Original Article

Alternative to the kangaroo mother care method In preterm infants

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ABSTRACT

Background

One of the effective methods for reducing mortality and morbidity among preterm newborns is the Kangaroo Mother Care (KMC) method. However, numerous barriers to implementing this method in neonatal units exist. Therefore, alternative methods replacing KMC in the care of preterm newborns are relevant.

Objective

To determine the effectiveness of using a diaper, which was placed on the mother's chest for 12-24 hours and then used as a "nest" for the preterm newborn, on neonatal mortality and morbidity rates.

Materials and Methods

A randomized controlled trial involving preterm infants with extremely and very low birth weight. The control group consisted of preterm infants cared for using the KMC method, and the main group comprised preterm infants in whose care diapers that had been placed on the mother's chest were used.

Results

Statistical data analysis revealed no significant differences in outcomes between the alternative approach and KMC, which may have been influenced by the small sample size. The number of fatal outcomes was similar in both groups, although children in the main group required intensive care for longer (11.48 vs. 8.32 days). The incidence of sepsis in post-mortem diagnoses was lower in the main group. The duration of using second- and third-line antibiotics did not differ between the two groups.

Conclusion

Despite the absence of statistically significant differences between the groups, the obtained data indicate the potential clinical applicability of this approach in settings where the implementation of the KMC method is limited or temporarily impossible.

Keywords

neonatal mortality; preterm newborns; kangaroo mother care; skin-to-skin contact; sepsis; bacterial infection.

INTRODUCTION

Prematurity remains one of the leading contributors to infant mortality worldwide. According to estimates from the World Health Organization, approximately 13.4 million infants were born preterm in 2020, of whom nearly 900,000 to 1 million died due to complications associated with premature birth[1,2]. Although the neonatal period represents a relatively brief stage of life, it accounts for nearly half of all infant deaths. For instance, in 2022, an estimated 2.3 million newborns died within the first 28 days after birth[3].

The risk of adverse outcomes is particularly high among infants with very low and extremely low birth weight. This underscores the urgent need for the implementation of effective, safe, and economically feasible care strategies aimed at improving survival rates, reducing morbidity, and enhancing long-term quality of life.

To reduce mortality and morbidity among preterm infants, there is substantial evidence regarding the advantages and benefits of the Kangaroo Mother Care (KMC) method in this group of children. According to a Cochrane Library systematic review, using the KMC method as an alternative to traditional care significantly

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reduces the risk of mortality, nosocomial infection/ sepsis, and hypothermia. Moreover, KMC leads to increased weight gain, length, and head circumference in preterm newborns [4]. The application of KMC is an accessible and low-cost method that improves neonatal outcomes among low birth weight preterm infants. It can be hypothesized that the colonization of the infant's gut with the mother's natural microbiota during KMC contributes to achieving the aforementioned results[5].

However, despite the compelling evidence base and the existence of international recommendations, the accessibility and low cost of KMC, its implementation into daily clinical practice remains inconsistent. Organizational and staffing constraints, features of intensive care unit infrastructure, as well as social and cultural factors influencing parental participation in newborn care, play a significant role. Researchers highlight the following barriers: nursing staff tend to avoid using KMC in preterm infants with extremely or very low birth weight, which is the most common reason for the barrier [6], especially if the infant is on mechanical ventilation and has a central vascular catheter [7]; parents experience fear, anxiety, and distress towards the preterm infant [8]; some parents are afraid to touch their own baby [7].

Given the numerous barriers, which may be justified in some situations, as an alternative to the KMC method, we used diapers that had been placed on the mother's chest for 12-24 hours for daily infant care (swaddling, covering the infant, creating a "nest"). A search for similar studies in MedLine, PubMed, Cochrane Library, etc., did not reveal any information in this direction. The aim of the study was to determine the effectiveness of using a diaper, which was placed on the mother's chest for 12-24 hours and then used as a "nest" for the infant, on mortality rates, the incidence of bacterial infection, necrotizing enterocolitis, etc.

