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REVIEW

Understanding kangaroo care and its benefits to preterm infants

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Abstract: The holding of an infant with ventral skin-to-skin contact typically in an upright position with the swaddled infant on the chest of the parent, is commonly referred to as kangaroo care (KC), due to its simulation of marsupial care. It is recommended that KC, as a feasible, natural, and cost-effective intervention, should be standard of care in the delivery of quality health care for all infants, regardless of geographic location or economic status. Numerous benefits of its use have been reported related to mortality, physiological (thermoregulation, cardiorespiratory stability), behavioral (sleep, breastfeeding duration, and degree of exclusivity) domains, as an effective therapy to relieve procedural pain, and improved neurodevelopment. Yet despite these recommendations and a lack of negative research findings, adoption of KC as a routine clinical practice remains variable and underutilized. Furthermore, uncertainty remains as to whether continuous KC should be recommended in all settings or if there is a critical period of initiation, dose, or duration that is optimal. This review synthesizes current knowledge about the benefits of KC for infants born preterm, highlighting differences and similarities across low and higher resource countries and in a non-pain and pain context. Additionally, implementation considerations and unanswered questions for future research are addressed.

Keywords: kangaroo care, skin-to-skin contact, infant, preterm, review

Introduction

Mothers hold babies to their chest instinctively. Currently, in less well developed societies, where cribs, strollers, and infant seats are not common, mothers or other caregivers carry their infants on their chest for many hours a day.[1] Often there is nothing between the caregiver's chest and the baby's skin other than a diaper. This paradigm of holding an infant with ventral skin-to-skin contact (SSC), typically in an upright position and with the swaddled infant on the chest of the parent, is also commonly referred to as kangaroo care (KC), due to its simulation of marsupial care. While there are no recordings of infant care from the distant past, it is likely that KC of newborns has been practiced for eons. An example of the basic survival value of skin-to skin contact between infant and mother can be demonstrated when there is no interference from health care providers at delivery, specifically when the infant is placed skin-to-skin on its mothers chest at birth, within 20 minutes it will work its way toward the nipple and suckle.[2]

The medical use of this natural phenomenon was originally introduced by Edgar Rey Sanabria in Columbia in 1978 as a strategy to replace the function of incubators, which were in short supply in that country. Infants who were preterm, but otherwise stable, were put in continuous KC with their mothers. There are variations in KC practices, but all of it involves SSC. For example, kangaroo mother care (KMC)

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refers to SSC that is provided continuously until the infant begins to sweat and resist the position, an indication of more mature temperature regulation and development. Breastfeeding is exclusive, and discharge home occurs earlier than usual, when the baby is stable and the mother is comfortable providing continuous SSC.[3–5] Fathers and other family members can also be providers when the mother is unavailable.[6]

In resource-rich countries, SSC is seen as complementary to incubator care, and so continuous KC is rare. Implementation of SSC in hospitals has largely been motivated by a desire to humanize what has become a medical experience, and as partial fulfillment of the requirements set out in the Baby Friendly Hospital Initiative (BFHI).[7] The purpose of SSC in resource-rich countries has therefore been focused on facilitating infant transition to extrauterine life, promoting early bonding and establishing exclusive breastfeeding. SSC has shown added benefit for the mother, including reduced incidence of post-partum hemorrhage;[8] however, this review focuses primarily on the benefits to infants. More recently, strong evidence related to the pain-relieving benefits of SSC, almost exclusively studied in developed countries, has emerged.

KC has been studied for its effect on mortality, morbidity, physiological stability, breastfeeding, parental bonding, development, and pain control.[9–11] Yet despite consistent positive findings for all outcomes, adoption of KC as a routine clinical practice remains extremely variable across settings. It is recommended that KC is a feasible, natural, and cost-effective intervention, and should be standard of care in the delivery of quality health care for all infants, regardless of geographic location or economic status. What remains uncertain is whether continuous KC should be recommended in all settings or if there is a critical period of initiation, dose, or duration that is optimal. This review provides a synthesis of our current knowledge about the benefits of KC, highlighting differences and similarities across gestational age, low and higher resource countries, and in a non-pain and pain context. Additionally, implementation considerations and unanswered questions for future research are addressed.

Benefits of KC

Since the inception of KC as a low-cost alternative to incubator care in areas with limited resources, clinicians and researchers have, over time, documented both physiologic and behavioral benefits for infant and mother (see Table 1). Many of these benefits have been researched sufficiently to permit meta-analysis, such that two Cochrane reviews exist on the subject.[9,10] One focuses on healthy term or late-preterm newborns,[9] while the second includes low birth weight infants.[10]

Physiologic benefits

Homeostasis (temperature regulation, physiological stability, blood glucose)

When compared with standard care (incubator, radiant warmer, or open crib), KC has shown benefits for homeostasis. Preterm infants who receive KC are more likely to maintain a healthy body temperature, and show increased cardiorespiratory stability.[10,12–20] Looking at the entire hospitalization, KC is associated with decreased likelihood of infection, severe illness, and death.[10,21] Additional evidence for the positive influence of KC exposure on autonomic regulation comes from a recent longitudinal study,[22] which showed a significant increase in baseline autonomic stability at 10 years follow-up. Even a very small amount of KC (1 hour a day for 14 days) provided to preterm infants compared with infants cared for only in an incubator was associated with improved infant and maternal outcomes. These findings are of particular interest because they are the first to demonstrate the long-lasting value of early KC.

Implications for practice

The evidence for the ability of KC to promote homeostasis is strong, especially in developing countries, where good evidence suggests that continuous KC can reduce mortality.[10] Unfortunately, the clinical picture is less clear in the developed world. The best evidence available is focused on intermittent use of KC, and while homeostatic benefits should theoretically persist when KC is continuous, there is a lack of studies designed to address this. Combined analysis conducted by Conde-Agudelo et al found that benefits that were clear in less developed countries (eg, reduction in sepsis, mortality, and severe illness) were not present when studies were limited to those in developed countries.[10] There remain limitations in making conclusions regarding the optimal time spent in KC to achieve maximum benefits. Feldman et al[22] offer compelling evidence that an average of 1 hour a day of KC may impart long-lasting benefits, but evidence is still lacking as to whether shorter or longer time periods may impart different benefits. Clinicians should use best judgment in balancing the illness acuity of individual infants, parent availability, and potential benefits.

