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Kangaroo care in advanced neonatal intensive care units: a systematic review

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Abstract

Objective: Despite recognition of Kangaroo Care (KC) as essential newborn care, optimal approaches to KC for medically complex infants are not well-defined. We aimed to synthesize the evidence for safety, effectiveness, and implementation of KC within advanced neonatal intensive care units (NICUs) providing care to this population.

Study design: Using Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, we systematically reviewed PubMed and Embase databases from 2000—2026 for studies of KC within advanced NICUs.

Results: Our search identified 387 citations with 34 studies included. Studies highlighted safety with no increase in unplanned extubations or medical device dislodgement compared to incubator care. While physiologic and neurodevelopmental outcomes were consistently favorable, uptake initiatives demonstrated a lack of standardized eligibility criteria for KC among medically complex infants.

Conclusion: Current evidence supports the safe implementation of KC in advanced NICU settings. Further efforts to standardize KC implementation within advanced NICUs are needed.

Introduction

The practice of Kangaroo Mother Care (KMC) is considered part of essential newborn care due to well-established benefits for premature and low birth weight infants [1]. Optimal KMC is defined by the World Health Organization (WHO) as the practice of early, continuous skin-to-skin contact between an infant and mother accompanied by exclusive breastfeeding and facilitation of early hospital discharge for continued parent-directed care at home with close follow up. However, in practice KMC is most commonly defined as intermittent infant-parent skin-to-skin contact, with terminology simplified to kangaroo care (KC) [2, 3]. KMC was developed in 1978 in response to limited access to traditional incubators in low- and middle- income countries. Since then, a wealth of evidence has demonstrated benefits of this practice related to neonatal mortality, sepsis, thermoregulation, cardiorespiratory stability, neurodevelopment, bonding, and alleviation of procedural pain [4–8]. Current international guidelines support the use of KC as a sustainable and cost-effective intervention for the care of all infants, regardless of geographic location or socioeconomic status [9, 10]. Within the United States, KC was recently highlighted as an integral component of the Vermont Oxford Network “All Care is Brain Care” collaborative to advance the health of preterm and low birth weight infants [11]. Despite these recommendations, resource rich contexts have been slow to embrace KC as a standard of care within the neonatal intensive care unit (NICU), particularly in those NICUs with high acuity and advanced technologies [12, 13].

The use of KMC in highly resourced settings is traditionally viewed as complementary to the “gold standard” of incubator care, focuses on small moments of parental bonding after the infant has fully stabilized and is typically only focused on intermittent KC [10, 14]. The most recent Centers for Disease Control Maternal Practices in Infant Nutrition & Care survey reported that 63% of advanced NICUs reported KC was practiced for > 80% of eligible newborns, however this report highlights gaps between offering KC and routinely implementing it for all eligible patients [15]. European settings trend toward higher adoption and support of KC, but logistical constraints such as visiting hours and availability of space limit sustained uptake of this practice [16, 17]. While recent literature supports the benefits of KC for extremely premature and low-birthweight infants worldwide, application to hospitalized infants who are medically vulnerable beyond gestational age or birthweight criteria remains underexplored [18, 19]. Efforts to improve KC uptake in well-resourced NICUs have been complicated by evolving degrees of extreme prematurity and medical complexity in these contexts and questions surrounding the safety and benefit of the practice for these infants [20, 21]. Commonly cited concerns include fear of medical device dislodgement, uncertain impacts on cardiorespiratory stability, and lack of clear policies and protocols to guide KC for technology-dependent neonates [22, 23]. Additionally, uptake of KC among neonates with surgical diagnoses has been low due to concerns about safety and exclusion of this population from many KC studies [24]. A recent systematic review highlights that KC is safe and beneficial to neonates after surgery however evidence is sparse [25]. Thus, we conducted a systematic review with the aim to synthesize the evidence from observational and experimental studies on the safety, effectiveness and implementation of KC in advanced NICU settings worldwide.

For the purposes of this review, we have used the term KC to describe studies with at least the skin-to-skin contact component of KMC. We defined an advanced NICU setting based on the *American Academy of Pediatrics Standards for Levels of Neonatal Care* to reflect settings providing care to medically complex, technology dependent, and extremely premature infants [26]. Advanced NICUs were defined by three minimum necessary elements: care of extremely preterm infants ≤ 32 weeks, care of very low birthweight infants ≤ 1500 grams (g), and availability of both conventional and high-frequency mechanical ventilation. Furthermore, advanced NICUs were required to provide at least one of the following additional criteria: 1) surgical repair of complex congenital or acquired conditions; 2) extracorporeal membrane oxygenation (ECMO); 3) a wide range of pediatric subspecialty services; or 4) advanced diagnostic imaging, such as magnetic resonance imaging or pediatric echocardiography services. This definition also encompassed studies conducted in delivery room settings where all included neonates were subsequently admitted to an advanced NICU for further care. By focusing on advanced NICU settings, our objective was to collate an evidence base for KC practice within this unique and growing context and to highlight areas for further study.

Methods

This study was a systematic review addressing key research questions outlined in Fig. 1. This systematic review was performed in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Appendix 1) [27].

Search Strategy and Eligibility Criteria

PubMed and Embase databases were searched for primary literature addressing the safety or benefit of KC in advanced NICU settings and strategies to improve KC uptake for medically complex infants. We limited our search to studies published from 2000 to June 2, 2026 to ensure a consistent definition of

available medical technology in advanced NICUs over time, using the strategy outlined in Appendix 2. The search was structured to include all descriptive terminology relevant to identification of advanced NICU settings, inclusion of all terminology related to KC, and the outcomes of safety, effectiveness and implementation.

Primary observational and experimental studies of any design, including qualitative exploration of key research questions, were included. To capture quality improvement efforts towards KC use in the setting of the advanced NICU, both peer-reviewed manuscripts and grey literature such as conference abstracts were considered. We defined the primary intervention of interest as KC and the primary outcomes as either effectiveness or implementation of KC within an advanced NICU setting.

