The Robot Kangaroo

The technology equipped version of the traditional Kangaroo Mother Care.

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List of acronyms and abbreviations

KMC	Kangaroo Mother Care
E	total equity
FTP	file transfer protocol
IT	information technology
L	total leverage
PhD	Doctor of Philosophy
WWW	world-wide web or internet
CEL	Community Empowerment Lab
NMR	Neonatal mortality Rate
RCT	Randomized controlled trial

Abstract

Hypothermia is defined as a state where talking particularly about infants, the 'real' body temperature drops below 36.5 degree centigrades. Therefore the infant becomes very prone to sepsis and neurological complications. BEMPU device is one of the most sought after hypothermia detection devices in the world. It has been supported by major biggies such as US-AID, UK-AID, Bill & Melinda Gates foundation and Grand challenges Canada and has been developed under the guidance of major institutions like Stanford University, Johnson & Johnson etc. It is typically in the shape of a watch made to wear around neonatal that enables us to know if the infant's body temperature has gone below 36.5 degree centigrade (hypothermia). The device is known for its function to alarm when a neonatal goes below the minimal range of temperature i.e.36.5 degree centigrade. The studies might have claimed its efficacy to reduce Neonatal Mortality Rate (NMR) around the world. We contradicted the studies methodology by pointing it to be an unsystematic approach towards the measurement of axillary temperature with a thermometer in every six hours and at the time when the device alarmed. In addition, most importantly, it does not measure the real core temperature. Therefore, devices developed with Helyxon Company in collaboration with Community Empowerment Lab, supported by Women Deliver, proved to be effective by 99.6% accuracy in a pre-study. Therefore, we wanted to develop an anabolic environment, which will prevent hyperthermia and coupled with proper nutrition help neonatal reach the normal birth weight of 2000 grams.

Methods: The RCT was carried out at Avanti bai hospital where in experiment group, four mothers with infants were equipped with fever watch, spo2 and pulse rate device for continuous monitoring. The nurses were pre trained to read and use the monitor and mothers were taught to provide an effective intervention in case of any emergency. The control group with four infants with mothers were using same old BEMPU device for intervention.

Conclusion: At the end of 30 day RCT, all the experiment group infants reached normal birth weight of 2000 grams at minimum whereas under control group, only two infants were able to reach the normal birth weight while the other two still lacked in it. The post study assessment also reported that mother found it easy to use and it did not develop any complications.

1. INTRODUCTION

Each year 15 million neonates are born preterm. Complications from preterm birth result in over one million deaths, comprising 35% of all new-borns mortality. Kangaroo Mother Care (KMC) has demonstrated to promote physiologic stability, facilitate early breastfeeding, provide a thermally supportive environment, reduce the risk of serious infections, and reduce the mortality of hospitalized, stable preterm and low birth weight infants. This practice also promotes bonding between infants and their mothers during the first hours and days of life. 3-6 Compared with conventional care, KMC has shown to reduce mortality of clinically stable low birth weight (LBW) infants by approximately 40%, nosocomial infection, sepsis by 55%, and hypothermia by 66%. It is estimated that universal coverage of KMC in facilities and the community could prevent up to 19,60,000 neonatal deaths every year based on an estimated average of number of neonatal that die due to lack of proper interventions. Given the significant percentage of births still taking place outside of facilities, research is currently assessing the efficacy of KMC initiated in community settings. The "Every New-born Action Plan" endorsed and launched by the World Health Assembly in May 2014 includes the goal of scaling up KMC to 50% of babies weighing under 2000 grams by 2020, and to 75% of these babies by 2025.

