A Randomized Controlled Trial of Intermittent Kangaroo Mother Care versus Conventional Care in Increasing the Rate of Weight Gain among Low-Birth-Weight Neonates

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ABSTRACT

Objective. To determine the effectiveness of Kangaroo Mother Care (KMC) in increasing the rate of weight gain and decreasing hypothermia, apnea, and sepsis rate, and shorten hospital stay among low-birth-weight infants.

Methods. Very low birth weight (VLBW) infants (≤1500 grams) were randomized to either the KMC or conventional care group. KMC provided skin-to-skin contact at least 6 hours per day while the conventional group received the usual care in the newborn intensive care unit (NICU). Daily weight measurements and weekly measurements of length, head, and chest circumference were recorded until discharge. Occurrence of hypothermia, apnea, sepsis, and length of stay was noted.

Results. KMC group had a higher mean weight gain per day (p=0.0102). There was no difference in the length, head, and chest circumference between the two groups. Sepsis and apnea rates were not significant between the two groups. Significantly more neonates experience hypothermia in the control group (p<0.0069).

Conclusion. KMC is effective in increasing the weight per day compared with the control group. KMC protects the neonates against hypothermia. There is not enough evidence to show a difference in the incidence of sepsis, apnea, and the length of hospital stay between the two groups.

Key Words: Kangaroo mother care, low birth weight, weight gain, skin to skin, intermittent KMC

INTRODUCTION

The World Health Organization (WHO) has defined low birth weight (LBW) as birth at less than 2500 grams.[1] Globally, around 15% of newborn infants are LBW, the proportion ranging from 6% in developed countries to more than 30% in some parts of the world.[2]

LBW contributes to neonatal and infant mortality and morbidity, with about 30% of neonatal mortality in developing countries.[3] In the Philippines, the neonatal mortality rate is at 17 per 1000 live births, and 39% of these deaths are attributable to prematurity.[4] LBW survivors demonstrate significant growth retardation as reflected by lower body weights, heights, and head circumferences than normal peers.

Medical care of low-birth-weight infants is complex, demands an expensive infrastructure and highly skilled staff, and is often a disruptive experience for families. Traditionally, they are kept in the neonatal intensive care unit, requiring sophisticated devices, usually placed inside an incubator

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monitored by highly skilled NICU staff. Mothers are allowed to visit NICU, but they have limited access and contact with their babies. The burden on health systems imposed by low-birth-weight neonates in high-income countries is considerable and well recognized. It is estimated that the cost of care for a single preterm birth in the USA is $51,600.00.[5] In low-income countries, this challenge remains invisible. Still, it is actually of greater magnitude as preterm birth rates are higher and the available resources are fewer, characterized by understaffed hospitals with ill-equipped or non-existent neonatal care units, which ultimately result in a higher mortality rate. Preventive programs, though very desirable, can be effective only on a medium and long-term basis, and prevention involves many non-health interventions; thus, a simple, cost-effective, evidence-based intervention is needed in the complex management of low-birth-weight infants.[6]

In the 1978's, motivated by the problems arising from shortage of incubators and also impact of mother and newborn separation, Dr. Edgar Rey, a pediatrician from Colombia, and his team in Institution Materno Infantil in Bogota, Colombia, developed a technologically simple method later named Kangaroo mother care (KMC). The major components of the intervention include prolonged skin-to-skin contact – Kangaroo position in which babies are kept, day and night, between the mother's breast in an upright position, frequent and exclusive breastfeeding, and early discharge from hospital regardless of weight or gestational age.[7] The duration of skin to skin contact between the mother and baby dyad can initially be done intermittently, with minimum cumulative 6 hours a day, then gradually increasing until at least 20 hours cumulative hours a day, which is called continuous KMC.[8]

KMC helps improve the survival of LBW infants, their growth and development while meeting the standards of quality and at the same time humanizing health care. The Kangaroo position offers skin-to-skin contact between mother and child in a vertical position. Mothers act as incubators, providing the primary source of nutrition and stimulation. Kangaroo mother care has three distinct uses: (1) it can be applied in places without appropriate neonatal care facilities as it is the only alternative to the lack of incubators; (2) in places with access to all levels of neonatal care, KMC offers early mother-infant, skin-to-skin contact, enhancing the quality of mother-infant bonding and successful breastfeeding, and (3) in situations where facilities are of a good standard, but insufficient to cope with the demands, KMC is an alternative to minimal care after the infant has overcome extrauterine life adaptation problems.[7]