MATERIALS AND METHODS

The design of this study corresponds to a randomized controlled trial (RCT) with an intervention involving the use of a diaper, previously placed on the mother's chest for 12-24 hours to be colonized with maternal microflora, and the use of this material as a care item (diaper, "nest") for the preterm infant. Mother-infant pairs meeting the selection criteria and providing informed consent were randomly assigned to 2 groups: Group 1 – preterm infants cared for using the KMC method with a total duration of approximately 0.5 – 1.5 hours twice a day (control group); and Group 2 – preterm infants who also received KMC + were placed in a "nest" formed from a diaper that had been on the mother's chest for 12-24 hours (main group). All facility staff involved in conducting KMC underwent a one-day retraining on this method, including counseling mothers. In accordance with the standard protocol, all mothers whose infants were included in the main and control groups were instructed on how to perform KMC and how to care for their small infants. Additionally, all women whose infants were in the main group were instructed on wearing the diaper on their chest, the duration of wearing, fixation, etc. Each woman in the main group, upon visiting her infant, received a cotton diaper that had been centrally laundered and processed. For 12 – 24 hours, the woman wore this diaper on her chest, including during the night (Fig. 1). The next day, the woman brought the diaper, which nurses used as material to form a "nest." If the woman could not bring the diaper in the morning, she brought it the next day during her evening visit.

Fig. 1 - Fixation and wearing of a diaper on the chest by the mother

of a preterm infant

Study Setting

The study was conducted in 2023-2024 at the City Perinatal Center No. 2 in Almaty. Annually, an average of 43,000-44,000 newborns are born in the city. , The Neonatal Resuscitation and Intensive Care Unit has 12 beds, and the Department of Neonatal Pathology and Nursing of Preterm Infants has 30 beds.

Study Population and Sample Size

The study included preterm newborns with a birth weight from 500 to 1500 grams whose parents consented to participate in the study.

Exclusion criteria were: infants with very and extremely low birth weight having congenital surgical pathologies or congenital anomalies incompatible with life, who died in the first 3 days of life; preterm infants hospitalized without their mothers for various reasons (maternal death, being in other medical facilities, inability to reach the perinatal center due to long distance).