Studies were excluded for the following reasons: 1) setting not confirmed as an advanced NICU either through the study itself or upon review of the unit's website; 2) isolated prevalence surveys of KC utilization without evaluation of the safety, effectiveness or implementation of this practice; 3) qualitative analysis of KC barriers or facilitators without associated implementation efforts; and 4) integration of KC into a care bundle where the effects of KC could not be differentiated from that of the combined interventions. Secondary literature such as systematic reviews or perspective pieces was excluded from data analysis but were reviewed for pertinent references. Incomplete clinical trial protocols were not considered. The search protocol was registered on PROSPERO (CRD420261432877).

Data Abstraction

All articles were uploaded to Covidence, an online software which streamlines the systematic review process [28]. Duplicate articles were automatically removed by the Covidence system. Two independent reviewers screened all abstracts and resultant full-text articles for inclusion. At each stage, reviewers compared results to ensure agreement, with arbitration by an additional reviewer where necessary. MS, SR, GS, and CM independently abstracted data from all studies meeting inclusion criteria, with overlapping review by multiple authors to ensure agreement on interpretation of study findings. Variables of interest were predefined and categorized into five broad topics: 1) study setting and population, including advanced NICU criteria; 2) clinical characteristics delineating medical complexity of included infants; 3) definition of KC as a study variable, including whether the amount of KC was defined or prescribed; 4) specific exposure or intervention of interest; and 5) study findings relevant to the safety, effectiveness and/or uptake of KC. All relevant data originated from existing literature without identification of individual patients.

Quality Assessment

All publications underwent quality assessment with use of the Joanna Briggs Institute (JBI) critical appraisal tool by study design as appropriate [29–32]. Each JBI checklist indicates specified quality criteria relevant to the study design, with higher scores indicating lower risk of bias. Items on the checklist are scored as "1 = Yes", "0 = No/Unclear", or "N/A = Not Applicable." Using thresholds established by prior systematic reviews, we classified studies scoring more than 70% of applicable items as good quality and low risk of bias, 50 to 69% as moderate quality and moderate risk of bias, and less than 50% as low quality and high risk of bias [33, 34]. Study quality assessment was performed by GS and CM, with conflicts resolved by discussion between the two reviewers. All studies meeting eligibility criteria were included for data analysis irrespective of study quality as these were still felt to provide important context to the review.

Results

Of 387 articles identified via the search, 34 publications were included for data extraction and quality assessment, representing 3 abstracts and 31 peer-reviewed manuscripts (Fig. 2). Studies were predominantly from the United States (n = 14), Canada (n = 2) or Europe (n = 7), but several studies originated from advanced NICUs in Asia (n = 7) or other regions (n = 4). Reflecting increasing relevance of this topic to advanced NICU care over time, 50% of studies (17/34) were published in the last five years. While 68% of studies (23/34) reported an average birthweight of ≤ 1500 g and gestational age ≤ 32 weeks for included infants, many unit-wide quality improvement (QI) studies did not report detailed demographic or clinical characteristics of infants. Eligibility criteria for participation in KC varied greatly; many studies excluded neonates with ventilatory requirements (n = 7) or cardiorespiratory instability (n = 6), while others specifically evaluated neonates receiving respiratory support (n = 4). Other common exclusion criteria for KC were grade III or IV intraventricular hemorrhage (IVH) (n = 10), congenital malformations (n = 13), umbilical catheters or central lines (n = 6), chest tubes (n = 4), and therapeutic hypothermia (n = 2). Of note, all studies included evaluated intermittent KC with no studies including the full KMC intervention, as defined by the WHO.

KC safety and effectiveness in advanced NICU settings

Twenty-one studies reported findings for the safety and/or effectiveness of KC in advanced NICU settings which are summarized in Table 1.

Medical device dislodgement

Among six studies reporting episodes of medical device dislodgement during efforts to increase KC uptake there were no increases in unplanned extubations or device complications compared to unit baseline [35–40]. Four quasi-experimental studies comparing various effectiveness measures of KC to incubator care directly observed a total of 514 infants during KC with zero unplanned extubations or medical device dislodgements across all studies [41–44].

Cardiorespiratory outcomes

Cardiorespiratory stability during KC, generally defined as episodes of apnea, bradycardia, and/or desaturation, was assessed by 41% of studies (14/34) [35, 41–43, 45–54]. Most studies exclusively examined KC effectiveness on cardiorespiratory stability among extremely premature or very low birthweight infants [42, 45, 46, 48, 49, 51, 53, 54]. In studies with KC sessions of up to 90 minutes, episodes of bradycardia were either unchanged or decreased during KC compared to incubator care [41, 52, 53]. In one quasi-experimental study evaluating a 60-minute KC session for intubated infants < 1500 g including those on a single weaning vasoactive agent, Azevedo et al. found that heart rates remained stable before, during, and after KC with no clinically significant differences (maximum HR variation = 5 bpm, $p < 0.001$, n = 43) [45]. In a larger cohort evaluating cardiorespiratory stability during KC for infants ≤ 32 weeks gestation on CPAP, Sehgal et al. reported favorable outcomes with KC when comparing bradycardic events during incubator care to one hour of subsequent KC (14% vs. 0%, $p = 0.012$, n = 50). This study reported similar positive findings for respiratory stability, with fewer infants 13/50 (26%) infants experiencing a desaturation ≥ 5% from baseline during KC compared to 24/50 (48%) infants one hour of incubator care ($p = 0.001$) [52]. In a 2001 publication evaluating mechanically ventilated infants, Smith et al. reported that among 14 infants participating in two-hour sessions of KC, mean fraction of inspired oxygen (FiO_2) requirements were significantly higher during the second hour of KC (mean FiO_2 = 45%, SD = 8.6) compared with the incubator phase (mean FiO_2 = 35%, SD = 8.8, $p = 0.009$) with the conclusion that KC leads to physiologic instability in mechanically ventilated infants. However, there was no statistically significant effect on mean oxygen saturation (SpO_2) between incubator care and KC ($F = 1.46$, $p = 0.24$) [54]. A more recent study evaluating 43 intubated infants ≤ 1500 g found statistically but not clinically significant variability in oxygenation parameters during KC with authors concluding safety of this practice in this population (SpO_2 ± 0.7%, FiO_2 ± 0.05, $p < 0.001$) [45]. Additional studies reporting respiratory outcomes including SpO_2, FiO_2, and desaturation events during KC also found no clinically significant differences between KC and incubator care [35, 41, 42, 46–48, 50, 51]. Two studies observed desaturations during transfer from incubator to parent; however, these findings were transient and did not require increase in FiO_2 once the infant was permitted to settle [43, 51].