In the Philippines, KMC started in Dr. Jose Fabella Memorial Hospital in 1998 after the return of Dr. Socorro Mendoza from training in Bogota, Colombia. Five years after its implementation, there was a significant reduction in mortality rates across all weight categories (OR 0.86 95%CI 0.85, 0.91) and deaths due to sepsis (p 0.000009, RR 0.75 (95% CI 0.66, 0.84).[9]

Low birth weight comprises 20% of all live births, similar to the statistics in Philippine General Hospital (PGH) from 2005-2009.[4] In Philippine General Hospital, where 20% of live births are low birth weight, overcrowding in the neonatal intensive care unit is a perennial problem. After stabilization and graduation from intensive care, because of the lack of facilities for rooming-in patients, low birth weight infants are being kept in the transitional care area of the NICU until they are ready for discharge. When available, they are placed inside an incubator, but otherwise, they are put in a crib, swaddled, and exposed under droplight to keep thermoregulated. During the peak of admissions, when all incubators and cribs are used up, 2-3 babies are placed in one crib. Mothers can visit and breastfeed their babies during visitation hours, but the unit nurses and paramedical staff provide all routine care. Overcrowding increases the risk of acquiring nosocomial infections, prolonged hospital stays, and subsequently increased hospital costs. These become a source of considerable economic burden on families and the institution where the infants are admitted. The study aimed to determine the efficacy of kangaroo mother care (KMC) in increasing the rate of weight gain among low-birth-weight neonates, which may subsequently result in a decreased duration of hospital stay and reduced incidence of nosocomial infection. It may also lead to reducing the economic burden on the families and the institutions as well. All these may ultimately translate to saving more neonates.

Specifically, this study aimed to determine if low birth weight neonates rendered kangaroo mother care would have a higher weight gain per day, decreased length of hospital stay, and decreased morbidities such as sepsis, apnea, and hypothermia compared with those given conventional care.

METHODS

This was a non-blinded randomized controlled trial involving a total of 52 neonates, 26 in each group. The sample size was calculated to achieve 95% power to detect a difference of 8.4 between the two groups with a significance level of 0.05.

Criteria for eligibility

All infants born at the University of the Philippines - Philippine General Hospital who cannot be placed inside the incubator due to lack of it and eligible for the study were included. Inclusion criteria were as follows: birth weight ≤1500 grams and stable neonates (no dependency on oxygen, intravenous fluid, or both, ability (at least partial) to feed) with stable vital signs for the past 24 hours (normal temperature (36.5-37.5˚C), normal heart rate (120-160 bpm), normal blood pressure per age, no apnea, no intravenous lines or with a well-secured peripheral line, no sepsis, no emerging signs of sepsis, on IV antibiotic therapy but clinically stable, can require phototherapy but with steady and not rising total serum bilirubin (TSB) level or TSB is not in a high-

risk zone. The following neonates were excluded from the study: neonates with chromosomal and life-threatening congenital anomalies, who were severely ill, whose mothers were critically ill, and whose mothers could not comply with the follow-up schedule.

Randomization

After informed consent was obtained from the parents, patients were randomized using a table of random numbers with codes place in a sequentially numbered opaque sealed envelope by a person not involved in the study to ensure concealment. Patients were randomized either to one of the two groups [kangaroo mother care (KMC) or conventional method care (CMC)].

All eligible babies were weighed naked on an electronic weighing scale upon birth, upon entry into the study, and subsequently daily one hour after feeding until discharged. Their length was measured at birth, weekly, and on discharge using an infantometer upon entry into the study. Likewise, head circumference (HC) and chest circumference (CC) were measured at birth, upon entry into the study, weekly, and on discharge using a non-stretchable tape. The same research assistant carried out all measurements.

Kangaroo Mother Care Group

Mothers in the KMC group were oriented in detail about KMC procedure. The mothers provided skin-to-skin contact using a specially tailored "kangaroo tube" made of soft flannel cloth. The mothers were encouraged to keep the baby in KMC as long as possible during the day and night for an accumulated time of at least 6 hours per day. The duration of the kangaroo care given by each of the mothers was recorded and tallied accordingly.

The infants were placed on continuous skin-to-skin contact between the mother and the baby as soon as possible. The mother kept her newborn infant between the breasts, in close contact with her body, and covered with the kangaroo tube. Infants wore a diaper and a cap during the procedure. (Figures 1 and 2). Breastfeeding was the standard feeding method.