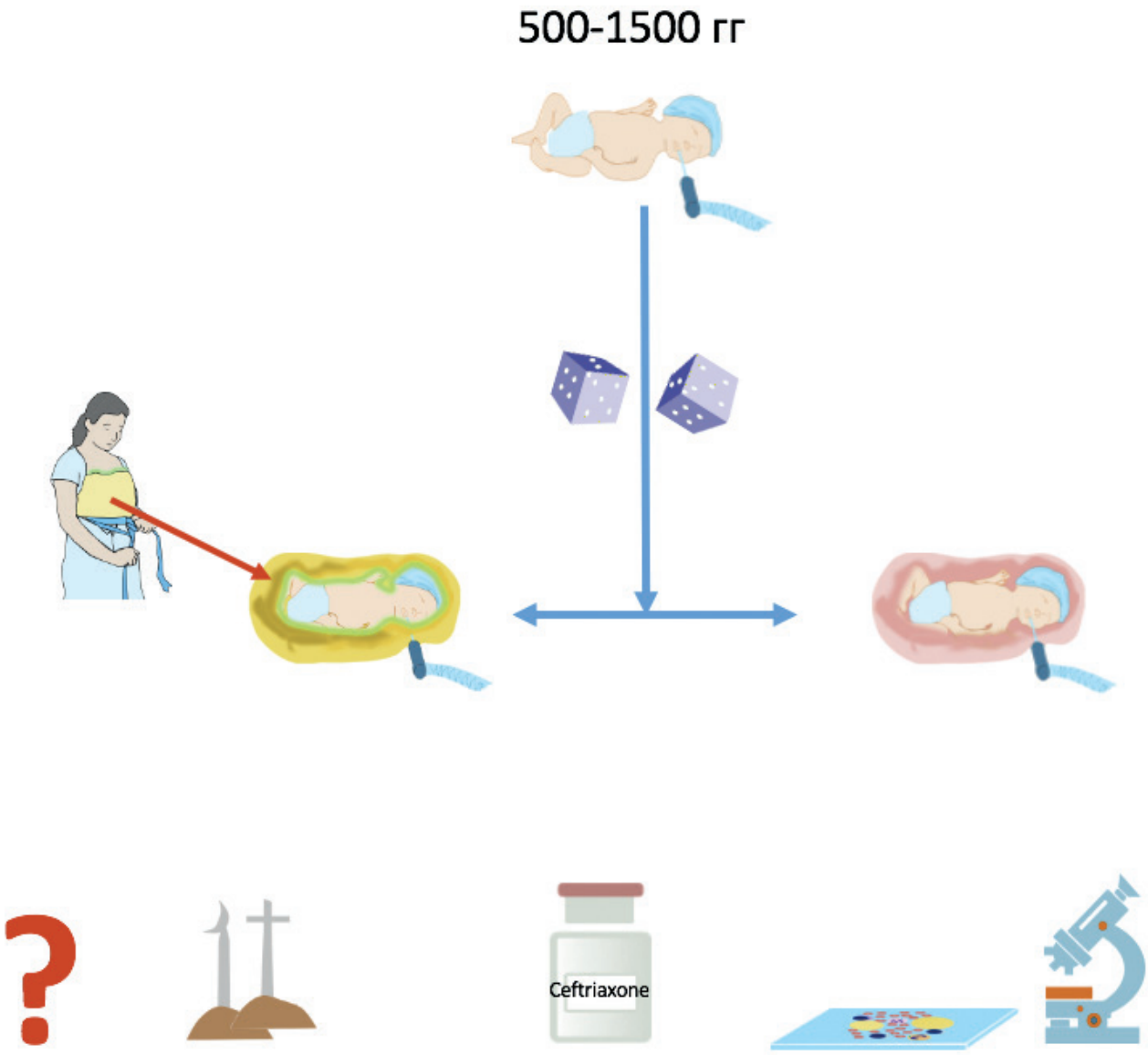

Fig 2 – Study Flowchart

Data Collection

Mother-infant pairs meeting the selection criteria and providing informed consent were randomized to receive cotton diapers. Eligible participants were allocated to intervention (main) and control groups in a random order (Fig. 2). Data were collected from January to December 2015. Data collection groups, including research staff, ward medical personnel, and clinical observers, were trained in the study protocol for five days under the guidance of the study leader and organization staff. Information was collected from the electronic health records of mothers and infants.

Data Analysis

The primary aim of this study was to determine the probability of reducing mortality in preterm newborns in the weight category from 500 to 1500 g using a diaper previously placed on the mother's breast and seeded with maternal microflora. The secondary aim was to determine the effect on other associated diseases of prematurity, such as late-onset bacterial sepsis, necrotizing enterocolitis, and intraventricular hemorrhages. Due to the impossibility of conducting qualitative bacteriological testing, it was decided to indirectly determine the reduction in nosocomial infection by examining the frequency and duration of use of second- and third-generation antibacterial drugs.

Ethical Clearence

The permission of the Institutional Ethical Committee was obtained for the study. During data processing, all information about patients was depersonalized. Written informed consent was obtained from parents of all participants before inclusion in the study.

Statistical Analysis

Chi-Square tests were used to assess differences between the study groups, and p-values less than 0.05 were considered statistically significant. All analyses were performed using Stata 11 [Statacorp LP, Texas, USA].

RESULTS

During the study period, 98 preterm newborns with a birth weight from 500 to 1500 g were admitted to the Neonatal Resuscitation and Intensive Care Unit of the Perinatal Center. Of these, 22 infants were excluded from the study because death occurred in the first three days after birth. Ultimately, 76 preterm infants participated in the study, including 39 infants in the main group and 37 in the control group. Table 1 shows the clinical characteristics of the two compared groups.