Implications for research

Benefits that were discovered through research in developing countries should not be extrapolated to better resourced

Table 1 Benefits of KC in non-pain context

Reference	Sample and setting	Design	Provider	Outcome measures	Results
Temperature regulation					
Christensson et al[12]	Sample: n=80, >1,500 g Mode of delivery: not reported Setting: teaching hospital, Zambia	RCT: KC versus incubator for treatment of hypothermia	Mother	Rectal temperature	KC > control normal temperature at 240 minutes (90% versus 60%, $P<0.001$)
Conde-Agudelo et al[10]	Sample: n=698 LBW infants (six studies)	Meta-analysis of RCTs	Mother	Hypothermia at discharge or 40–41 weeks of PMA	KC < SC (RR 0.34, 95% CI 0.17–0.67)
Ludington-Hoe et al[13]	Sample: n=29, preterm (26–35 weeks) Mode of delivery: not reported Setting: level II NICU in USA	RCT: KC ×3 2.5–3.0 hours versus SC	Mother	Abdominal and toe temperature	Abdominal temperature: no difference Toe temperature: KC > SC ($F=7.04$, $P=0.02$)
Legault and Goulet[14]	Sample: n=61, premature (32–35 weeks) Mode of delivery: not reported Setting: level III NICU, Canada	Randomized crossover trial	Mother	Skin temperature	No difference
Chwo et al[15]	Sample: n=34, 34–36 weeks GA Mode of delivery: V (n=11) C/S (n=23) Setting: Taiwan	RCT: KC versus control versus SC	Mother	Tympanic temperature	KC > SC (MD 37.3°C versus 37.0°C, $P=0.01$)
Marin Gabriel et al[16]	Sample: n=137, 35–42 weeks GA Mode of delivery: V Setting: hospital, Spain	RCT: early KC ×2 hours versus SC	Mother, early KC ×2 hours	Axillary temperature	Rise in temperature first 5 minutes: KC > SC 0.07°C±0.58°C versus –0.22°C±0.52°C in the CG ($P<0.001$). Mean temperature first 5 minutes of life: 36.6°C±0.79°C in the KC group versus 36.9°C±0.58°C in the CG ($P<0.01$)
Gathwala et al[43]	Sample: n=110 LBW infants (35 weeks mean GA) Mode of delivery: not reported	RCT: KC at least 6 hours/day versus incubator care; 16-month longitudinal study	Mother	Mean axillary temperature, episodes of hypothermia	Mean temperature: KC > SC (36.67°C±0.24°C versus 36.44°C±0.22°C; $P<0.05$) Episodes of hypothermia: no statistically significant difference
Physiological stability					
Bergman et al[17]	Sample: 31 KC, mean 34.2 weeks; 13 controls, mean 35.3 weeks Mode of delivery: V Setting: two secondary hospitals in South Africa	31 KC, mean 34.2 weeks; 13 controls, mean 35.3 weeks	Mother	SCRIP[a] score during first 6 hours after birth Infants who did not exceed defined physiological parameters requiring attention	Higher scores in KC (MD 2.88; 95% CI 0.53–5.23). Attention more likely to be required in SC group (RR 10.83; 95% CI 1.63–72.02)
Ludington-Hoe et al[18]	Sample: 24 preterm (33–35 weeks GA at birth) Mode of delivery: N/A Setting: NICU, USA	RCT: KC versus SC in infants nearing discharge	Mother	HR, RR, O_2 saturation, abdominal skin temperature	Mean cardiorespiratory and temperature outcomes within acceptable ranges during KC; no apnea, bradycardia, or periodic breathing in KC; KC > regular breathing
Mitchell et al[19]	Sample: n=38, 27–30 weeks GA Mode of delivery: not reported Setting: NICU, USA	RCT: 2 hours KC versus SC	Mother	HR, O_2 saturation	Bradycardia/hour: KC < SC ($P=0.048$) O_2 desaturation events: KC < SC ($P=0.017$)

(*Continued*)

Table 1 (*Continued*)

Reference	Sample and setting	Design	Provider	Outcome measures	Results
Legault and Goulet[14]	Sample: n=61, premature (32–35 weeks) Mode of delivery: not reported Setting: level III NICU, Montreal, Canada	RCT crossover	Mother	HR, RR, O_2 saturation	O_2 saturation: KC > SC (92.8% versus 90.5%, $P<0.0001$)
Rojas et al[20]	Sample: 60 LBW (32 weeks, <1,500 g) Mode of delivery: not reported Setting: pediatric hospital, USA	RCT: KC for 1 hour versus holding clothed in supine position	Mothers and fathers (70±40 minutes/day)	Percentage of infants with O_2 desaturation during observation	KC < control (30% versus 56%, $P=0.05$)
Sleep organization					
Ludington-Hoe et al[30]	Sample: n=28, PMA 32 weeks Mode of delivery: not reported Setting: USA	RCT: 2–3 hours KC versus SC	Mother	Sleep arousal, REM, quiet sleep, indeterminate sleep	Sleep arousal: KC < SC (BKC = –7.35, $P=0.015$); REM counts during AS: KC < SC REM counts during AS (BKC = –8.9, $P=0.029$) REM counts during study period: KC < SC (BKC = –5.11, $P=0.013$) Quiet sleep: KC > SC % QS ($\beta = +10.3$, $P=0.05$), Indeterminate sleep: KC < SC % IS ($\beta = -9.0$, $P=0.01$)
Chwo et al[15]	Sample: n=34, 34–36 weeks GA Mode of delivery: V (n=11) C/S (n=23) Setting: Taiwan	RCT: KC versus control versus SC	Mother, 3 hours	Quiet sleep (recorded at 5-minute intervals)	KC > control (62% versus 22%, $P=0.001$)
Scher et al[31]	Sample: eight preterm Mode of delivery: not reported Setting: USA	Cohort comparison	Mother	Sleep analysis (EEG)	REM counts during study period: KC < SC ($P<0.0001$) Sleep cycle length: KC > control ($P=0.01$) Quiet sleep: KC > control ($P=0.0001$) Spectral beta power: KC < control ($P=0.025$) Spectral respiratory irregularity: KC > control ($P=0.02$)
Mortality					
Conde-Agudelo et al[10]	Sample: 1,736 LBW infants (eight studies)	Meta-analysis of RCTs		Mortality at discharge or 40–41 weeks PMA	KC < SC (RR 0.60; 95% CI 0.39–0.92)
	2,167 LBW infants (eleven studies)			Mortality at latest follow-up	KC < SC (RR 0.67; 95% CI 0.48–0.95)
Infection					
Conde-Agudelo et al[10]	Sample: 1,343 stabilized LBW infants (seven studies)	Meta-analysis of RCTs	Mother	Severe infection/sepsis at latest follow-up	KC < SC (RR 0.56; 95% CI 0.40–0.78)
	283 LBW (one study)			Severe illness at 6 months	KC < SC (RR 0.30; 95% CI 0.14–0.67)
	913 LBW (three trials)			Nosocomial infection/sepsis at discharge or 41 weeks PMA	KC < SC (RR 0.45; 95% CI 0.27–0.76)
	283 LBW (one study)			Lower respiratory tract disease at 6 months follow-up	KC < SC (RR 0.89; 95% CI 0.15–0.89)
	1,266 LBW infants (four studies)			Mild/moderate infection or illness at latest follow-up	No difference (RR 1.28; 95% CI 0.87–1.88)
	448 LBW (four studies)	RCT	Mother	Hyperthermia at discharge or 40–41 weeks' PMA	No difference (RR 0.79; 95% CI 0.59–1.05)

