



# BATTERY OPERATED CLOTH-WRAP WARMER TO PREVENT HYPOTHERMIA OF NEWBORN BABIES

*Submitted by*

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**Abstract:**

The cloth-wrap warmer is designed to provide warmth to the newborn babies to maintain the body heat and prevent them from getting into hypothermia. Hypothermia is a leading cause of neonatal mortality and morbidity, affecting millions of babies every year. The cloth-wrap Warmer consists of a sleeping bag-like pouch that contains a battery-operated heater technology, which can maintain a constant temperature of 37°C for up to 8 hours with a single charge. The cloth-wrap Warmer is designed to complement skin-to-skin care, also known as kangaroo mother care, which is the recommended practice for preventing and treating hypothermia. The device can be used in hospitals, clinics, or homes, and can be reused multiple times. This warmer is for a temporary solution and it is recommended to treat the baby under trained professionals using a conventional radiant warmer.

**Keywords:** Hypothermia; body heat; kangaroo mother care; skin-to-skin care

## 1. Introduction:

### 1.1. Aim

To develop a simple & portable warmer to assist the baby to prevent from hypothermia.

### 1.2. Overview

Cloth-wrap warmer is designed to enable the most efficient, safest & simplest warming solution. It is a specially designed Infant Swaddle Warmer to aid efficient thermoregulation with advanced automation for the treatment of Newborn & Low Birth Weight babies.

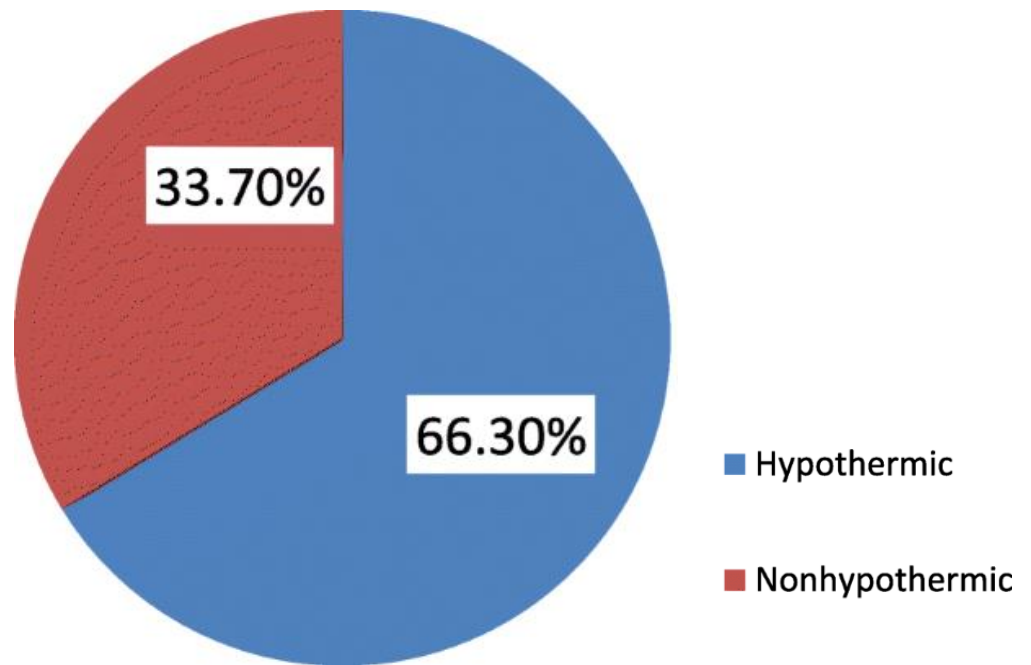
NICU's in hospitals and other infant healthcare providers like UPHCs, maternal clinics and fertility centres are our targeted customers. However, the benefits reaped extends to the service provider (hospital/clinic), the patient/patient family, doctors and to the government. The lower investments and space requirements for clinically stable babies, breaking the barrier between the baby and mother while being in treatment, encouraging Breastfeeding and Kangaroo Mother Care . We crafted this equipment to make the rural population to have sustainable and affordable healthcare and as a tiny step towards a safer world for newborn.