Table 1. Clinical characteristics of the compared groups

Variables	Total	Main	Control	p-value
Group Study	76	39	37	
Antenatal steroid prophylaxis (none, partial, complete)	16 7 53	7 5 27	9 2 26	0.5401
Antibiotic prophylaxis for preterm labor (none, partial, complete)	15 5 56	5 4 30	10 1 26	0.1675
Cesarean section	57,89%	53,85%	62,16%	0.4693
Delayed cord clamping	93,42%	92,31%	94,59%	0.6912
Apgar 1 minute	6.303	6.231	6.378	0.676
Apgar 5 minute	7.908	7.948	7.865	0.7087
Child's sex (male)	51,32%	53,85%	48,65%	0.6557
Gestational age (weeks)	30.07	29.79	30.35	0.2512
Birth weight (g)	1360	1329	1393	0.3276
Body length (cm)	36.50	36.26	36.76	0.4641
Head circumference (cm)	25.95	25.69	26.22	0.3609
Start of KMC (days)	4.25	4.358974	4.135135	0.8684
Duration of CPAP (days)	5.855	5.897	5.811	0.9615
Duration of mechanical ventilation (days)	2.711	3.974	1.378	0.1788
Duration of partial PN (days)	4.368	4.718	4	0.6038
Duration of total PN (days)	0.8684	0.9487	0.7838	0.7202
Treatment for PDA	23,68%	30,77%	16,22%	0.1373

Preventive measures taken for risks of preterm birth and early-onset bacterial infection (antenatal steroid prophylaxis, antibiotic prophylaxis) did not differ between the main and control groups, with p-values of 0.5401 and 0.1675, respectively. Most preterm births in the main and control groups occurred via cesarean section (53.8% and 62.12%, respectively), and no statistically significant differences were found between the groups (p=0.4693). One effective intervention to reduce mortality and other complications in the neonatal period is delayed cord clamping. This intervention was performed at similar rates in both groups: main group - 92.31% and control group - 94.59% (p=0.6912). The condition of infants at birth was similar in the main and control groups, as evidenced by Apgar scores at 1 minute (6.23 and 6.378, p=0.676) and 5 minutes of life (7.94 and 7.86, p=0.70). Anthropometric data in the main and control groups were also statistically similar:

birth weight 1329 g and 1393 g (p=0.3276); body length 36.26 cm and 36.76 cm (p=0.4641); head circumference 25.69 cm and 26.22 cm (p=0.3609).

Kangaroo Mother Care was started on day 4 of life in both groups (main - 4.35, control - 4.13, p=0.86). The main therapeutic interventions, such as the duration of respiratory support, also did not differ: duration of mechanical ventilation in the main group was 3.97 days and in the control group 1.37 days (p=0.1788); duration of CPAP use in the main group was 5.89 days and in the control group 5.81 days (p=0.96). Consequently, the duration of CPAP predominates over invasive respiratory support, consistent with international recommendations. The duration of partial and total parenteral nutrition did not differ statistically between the two compared groups.

Thus, the two compared groups do not differ statistically in key clinical characteristics and types of interventions that could affect mortality, morbidity, and complications in the early and late neonatal periods.

Statistical analysis of the obtained data revealed no statistically significant differences in outcomes between the two groups (Table 2).

Table 2. Clinical outcomes of the two compared groups

Variables	Total	Main	Control	p-value
Discharged	81,58%	82,05%	81,08%	0.9146
Days in NICU	9.947	11.487	8.324	0.2928
IVH	2.092	2.179	2	0.3816
Post-mortem diagnosis:				
Sepsis	1,35%	0	2,7%	0.324
IVH	13,16%	12,82%	13,51%	0.93
RDS	10,53%	10,26%	10,81%	0.9383
Extreme immaturity	0			
PDA	3,95%	2,56%	5,41%	0.5353
NEC	2,63%	5,13%	0	0.16
BPD	1,32%	2,56%	0	0.3236
Pulmonary hemorrhage	1,32%	2,56%	0	0.3236
Duration of 1st-line antibiotics (days)	2.526	2.487	2.568	0.8186
Duration of 2nd-line antibiotics (days)	0.7895	1.0256	0.5405	0.3141
Duration of 3rd-line antibiotics (days) 2.158 2.154 2.162 0.9921	2.158	2.154	2.162	0.9921