2. OVERVIEW OR BACKGROUND

Kangaroo mother care Kangaroo Mother Care (KMC) for preterm and low birth weight (LBW) infants has emerged as a promising low-cost innovation with a high potential for public health integration and scale. The KMC method was introduced in 1978 by Rey and Martinez in Colombia for care of preterm infants in response to an acute shortage of incubators and severe hospital infections. The method was originally defined as: 'Early, prolonged, and continuous skin-to-skin contact between a mother and her new-born low birth weight infant (<2,500g, viz. preterm and/or low birth weight infant), both in hospital and after early discharge, with (ideally) exclusive breastfeeding, and proper follow-up.' The innovators explained that mother kangaroo was selected

to illustrate the three key components of the model: warmth, breast milk and love. The 'frog' position in Kangaroo Mother Care accounts for a natural ecosystem between mother and her child which has been saving lives of millions, the best example being of Shivgarh, where in a course of sixteen months and against the odds of 90% of home births, there was an 80% uptake of the practice and **54% reduction in Neonatal Mortality Rate.**

Community Empowerment Lab has been successful in implementation, scale up of Kangaroo Mother Care units across government health facilities in the state of Uttar Pradesh – the state with highest population density in the world, and is the NMR capital of the world with 49 neonatal deaths per 1000 of live births. However, due to sparse rates of literacy rates, lack of proper skills among nurses for the process of admission, discharge and follow up, and use of less validity of the **old BEMPU device** that is the only robotic technology in KMC, it is very difficult to catalyse the process of uptake of KMC by up to 50% by 2020. Therefore, instead of manmade techniques and reliable but less valid BEMPU device, the concept of "**The Robot Kangaroo**" should be focused upon.

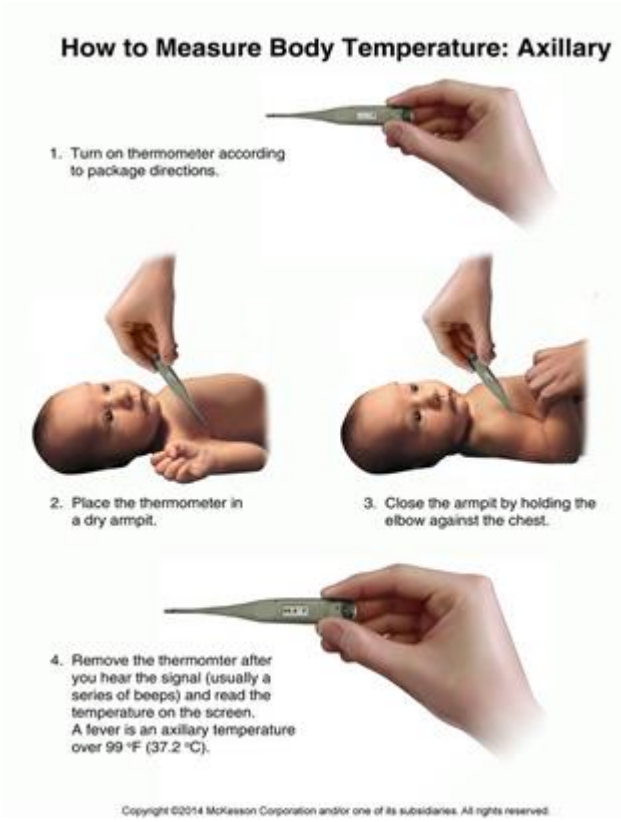
The Robot Kangaroo is the process where we equip mother or the respective guardian providing KMC to the child with the best technological devices that help her/them to understand the needs of the child, irrespective of any external supervision whether from a nurse or from a doctor. The fever watch 98.6 and the spo2 device developed by Helyxon Company in collaboration with Community Empowerment Lab is the wireless device that helps send the signals of temperature stages – whether hypothermic or hyperthermia, spo2 levels and pulse rates to an i-pad for which the decoder app has already been designed and published by Helyxon Company. The device can alarm a mother about the stage of the infant and can help her to take actions accordingly to prevent any sort of complication. The i pad will be placed in every facility as a central monitor and nurses will be responsible for pre-training of the KMC patients. The alarm system is connected to the i-pad, which will alarm in case of any emergency, which requires immediate action and attention of nurses, and doctor.