Thermoregulation

Studies assessing impact of KC on infant thermoregulation in advanced NICU settings did not find clinical or statistical significance when comparing KC to incubator care [42–47, 54]. Of the five studies comparing KC and incubator care conducted in premature infants, investigators found either no difference or minimal variability from 0.2º C decrease to 0.3º C increase [42, 45–47, 54]. Smith et al. reported that the difference in central to peripheral skin temperature decreased from 0.86°C (± 0.4°) to 0.12°C (± 0.3°) over 2 hours of KC ($p < 0.01$), a finding of uncertain clinical significance [54]. There were two studies evaluating immediate KC in the advanced NICU setting and each reported thermoregulation as a safety outcome. Serrano-Llop et al. offered brief “birthday cuddles” to both term and preterm infants with medical or surgical complexity and found lower rates of hypothermia among preterm infants who received KC compared with those who did not, though this was not statistically significant (11% vs. 21%, n = 316, $p = 0.425$) [44]. The study by M’Rini et al. evaluating feasibility of KC during transfer from the delivery room found that 42% (27/64) of neonates experienced hypothermia at any timepoint during the intervention with no difference between term and preterm infants (42.4% vs. 41.9%, $p = 1.00$). Patients were most commonly hypothermic prior to KC (i.e. during initial resuscitation, positioning and set up for KC) with improvement in median temperature after an average of 120 minutes of KC. Only 15.2% were hypothermic upon NICU arrival compared to 26.8% prior to departure [43]. As this was a feasibility trial, there was no control group and the authors did not report how this compared to the baseline hypothermia admission rates in their unit. Many other studies reported stable temperatures although no other studies included KC during transport [44, 45, 47].

Cerebral oxygenation parameters and neurodevelopmental outcomes

Studies reporting associations between KC and neurologic outcomes were heterogenous in measures and strength of association; however, findings trended towards favorability of KC for cognitive development [55, 56], sleep-wake differentiation [57], and cerebral blood flow [58] in extremely premature infants. Four studies used near-infrared spectroscopy (NIRS) monitoring during KC to compare cerebral oxygenation indices for infants < 32–33 weeks without IVH or congenital malformations [46, 48, 51, 53]. Three of these studies found no clinically significant difference in regional cerebral tissue oxygen saturation or extraction between KC and incubator care [46, 48, 51]. The fourth study by Solaz-Garcia et al. evaluating infants ≤ 32 weeks on CPAP found a significant increase in cerebral oxygenation and decreased cerebral metabolic demand during KC compared to post-KC incubator care (fractional tissue oxygen extraction, or FToE, calculated as the difference between systemic oxygen saturation and regional cerebral oxygen saturation as measured by NIRS: 24 during KC vs. 27 post-KC, n = 43, $p = 0.019$) with no difference between pre- and post-KC measurements (FTOE 26 pre-KC vs. 27 post-KC, n = 43, $p = 0.664$). This was theorized to be related to changes in infant positioning from supine to upright during study periods, and authors called for further research into the significance of this finding [53]. In the other studies reporting no difference in cerebral NIRS, infants were either held in a reclined position [46, 51] or did not comment on whether the parent was upright or reclined [48]. Only one QI study considered IVH as a balancing measure, and within this population of infants < 32 weeks GA there was no increase in IVH from baseline rates across implementation and sustainability phases of the program (n = 149) [39].

Parental bonding and additional outcomes

Consistent with prior literature [59], three studies reported positive outcomes related to infant-parent bonding in advanced NICU settings, with parents and caregivers noting powerful emotional and mental health benefits from KC sessions as short as five minutes [37, 44, 60]. Individual studies also suggested favorable outcomes for breastfeeding [55], systemic oxidative stress [47], skin microbiome composition [61], infant pain tolerance [49], and retinopathy of prematurity [62].

Table 1
Summary of KC effectiveness for various outcome domains relevant to advanced neonatal intensive care unit settings.