The primary aim of this study was to identify the impact of the intervention – using a diaper pre-colonized with maternal microflora (the infant's mother wore the diaper on her chest for 12-24 hours) – on mortality among preterm infants with extremely and very low birth weight. The number of discharged infants in the main and control groups was similar, at 82.05% and 81.08%, respectively (p=0.9146). The length of stay in the Neonatal Resuscitation and Intensive Care Unit was shorter in the control group (8.32 days) than in the main group (11.48 days). However, this difference was not statistically significant (p=0.2928). Post-mortem diagnoses in the two compared groups also did not differ statistically. It was hypothesized that the use of diapers pre-colonized with maternal microflora, due to being worn on the chest for 12-24 hours, would reduce the incidence of healthcare-associated bacterial infection and also affect the use of 2nd and 3rd generation antibiotics. As shown in Table 2, the incidence of sepsis in post-mortem diagnoses was lower in the main group, but this difference was not statistically significant. The duration of 2nd and 3rd-line antibiotic use was also not statistically significant between the two study groups.

Thus, the two compared groups showed no statistical differences in main clinical outcomes. The incidence of sepsis was lower in the main group than in the control group, but this was not statistically significant.

DISCUSSION

Survival among preterm infants is directly proportional to gestational age and birth weight; the lower the gestational age and birth weight, the lower the probability of survival. In high-income countries with well-developed perinatal care systems, survival rates for extremely low birth weight preterm newborns (<1000 g) in specialized NICUs can reach 80–90%. This aligns with data from Japan, selected centers in the USA, Canada, and South Korea [9,10]. In LMIC and LIC countries, this rate is <50% [11].

In the Republic of Kazakhstan, approximately 5–6% of all newborns are born prematurely, amounting to about 20–22 thousand children annually [12]. In the structure of early neonatal deaths, 59% of all fatalities occur in prematurely born infants with a birth weight ≤ 1500 g [13].

In the Republic of Kazakhstan, the Kangaroo Mother Care method (skin-to-skin contact) is gradually being introduced into the practice of perinatal centers; however, its use is accompanied by certain

barriers related to the awareness of medical staff and organizational difficulties. An analysis conducted in 37 perinatal centers in Kazakhstan showed that the level of implementation and practical application of the method varies, despite its proven effectiveness and potential benefits for preterm newborns and their families [14]. According to the results of multicenter studies, a key factor in the effectiveness of KMC is the time of its initiation [15]. Most clinical protocols and WHO recommendations state that skin-to-skin contact usually begins after the newborn's clinical stabilization. However, stabilization of preterm and low birth weight newborns can take from several hours to several days depending on gestational age, birth weight, and the severity of the condition at birth. In studies included in the Cochrane review, the median age for starting KMC in a hospital setting varied from 3 to 24 days of life. Initiating the method after the third day of life did not allow influencing the risk of early neonatal mortality, which accounts for up to 62% of all deaths in the neonatal period [16-19]. Our proposed care method using diapers pre-colonized with maternal microflora could potentially be considered an additional approach to early neonatal support, as its application is possible without waiting for the infant's full clinical stabilization.

Although the Cochrane Library notes the positive effect of KMC in reducing mortality and the incidence of nosocomial infection [19], there is a lack of information elucidating the mechanisms of the therapeutic/preventive effect of KMC concerning the development of the infectious process. We hypothesize that the prevention of nosocomial infection occurs through improved diversity and evenness of the skin microflora of the preterm infant, which in turn prevents the predominance of pathological microflora and stimulates the formation and maturation of local immunity. The immaturity and immunological incompetence of the preterm infant's immune system makes them vulnerable to nosocomial infections in the aggressive environment of the neonatal intensive care unit [21,22]. The skin is the largest organ of the human body and is inhabited by highly variable microbial communities, called microbiota, influenced by many factors. Differentiated communities with various functions are present in the epidermal and dermal layers; the environment exerts a broader influence on the microbiota of the outer epidermal layers [27,28]. KMC provides positive contact between infant and mother, as well as microbial transmission. However, no studies were found that specifically investigated the relationship between KMC and the infant microbiome. However, one study examined the infection rate after KMC in preterm infants [29]. After 5 consecutive days of KMC for 90 minutes, only one infant developed a nosocomial infection within 7 days after discontinuing KMC. None of the mothers showed any signs or symptoms of infection within the first thirty days after discharge [29]. Two studies identified microbial transmission from parents to infants in the NICU [30,31].