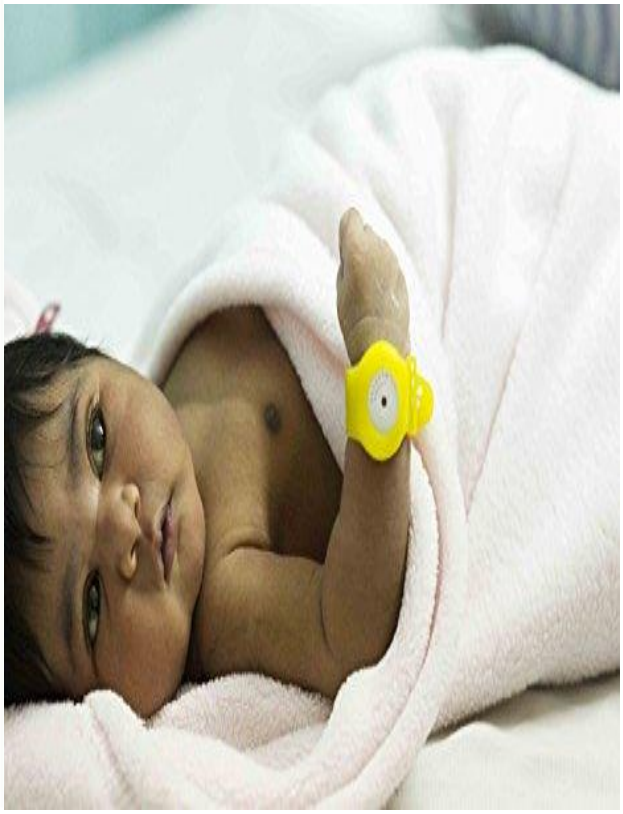
3. RESEARCH FOCUS

The idea begins from the need of the **latest** robotic equipment's integration with KMC.

3.1 Research problem

Until this point, the robotic technology only is limited a device known as – BEMPU device. BEMPU device is the most sought after hypothermia devices that alarms the transition of infant's body temperature to hypothermia stage (less than 37.5 degrees at axilla). The traditional studies for BEMPU device claims that it is 98.6 % sensitive and 95% specific and 99.6% accurate and to infant's body temperature. However, it is afflicted with one great blunder of comparison of the point temperature at BEMPU's alarm on the wrist to axillary temperature with a thermometer. Nowhere in the study, is a difference between temperatures of sub branch radial artery and axillary artery under consideration (Reference study 1). Therefore, the claims on its accuracy of sensitivity and specificity are false. Moreover, it led to a false belief among facilities that the device is accurate enough to detect hypothermia. Adding to it, the facilities are not equipped with other continuous vital measuring instruments such as spo2 and heart rate.





3.2 Research Questions

- Is BEMPU device effective for detection of accurate hypothermia and can it push the infant into the stage of hyperthermia? (short term study)
- Are devices - fever watch, spo2 and pulse rate device effective on the weight gain of low birth weight babies. ?

3.3 RESEARCH OBJECTIVES

The objectives of this research is

- To estimate the accuracy of BEMPU device for hypothermia detection
- To test the effectiveness of fever watch, spo2 and pulse rate device on the low birth weight of babies

RESEARCH METHODOLOGY

The methodology consisted of two monitoring and evaluation tests, which consisted of monitoring of the interventions that were being given to the infant and its evaluation at the end. There were some arguments that we had to consider before conducting the tests –

- The infant's body temperature remains in the thermos neutral range (36.5-37.5) to breastfeeding (Reference study 2)
- Fever watch 98.6 is 99.8% accurate to the readings obtained
- The infant's temperature is not affected by any external environment as long as skin to skin contact is maintained between mother and child

BEMPU device evaluation

The BEMPU devices come in two types – the blue for the male neonatal and the orange one for the Female neonatal. To calculate the sensitivity, specificity, wireless fever watch was constantly monitoring positive predictive value and negative predictive value the infant for the time when it alarmed during hypothermia. The study was for one session and the duration was 12 hours long and was on 11th May 2018 between 9:00 am – 9:00 pm. Table A.1 below

Time	Male/Female	Temperature at which BEMPU alarmed	Hypothermia	True Positive Rate	True Negative Rate	False Positive Rate	False Negative Rate
10:20	Female	36.53	NO	0	0	1	0
10:21	Female	36.56	NO	0	0	1	0
10:23	Female	36.62	NO	0	0	1	0
10:25	Female	36.65	NO	0	0	1	0
10:27	Female	36.70	NO	0	0	1	0
10:29	Female	36.77	NO	0	0	1	0
10:31	Female	36.84	NO	0	0	1	0