Study	Design	Relevant unit or cohort demographics	Outcome Domain						
			Medical device dislodgement	Cardio-vascular stability	Respiratory stability	Thermo-regulation	Cerebral oxygenation and/or blood flow	Cognitive development	Ot
Azevedo et al. (2012)	Quasi-experimental study evaluating a 60-minute KC session for intubated infants < 1500 g (excluding phototherapy, congenital malformations or grade III/IV IVH)	Mean BW = 1133.4 g (range 640–1480); mean GA = 29.1 weeks; 100% MV; all infants on single weaning vasoactive agent (n = 43)	–	↔	↔	↔	–	–	–
Balasundaram et al. (2024)	QI initiative for infants < 35 weeks GA in a level IV NICU focused on parent, nurse, and resident education and daily rounds discussion of KC eligibility	Mean BW = 1090 g; mean GA = 29.1 weeks; excluded infants with arterial lines, chest tubes, hemodynamic instability, or those < 32 weeks within the first 72 hours of life (n = 185)	0 events	–	–	–	–	–	–
Bedetti et al. (2023)	Quasi-experimental study evaluating safety of ≥ 90 minutes of KC for preterm infants within the first 3 weeks of life, excluding those with grade III/IV IVH, NEC, sepsis, or congenital malformations	Median BW = 1130 g (range 630–2206); median GA = 31 weeks (range 25–34); 1.2% MV; 68.7% CPAP; 7.2% HFNC; 66.6% with central lines (n = 38)	0 events	↔	↔	–	–	–	–
Blomqvist et al. (2020)	Prospective cohort study measuring physiological stability and cerebral oxygenation during KC for infants ≤ 32 weeks	Mean BW = 790 g (range 480–1510); mean GA = 25 weeks (range 22–32); 44% MV, 56% CPAP; mean KC duration of 3 hrs 30 mins per session (n = 16)	–	↔	↔	↑	↔	–	–
Carbasse et al. (2013)	Prospective cohort study examining safety of KC for infants < 33 weeks on < 50% FIO2 without IVH grade III/IV or sepsis	Median BW = 1070 g (range 510–1972); median GA = 28 weeks (range 24–33); 18% MV; 52% CPAP; 85% with PICC lines, 11% UVC (n = 96)	0 events	↔	↔	↔	–	–	–
Eknoyan et al. (2026)	Retrospective cohort analysis of 22–27-week infants in a level IV NICU evaluating association between timing of KC introduction and neurodevelopment outcomes at 22–28 months corrected gestational age	Median time to first KC 27.3 days (IQR 14.8, 39.5) for 22–24-week infants and 16.9 days (IQR 12.6,26.9) for 25-27-week infants (n = 142)	–	–	–	–	–	↑	–
Feldman et al. (2003)	Matched case-control study evaluating KC and neurobehavioral maturation of LBW infants 31–	Mean BW = 1230 g (range 540–1650); mean GA = 30 weeks (25–33). Included 35 infants in KC group	–	–	–	–	–	↑	–

Study	Design	Relevant unit or cohort demographics	Outcome Domain						
			Medical device dislodgement	Cardio-vascular stability	Respiratory stability	Thermo-regulation	Cerebral oxygenation and/or blood flow	Cognitive development	Ot
	33 weeks GA, excluding infants with grade III/IV IVH, genetic or metabolic disease, and ongoing MV	(minimum 1 hour of KC per day for 14 days) and 35 in control group (n = 35 per group)							
Forde et al. (2020)	RCT conducted in a level IV NICU evaluating physiologic parameters and biomarkers of oxidative stress (mean urinary allantoin) between KC and incubator care for infants 24–36 weeks GA; excluded infants with IVH, severe hemodynamic instability, or surgical conditions	Mean BW = 1827 g (KC group) and 1642 g (control group); mean GA = 32.0 weeks (KC) and 31.4 weeks (control); 0% MV in KC group and 8.3% MV in control group (n = 26 KC, 25 control)	–	↔	↔	↔	–	–	↑
Gonya et al. (2017)	Retrospective cohort study among infants < 27 weeks GA comparing low and high KC groups (below and above unit median of 17.2 total KC hours from admission to 40 weeks) on cognitive and communication performance at 6 and 12 month follow up assessments	Mean BW = 748.2 g (SD 164.5) for low-KC group, 719.6g (SD 188.5) for high KC group; median GA 25 weeks (range 22–26); 51% with IVH (n = 97)	–	–	–	–	–	↑	–
Govindarajan et al. (2024)	Prospective cohort study evaluating the impact of structured KC on pathogen dominance within the skin microbiome of infants < 32 weeks; excluded those with major congenital malformations, dermatologic abnormalities, or hemodynamic instability	Median BW = 1300 g (IQR 890–1830); median GA = 31 weeks (IQR 30–32); 7% MV, 57% CPAP; 37% with clinical sepsis (n = 30)	–	–	–	–	–	–	↑
Hanke et al. (2022)	Cohort study evaluating differences in rcSO2 during KC versus incubator care for infants < 32 weeks GA within the first 120 hours of life; excluded infants with congenital malformations	Median BW = 1149 g (IQR 953–1454); median GA = 28.8 weeks (IQR 27–30.7); 18% MV; 24% with sepsis (n = 76)	–	–	↔	–	↔	–	–
Johnston et al. (2008)	Randomized controlled trial evaluating effect of KC versus incubator care on	Mean BW = 1421 g (SD 490); mean GA 30.5 weeks (SD 1.0); 0% on respiratory support	–	↑	–	–	–	–	↑

Study	Design	Relevant unit or cohort demographics	Outcome Domain						
			Medical device dislodgement	Cardio-vascular stability	Respiratory stability	Thermo-regulation	Cerebral oxygenation and/or blood flow	Cognitive development	Ot
	pain indicators during heel lance procedure for infants 28–32 weeks; excluded those with oxygen requirement, grade III/IV IVH, major congenital anomalies, prior surgeries, or recent analgesia	(exclusion criteria) (n = 61)							
Kato et al. (2024)	Pre-post study evaluating physiologic stability and diaphragm electrical activity during KC vs. incubator care for preterm infants on CPAP without significant congenital anomalies	Median BW 768 g (IQR 656.5–910.5); median GA = 25 weeks (IQR 23–27), though corrected GA at time of KC = 35 weeks (IQR = 34–36); 100% on CPAP, 79% with BPD (n = 14)	–	↔	↔	–	–	–	–
Kelley-Quon et al. (2019)	QI initiative to increase KC among surgical infants in a level IV NICU consisting of 1) clear policies and procedures; 2) family and nursing education; 3) standardized EHR documentation; and 4) provision of garments to facilitate KC	100% with a general pediatric surgery consult, regardless of whether surgery was performed. Excluded infants on ECMO or those with tracheoesophageal fistula, new tracheostomy, gastroschisis or omphalocele before repair, or active chest tube	↔	–	–	–	–	–	–
Levesque et al. (2020)	Unit-wide QI initiative introducing parental and staff education, standardized team huddles prior to any hold, identification of KC champions, and buy-in from surgical teams; audits included qualitative assessment of FiO2 requirements during KC and perceived parent-child interactions	100% of infants with cardiac and/or surgical conditions (n = 315)	0 events	–	↑	–	–	–	↑
Li et al. (2023)	Qualitative interviews of mothers regarding perceived benefits of participating in early KC and non-nutritive comfort sucking for non-intubated infants	Mean BW = 1239.44 +/-179.66 g; mean GA = 28.74 +/-0.60 weeks; mean chronological age of 31.39 +/- 14.38 days at time of interview (n = 18)	–	–	–	–	–	–	↑