Sloan et al[21]	Sample: 283 LBW (mean GA 33 weeks) Mode of delivery: not reported Setting: Ecuador	RCT: KC w/frequent BF versus SC with scheduled BF	Mother	Diarrhea at 6 months follow-up	No difference (RR 0.65; 95% CI 0.35–1.20)
Growth					
Conde-Agudelo et al[10]	1,072 LBW (ten studies) 251 LBW (two studies) 369 LBW (three studies)	Meta-analysis of RCTs	Mother	Weight/day Length (cm) Head circumference	KC > control (MD 3.7 g, 95% CI 1.9–5.6) KC > control (MD 0.29 cm, 95% CI 0.27–0.31) KC > control (MD 0.18 cm, 95% CI 0.09–0.27)
Charpak et al[48]	592 LBW	RCT: 24 hours/day KC versus SC	Mother	Head circumference at 6 months' corrected age	KC > control (MD 0.34 cm, 95% CI 0.11–0.57)
Nagai et al[27]	Sample: 73 LBW 32–34 weeks GA Mode of delivery: not reported Setting: five hospitals, Iran	RCT, early (<24 hours) versus late (>24 hours) onset KC in relatively stable infants	Mother	Reduction in body weight loss from birth to 48 hours	KC > control (MD 43.4 g, 95% CI 5.5–81.1)
Rojas et al[20]	Sample: 60 LBW (≤32 weeks, <1,500 g) Mode of delivery: not reported Setting: pediatric Hospital, USA	RCT: KC for 1 hour versus holding clothed in supine	Mothers and fathers (70±40 minutes/day)	Rate of head growth	Total head growth: KC > control (P=0.03) Head growth rate: KC > control (P=0.05)
Suman et al[23]	Sample: 206 <2,000 g Mode of delivery: not reported Setting: level III NICU in Western India	RCT	Mothers, 13.5 hours/day average	Growth	KC > control (weight 2,388 g, length 47.8 cm, and head circumference 33.4 cm versus weight 2,065 g, length 46.4 cm, and head circumference 32.1 cm; P<0.05)
Gathwala et al[43]	Sample: 110 LBW infants (35 weeks mean GA) Mode of delivery: not reported Setting: hospital, India	RCT KC at least 6 hours/day versus incubator care. 16-month longitudinal study	Mother	Weight gain, length, head circumference	Weight: KC > SC (16.23±0.49 g/day versus 14.10±0.52 g/day; P<0.05) Length: KC > SC (1.03±0.05 cm/week versus 0.74±0.05 cm/week; P<0.05) Head circumference: KC > SC (0.59±0.04 cm/week versus 0.47±0.03 cm/week, P<0.05)
NICU admissions/hospital length of stay/readmission					
Bergman et al[17]	Sample: 31 KC, mean 34.2 weeks; 13 controls, mean 35.3 weeks Mode of delivery: V Setting: two secondary hospitals in South Africa	RCT: KC in first 6 hours post birth versus SC	Mother	NICU admission	No difference (RR 1.44; 95% CI 0.15–14.29)
Conde-Agudelo et al[10]	946 LBW (two studies) 931 LBW (ten studies)	Meta-analysis of RCTs	Mother	Readmission to hospital at latest follow-up Length of hospital stay (days)	No difference (RR 0.60; 95% CI 0.34–1.06) KC < SC (MD –2.17, 95% CI –3.72, –0.63)
Nagai et al[27]	Sample: 73 LBW 32–34 weeks GA Mode of delivery: not reported Setting: five hospitals, Iran	RCT: early (<24 hours) versus late (>24 hours) onset KC in relatively stable infants	Mother	Length of hospital stay (days)	Non-significant difference, early KC < late KC (MD –0.9, 95% CI –3.01 to 1.2)

(*Continued*)

Table 1 (*Continued*)

Reference	Sample and setting	Design	Provider	Outcome measures	Results
Breastfeeding rates/milk volume					
Conde-Agudelo et al[10]	1,333 LBW (five studies) 600, LBW (five studies) 1,576 LBW (nine studies) 538 LBW (six studies) 924 LBW (five studies)	Meta-analysis of RCTs	Mother	EBF at discharge or 40–41 weeks PMA EBF at 1 month follow-up Any BF at discharge or 40–41 weeks PMA Any BF at 1–2 months follow-up Any BF at 3 months follow-up	KC > control (RR 1.20; 95% CI 1.07–1.34) KC > control (RR 1.20; 95% CI 1.01–1.43) KC > control (RR 1.20; 95% CI 1.06–1.36) KC > control (RR 1.33; 95% CI 1.00–1.78) KC > control (RR 1.14; 95% CI 1.06–1.23)
Svensson et al[24]	Sample: 103, 1–16 weeks post-partum with difficulty with latching Mode of delivery: V (n=67), C/S (n=36) Setting: university hospital, Sweden	RCT: KC versus fully clothed	Mother	Maternal experience, time to latch	Time to regular latching: KC < control (2.0 weeks, Q1 =1.0, Q3 =3.7 versus 4.7 weeks Q1 =2.0, Q3 =8.0, *P*=0.020); 94% of infants in KC with hx of "strong reaction" during "hands-on latch intervention" latched within 3 weeks versus 33% of control (*P*=0.0001) Mothers' positive feelings: KC > control, *P*=0.022
Chiu and Anderson[25]	Sample: 100 dyads, 32–37 weeks GA Mode of delivery: V (n=73), C/S (27) Setting: university Hospital, USA	RCT: early KC (mean 1.3 hours ×11.6 times) versus SC	Mother	Nursing Child Assessment Satellite Feeding Scale and Teaching Scale	Infant teaching scores: KC < SC at 6 months (*P*=0.001), SC > child's response to caregiver subscale (*P*=0.001)
Rojas et al[20]	Sample: 60 LBW (≤32 weeks, <1,500 g) Mode of delivery: not reported Setting: pediatric hospital, USA	RCT: KC for 1 hour versus holding clothed in supine	Mothers and fathers (70±40 minutes/day)	Successful BF	KC > control (OR 10, 95% CI 8–57, *P*=0.01)
Hake-Brooks and Anderson[44]	Sample: 66 preterm infants 32–36 weeks Mode of delivery: N/A in Setting: hospital, USA	RCT	Mothers (4.47 hours)	Breastfeeding status at hospital discharge and at 1.5, 3, 6, 12, and 18 months as measured by Breastfeeding Index	Breastfeeding duration: KC > control (5.08 months versus 2.05 months, *P*=0.003) Breastfeeding exclusivity: KC > control *P*=0.047 Full exclusivity: KC > control at discharge, 1, 5, 3, and 6 months
Gathwala et al[43]	Sample: 110 LBW infants (35 weeks mean GA) Mode of delivery: not reported Setting: hospital, India	RCT, KC (at least 6 hours/day) versus incubator care. 16-month follow-up.	Mother	Breastfeeding status	Exclusive BF initiated with all infants; at study conclusion (16 months): KC > SC (44/50 versus 36/50; *P*<0.05)
Heidarzadeh et al[42]	Sample: 251 premature (>27 weeks) Mode of delivery: V (n=86), C/S (n=165) Setting: hospital, Iran	Cross-sectional	Mothers and fathers	Exclusive breastfeeding at time of discharge	KC > SC (OR: 4.1; 95% CI: 2.2–7.5
Hurst et al[40]	Sample: 24 LBW infants Mode of delivery: NA Setting: N/A	Retrospective comparison following policy initiation of KC	Mother	24-hour milk volume	KC > control (strong linear increase, versus no change)
Time crying					
Chwo et al[15]	Sample: n=34, 34, 36 weeks GA Mode of delivery: V (n=11) C/S (n=23) Setting: Taiwan	RCT: KC versus control versus SC	Mother, KC 3 hours ×2 days	Number of times observed crying during 3-hour period	KC < control (2% versus 6%, *P*=0.001)
Neurodevelopment					