10:32	Female	36.93	NO	**0**	**0**	**1**	**0**
13:12	Female	**36.86**	NO	**0**	**0**	**1**	**0**
13:15	Female	**36.80**	**NO**	**0**	**0**	**1**	**0**
13:17	Female	**36.74**	**NO**	**0**	**0**	**1**	**0**
13:19	Female	36.69	**NO**	**0**	**0**	**1**	**0**
13:21	Female	36.65	NO	0	0	1	0
13:23	Female	36.59	NO	0	0	1	0
13:25	Female	36.56	NO	0	0	1	0
13.23	Female	36.52	No	0	0	1	0
13.25	Female	36.49	YES	1	0	0	0
13:27	Female	36.48	YES	1	0	0	0
13:27	Female	36.50	NO	0	0	1	0
13:29	Female	36.54	No	0	0	1	0
13:31	Female	36.58	NO	0	0	1	0
13:33	Female	36.62	NO	0	0	1	0
13:35	Female	36.66	NO	0	0	1	0
13:37	Female	36.70	NO	0	0	1	0

13:39	Female	36.74	NO	0	0	1	0
13:41	Female	36.76	NO	0	0	1	0
13:43	Female	36.78	NO	0	0	1	0
13:45	Female	36.80	NO	0	0	1	0
13:47	Female	36.84	NO	0	0	1	0
13:49	Female	36.88	NO	0	0	1	0
13:51	Female	36.92	NO	0	0	1	0

Evaluation

The highest temperature up to which BEMPU device alarmed = 36.93 degree Celsius

The actual temperature at which the BEMPU device should alarm = 36.49 degree Celsius

The difference obtained = 0.44 +- 0.01% of 0.44 degree Celsius

Degree of inaccuracy = 0.44/36.49 *100 = 1.21%

Accuracy obtained = 98.79%

Utility of device

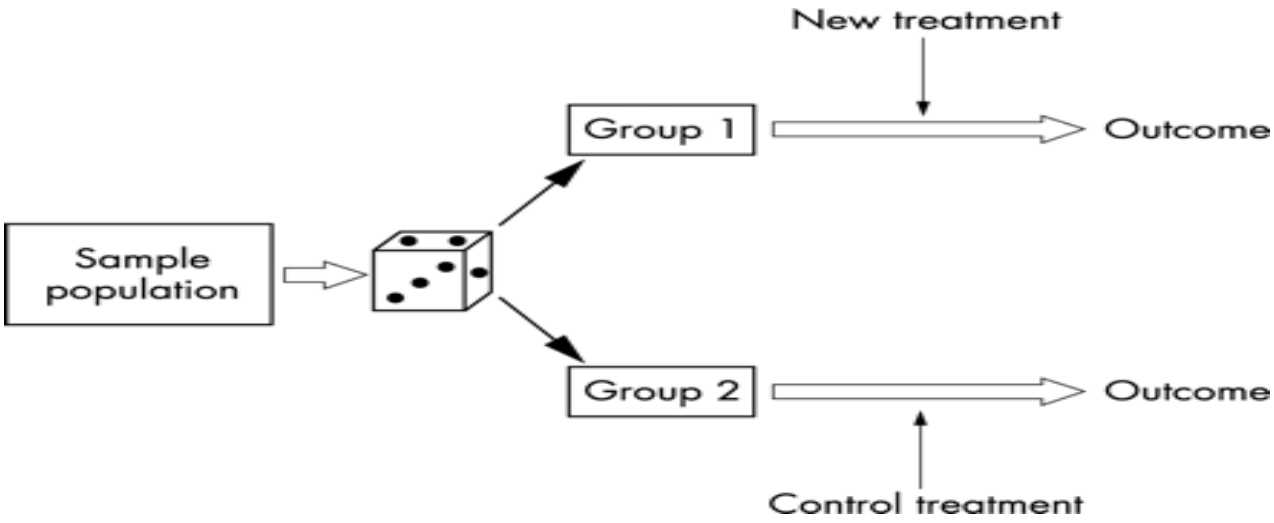
Therefore, the BEMPU device alarm alarms up to 36.93 degree Celsius even when the infant is not in hypothermia. Therefore, it can push the infant into a stage called ‘hyperthermia’ (pre study), which can again create complications (Reference study 4) for the infant such as –