Study	Design	Relevant unit or cohort demographics	Outcome Domain						
			Medical device dislodgement	Cardio-vascular stability	Respiratory stability	Thermo-regulation	Cerebral oxygenation and/or blood flow	Cognitive development	Ot
Lorenz et al. (2017)	Quasi-experimental study measuring rsCO2 and cardio-respiratory stability during 90 minutes of KC vs. incubator care for infants < 33 weeks and < 1500 g without baseline IVH, umbilical catheters, or ongoing hemodynamic instability	Median BW = 969 g (range 817–1263) and median GA = 27.6 weeks (range 26.0–28.9), with 57.5% <28 weeks; 25% MV, 37.5% CPAP, 37.5% HFNC (n = 40)	–	↔	↔	–	↔	–	–
Marsh et al. (2021)	Unit-wide QI initiative including relaxed restrictions on eligibility for KC and allowing 20 minutes for stabilization before aborting KC; streamlined nursing and physician documentation for KC; staff and family education; and physical supports such as recliners and privacy curtains	Level IV US NICU, infants only excluded from KC based on 1) infants < 32 weeks during the first 72 hours of life; 2) therapeutic hypothermia; or 3) parents with rashes or open skin lesions	↔	–	–	–	–	–	–
M'Rini et al. (2024)	Quasi-experimental study of infants BW > 1500 g to evaluate safety and feasibility of KC during transfer from delivery room to an advanced NICU setting, excluding those with severe congenital malformations or mechanical ventilation requirement	64 infants with BW 1700–4540 g, GA 31–42 weeks (48.4% preterm); CPAP required for 21.2% of preterm and 29.0% of term infants; HFNC required for 18.2% of preterm and 45.2% of term infants; 53.1% NG and 35.9% IV access (n = 64)	0 events	↔	↔	↔	–	–	–
Nguyen et al. (2025)	QI initiative to increase KC in infants < 32 weeks GA that included 1) family education and multidisciplinary rounds to encourage 1 hour of KC daily and 2) integration of a comprehensive developmental support program	Median BW = 1163 g, median GA = 29.2 weeks, 50% with history of MV (n = 149)	↔	–	–	–	↔	–	–
Sahoo et al. (2023)	Prospective cohort study evaluating changes in cerebral blood flow parameters among stable 30–34 week neonates who received at least one 2-hour session of KC; excluded those on	Median BW = 1432.75 g (+/- 177), median GA = 32 weeks (+/- 1.3 weeks); 0% on respiratory support (exclusion criteria) (n = 40)	–	–	–	–	↑	–	–

Study	Design	Relevant unit or cohort demographics	Outcome Domain						
			Medical device dislodgement	Cardio-vascular stability	Respiratory stability	Thermo-regulation	Cerebral oxygenation and/or blood flow	Cognitive development	Ot
	intravenous fluids, respiratory support, or those with CNS malformations and IVH; measured via doppler ultrasonography								
Sehgal et al. (2024)	Quasi-experimental study evaluating cardiorespiratory stability during incubator care vs. KC among infants ≤ 32 weeks gestation on CPAP	Median BW = 1137 ± 301 g and median GA = 28.4 ± 2.1 weeks; 100% on CPAP; no infants with inotrope requirement, sepsis, or IVH (n = 50)	–	↑	↑	–	–	–	–
Serrano-Llop et al. (2026)	Prospective cohort study offering immediate KC to all infants with stable cardiorespiratory status and secure airway prior to transfer to advanced NICU; primary outcomes of neonatal hypothermia and parental bonding	Median BW = 2230 g (range 520–5050) and median GA = 34.3 weeks (range 22.7–42.0); 30% MV, 32% CPAP, 28% HFNC; congenital surgical anomalies including neural tube defects, gastroschisis, and CDH (n = 316)	0 events	–	–	↔/↑	–	–	↑
Singh et al. (2024)	Prospective cohort study evaluating the role of effective KC (> 6 hours/day for three days after extubation) on development of retinopathy of prematurity for infants < 34 weeks and 1000–1800 g without major congenital malformations	Median BW = 1460 ± 190 g; median GA = 31.58 ± 1.49 weeks; 61.3% of infants received effective KC; ineffective KC group notably had higher initial PEEP requirements (n = 783)	–	–	–	–	–	–	↑
Solaz-Garcia et al. (2023)	Quasi-experimental study among infants < 32 weeks GA without IVH, congenital malformations, or pharmacologic sedation; compared cerebral fractional tissue oxygen extraction and physiologic stability during ~ 90 minutes of KC with pre/post KC incubator care	Median BW = 950 g (IQR 418.8) and median GA = 27 weeks; 16% MV, 42% CPAP (n = 43)	–	↔	↔	–	↑	–	–
Stadd et al. (2019)	Unit-wide QI initiative involving development of a KC pathway to guide implementation; introduction of a simulated education video; and designating KC champions	All patients in a level IV NICU excluding infants with hemodynamic instability, fresh tracheostomy, open wound defects, chest tubes, arterial catheters, or therapeutic	0 events	–	–	–	–	–	–