Thus, in this study, we attempted to investigate the influence of maternal skin microflora on reducing morbidity and mortality in very and extremely low birth weight preterm infants requiring intensive care and, upon obtaining a positive effect, to propose it as a substitute for the KMC method when barriers to its implementation exist. The trend towards a lower incidence of sepsis in post-mortem diagnoses in the main group is noteworthy, as is the absence of differences in the duration of second- and third-line antibiotic therapy, which may indicate the comparable infectious safety of the alternative method.

A limitation of our study is the small sample size and single-center nature, which currently do not allow for providing sufficient evidence.

Although no randomized study to date has investigated the effect of regularly using maternal scent-soaked wipes in incubators as an alternative to KMC, several studies and clinical reports describe the use of maternal scent and fabrics soaked with the mother's body scent or breast milk as an element of so-called sensory and contact interventions, including modified versions of KMC. These interventions included using small pieces of fabric impregnated with the mother's scent, placed in close proximity to the infant's head or face, which was associated with improved physiological parameters and reduced stress markers in preterm infants [32,33]. Thus, although the practical application of maternal diapers for microbiological modulation of the incubator environment is not described as a separate procedure in the literature, conceptual data on the use of a diaper that was on the mother's chest, also impregnated with the mother's scent, provides a theoretical basis for further research.

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Conflict of Interest: The authors declare no conflict of interest.

Ethical clearence: This study was conducted in

accordance with ethical standards. Ethical approval was obtained from the appropriate institutional review board, and informed consent was secured from all participants prior to data collection.

Authors's contribution

Data gathering and idea owner of this study: [1]Karin B.T., [1]Jaxalykova K.K.,

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Writing and submitting manuscript: [3]Umesheva K.A, [2,4]Berdiyarova G.S.,

Editing and approval of final draft: [2,4]Ashirbay K.S, [5]Aitbayeva E.B.

