract: The purpose of this randomized crossover trial was to determine the effects on autonomic responses in preterm infants of longer Kangaroo Care (30 minutes, KC30) and shorter KC (15 minutes, KC15) before and throughout heel stick compared with incubator care (IC). Beat-to-beat heart rate (HR) and spectral power analysis of heart rate variability, low frequency power (LF), high frequency power (HF), and LF/HF ratio were measured in 26 infants. HR changes from Baseline to Heel Stick were significantly less in KC30 and KC15 than in IC, and more infants had HR decrease in IC than in 2 KC conditions. In IC, LF and HF significantly increased from Baseline to Heel Stick and dropped from Heel Stick to Recovery; in 2 KC conditions, no changes across study phases were found. During Heel Stick, LF and HF were significantly higher in IC than in KC30. In all 3 conditions, LF/HF ratio decreased from Baseline to Heel Stick and increased to Recovery; no differences were found between IC and two KC conditions. Both longer and shorter KC before and throughout heel stick can stabilize HR response in preterm infants, and longer KC significantly affected infants' sympathetic and parasympathetic responses during heel stick compared with incubator care.

***Perspective:** This study showed that KC has a significant effect on reducing autonomic pain responses in preterm infants. The findings support that KC is a safe and effective pain intervention in the neonatal intensive care unit.*

***Key words:** Pain, skin-to-skin contact, heart rate variability, heel stick, preterm infant.*

In the high-tech neonatal intensive care unit (NICU), preterm infants are subjected to an average of 10 to 16 painfully invasive procedures per day, with repeated heel sticks accounting for 55 to 86% of these procedures.[11,15,30] Unrelieved pain caused by invasive procedures is associated with detrimental physiologic and behavioral outcomes in all major organ systems, can be life-threatening, and has lasting implications for impairment of biobehavioral outcomes in adulthood.[1,22,24,39,46] Although recent advances in neurobiology and clinical studies have demonstrated that preterm infants do experience and respond to pain,[6,17,46,53] 40 to 90% of infants do not receive preventive and/or effective treatment to reduce procedural pain.[11,30,34,55] Opioids have been found ineffective against procedural pain in preterm infants and are not recommended.[4,10] Nonpharmacologic interventions, especially those incorporating parental involvement, are highly recommended but are known to need further investigation.[3] Unmanaged procedural pain is a significant problem in most NICUs, and documenting effective interventions to reduce painful experiences in neonates is of utmost importance.[9]

Skin-to-skin contact, also called Kangaroo Care (KC), is operationally defined as the upright prone positioning of the diaper-clad infant skin-to-skin and chest-to-chest with an adult. Several reports have shown that KC has a powerful effect on reducing procedural pain in preterm infants compared to standard incubator care.[12-14,16,19,25,26,28,36] In addition, a recent meta-analysis[49] on nonpharmacological management of infant pain shows KC is effective in reducing pain reactivity and improving pain-related regulation for preterm infants. Various durations/doses of KC intervention, the effect of KC on pain response when used for 10 to15 minutes,[12,16,19,25] 30 minutes,[14,26,28] 80 min,[13,14] or 3