### 1.3. Objective

The main objective of this project is to develop a simple and efficient warmer that can be kept as a temporary alternate to the traditional warmers. The tradition classic warmers are exclusively kept within the NICU and the mother is kept far from the baby, many cases the breastfeeding is delayed due to this case, or when the baby is removed from the warmer to be fed, it gets sick due to improper thermoregulation. the Kangaroo Mother Care is for the completely normal baby only, and not for baby's kept under observation too.

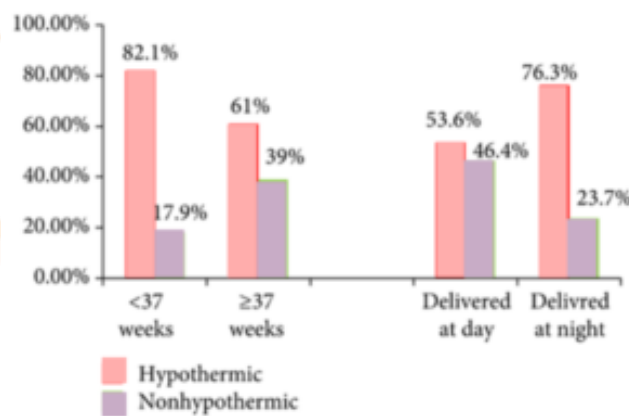
## 2. Background of the Project:

Temperature measurement and thermoregulation are central components of newborn care. To promote thermoregulation. According to World Health Organization, neonatal hypothermia is defined as an abnormal thermal state in which the newborn's body temperature is below 36.5 °C. It is classified into three different categories based on core temperature of a new-born below 36.5 °C measured as skin temperature in the axilla: mild hypothermia (36.0 °C–36.4 °C), moderate hypothermia (32.0 °C–35.9 °C) and severe hypothermia (< 32.0 °C).



The World Health Organization (WHO) released thermal guidelines including the warm chain, made up of a set of 10 procedures to reduce the likelihood of infants developing hypothermia.

The steps include warm delivery room, immediate drying, skin-to-skin contact, breastfeeding, postponed bathing and weighing, appropriate clothing and bedding, couplet care, warm transportation, warm resuscitation, and appropriate relevant training.



Maintaining of baby’s body heat using a bag-like pouch can allow the parent’s or clinician to hold the baby even during the treatment. This project is designed in such a way that it can be used for home-care environment also. This project is developed from the existing technology called “Embrace Warmer”.



## 2.1. Existing Methodology:

The existing medical device named Embrace warmer consists of a bag-like pouch with phase changing gel used as a heater. In this technology, an additional heating kit is used along to heat the phase changing gel frequently. The heated gel pad is placed inside the pouch, underneath the baby.



## 2.2. Problem identification:

Since, the phase changing gel is used as a heating source, there are various drawbacks in this methodology, such as follows:

- Heat reducing frequently
- Not able to maintain a constant heat
- Heat easily influenced by the environment temperature
- Risk of accidental leakage of gel and getting into baby compartment
- Carrying of additional device to heat the gel

### 3. Literature Survey:

#### **Embrace versus Cloth Wrap in preventing neonatal hypothermia during transport: a randomized trial**

**PMID:** 32686755 **DOI:** 10.1038/s41372-020-0734-x

**Background:** We assessed the efficacy of Embrace Nest Infant Warmer versus Cloth Wrap in preventing hypothermia during short-term transport from the emergency department (ED) to the neonatal intensive care unit (NICU).

**Methods:** Neonates weighing  $\geq 1500$  g coming to the ED were randomized for transport to the NICU. Axillary temperature was measured.

**Results:** A total of 120 newborns (60 per group) were enrolled. From ED exit to NICU entry, the mean (SD) temperature increased in the Embrace group by  $0.37$  °C (0.54), whereas it reduced by  $0.38$  °C (0.80) in the Cloth group ( $p < 0.001$ ). Hypothermia cases reduced in the Embrace group from 39 (65%) to 21 (35%), while it increased from 21 (35%) to 39 (65%) in the Cloth group ( $p = 0.001$ ) from ED exit to NICU entry. The thermoregulation for 24 h after admission to the NICU was superior in the Embrace group.

**Conclusions:** Embrace showed significantly better thermoregulation in neonates. Further studies should be done to measure its effectiveness in different environments and distances.