Study	Design	Relevant unit or cohort demographics	Outcome Domain						
			Medical device dislodgement	Cardio-vascular stability	Respiratory stability	Thermo-regulation	Cerebral oxygenation and/or blood flow	Cognitive development	Ot
	who received additional simulation training on patient transfers	hypothermia; of included infants, 7.4% MV, 1.5% HFOV, 8.8% CPAP, 14.7% HFNC; 31% with a PICC (n = 68)							
Smith et al. (2001)	Comparison of oxygenation and temperature control among ventilated infants on full enteral feeds who were assigned to 2 days of KC (2 hours each day) vs. standard incubator care	Among 14 included infants, median BW = 990 ± 155g and median GA = 30 ± 1 weeks; 100% MV; all infants diagnosed with BPD	–	–	↓	↓	–	–	–

KC, Kangaroo Care; IVH, Intraventricular hemorrhage; BW, Birthweight; GA, Gestational age; MV, Mechanical ventilation; QI, Quality Improvement; NEC, Necrotizing enterocolitis; CPAP, Continuous positive airway pressure; HFNC, High-flow nasal cannula; PICC, Peripherally-inserted central catheter; UVC, Umbilical venous catheter; IQR, Interquartile range; LBW, Low birth weight; SD, Standard deviation; rcSO2, Regional cerebral tissue oxygen saturation; BPD, Bronchopulmonary dysplasia; EHR, Electronic health record; ECMO, Extracorporeal membrane oxygenation; CNS, Central nervous system; CDH, Congenital diaphragmatic hernia; PEEP, Peak end expiratory pressure; HFOV, High frequency oscillatory ventilation

↔ Authors conclude no clinically- or statistically- significant difference between KC and standard care

↑ Authors conclude outcomes favorable with KC compared to standard care

↓ Authors conclude outcomes less favorable with KC compared to standard care

– Outcome not assessed or not reported

Uptake

Thirteen of thirty-four studies (38%) addressed strategies to improve KC uptake within advanced NICU settings (Table 2). Notably, uptake initiatives varied widely in classifying which neonates were eligible for KC participation based on degree of medical complexity. While several studies excluded infants with central lines, chest tubes, or endotracheal tubes for mechanical ventilation, other studies demonstrated safe KC with these medical devices in use. Studies concentrating on surgical populations varied in determination of KC eligibility, with some infants excluded within 24 hours of any procedure while others were only excluded for specific conditions such as fresh tracheostomy or open wound defects [37, 38, 40, 63]. While hemodynamic instability was the most consistent exclusionary criteria, one study [38] permitted KC for infants with active vasopressor requirements.

Prior to implementation of study measures, six studies reported cohort or unit-wide baseline KC coverage ranging from 5—71% of infants receiving any KC while in the NICU [36, 37, 39, 64, 65]. Four studies reported baseline duration of KC episodes ranging from 13—120 minutes per session [35, 65–67]. Only two studies reported baseline time to first KC episode which ranged from 13.3—18.0 days [35, 66]. Commonly cited uptake strategies included introduction of standardized documentation for KC episodes [38, 64, 68, 69] parental counseling and engagement regarding the benefits of KC [35, 37–39, 63–65], and reliance on KC “champions” to encourage daily practice [37, 38, 65]. Further emphasis was also placed on clear KC guidelines and nursing education; unique strategies to improve uptake included simulation-based training for nurses [66] and use of crib cards to designate infant KC eligibility [68]. One study conducted by McMillin et al. evaluated the feasibility of a dedicated intervention, the Kangarobe™, to increase KC for medically fragile infants in a level IV NICU; among 25 infants, use of this novel garment led to an increase in average KC duration from a unit baseline of 75 minutes per session to 171 minutes per session, with feedback that reducing logistical barriers such as positioning of wires and tubes made KC easier and more enjoyable [67].

While timing of audits varied (namely timing of introduction, daily duration, or proportion of eligible infants who received any KC), all included studies demonstrated successful increase in KC utilization in advanced NICU settings. Four studies reported final unit-wide KC coverage rates ranging from 51—89% [37, 40, 64, 65]. The one exception was a study by Horn et al. conducted at a Level IV NICU in Texas where parents of infants 22—34 weeks were assigned to either receive dedicated KC education or a control group. This study found a longer time to first KC for extremely premature infants in the intervention group compared to the control group (12.8 vs.10.5 days, p = 0.035), with findings attributed to greater perceived medical and social barriers within the intervention group (time to first KC 2.9 vs.12.8 days for English vs. non-English speaking mothers, p = 0.038). The authors concluded that language and medical barriers likely play a greater role in KC uptake compared to parental education initiatives alone [63].

Table 2
Neonatal eligibility criteria for Kangaroo Care among uptake initiatives in advanced neonatal intensive care units.

Study	Birthweight ≤ 1500 g	Gestational age ≤ 32 weeks	Chronologic age ≤ 72 hours	Non-invasive positive pressure ventilation	Mechanical ventilation	Central line	Arterial line	Chest tube	Surgical condition	Hemodynamic instability/ vasopressor requirement
Balasundaram et al. (2024)			+						o	
Hendricks-Munoz et al. (2014)										
Horn et al. (2025)										
Kelley-Quon et al. (2019)								▯	◊	
Lati et al. (2025)										
Leeman et al. (2018)										
Levesque et al. (2020)										
Marsh et al. (2021)			+							
McMillin et al. (2024)										
Nguyen et al. (2025)					∞					
Prajapati et al. (2025)										
Stadd et al. (2019)									Ω	
Zhang et al. (2014)										

Green = KC eligible

Red = KC ineligible

Yellow = Subset of the population considered KC eligible

Grey = KC eligibility not specified or addressed

+ Excluded neonates with chronological age ≤ 72 hours if gestational age ≤ 32 weeks

o Excluded surgical neonates within 24 hours of a procedure

▯ Determination of KC eligibility with chest tube in place per attending surgeon

◊ Excluded patients with fresh tracheostomy, extracorporeal membrane oxygenation dependence, or gastroschisis with silo or Schuster for omphalocele

∞ Excluded infants on high frequency oscillatory ventilation

Ω Excluded patients with fresh tracheostomy and open wound defects

Acknowledging logistical constraints posed by medical complexity, some studies highlight that creative positioning (such as side-lying or cradled rather than prone KC) may be needed and others also offered alternatives to KC such as clothed cradle holds, hand hugs (also referred to as facilitated tucking), or in-bed arm encirclement [37, 39]. In one advanced NICU exclusively caring for surgical infants, a unit-wide quality improvement initiative involving parental and staff education along with standardized team huddles prior to any parent holding led to a greater increase in holding without skin contact (77% of infants at 18 months post-intervention audit) compared to KC (7.4% of infants) [37]. Across all studies, further heterogeneity was observed in defined target metrics with end goals not only focusing on time to first KC or daily KC duration but also correct KC positioning and accurate nursing documentation.