REFERENCES

1. Ohuma EO, Moller AB, Bradley E, Chakwera S, Hussain-Alkhateeb L, Lewin A, et al. National, regional, and global estimates of preterm birth in 2020, with trends from 2010: a systematic analysis. Lancet. 2023 Oct 7;402(10409):1261-1271. doi:10.1016/S0140-6736(23)00878-4. Erratum in: *Lancet.* 2024 Feb **17**;403(10427):618. doi:10.1016/S0140-6736(24)00267-8. https://www.who.int/news-room/fact-sheets/detail/preterm-birth https://www.who.int/news-room/fact-sheets/detail/newborn-mortality/ https://www.cochrane.org/CD002771/NEONATAL_kangaroo-mother-care-reduce-morbidity-and-mortality-low-birthweight-infants
2. Hartz LE, Bradshaw W, Brandon DH. Potential NICU Environmental Influences on the Neonate's Microbiome: A Systematic Review. *Adv Neonatal Care.* 2015 Oct;**15**(5):324-35. doi:10.1097/ANC.0000000000000220.
3. Chan G, Bergelson I, Smith ER, Skotnes T, Wall S. Barriers and enablers of kangaroo mother care implementation from a health systems perspective: a systematic review. *Health Policy Plan.* 2017 Dec 1;**32**(10):1466-1475. doi:10.1093/heapol/czx098.
4. Olsson E, Andersen RD, Axelin A, Jonsdottir RB, Maastrup R, Eriksson M. Skin-to-skin care in neonatal intensive care units in the Nordic countries: a survey of attitudes and practices. *Acta Paediatr*. 2012 Nov;**101**(11):1140-6. doi:10.1111/j.1651-2227.2012.02802.x.
5. Bigelow A, Power M, MacLellan-Peters J, Alex M, McDonald C. Effect of mother/infant skin-to-skin contact on postpartum depressive symptoms and maternal physiological stress. *J Obstet Gynecol Neonatal Nurs.* 2012 May-Jun;**41**(3):369-82. doi:10.1111/j.1552-6909.2012.01350.x.
6. Jia CH, Feng ZS, Lin XJ, Cui QL, Han SS, Jin Y, et al. Short term outcomes of extremely low birth weight infants from a multicenter cohort study in Guangdong of China. *Sci Rep*. 2022 Jul 1;**12**(1):11119. doi:10.1038/s41598-022-14432-2. https://emedicine.medscape.com/article/979717-overview
7. Ramaswamy VV, Abiramalatha T, Bandyopadhyay T, Shaik NB, Bandiya P, Nanda D, et al. ELBW and ELGAN outcomes in developing nations-Systematic review and meta-analysis. *PLoS One*. 2021 Aug 5;**16**(8):e0255352. doi:10.1371/journal.pone.0255352.
8. Sairankyzy S, Kinayatova I, Amangeldi D, Zhumatova A, Bozhbanbayeva N, Ismailova A, et al. Comparative analysis on the efficacy of antenatal corticosteroids in preterm newborns in a Kazakhstani Tertiary Care Hospital setting. *World J Clin Pediatr*. 2025 Sep 9;**14**(3):103873. doi:10.5409/wjcp.v14.i3.103873.
9. Chuvakova T.K, Karin B.T., Dzhaksalykova K.K. , Zhumambayeva S.M. _Reserves for reducing early neonatal mortality in the Republic of Kazakhstan. *Science & Healthcare.* 2021;**23**(5):49-57 doi:10.34689/SH.2021.23.5.006
10. Karin B, Chuvakova T, Jaxalykova K, Nurmagambetova B., Alibekova B. Factors contributing to the introduction of the Kangaroo method into the practice of perinatal centers of the Republic of Kazakhstan and existing barriers. *Nauka i Zdravookhranenie*. 2022;**24**(1):90-97. doi:10.34689/tnzsb906
11. Laus G, Cassano T, Zerulo SR. Early Kangaroo Mother Care in Preterm Infants, Implications, Timing, and Feasibility: A Systematic Review. *Adv Neonatal Care*. 2026 Feb 1;**26**(1):73-81. doi:10.1097/ANC.0000000000001335.
12. Sankar MJ, Natarajan CK, Das RR, Agarwal R, Chandrasekaran A, Paul VK. When do newborns die? A systematic review of timing of overall and cause-specific neonatal deaths in developing countries. *J Perinatol*. 2016 May;**36** Suppl 1(Suppl 1):S1-S11. doi:10.1038/jp.2016.27.
13. WHO Immediate KMC Study Group; Arya S, Naburi H, Kawaza K, Newton S, Anyabolu CH, Bergman N, et al. Immediate "Kangaroo Mother Care" and Survival of Infants with Low Birth Weight. *N Engl J Med*. 2021 May 27;**384**(21):2028-2038. doi:10.1056/NEJMoa2026486.
14. Brotherton H, Gai A, Kebbeh B, Njie Y, Walker G, Muhammad

AK, et al. Impact of early kangaroo mother care versus standard care on survival of mild-moderately unstable neonates <2000 grams: A randomised controlled trial. *EClinicalMedicine.* 2021 Aug 6;**39**:101050. doi:10.1016/j.eclinm.2021.101050.