- Shivering
- Weak pulse
- Slow breathing
- Weak immunity in the long run

Randomized Controlled Trial for the 'robot kangaroo'

Therefore, to conduct an observational study for robot kangaroo we had to set up a protocol for the two Kangaroo mother care units. Since KMC at the facility is recommended for up to 7 days therefore the Randomized controlled trial was for 30 days at Avanti Bai Mahila Chikitsalay and the following setups were made (table A.2) –

Kangaroo Mother Care Unit Ward 1 (Experiment Group)	**Kangaroo Mother Care Unit Ward 2 (Control Group)**
Sample size – 4 infants with respective mothers	Sample size – 4 infants with respective mothers
Number of nurse's pre trained for the new intervention were two in number.	Number of nurses conventionally were two.
The devices for temperature (continuous), spo2, and pulse rate were attached with the infants.	The device BEMPU was attached with the infants.
The mothers were pre trained to read the monitor and intervene with KMC or remove shrouds in case of hyperthermia whenever necessary.	The mothers were already using for long the BEMPU device to detect hypothermia whenever it alarmed.
The nurses were pre trained to assist in case of alarm emergency.	The nurses were pre trained to approach in case of alarm emergency.
The monitors and devices were separate and installed for each and every bed	There were no technical monitors as such



Data table

The infants were weighed using SEIKA machine

Experiment group

The infant and mothers were selected randomly on the basis of simple random sampling in the Kangaroo mother care unit 1. (Consent was obtained)

Rupali's baby	1763 gms
Sita's baby	1802 gms
Meenu's baby	1601 gms
Shakti's baby	1734 gms

The recommended KMC was for 20 hours a day

The devices used were-

1. Fever watch
2. Spo2 device and pulse rate
3. I pad for monitoring

Control group

These babies were selected on the basis of simple random sampling in the Kangaroo mother care unit 2. (Consent was obtained)

Meeta's baby	1705 gms
Gungun's baby	1850 gms
Deepika's baby	1743 gms
Usha's baby	1799 gms

Device used-

BEMPU device for hypothermia detection. It is most traditionally used method.

Precautions and considerations –

- Kangaroo mother care should be up to 20 hours a day for low birth weight babies
- Spo2 and pulse rate was used when infant was not in KMC position
- Fever Watch was used when infant was in KMC position
- Mothers were taught and demonstrated to read the monitor and intervene accordingly.
- The alarm system was fitted with the i-pad device in case of any nursing assistance.
- The 'robot kangaroo' ensured the best monitoring of all the vitals