When the baby was not in KMC, the baby was placed in the bassinet under a light bulb, adequately clothed and covered.

Conventional Mother Care

A conventional care method was the routine care offered in the neonatal unit to low birth weight infants. In the absence of an incubator, this generally includes placing the baby in the bassinet under light bulbs, providing 25 watts, adequately clothed and covered.[10] (Figures 3 and 4). Breastfeeding was also the standard feeding method, but babies can also be fed with expressed breastmilk through tube or cup feeding if indicated. The mothers were allowed to visit their babies anytime and cuddle their babies with swaddles upon request.

Figure 1. The baby is in skin-to-skin contact with her mother, placed between her breast and covered with a kangaroo tube and bonnet.

Figure 2. The mother uses a lounge chair while on KMC.

Figure 3. The baby is placed in a crib swaddled using linen under light bulbs.

Figure 4. In the absence of incubators, babies are placed in cribs, wrapped, and, if needed, placed under light bulbs for thermoregulation.

Babies in both groups were monitored hourly. Their heart rate, respiratory rate, and temperature were observed and recorded. Also noted were any untoward event like hypothermia (temperature below 36.5˚C),[11] hypoglycemia (blood sugar level below 50mg/dl),[11] apnea (cessation of breathing for longer than 20 seconds any duration if accompanied by cyanosis or bradycardia),[12] signs of sepsis (temperature instability, respiratory distress, feeding difficulties, sensorium changes, seizures, hypotonia, bulging fontanel, poor perfusion, bleeding problems, jaundice), and feeding problems (50% gastric residuals, abdominal distention, vomiting).[12,13]

Discharge criteria

Low birth weight infants both in the intervention and control group were discharged from the hospital according to the following criteria: baby's general health was good as assessed by the attending physician and no evidence of infection, feeding well and receiving breast milk exclusively, gaining weight (at least 15-20 grams/k/day for at least three days), maintaining body temperature satisfactorily for at least three consecutive days in room temperature and the mother and family members were confident to take care of the baby in KMC.

Statistical Analysis

The data collected were statistically analyzed using Pearson's chi-square test and Student's t-test. A p-value of <0.05 was considered significant.

Ethics

Before the study, the researchers obtained approval from the Institutional Review Board and Ethics Committee of the National Institutes of Health. Written informed consent was taken from the mothers after the babies were stable and ready for enrolment.

RESULTS

In this study, 52 infants were recruited, 26 randomized into the kangaroo mother care group and 26 into the conventional mother care group. In the KMC group, one patient developed neonatal cholestasis and needed work-up. The mother of the other patient had pneumonia hence was not able to go to the hospital to continue KMC. All subjects were analyzed in the group they were randomized.

As shown in Table 1, the neonatal baseline characteristics were comparable between groups. There was no significant difference in their birth weight and baseline anthropometric measurements. Sex, mode of delivery, gestational age, and age on enrolment were likewise comparable.

Neonates randomized into KMC achieved a significantly higher weight gain per day than the conventional care group (26.95 g ± 12.83 vs. 19.83g ± 6.64 p-values 0.0102) (Table 2). During the study period, other anthropometric measurements, head and chest circumference, and length did not show any significant difference with the p-value of 0.5368, 0.4954, and 0.1244, respectively.

Table 3 illustrates the morbidities observed during the patient's hospital stay. There was a higher incidence of hypothermia among the CMC group than the KMC group (p 0.0069). KMC reduced the risk of hypothermia among LBW by 75% (RR of 0.3529 (95% CI 0.1658, 0.7513). The incidence of sepsis and apnea between the two groups did not differ significantly (p 0.1799 and 0.4867, respectively). Likewise, the mean duration of hospital stay between the

Table 1. Comparison of Baseline Characteristics of the Low-Birth-Weight infants in the KMC versus the CMC groups