15. Sivanandan S, Sankar MJ. Kangaroo mother care for preterm or low birth weight infants: a systematic review and meta-analysis. *BMJ Glob Health*. 2023 Jun;**8**(6):e010728. doi:10.1136/bmjgh-2022-010728.
16. Conde-Agudelo A, Diaz-Rossello JL, Belizan JM. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. *Cochrane Database Syst Rev*. 2003;**2**:CD002771. doi:10.1002/14651858.CD002771. Update in: *Cochrane Database Syst Rev.* 2011 Mar **16**;(3):CD002771. doi:10.1002/14651858.CD002771.pub2.
17. Azizia M, Lloyd J, Allen M, Klein N, Peebles D. Immune status in very preterm neonates. *Pediatrics*. 2012 Apr;**129**(4):e967-74. doi:10.1542/peds.2011-1579.
18. Kallapur SG, Kramer BW, Knox CL, Berry CA, Collins JJ, Kemp MW, et al. Chronic fetal exposure to Ureaplasma parvum suppresses innate immune responses in sheep. *J Immunol*. 2011 Sep 1;**187**(5):2688-95. doi:10.4049/jimmunol.1100779.
19. Hilgendorff A, Windhorst A, Klein M, Tchatalbachev S, Windemuth-Kieselbach C, Kreuder J, et al. Gene expression profiling at birth characterizing the preterm infant with early onset infection. *J Mol Med (Berl).* 2017 Feb;**95**(2):169-180. doi:10.1007/s00109-016-1466-4.
20. Pagel J, Hartz A, Figge J, Gille C, Eschweiler S, Petersen K, et al. Regulatory T cell frequencies are increased in preterm infants with clinical early-onset sepsis. Clin Exp Immunol. 2016 Aug;185(2):219-27. doi:10.1111/cei.12810.
21. Birle A, Nebe CT, Hill S, Hartmann K, Poeschl J, Koch L. Neutrophil chemotaxis in cord blood of term and preterm neonates is reduced in preterm neonates and influenced by the mode of delivery and anaesthesia. *PLoS One.* 2015 Apr 13;**10**(4):e0120341. doi:10.1371/journal.pone.0120341.
22. Silveira-Lessa AL, Quinello C, Lima L, Redondo ACC, Ceccon MEJR, Carneiro-Sampaio M, et al. TLR expression, phagocytosis and oxidative burst in healthy and septic newborns in response to Gram-negative and Gram-positive rods. *Hum Immunol*. 2016 Oct;**77**(10):972-980. doi:10.1016/j.humimm.2016.07.230.
23. de Jong E, Strunk T, Burgner D, Lavoie PM, Currie A. The phenotype and function of preterm infant monocytes: implications for susceptibility to infection. *J Leukoc Biol.* 2017 Sep;**102**(3):645-656. doi:10.1189/jlb.4RU0317-111R.
24. Bay L, Barnes CJ, Fritz BG, Thorsen J, Restrup MEM, Rasmussen L, et al. Universal Dermal Microbiome in Human Skin. *mBio.* 2020 Feb 11;**11**(1):e02945-19. doi:10.1128/mBio.02945-19.
25. Abouelfettoh A, Ludington-Hoe SM, Burant CJ, Visscher MO. Effect of skin-to-skin contact on preterm infant skin barrier function and hospital-acquired infection. *J Clin Med Res.* 2011 Feb 12;**3**(1):36-46. doi:10.4021/jocmr479w.
26. Brooks B, Firek BA, Miller CS, Sharon I, Thomas BC, Baker R, et al. Microbes in the neonatal intensive care unit resemble those found in the gut of premature infants. *Microbiome.* 2014 Jan 28;**2**(1):1. doi:10.1186/2049-2618-2-1.
27. Conceição T, Aires de Sousa M, Miragaia M, Paulino E, Barroso R, Brito MJ, Sardinha T, et al. Staphylococcus aureus reservoirs and transmission routes in a Portuguese Neonatal Intensive Care Unit: a 30-month surveillance study. *Microb Drug Resist*. 2012 Apr;**18**(2):116-24. doi:10.1089/mdr.2011.0182.
28. Maayan-Metzger A, Kedem-Friedrich P, Bransburg Zabary S, Morag I, Hemi R, Kanety H, et al. The Impact of Preterm Infants' Continuous Exposure to Breast Milk Odor on Stress Parameters: A Pilot Study. *Breastfeed Med.* 2018 Apr;**13**(3):211-214. doi:10.1089/bfm.2017.0188.
29. Aypar Akbağ, N. N., Aluş Tokat, M. ., Özöztürk, S., & Uğur, G. (2024). Do demographic and obstetric characteristics affect fetal health locus of control among high-risk pregnancies? A Turkish sample. *Bangladesh Journal of Medical Science*, **23**(2), 438–446. https://doi.org/10.3329/bjms.v23i2.62742