Observations

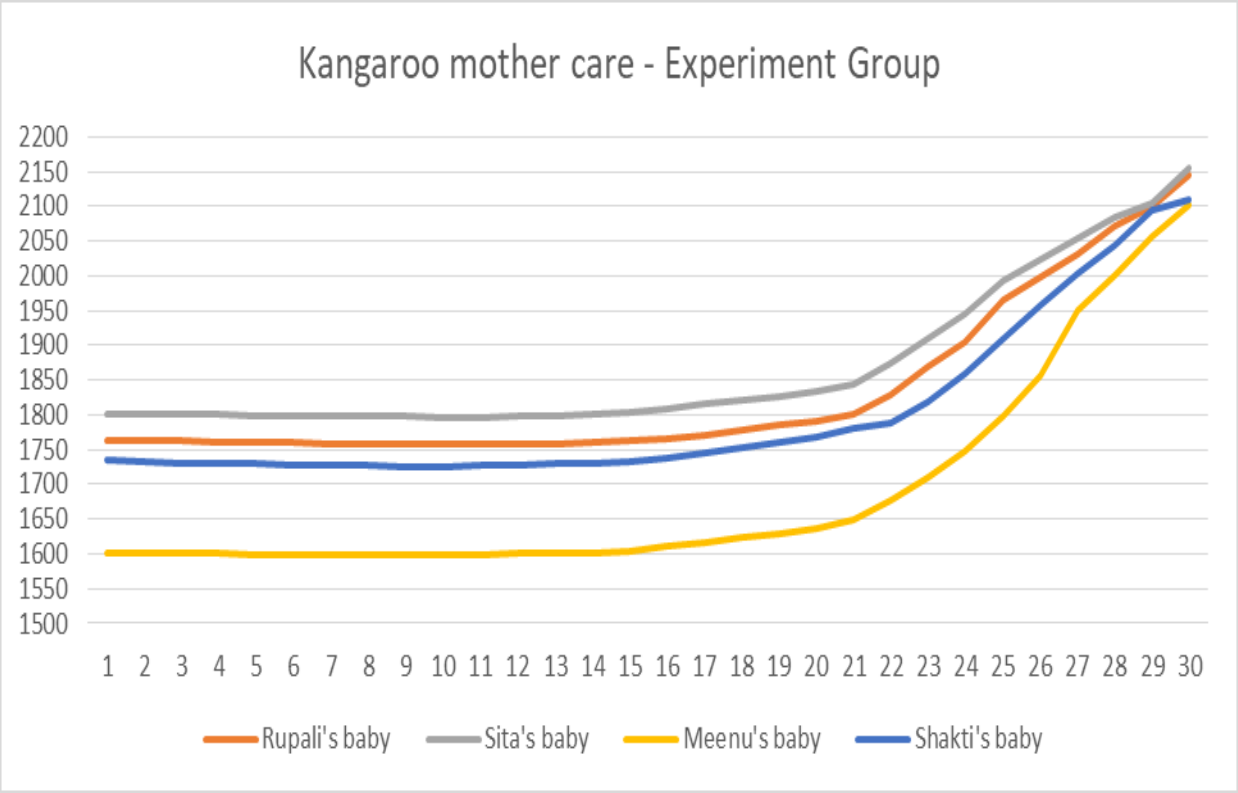
Based on the everyday weighing of infants, following data chart was prepared table A.3

Experiment Group	**Control Group**

Days	Rupali's infant	Sita's infant	Meenu's infant	Shakti's infant	Meeta's infsnt	Gungun's infant	Deepika's infant	Usha's infant
1	1763	1802	1601	1734	1705	1850	1743	1799
2	1762	1802	1601	1732	1702	1848	1741	1798
3	1762	1801	1600	1731	1700	1847	1740	1797
4	1761	1800	1600	1730	1698	1846	1738	1795
5	1761	1799	1599	1729	1696	1845	1736	1793
6	1760	1799	1599	1728	1695	1844	1735	1791
7	1758	1798	1598	1727	1694	1843	1734	1790
8	1757	1798	1598	1727	1694	1843	1732	1789
9	1757	1798	1598	1726	1694	1842	1732	1788
10	1757	1797	1598	1726	1694	1841	1731	1788
11	1758	1797	1598	1727	1694	1841	1731	1788
12	1758	1798	1600	1728	1694	1841	1731	1788
13	1759	1799	1601	1729	1694	1841	1731	1787