Variables	KMC (n=26)	CMC (n=26)
No. (%)		
Sex		
Female	17 (65.38%)	15 (57.70%)
Male	9 (34.62%)	11 (42.30%)
Mode of delivery		
Normal	9 (34.61%)	10 (38.46 %)
Caesarian section	17(65.38%)	16 (61.54%)
Maturity		
Preterm	25 (96.15%)	26 (100%)
Term	1 (3.85%)	0 (0%)
Gestational age based on Lubchengco chart		
Small	16 (61.54%)	15 (57.70%)
Appropriate	10 (38.46%)	11 (42.30%
Large	0 (0%)	0 (0%)
Mean ± SD		
Gestational Age (weeks)	32.5 (2.76)	32.1 (2.51)
Age on enrolment (days)	15.7 (11.37)	14.4 (11.22)
Anthropometric		
Birth weight (grams)	1166.1 (0.19)	1210.0 (0.23)
Upon enrolment:		
Weight (grams)	1246.9 (0.17)	1300.0 (0.16)
Head circumference (cm)	23.2 (1.24)	27.5 (1.37)
Chest circumference (cm)	27.7 (1.35)	23.8 (1.05)
Length (cm)	38.9 (1.96)	39.4 (2.79)

groups did not show a significant difference (33.314 ± 17.8 days vs. 33.255 ± 17.816 days p 0.9905).

DISCUSSION

Kangaroo mother care has been associated with a range of potential benefits to the newborn, such as better weight gain, thermoregulation, physiological stability, and decreased incidences of morbidities, including sepsis, hypothermia, apnea, and decreased mortality rates. This study showed higher weight gain per day among neonates randomized to the KMC group than CMC, p-value 0.0102. This is in agreement with the randomized controlled trials made by SumanRao, et al., Ali et al., and Ramanathan et al. In the study of SumanRao, the KMC group had better weight gain per day, 23.99 grams versus control 15.58 g with p-value <0.001.[7] Ali et al., duplicated this result with KMC group having higher weight gain per day (19.3 ± 3.8 grams versus 10.4± 4.8 grams (p.001).[8] The same results were also found in the paper of Ramanathan et al. with a p-value of 0.005.[14]

As seen in the infants receiving kangaroo, better weight gain can be caused by the interplay of several physiological mechanisms brought about by the release of oxytocin in the mother and the newborn. Various sensory stimuli can induce oxytocin release. Touch or skin-to-skin contact, as in KMC, stimulates the release of oxytocin in the blood and cerebrospinal fluid. Oxytocin, a hormone known to stimulate labor and milk ejection, causes a broad spectrum of physiological effects mediated through the receptors in the brain and appears to influence growth in neonates placed on skin-to-skin contact with their mothers. Among these effects is the increase in the nociceptive thresholds by enhancing endogenous opioids in the newborn. It also induces an anti-stress-like pattern through a decreased activity in the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system. The neonate becomes calmer as long as it is kept skin to skin on its mother's chest.[15]

The physiological relaxation is expressed by decreased heart and respiratory rate and blood pressure. Heart and respiratory rates, respiration, oxygenation, oxygen consumption, blood glucose, sleep patterns, and behavior observed in low-birth-weight infants held skin-to-skin is better than those observed in infants separated from their mothers. A meta-analysis of 23 studies of stable preterm infants in an incubator, then in KC, and finally back in the incubator revealed that heart rate was significantly different than in the incubator.[16] During skin-to-skin contact with their mothers, low-birth-weight infants maintain higher oxygen saturation and are less likely to have desaturation to less than 90% oxygen.[17] Oxygen saturation was higher during

Table 2. Comparison of Mean Changes in Anthropometric Measurements of KMC versus CMC groups

Variables	KMC (n=26)	CMC (n=26)	P value (CI)
Mean ± SD			
Weight (gram/day)	27.0 (12.83)	19.4 (6.64)	0.010 (-13.2606, -1.8794)
Head circumference (cm/week)	0.8 (0.38)	0.9 (0.43)	0.537 (-0.1560, 0.2690)
Length (cm/week)	1.0 (0.44)	0.8 (0.52)	0.124 (-0.4799, 0.0599)
Chest circumference (cm/week)	0.8 (0.42)	0.7 (0.42)	0.495 (-0.3140, 0.1540)

Table 3. Comparison of morbidities between low-birth-weight infants in the KMC and CMC groups

Morbidities (n, %)	KMC (N=26)	CMC (N=26)	p-value	RR	RRR	ARR	NNT
Hypothermia	6 (23.0)	17 (65.4)	0.0069	0.35 (0.166,0.751)	0.65 (0.249, 0.834)	0.42 (0.153, 0.834)	2
Apnea	6 (23.0)	4 (15.4)	0.4867	1.50 (0.479,0.702)	-0.50 (-3.701, 0.521	-0.08 (-0.288, 0.141)	13
Sepsis	3 (11.5)	7 (26.9)	0.1799	0.43 (0.124,0.479)	0.57 (-0.479, 0.876)	0.15 (-0.065, 0.36)	7

skin-to-skin contact (*P*<.001). Another paper by Bier et al. also reported higher oxygen saturation during skin-to-skin contact than standard care. Twenty-four percent of low birth weight receiving standard care had less than 90% oxygen saturation values compared with only 11% in the skin-to-skin contact group.[18] Physiologic stability was also seen in the meta-analysis done by Anderson et al. wherein that infants in the skin-to-skin contact have lower respiratory rate compared with those in incubator.[19]