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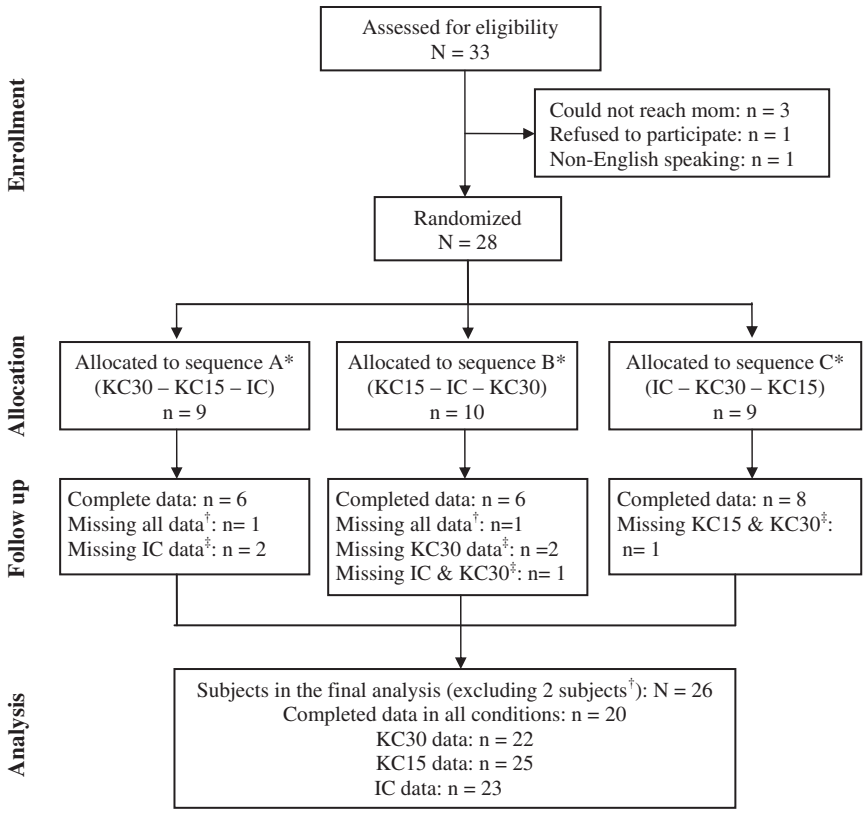

Figure 1. CONSORT diagram of enrollment, allocation, follow-up, and data analysis. *Sequence A: the consecutive study conditions were KC30, KC15, and then IC; Sequence B: the consecutive study conditions were KC15, IC, and then KC30; Sequence C: the consecutive study conditions were IC, KC30, and then KC15. †No data were collected in all 3 study conditions. ‡Early termination of the data collection.

hours[36] before and through the heel stick, have been studied; all durations have been shown to be effective in reducing behavioral and physiological pain responses. However, the autonomic responses to different durations of KC are unknown, and studies determining the most effective duration of KC for maximum pain reduction in young preterm infants have not been reported.

Physiological responses to painful stimuli in infants include increases in heart rate, respiratory rate, blood pressure, intracranial pressure, and palmar sweating, and decreases in transcutaneous oxygenation saturation, vagal tone, and peripheral and cerebral blood flow.[39,47,54,60] Although most infants show both behavioral and physiological responses to pain, young preterm infants often respond to pain without concordant behavioral and physiologic measures. Behavioral responses may diminish when acute pain abates, but physiological responses may remain elevated when stress continues.[5,54] Therefore, behavioral and physiological indicators should be distinctly measured as pain outcomes in preterm infants. In addition to monitoring infants' behavioral responses, the measure of KC's pain reduction ability can be established by determining KC's effects on autonomic responses. One such autonomic response—heart rate variability (HRV)—is the variation in the R-to-R, or beat-to-beat interval. It is a noninvasive measure of autonomic regulation of heart rate (HR) and is a sensitive index of stress due to pain reactivity. The spectral analysis of HRV is used to determine the frequency content of the fluctuating HR. The spectral power of the low-frequency (LF) band (.04–.15 Hz) primarily represents sympathetic activity with some parasympathetic activity, while the high-frequency (HF) band (.15–1.0 Hz) is related to respiratory sinus arrhythmia and reflects parasympathetic activity. The LF/HF ratio reflects the balance of sympathetic and parasympathetic activities. HRV is a recommended indicator to be examined in response to painful events shortly after birth.[20,59] The purpose of this study was to examine the effect on autonomic pain responses in preterm infants of longer and shorter durations of KC before, during, and after heel stick compared to the standard incubator care.

Methods

Design

A randomized cross-over design was used to determine the effect of a longer KC condition (30 minutes of KC before and throughout heel stick; KC30) and a shorter KC condition (15 minutes of KC before and throughout heel stick; KC15) compared with standard incubator care (IC) during heel stick. Mother-infant dyads were randomly assigned to 1 of the 3 sequences of the intervention order: Sequence A with KC30, KC15, and then IC; Sequence B with KC15, IC, and then KC30; and Sequence