Charpak et al[48]	Sample: 588 LBW Mode of delivery: V, C/S Setting: tertiary center, Colombia	RCT (all outcomes at 12 months corrected age)	Mother	Psychomotor development, cerebral palsy, deafness, visual impairment	Psychomotor development: no difference Cerebral palsy: no difference (RR 0.65; 95% CI 0.21–2.02) Deafness: no difference (RR 0.30; 95% CI 0.03–2.90) Visual impairment: no difference (RR 0.91; 95% CI 0.53–1.56)
	Sample: 579 LBW			General developmental quotient	KC > control ($P<0.01$)
Schneider et al[35]	Sample: 39 adolescent former premature (<33 weeks GA) and nine born at term Mode of delivery: not reported Setting: Bogotá, Colombia	Longitudinal follow-up of RCT	Mothers/fathers/family (24 hours/day)	Motor systems maturation via transcranial magnetic stimulation	MEP latency: KC < control (P=0.03); in KC, decrease in MEP latency correlated with time in KC (P=0.02) Short-interval intracortical inhibition and facilitation in M1: no difference, but obtained more easily in KC and term groups Interhemispheric inhibition: more frequent, with shorter latency and longer duration in KC ($P<0.0001$) Group × sex × side interaction: shorter latency in all KC and term subjects in dominant ($P\leq0.0001$) and non-dominant ($P\leq0.001$) hemispheres No differences between KC and term
Parent–infant attachment					
Charpak et al[48]	Sample: 82–406 LBW Mode of delivery: V, C/S Setting: tertiary center, Colombia	RCT	Mother	Mother's perception of premature birth questionnaire (1–5) and nursing child assessment feeding scale	KC > control (MD, 95% CI): Mothers' perceptions: sense of competence 1–2 days post birth (0.41, 0.14–0.68); sense of competence, infant admitted to NICU (0.54, 0.05–0.43); sense of competence, infant not admitted to NICU (0.24, 0.05–0.43); worry and stress free at 1–2 days (0.31, 0.04–0.58); social support at 14 days (–0.47, –0.84, –0.10); social support, infant not admitted to NICU (–0.20, –0.39, –0.01) Feeding scale: mothers sensitivity at 14 days (0.06, 0.01–0.11); Responsiveness, 14 days (0.05, 0.01–0.09) KC > SC (MD 0.79, 95% CI 0.74–0.84)
	338 LBW			HOME[b] environment total score	No data reported on fathers, but author claims increased involvement
Gathwala et al[47]	Sample: 100 LBW (mean GA 35 weeks) Mode of delivery: V (81), C/S (9) Setting: India	RCT: KC 6 hours/day versus SC	Mother	Mother–infant attachment at 3 months	KC > control (MD 6.24, 95% CI 5.57–6.91)

(*Continued*)

Table 1 (*Continued*)

Reference	Sample and setting	Design	Provider	Outcome measures	Results
Roberts et al[49]	Sample: 30 LBW Mode of delivery: N/A Setting: Australia	RCT: KC versus cuddling minimum 2 hours/day	Mother	Mother–infant attachment: stress in the NICU	Relationship with infant: KC > control (MD 1.00, 95% CI 0.35–1.65)
Neu and Robinson[50]	Sample: 65 LBW 32–34 weeks GA Mode of delivery: not reported Setting: five hospitals, USA	RCT: 1 hour a day of either holding in blanket or KC for 8 weeks	Mother	Mother–infant interaction at 6 months	Symmetrical coregulation: KC > control : (MD 16.38, 95% CI 13.61–19.1) Asymmetrical coregulation: KC < control (MD −18.31, 95% CI −21.42, −15.20)
Miles et al[51]	Sample: n=79, <32 weeks GA Mode of delivery: not reported Setting: UK	Randomized crossover by site: 20 minutes KC daily ×4 weeks	Mother	Infant interaction	No statistically significant difference
Tessier et al[26]	Sample: 338, LBW Mode of delivery: not reported Setting: Colombia	RCT: (70±40 minutes/day)	Mothers and fathers 24 hours/day until no longer tolerated by infants	HOME score	HOME score: KC > mean score [0.28 versus −0.51, $F(1,330)=4.9$, $P<0.03$], neurologically at-risk subgroup [0.33 versus −1.09, $F(1,330)=5.2$, $P<0.03$], boys subgroup [0.26 versus −1.02, $F(1,330)=7.3$, $P<0.001$]; KC families > openness [$F(1,330)=3.9$, $P<0.05$] boys and girls, girls only [$F(1,330)=9.4$, $P<0.01$], neurologically at risk girls subgroup [0.17 versus −0.87, $F(1,330)=9.03$, $P<0.01$]; KC > for boys only subscales for responsiveness [$F(1,330)=9.1$, $P<0.01$] more positive (less punitive) [$F(1,330)=3.5$, $P<0.10$] and structured environment [$F(1,330)=5.3$, $P<0.03$]; higher HOME scores correlated with infants' developmental quotient [$F(2,325)=5.6$, $P<0.01$]

Notes: [a]Stability of the Cardio-Respiratory system In Premature infants. Composite tool that indicates physiologic stability; [b]Home Observation for Measurement of the Environment,assesses quality and extent of stimulation available to a child in the home environment.

Abbreviations: LBW, low birth weight; NICU, neonatal intensive care unit; RCT, randomized controlled trial; KC, kangaroo care; MD, mean difference; V, vaginal; C/S, cesarean section; GA, gestational age; RR, relative risk; CI, confidence interval; HR, heart rate; hx, history; REM, rapid eye movement; EEG, electroencephalography; BF, breast feeding; BKC, birth kangaroo care; OR, odds ratio; N/A, not available; MEP, motor evoked potentials; PMA, postmenstrual age; SC, standard care; CG, control group; EBF, exclusive breastfeeding .

countries. There remains a paucity of studies investigating the effect of KC on mortality, infection, and serious illness in resource-rich countries. Methodologically rigorous studies are needed to understand how to maximize the clinical benefits of KC in hospital environments where advanced support is readily available. Many of the questions that remain are most appropriately answered by randomized controlled trials. In both developed and developing countries, our understanding of the physiological benefits of KC would benefit from routine use of composite physiological measures from which investigators can interpret a more meaningful clinical picture. In a review of the benefits of KC in term children, Moore suggests the use of SCRIP scores, (eg, stability of the cardiorespiratory system as the primary physiological outcome).[9] This would help draw conclusions that more broadly address stability as opposed to attempting to interpret outcomes separately.