Study quality assessment

Quality assessment scoring based on JBI criteria classified 21 studies as good quality with low risk of bias, 9 studies as moderate quality with moderate risk of bias, and 4 studies including 2 abstracts as low quality with high risk of bias (Appendix 3). Studies of moderate or low quality were most commonly QI

reports which lacked a control group, were unable to report on the similarity of demographics between comparison time points and could not report on the similarity of other treatments for participants or had insufficient strategies to address confounding. No studies were excluded due to issues of data quality.

Discussion

This systematic review highlights 34 studies from advanced NICU settings demonstrating feasibility of KC for vulnerable neonates though with highly varied approaches to KC implementation. While specific benefits of KC for extremely premature and low birthweight infants have been summarized elsewhere, this review is unique in examining studies on KC for infants considered medically vulnerable beyond birthweight or gestational age classifications [18]. Our findings here confirm that current evidence supports the safe use of KC in advanced NICUs, however implementation efforts are needed due to wide variability shown across studies.

When compared to standard incubator care, studies demonstrated consistent effectiveness of KC in maintaining positive cardiorespiratory regulation, with either unchanged or decreased episodes of bradycardia and no clinically significant differences in FiO2 requirements or SpO2 measurements for infants on respiratory support. Only one study (Smith et al.) had unfavorable conclusions regarding the safety of two hours of KC for mechanically ventilated infants; however, the average age of enrolled infants was 34 days and all included infants had a diagnosis of bronchopulmonary dysplasia [54]. Thus, it is not surprising that this cohort would require FiO2 adjustments with changes in positioning and no KC sessions were terminated early due to intolerance. Moreover, recent studies and consensus criteria have increasingly supported the use of KC while on conventional ventilation, and many settings have incorporated this into routine clinical practice [70–72]. KC for invasively ventilated patients is further supported by the findings of this review demonstrating no increase in unplanned extubation or medical device dislodgement across all studies. Notably, only one included study had a patient on high frequency oscillatory ventilation who received KC, thus more must be done to identify feasible strategies to provide KC for these infants if physiologically appropriate [40]. Several studies found no difference in regional cerebral tissue oxygen parameters between KC and incubator care, though more must be done to understand the significance of these findings.

This review found no clinically or statistically significant hypo- or hyperthermia for medically complex infants, suggesting that parental contribution to infant thermoregulation is comparable to incubator care. This safety finding is particularly important considering the several studies suggesting favorable impact of KC among this high-risk population. Three studies in this review showed favorable findings for neurodevelopmental outcomes, adding to a robust evidence base for premature and low birthweight infants who receive KC. These findings indicate that KC could play an important role in promoting optimal neurodevelopment in infants at highest risk for adverse neurocognitive outcomes [73]. While studies commonly reported positive clinical outcomes of KC, the effect on infant-parent bonding should not be overlooked; findings from this review echoed previous literature in parents' experience of profound meaning and comfort from the practice of KC during an otherwise challenging experience of prolonged NICU admission [74].

With these findings demonstrating feasibility and effectiveness of KC practice, there is an opportunity for advocacy towards greater utilization of KC in advanced NICU settings. While this review demonstrates the success of implementation strategies such as parental education, efforts to increase healthcare worker buy-in, and integration of this practice into unit culture, there is a notable lack of consensus criteria on KC eligibility for infants with medical or surgical complexity. Among included studies, target populations for KC uptake varied widely from one study focusing only on clinically stable neonates ≥ 35 weeks gestational age [64] to a unit-wide initiative which only excluded infants based on gestational age ≤ 32 weeks within the first 72 hours of life, therapeutic hypothermia, or parents with rash or open skin lesions [38]. This was further highlighted by discrepancies in eligibility for surgical infants with differing criteria established by each institution. Though prior literature emphasizes the lack of a "one size fits all" approach to KC implementation in high-resource settings, there is a clear need to establish a feasibility framework for adoption of KC in advanced NICU settings and increase access to this important aspect of neonatal care [12]. Additionally, as some studies found there are unique and complex barriers in advanced NICUs that education initiatives alone cannot overcome [63].

Limitations of this review include the small number of studies based upon a lack of available literature on this topic. In observational studies of KC, it is often not possible to completely account for the fact that less severely ill infants are more likely to receive KC; thus, it is possible that some of the associations reported are confounded by differences in illness severity. Despite this, the review includes strong representation from infants requiring respiratory support, central lines, and surgical considerations, all of which make KC considerably more challenging and thus guide discussion on further strategies for optimal KC implementation. This review excluded non-English language literature, however only three studies were excluded from the search for this reason suggesting limited risk of language bias. Quality of the studies and risk of potential bias varied, yet small observational studies provide important contributions to our understanding of KC within advanced NICU settings. Given substantial heterogeneity in eligibility criteria and outcome measurement, the study authors judged that performing meta-analyses to summarize KC outcomes would risk applying inaccurate assessment of findings to a diverse patient population and would not be suitable for correction by a random-effects model. Together, these highlight the need for further high-quality studies on the use of KC in advanced NICU settings.