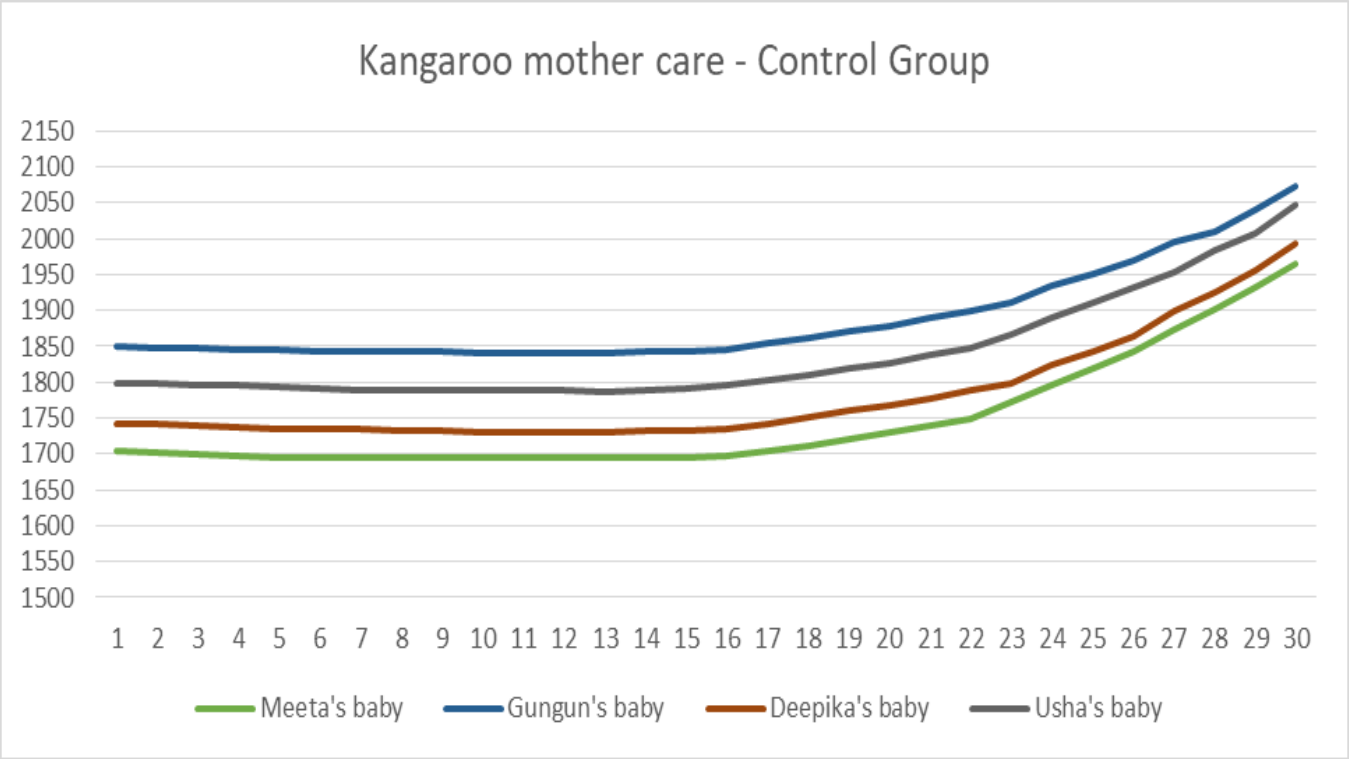
14	1760	1800	1602	1730	1695	1842	1732	1789
15	1763	1804	1604	1733	1696	1843	1733	1792
16	1766	1809	1610	1738	1697	1845	1735	1795
17	1770	1815	1616	1745	1705	1854	1743	1803
18	1778	1822	1624	1753	1712	1862	1751	1810
19	1785	1826	1629	1760	1720	1871	1760	1819
20	1791	1834	1637	1769	1729	1878	1768	1827
21	1800	1845	1649	1780	1739	1889	`1778	1838
22	1830	1875	1678	1788	1750	1900	1788	1847
23	1870	1910	1709	1819	1772	1911	1799	1867
24	1905	1945	1749	1859	1795	1935	1824	1891
25	1965	1993	1799	1909	1820	1952	1843	1911
26	1998	2024	1856	1959	1844	1969	1863	1931
27	2032	2054	1951	2003	1874	1996	1899	1954
28	2071	2084	2001	2045	1901	2010	1925	1984
29	2100	2105	2056	2095	1931	2041	1956	2008
30	2146	2156	2102	2110	1965	2074	1994	2048

Results



For the experiment group –

- There was a slow and steady decline and a rapid increase in weight of the infants
- All the babies were able to reach the normal weight by the end of the 30 day study
- The infant with lowest birth weight – Meenu's baby was able to hit the normal weight by the end of the study
- There have been no reported case of complications or diseases at the end of the study
- The post study review reports that mothers and nurses found it easy and convenient to use such devices. Mothers have understood the idea of KMC and want to uptake it.