There is little evidence from which to determine minimum times for KC to maximize physiological benefits, which are of particular interest to clinicians in countries like Canada and the United States of America (USA) where parent availability is often limited. Continuous KC potentially represents a free alternative to expensive equipment, but the price may be high for parents who bear the burden of additional costs associated with being available in neonatal intensive care units. A recent systematic review and meta-analysis[28] of 29 papers addressing parental experiences during KC, including 401 mothers and 94 fathers, revealed two overarching themes, ie, a beneficial and restoring effect on both themselves and their child(ren), but also an increased burden, which was a draining experience. Improving our understanding of the optimum daily duration of KC will be important in order to ensure that we do not unjustifiably transfer burden from the health care system to parents.

Late-preterm infants, primarily delivered in developed countries, who are deemed healthy enough to remain on the post partum ward, have been excluded from much of the current literature.[9] If physiological stability can be improved by introduction of early and sustained KC interventions for this population, there is potential for considerable impact on health care costs, family burden, and reduction of interventions. Similarly, there is a lack of analysis of benefits for infants born via cesarean section. In the studies included in this review, none considered analysis of outcomes in cesarean deliveries separately. This lack of evidence was one of the issues highlighted in a recent Cochrane review of vaginal versus cesarean birth for preterm infants.[29] While results of that meta-analysis found no difference in any of the reported outcomes (respiratory distress, Apgar scores, mechanical ventilation, supplemental oxygen), investigators were only able to include four trials, the most recent published in 1996.

For preterm or low birth weight infants, there is a need for more research examining the effectiveness of continuous early KC for both nonstabilized and relatively stabilized infants.[10] Perhaps unstable infants would benefit differentially from KC when compared with stable infants. Moreover, it remains unclear whether physiological benefits are variable depending on the KC provider, because there is so little research comparing mothers and alternative providers, such as fathers, grandparents, or trained volunteers.[22]

Growth, neurodevelopment, and neurosensory impairment

Perhaps one of the most interesting benefits of KC is the effect on sleep, neurodevelopment, and growth. A recent study by Feldman et al[22] provides compelling evidence in this domain as well as in the physiological domain. They found that infants who received an average of 1 hour of KC for 14 days showed a more organized sleep–wake cycle at 10 years of age. Short-term benefits of KC on sleep patterns in preterm infants have been well established and include an increase in quiet sleep, longer cycles, and increased respiratory regularity.[15,30,31]

As a consequence of the tremendous rate of neurodevelopment that occurs in utero, it is no surprise that preterm infants often suffer neurophysiological sequelae.[32,33] Two recent cohort studies used electroencephalographic complexity to measure differences in neurological maturity between preterm infants who received KC and those who did not. While sample sizes were small, the investigators were able to identify a relationship between KC and increased electroencephalographic complexity.[34] Additionally, the results showed an increase in primary motor cortex synchronization in response to transcranial magnetic stimulation in the group of infants that received KC.[35] These results suggest that KC plays a role in supporting neurodevelopment, which is consistent with earlier findings.[31]

A recent clinical trial in an Indian hospital compared sustained KC with conventional care in preterm infants. The infants were enrolled in groups of five, with the smallest three infants in each group being assigned to the KC condition.[36] Growth at a corrected gestational age of 40 weeks was similar between the intervention group and the control group, but infants receiving KC achieved more rapid physical growth after this point. Evidence for an association between KC and augmented growth comes from the meta-analysis by Conde-Agudelo et al, which found benefits for both continuous and intermittent KC.[10] When KC was continuous (KC) it was associated with an increase in weight gain, length, and head circumference.

Clinical implications

Current evidence suggests that KC improves sleep, neurodevelopment, and growth, and should therefore be encouraged in clinical practice. While there is a lack of guidance regarding the optimal duration, the compelling outcomes described by Feldman et al were the result of just 14 days of sessions lasting an average of 1 hour.[20] Given the lack of uptake of any variation of KC in some practice settings, it would be reasonable to recommend that all infants should have KC initiated as soon as possible after birth and receive at least this minimal dose daily.

Research implications

The potential for KC to impact neurodevelopment and growth in preterm infants is exciting, but there is still much left to be understood. Dose-response studies would be particularly interesting because they would help families and clinicians to collaborate in order to achieve the best outcomes for the least cost. Studies should be randomized when possible in order to help control for unknown confounding variables.

Investigators should take advantage of the diverse range of instruments available to them in order to learn more about the neurodevelopment changes associated with KC. For example, is the hypothesis that KC increases the rate of neurodevelopment supported by brain imaging? Are the benefits exclusive to pathways related to attention and sleep regulation, or do preterm infants who receive KC have more rapid peripheral neurodevelopment as well?

Studies designed to elucidate the mechanisms via which KC imparts its benefits are lacking. Sleep, neurodevelopment, weight, and length are clinically relevant outcomes but we also need studies designed to tease out how KC interacts with these.

Behavioral benefits

Breastfeeding rates

The BFHI, devised by the World Health Organization, is an international set of guidelines to promote, protect, and support breastfeeding.[7] Provision of KC is one of the "ten steps to successful breastfeeding" outlined in the BFHI. Although initially developed for healthy term infants, an international group of experts has made recommendations for adapting the "ten steps" of the BFHI to be applicable to ill and premature infants in neonatal settings.[37] In the modified BFHI for neonatal units proposed by Nyqvist et al,[37] provision of early, continuous, and prolonged KC without unjustified restrictions is cited as crucial to improving breastfeeding outcomes in this vulnerable infant population.

Evidence supports the influence of KC in increasing maternal milk volume and promoting breastfeeding exclusivity and duration in preterm infants.[38–40] Flacking et al[41] used a prospective longitudinal design to examine the influence of KC on breastfeeding in two age groups: those born very preterm (less than 32 weeks' gestational age) and preterm (32–36 weeks' gestational age). They found that in very preterm infants, those who were breastfeeding at 1, 2, 5, and 6 months post discharge has significantly more KC time in hospital. In randomized controlled trials comparing KC interventions with standard care, preterm infants demonstrate initiation of earlier breastfeeding,[10] higher breastfeeding exclusivity,[10,42] and a longer duration of breastfeeding[10,43,44] when compared with infants who are cared for in an incubator or are wrapped in blankets when held by their mothers.