Notably, this review did not yield any studies addressing the impact of KC on neonatal sepsis and infection prevention in advanced NICU settings. This is an interesting area to explore further; specifically noting the high prevalence of *Staphylococcus aureus* colonization and infection within many advanced NICUs. A 2015 study conducted in the NICUs of three public maternity hospitals in Brazil showed that methicillin-resistant *S. aureus*-colonized infants who received two-hour structured KC sessions for seven days from non-colonized mothers were 2.35-times more likely to decolonize compared to those who did not receive structured KC [75, 76]. A more recent national population-based cohort analysis in France found that among 3422 included infants, KC exposure before day 4 of life was not associated with increased risk of late-onset sepsis (LOS) with *S. aureus*, supporting safety of this practice (RR 0.77, 95% CI 0.31–1.87) [77]. These findings suggest that KC could serve as a novel IPC strategy to decrease neonatal pathogen colonization and transmission but requires further exploration to understand the role of this practice in conjunction with traditional IPC measures in advanced NICU settings.

Conclusion

Current evidence supports the safe use of KC in advanced NICU settings while highlighting important gaps in the literature regarding standardized implementation of this practice for medically complex infants. Further high-quality prospective studies are needed to establish best practices for encouraging KC uptake in advanced neonatal care.

Declarations

Conflict of Interest:

All authors have declared no competing financial interests.

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Author contributions:

All authors conceptualized and designed the search strategy. MS and SR independently reviewed abstracts for relevance and progression to full-text review, with secondary review and arbitration performed by GS. This process was repeated by MS, SR, and GS at the full-text review stage to confirm eligibility criteria and identify articles for full-text inclusion. Reference lists for full-text articles, adjacent systematic reviews, and relevant articles previously known to the authors were manually reviewed by GS. GS designed the data collection instruments, wrote the original draft, created the tables and figures. All authors participated in data analysis, critically reviewed the manuscript and approved the final manuscript as submitted.

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Figures

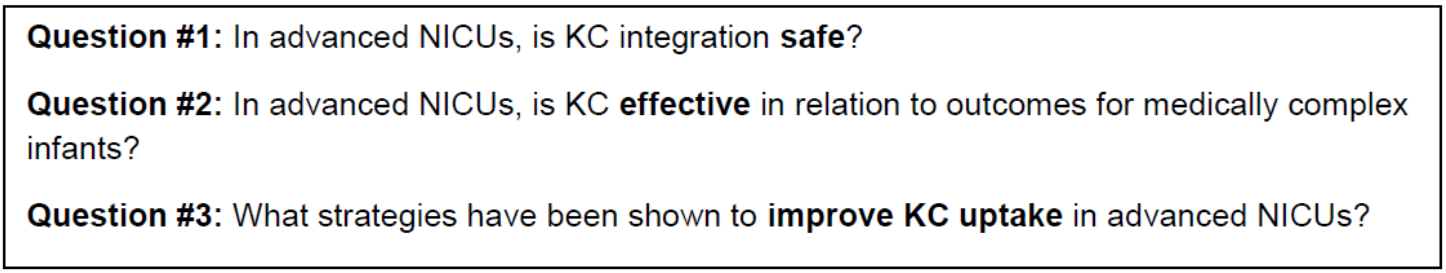

Figure 1

Key research questions guiding the literature search

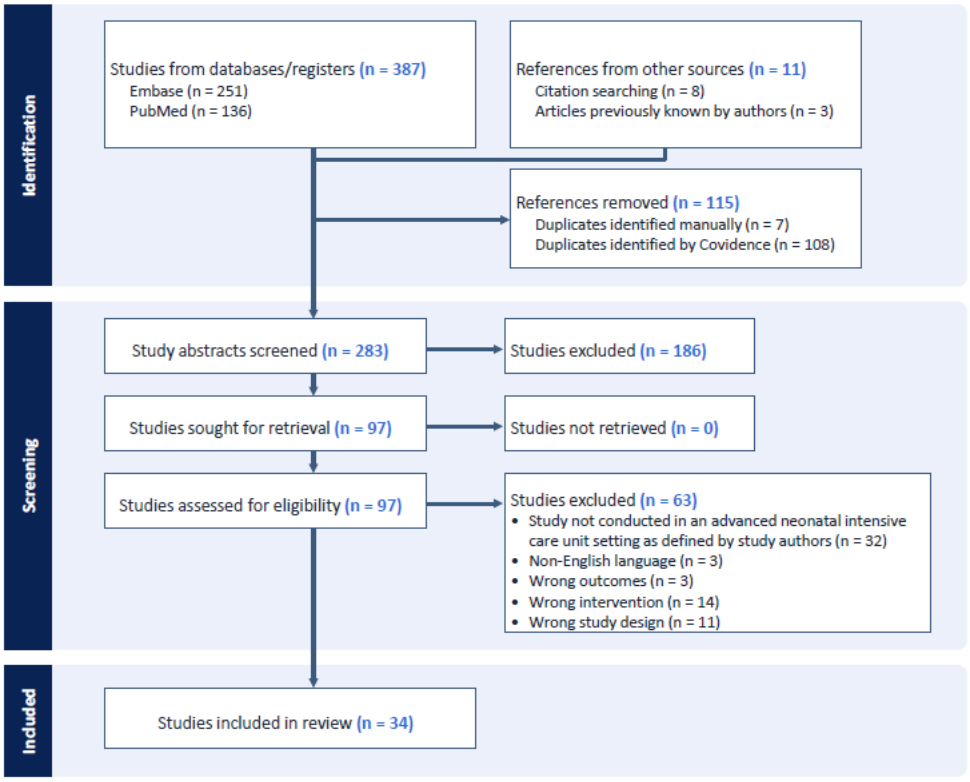

Figure 2

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flowchart

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- KCAppendix1PRISMAChecklist.docx
- KCAppendix2Databasesearchstrategy.docx
- KCAppendix3JBIAssessment.docx