In addition, salivary cortisol, an indicator of possible stress, also appears to be lower in the newborn held in skin-to-skin contact.[20] Closer studies of the pre-term's nervous systems describe that it is more organized while in a calm environment without excessive stimuli.[21, 22]

Moreover, oxytocin also is positively associated with breastfeeding. Some studies show that milk production is ameliorated, breastfeeding time is prolonged, and more stable breast milk production.[15] Through this, the amount of breast milk that the newborn would be getting would be increased, contributing to its better weight gain.

In all of these physiologic mechanisms, KMC promotes better growth through more efficient calorie utilization. Energy is used for anabolism and growth instead of energy expenditure.

Furthermore, there is reciprocity of the oxytocin effect to the mother and neonate. In the mother, it stimulates milk ejection and dilates the cutaneous blood vessels on the chest, whereby the mother may transfer warmth to the neonate. Through this, the neonate becomes calmer, followed by increased peripheral circulation, and thereby the feet of the neonate become warm.

Thermoregulation is a critical physiologic function that is closely related to the transition and survival of the infant. It is a basic component of intensive care for preterm infants. Any challenge to its disruption, such as removal from a neutral thermal environment, contributes to concern for physiologic stability and growth.[20,21] This study confirms previous findings of a definitive protective effect of KMC against hypothermia. In this study, episodes of hypothermia were significantly reduced in the KMC neonates (p= 0.0069). Prolonged skin-to-skin contact between the mother and her low-birth-weight infant, as in KMC, provides effective thermal control and is associated with a reduced risk of hypothermia. The same results were observed in the study of Ali et al (KMC = 1.7% versus control 17.9% p= 0.003).[8] The results were also duplicated in the study of Suman Rao, which showed a significantly higher number of babies in the CMC group who suffered from hypothermia (CMC 36.9% versus KMC 5.9% p= <0.001).[7]

The study did not show a significant difference in the effect of KMC on the head and chest circumference and length of the neonates (p-value 0.5772, 0.1753, 0.0544, respectively). This could be explained by the short observation period with only 2.5±1.67 weeks in CMC and 2.8±1.55 weeks in KMC to monitor growth.

KMC has been proven to decrease the incidence of sepsis among low-birth-weight neonates. In the meta-analysis of Conde-Aguedo et al., KMC was associated with a reduced risk of acquiring nosocomial infection at 41 weeks age of gestation (AOG).[23] This study showed that more neonates had sepsis in the CMC group (23%) than in KMC (11.5%). However, it did not reach statistical significance (p = 0.1799). Relative risk was 0.4; however, the confidence interval still included 1 (Table 3). Early discharge is one of the components of KMC and was also implemented during the conduct of the study. LBWs were discharged even before reaching 41 weeks AOG, thus decreasing the risk of acquiring nosocomial infection. The small size in this study might have also affected the results since it was computed based on the primary outcome.

While previous studies showed that the KMC group had a shorter duration of hospital stay, this study shows otherwise.[3,7] The mean duration of hospital stay in KMC group was 33.314 ± 17.803 and 32.255 ± 17.816 in CMC, p= 0.9905. This might have been affected by the two patients in the KMC group who were pulled out from the study. The first patient had neonatal cholestasis needing workup and treatment and stopped on the 19th day after enrolment. The other patient discontinued KMC on the 16th day of the study due to maternal health issues. This can also be due to the sample size computed for the different outcomes. The same result was also found in Suman Rao et al. (KMC 12.78± 6.27 CMC 12.86 p= 0.93).[7]

CONCLUSION

Kangaroo mother care significantly improves weight gain among low-birth-weight neonates. It protects neonates against hypothermia. There is not enough evidence to show that sepsis, apnea, and length of hospital stay differ between the two groups.

Statement of Authorship

Both authors participated in the data collection and analysis and approved the final version submitted.

Author Disclosure

Both authors declared no conflicts of interest.

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