Clinical implications

Based on consistent evidence for KC in promoting breastfeeding, clinicians should encourage KC for preterm infants both in the neonatal intensive care unit and following hospital discharge.[5,6] Given the variability in duration of KC provided across studies, there is no consensus regarding the length of time required to optimize the benefit for breastfeeding outcomes. Therefore, it is recommended that mothers be informed of the benefits of KC for breastfeeding, and that they are encouraged and supported in providing KC as early as possible (ideally from birth) and for as long and as often as they would like.[31]

Limitations and implications for future research

A limitation in the research examining KC and breastfeeding is the reliance on maternal self-report. Given the potential for bias in reporting breastfeeding outcomes due to the social desirability of exclusive breastfeeding, it is important to interpret the findings with caution. While some researchers[44] have considered and controlled for baseline maternal intentions to breastfeed, this is not consistently done. Given the significant influence of prenatal intentions to breastfeed in predicting long-term breastfeeding outcomes,[45] this is an important variable to measure and report in future studies. While Flacking et al[41] found that KC had the greatest benefit for very preterm infants (born at less than 32 weeks' gestational age), research in this young age group is limited. Future studies examining the relationship between KC and breastfeeding initiation, duration, and exclusivity in infants born at a gestational age of less than 32 weeks is needed. There was variability in measures of exclusivity of breastfeeding, length of KC intervention time in clinical trials, follow-up time points, and control interventions used (eg, incubator care, being wrapped in blankets when held) across the literature. Possibilities of both overestimation and underestimation of the effect of KC on breastfeeding stem from issues such as the treatment of breastfeeding as a dichotomous variable, failure to capture information such as nipple protractility, and "standard care" conditions that include breastfeeding counseling expertise which may not accurately reflect the day to day reality of the unit.[9] Consistency in interventions and outcomes is necessary to strengthen future research.

Parent–infant attachment

Attachment is defined as the emotional connection that is formed between infants and caregivers, and it is relevant for clinicians to consider this in infants of all gestational ages, especially in those born preterm.[46] Infant-maternal relationships have been shown to be less positive in infants born preterm, and evidence suggests that poor attachment can contribute to more negative outcomes.[46,47]

Charpak et al[48] found that mothers in a KC group scored more favorably on sense of competence, feelings of worry or stress, sensitivity, and infant responsiveness. Total attachment scores determined through structured interviews by Gathwala et al[47] were higher in the KC group than in controls. An improved relationship with the infant was supported by higher scores in an investigation by Roberts et al,[49] and KC mother–infant pairs showed more symmetrical and less asymmetrical coregulation in a recent study that used the still-face paradigm tool as one of their outcomes.[50] Feldman et al[22] provided additional evidence supporting the relationship between KC and increased attachment behaviors across the post partum period in addition to greater mother–child reciprocity at 10 years. In one study excluded for using a crossover design, the investigators found no differences between KC and standard care at 4 or 12 months of age in measurement of infant interaction.[51]

Clinical implications

A significant barrier to the provision of KC is the lack of facilities available for parents to stay (ie, sleep and cooking) near the infant to promote prolonged KC. This is a significant issue in both poorly resourced and resourced areas, although the trend toward single room versus open bay neonatal units and KC centers may lessen this concern and should be supported.[52]

Research implications

A consistent approach to the measurement of parent–infant attachment would be of benefit because measures vary and make interpretation more difficult. The current evidence suggests that KC promotes greater parent–infant attachment, and the implications of this benefit should cause investigators to consider the inclusion of measures for attachment. Due to the potential neurodevelopment consequences of poor parent–infant attachment, increased information combined with longitudinal designs may help understand the basis of the seemingly neuroprotective effects of KC. More positive attachment may also partially explain some of the observed benefits to breastfeeding initiation and duration. There remains a knowledge gap with regard whether the same benefits in relationships that are observed between mother–infant dyads as a result of KC are also observed between father–infant[20] dyads.

KC in the context of pain

Given the benefits of improved physiological stability, and enhanced sleep and regulation, investigation of KC to diminish newborn procedural pain has become a rapidly growing field of study (see Table 2). The role of KC in this context was first examined in full-term infants in 2000 by Gray et al.[53] Three years later, Johnston et al examined its effectiveness in preterm infants at a gestational age of 32 to 36 weeks at birth.[54] Both studies reported a significant lowering of behavioral pain responses, and numerous other studies followed with similar results favoring KC. A recent Cochrane review included 19 randomized trials (n=1,594 infants, with 765 being term infants[54–67]) and used physiological, behavioral, and composite measures as the primary outcomes.[11] The majority of the studies[53–59,64–70] (n=1,219) compared KC with standard care or no treatment, and used heel lance as the painful procedure.[53,54,56–67,71]

Kangaroo care compared with incubator control

Physiological parameters

Physiological indicators reported were heart rate response, heart rate recovery, heart rate variability, oxygen saturation during the painful procedure, oxygen saturation after the painful procedure, and change in oxygen saturation. Twelve studies examined heart rate or heart rate variability during

Table 2 Benefits of kangaroo care in pain context

Reference	Sample and setting	Design	Provider	Outcome measures	Results
Physiological stability					
Johnston et al[11]	121 preterm (four studies)	Meta-analysis of RCTs	Mother	HR during and following painful procedure	No significant difference
	38 preterm (two studies)		Mother	HRV during and following painful procedure measured using low, high, and low/high frequency ratio	No significant difference
Johnston et al[54]	Sample: n=74, 32–36 weeks GA Mode of delivery: not reported Setting: level III NICU, Canada	RCT crossover: 30 minutes of KC versus swaddled in incubator	Mother	HR	No significant difference
Johnston et al[64]	Sample: 61 preterm (28–31 weeks GA) Mode of delivery: not reported Setting: Canada	RCT crossover: 15 minutes of KC before and during	Mother	Return to baseline HR, maximum HR, minimum oxygen levels	Return to baseline: KC $<$ SC (123 seconds, 95% CI 103–142 versus 193 seconds, 95% CI 158–227; $P<0.0000$) Maximum HR: KC $<$ SC at 30, 60, and 90 seconds Minimum oxygen levels: KC $>$ SC at 30, 60, and 90 seconds
Nimbalkar et al[67]	Sample: 47 preterm (32–36 weeks) Mode of delivery: not reported Setting: neonatal care unit, Karamsad, India	RCT: 15 minutes KC before, during, and after heel lance	Mother	HR, SpO_2	HR: KC $<$ KC SpO_2: no difference
Ludington-Hoe et al[66]	Sample: 23 preterm ($<$37 weeks GA) Mode of delivery: not reported Setting: USA	RCT crossover: 3 hours KC before and during heel lance	Mother	SpO_2	No significant difference
Cong et al[57]	Sample: 28, 30–32 weeks GA Mode of delivery: V (8), C/S (20) Setting: level II NICU in USA	RCT: study a) 60 minutes KC, b) 10 minutes KC	Mother	Salivary and serum cortisol	Salivary cortisol: KC $<$ SC at end of recovery ($P<0.5$) Serum cortisol: KC $<$ SC during heel lance
Chidambaram et al[88]	Sample: 47 preterm (32–46 weeks GA) Mode of delivery: not reported Setting: South India	RCT crossover: 15 minutes KC	Mother	HR, SpO_2	No significant difference
Pain score					
Johnston et al[11]	30 seconds: 268 preterm (six studies) 60 seconds: 164 preterm (four studies) 90 seconds: 163 preterm (four studies) 120 seconds: 156 preterm (four studies)	Meta-analysis of RCTs	Mother	PIPP score at 30, 60, 90, and 120 seconds after painful procedure	30 seconds: KC $<$ SC (MD –3.21, 95% CI –3.94, –2.48) 60 seconds: KC $<$ SC (MD –1.85, 95% CI –3.03, 0.068) 90 seconds: KC $<$ SC (MD –1.34, 95% CI –2.56, –0.13) 120 seconds: no difference