For the control group –

- There was a slow and steady decline and slow and steady increase in weight.
- Two infants reached the normal weight while the other two still were not able to reach the 2000 gms benchmark at the end of 30 day study
- The BEMPU device could not detect hyperthermia
- The post study asessment found that BEMPU alarmed at erratic times causing confusion and restlessness among nurses and mothers
- Moreover, there have been instances of slightly higher temperature when BEMPU device alarmed.

Conclusion

Therefore, the concept of 'Robot Kangaroo' be up taken in the health facilities and it can be a very effective catalyst for the ongoing KMC practices. The devices have been instrumental in maintaining an anabolic environment for the infants coupled with proper nutrition and long hours of KMC, it can **help** the low birth weight babies to reach normal weight and thereby preventing neonatal associated complications, which **can prevent Neonatal Mortality Rate in the end** and **promote uptake of KMC practice by more facilities. With some limitations, the devices have been found useful**

Limitations of the study

- The growth is a secondary factor
- The sample size is low
- The hyperthermia frequency recordings have not been done which could also indicate any other barring factor
- Some can claim that genetics can also be the reason.

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- Kumar Vishwajeet (15 november, 2015) TedXtalk on neonatal mortality rate

LITERATURE REVIEW

The study proposed by Klein DG, Mitchell C, Petrinec A, Monroe MK, Oblak M, Ross B, Youngblut JM on the topic “A comparison of pulmonary artery, radial artery, axillary artery, rectal, and tympanic membrane temperature measurement in the ICU.” It was very helpful in gaining an insight about the BEMPU device evaluation because the misinterpretation of the negligible temperature difference between radial artery and axillary artery was clear in the past study conducted on BEMPU device evaluation. Backing it up with science and logic, we had to conduct a study with continuous temperature monitoring of the axilla and cross comparing it with the BEMPU device alarm. Therefore, we had to conduct one with this study as the baseline.

The study proposed by Chiu SH, Anderson GC, Burkhammer MD on “Newborn temperature during skin-to-skin breastfeeding in couples having breastfeeding difficulties.” It has served as a guideline to remove any sort of hindrances in the continuous temperature monitoring since we were afraid of the fact that breastfeeding could fluctuate readings. However, the study states that the babies maintain thermoneutral temperature in between 36.5 to 37.5 degree Celsius. It was the time when the natural ecosystem maintains its own temperature with this phenomenon. This was very helpful in continuous monitoring and therefore, provided an effective intervention technique.

“Reducing low birth weight through home visitation: a randomized controlled trial.” Proposed by Lee E1, Mitchell-Herzfeld SD, Lowenfels AA, Greene R, Dorabawila V, DuMont KA. It consisted of a very accurate formate of a long term follow up which helped us reaching the point where we could clearly draw out the results. Home visitation is an effective way of behaviour change communication, and randomized controlled trial is the best way to assess it. Therefore, it proved to be an effective strategy for our research.

We conducted a pre study before the fever watch implementation. In order to check its effectiveness, it was much needed since we are investing on the lives of neonatal. We cross compared it with axillary temperature with a thermometer every minute for 30 minutes or so.

Therefore, we found it that it is 99.6% accurate as is only 0.1% less of what it claims. Therefore, it proved to be a very effective instrument with reference to what we were looking for.

Women Deliver, has been supportive in throughout the process. Women deliver debuted as a global conference in London in 2007, under the visionary leadership of Jill W. Sheffield. At the time, it was described as a “ground-breaking” event and credited with igniting a movement that was desperately needed. In 2010 the organization lead the charge to put Millennium Development Goal 5 – Improve Maternal Health – on the global development agenda.

Dr. Vishwajeet Kumar’s take on Uttar Pradesh’s conditions reflects a lot on gender discrimination and health conditions in India. He has clearly described in the tedXtalk that Uttar Pradesh needs a long way to reach a stage of sustainability. Owing to the fact that it is impossible to reach so many population, he inspires all the public health managers to work for sustainability and balance.