Cong et al[57]	Sample: 28, 30–32 weeks GA Mode of delivery: V (8), C/S (20) Setting: level II NICU in USA	RCT: study a) 60 minutes KC, b) 10 minutes KC	Mother	PIPP scores 30, 60, 90, 120 seconds beyond the time of the procedure	KC $<$ SC (between 8.12 and 0.4 points), greater differences the closer to the end of the procedure
Chidambaram et al[88]	Sample: 47 preterm (32–46 weeks GA) Mode of delivery: not reported Setting: South India	RCT crossover: 15 minutes KC	Mother	PIPP score	KC $<$ SC at 30 and 60 seconds (P=0.001)
Cry duration					
Johnston et al[11]	Sample: 33 preterm (two studies) Setting: Canada	Meta-analysis of RCT crossovers	Mother	Cry duration	No statistically significant difference
Sleep–wake state					
Ludington-Hoe et al[66]	Sample: 23 preterm ($<$37 weeks GA) Mode of delivery: not reported Setting: USA	RCT crossover: 3 hours KC before heel lance	Mother	Sleep state during baseline and post stick	Baseline: KC $>$ SC ($P<0.04$) Post stick: KC $>$ SC ($P<0.05$)
Cong et al[57]	Sample: 26 preterm (28–32 weeks) Mode of delivery: V (3), C/S (20) Setting: level III NICU, USA	RCT crossover: 30 minutes KC versus 15 minutes KC versus SC	Mother	Time in quiet sleep	KC 30 and KC 15 minutes $>$ SC during recovery ($P<0.05$)
KC versus alternative provider in pain context					
Johnston et al[11]	Sample: 80 preterm	Meta-analysis of randomized crossover trials	Father or unrelated woman	PIPP score at 30, 60, 90, and 120 seconds after painful stimulus	No statistically significant difference
Johnston et al[63]	Sample: 30s: 62 preterm (28–36 weeks GA) Mode of delivery: not reported Setting: level II NICU, Canada	RCT crossover	Father	PIPP score at 30, 60, 90, and 120 seconds after painful stimulus, HR recovery	No statistically significant difference
Johnston et al[61]	Sample: 16 preterm (28–37 weeks GA) Mode of delivery: not reported Setting: level III NICU, Canada	RCT crossover	Unrelated woman	PIPP score at 30, 60, 90, and 120 seconds after painful stimulus, HR recovery	No statistically significant difference
KC versus sweet taste in pain context					
Freire et al[60]	Sample: 95 preterm (28–36 weeks GA) Mode of delivery: not reported Setting: university hospital, Brazil	RCT: 10 minutes KC before, and during heel lance versus sweet taste 2 minutes before procedure versus SC	Mother	PIPP score, HR variation, SpO_2, duration of facial activity	HR variation: KC $<$ all (P=0.0001) SpO_2: KC $<$ all (P=0.0012) Facial activity: KC $<$ all (P=0.0001) PIPP score: KC $<$ all (P=0.0001)
KC versus expressed breast milk in pain context					
Nanavati et al[89]	Sample: 50 very LBW neonates, mean GA 32.33±1.34 weeks Mode of delivery: not reported Setting: NICU, India	RCT, 15 minutes KC versus EBM for adhesive tape removal	Mother	PIPP score, HR, SpO_2	No statistically significant difference
KC versus enhanced KC in pain context					
Johnston et al[63]	Sample: 90 preterm (32–36 weeks GA) Mode of delivery: not specified	RCT crossover, 30 minutes KC before and during heel lance versus 30 minutes enhanced KC	Mother	PIPP at 30, 50, 90, and 120 seconds; HR return to baseline	No statistically significant difference

Abbreviations: EBM, expressed breast milk; GA, gestational age; KC, kangaroo care; CI, confidence interval; MD, mean difference; HR, heart rate; HRV, heart rate variability; SpO_2, oxygen saturation; PIPP, premature infant pain profile; RCT, randomized controlled trial; LBW, low birth weight; NICU, neonatal intensive care unit; V, vaginal; C/S cesarean section; SC, standard care.

and/or heart rate recovery following a heel lance procedure.[53,54,56–58,60,64,66,67,69–71] All studies favored KC or found no difference, but only a few studies could be combined in meta-analysis. Oxygen saturation during and/or following the painful procedure, reported by four studies,[64,66,69,70] was unable to be combined. Although two of the studies[64,70] reported that average oxygen saturation was higher in the KC group during the painful procedure, only Sajedi et al[70] showed these differences to be significant. Of two studies reporting change in oxygen saturation, neither found a difference between KC and standard care.[60,67]

Validated pain assessment tools

Validated pain scores, including the Premature Infant Pain Profile (PIPP),[54,55,59,60,64] Neonatal Facial Coding System,[56,68] and Neonatal Infant Pain Scale[68–70] were measured in ten studies. Pain scores regardless of the tool used appeared to favor KC with lower Neonatal Facial Coding System scores during procedure, with a mean difference of 1.872 in favor of KC ($P<0.001$) in Castral et al.[56] Both Sajedi et al[70] and Saeidi et al[69] reported Neonatal Infant Pain Scale scores that significantly favored KC. Five studies used the PIPP as the outcome for heel lance.[54,55,59,60,64] Based on the combined analysis of four studies,[54,59,60,64] there was a significant effect post heel lance in favor of KC at 30 seconds, at 60 seconds,[54,59,64] and 90 seconds.[54,59,64] No significant difference between KC and controls were noted in PIPP scores at 120 seconds.[54,59,64] Additional outcomes, including endocrine response, cry duration, infant state, and adverse effects, were measured in a few small studies, with mixed or nonsignificant findings.[59]

Kangaroo care versus alternative treatments or alternative providers

Comparisons have been made in four studies with sweet taste,[60,68] breastfeeding,[71] enhanced KC (including the addition of rocking and singing with KC),[62] fathers,[62] and unrelated females.[61] When KC with sweet taste (glucose) was compared with control in preterm neonates undergoing heel lance, heart rate, oxygen saturation variability, and PIPP scores all were reported to significantly favor KC. Similarly, heart rate, oxygen saturation, Neonatal Facial Coding System, and duration of crying were not reported to be different between KC and breastfeeding, but both were better than swaddled control.[60] The addition of auditory, vestibular, or gustatory factors with KC (rocking, singing, and offering the infant a finger or pacifier for sucking by the mother providing KC) did not result in any differences when compared with maternal KC alone. Two studies, both using a crossover design, compared the analgesic effect of maternal KC to SSC provided by an alternate caregiver: one with fathers[62] and the other with an unrelated woman.[61] In both cases, the differences in heart rate recovery and PIPP scores were not significant in spite of the large mean difference in favor of the mother, due mostly to high variance.

Clinical implications

KC is a simple, natural, and cost-effective intervention to effectively diminish behavioral pain response in preterm infants. KC should be routinely offered to all infants undergoing needle-related procedures. Although there is some evidence that combining KC provided by the mother with sweet-tasting solutions may be synergistic, further study is warranted before this combination can be recommended as standard care. In the absence of a mother, a father,[62] unrelated woman,[61] or a co twin,[72,73] may be considered as as there is some evidence that they may be an effective alternate.

Implications for research

Despite strong evidence that KC effectively lowers composite behavioral pain scores for both full-term and preterm infants as young as 28 weeks' gestational age undergoing a single heel lance or intramuscular injection compared with incubator control, there remain many unanswered questions. Studies examining the sustained effect of KC over repeated procedures, as well as studies with larger sample sizes replicating prior work, including similar outcomes, are required. Moreover, little is known about whether combining KC with other comforting interventions can enhance its benefits for pain relief. It is clinically important for future studies to examine the optimal dose or duration of KC needed to be effective. The range of time for KC prior to the painful procedure was 2 minutes[68] to 3 hours.[66] The only studies that compared times were two studies by Cong et al.[58,59] Although both studies seemed to favor 30 minutes to either longer (80 minutes)[58] or shorter doses (15 minutes),[59] other studies using different outcomes favored KC for times longer and shorter than 30 minutes, so no conclusion can be made. Investigators should consider reporting findings from the entire sample as well as differentiating among gestational ages when possible. Lastly, examining whether the benefits of KC associated with early pain reduction and immediate pain relief may also lead to improved longer term outcomes are needed.

Considerations for implementation

In spite of the plethora of documented benefits of KC in preterm infants, KC is not consistently practiced in this population. In a national survey of nurse managers in USA Newborn Intensive Care Units (NICUs), Engler et al[74] found that while 82% of respondents indicated that KC was implemented in some form on their unit, practice was informed by nurse perceptions as opposed to scientific evidence. It has been consistently demonstrated that both parents and clinicians perceive KC as a positive intervention for mothers and their infants.[75–79] However, despite generally positive attitudes, inconsistencies may exist in parent and nurse perceptions of optimal KC practices. For example, in a recent prospective cohort study conducted by Hendricks-Munoz et al,[80] parents and nurses both reported that KC benefits infants; however, only 18% of nurses compared with 63% of mothers believed that KC should be provided to their infants on a daily basis.

In addition to varying attitudes toward KC, numerous barriers have been identified. A consistently described barrier relates to the safety of facilitating KC in the preterm infant. Specifically, the highly technological equipment used to care for these infants has been identified as limiting opportunities for KC,[74,76–79,81,82] with several studies reporting inconsistent policies and KC practices in infants who are intubated or have arterial or venous lines in place.[74,81] Maternal concern around infant well-being during KC, such as fear that the infant may stop breathing, is another concern that has been reported.[77,79] Inadequate staff education and experience in facilitating KC for clinically compromised infants was another barrier identified, as well as lack of staff and time to appropriately support KC in both the NICU[74,77,79,81] and following delivery by cesarean section.[83] Both parents and health care providers identified the NICU environment as limiting parental visitation and opportunities to provide KC. For example, frequently identified barriers included lack of privacy, space, and comfortable chairs at the bedside, as well as a lack of facilities for meal preparation and parental rooming in.[77,78,81,84] Parent-related factors such as maternal pain (eg, breast, back, or incisional pain),[77,85] having responsibilities in the home (eg, other children, chores),[77,81,85] and limited knowledge of the benefits of KC were additional barriers that were identified to limit the availability and motivation of mothers to provide KC.[81]

While it is evident that there are numerous barriers to successful implementation of KC, findings also highlight ways in which to facilitate this practice in preterm infants. Educational interventions have been consistently cited as necessary to train staff in the knowledge and skills needed to promote and support KC effectively.[74,76,80,81,86] In a recent prospective cohort study examining the impact of a training program on KC perceptions and practice competency, nurses received didactic education and simulation training for assessing and placing infants in KC.[80] Nurses' competency in supporting KC for infants requiring nasal continuous positive airway pressure and mechanical ventilation improved from 30% to 92% ($P<0.001$) and from 10% to 48% ($P<0.004$), respectively. In addition, nurses who reported feeling uncomfortable in this competency decreased to 0%, and the perceived value increased from 50% to 100% ($P<0.001$). Having clear policies in place to guide evidence-informed KC implementation,[74,81,86] as well as KC leaders and unit-based champions,[81] have also been identified as ways to facilitate ease of use in ill full-term and preterm infants.

In addition to educational interventions for staff, parent education regarding the benefits of KC and how to safely hold their infant in addition to assessing their well-behind has been documented as a way to encourage KC implementation.[78,81,83,86,87] Modification of the physical environment by providing privacy screens, comfortable chairs, and family rooms has been identified by parents to support KC.[77,78] Finally, assistance in positioning infants in KC, providing parents with information and practical advice, as well as providing reminders and follow-ups around KC practices,[77,78,81,87] have been identified by both parents and health care providers as valuable in supporting the implementation of KC.

Conclusion

Kangaroo care is a natural, effective, and low-cost intervention that can be utilized in any setting. There is strong evidence related to its numerous benefits, including physiological, behavioral, and pain-relieving aspects for preterm newborns, both healthy and ill, as well as less stress and improved self-efficacy in parents. Mothers and family members have a unique relationship and are highly invested to ensure that optimal outcomes are achieved for their newborns. Yet their active participation in care often remains underutilized. Despite a few remaining unanswered questions, the use of KC should be considered standard of care for all infants and be initiated early with the ultimate goal to minimize separation of the mother–infant dyad.

More evidence is required in order to recommend implementation of KC in resource-rich environments. Though it is tempting to make this recommendation considering the diverse array of benefits offered, questions remain as to how implementation might affect mortality, infection, and severe illness. There a need for dose-response studies in this population that include a continuous or near-continuous arm, but these should be accompanied by economic measurements that will determine the tangible and intangible costs taken on by parents. To this end, health economists should be considered as potential members of the interdisciplinary team. Additionally, in poorly resourced countries, greater government funding should target the creation of KC centers that incorporate clean water, cooking, and sleeping facilities for mothers to remain exclusively with their infants.

Disclosure

The authors report no conflicts of interest in this work.

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