#### **Usage of EMBRACE(TM) in Gujarat, India: Survey of Paediatricians**

**PMID:** 25530887 **PMCID:** PMC4230002 **DOI:** 10.1155/2014/415301

EMBRACE(TM) is an innovative, low cost infant warmer for use in neonates. It contains phase change material, which stays at constant temperature for 6 hours. We surveyed paediatricians using EMBRACE(TM) regarding benefits, risks, and setup in which it was used in Gujarat. **Methods.** Questionnaire was administered telephonically to 52 out of 53 paediatricians. **Results.** EMBRACE(TM) was used for an average of 8.27 (range of 3-18, SD = 3.84) months by paediatricians. All used it for thermoregulation during transfers, for average (SD) duration of 42 (0.64) m per transfer, 62.7% used it at mother's side for average (SD) 11.06 (7.89) h per day, and 3.9% prescribed it at home. It was used in low birth weight neonates only by 56.9% while 43.1% used it for all neonates. While hyperthermia was not reported, 5.9% felt that EMBRACE(TM) did not prevent hypothermia. About 54.9% felt that they could not monitor the newborn during EMBRACE(TM) use. Of paediatricians who practiced kangaroo mother care (KMC), 7.7% have limited/stopped/decreased the practice of KMC and substituted it with EMBRACE(TM). **Conclusions.** EMBRACE(TM) was acceptable to most but concerns related to monitoring neonates and disinfection remained. Most paediatricians felt that it did not hamper KMC practice.

## Market mechanisms for newborn health in Nepal

**PMID:** 29258465 **PMCID:** PMC5738188 **DOI:** 10.1186/s12884-017-1599-7

**Background:** In Nepal, hypothermia is a major risk factor for newborn survival, but the country's public health care sector has insufficient capacity to improve newborn survival given the burden imposed by distance to health facilities and cost. Low-cost technology to provide newborn thermal care in resource-limited environments exists, but lacks effective distribution channels. This study aims to develop a private sector distribution model for dedicated newborn thermal care technology to ensure equitable access to thermal protection and ultimately improve newborn health in Nepal.

**Methods:** We conducted a document analysis of newborn health policy in Nepal and a scoping literature review of approaches to newborn hypothermia in the region, followed by qualitative interviews with key stakeholders of newborn health in Nepal.

**Results:** Current solutions addressing newborn hypothermia range from high-technology, high-cost incubators to low-cost behavioral interventions such as skin-to-skin care. However, none of these interventions are currently implemented at scale. A distribution model that provides incentives for community health volunteers and existing public health services in Nepal can deliver existing low-cost infant warmers to disadvantaged mothers where and when needed. Newborn technology can serve as an adjunct to skin-to-skin care and potentially create demand for newborn care practices.

**Conclusion:** Harnessing market forces could promote public health by raising awareness of newborn challenges, such as newborn hypothermia, and triggering demand for appropriate health technology and related health promotion behaviors. Market approaches to promoting public health have been somewhat neglected, especially in economically disadvantaged and vulnerable populations, and deserve greater attention in Nepal and other settings with limited public health service delivery capacity.

**Keywords:** Health technology; Hypothermia; Incentive; Nepal; Newborn; Social entrepreneurship.

## Neonatal hypothermia in low-resource settings

**PMID:** 21094417 **PMCID:** PMC3001630

**DOI:** 10.1053/j.semperi.2010.09.007

Hypothermia among newborns is considered an important contributor to neonatal morbidity and mortality in low-resource settings. However, in these settings only limited progress has been made towards understanding the risk of mortality after hypothermia, describing how this relationship is dependent on both the degree or severity of exposure and the gestational age and weight status of the baby, and implementing interventions to mitigate both exposure and the associated risk of poor outcomes. Given the centrality of averting neonatal mortality to achieving global milestones towards reductions in child mortality by 2015, recent years have seen substantial resources and efforts implemented to improve understanding of global epidemiology of neonatal health. In this article, a summary of the burden, consequences, and risk factors of neonatal hypothermia in low-resources settings is presented, with a particular focus on community-based data. Context-appropriate interventions for reducing hypothermia exposure and the role of these interventions in reducing global neonatal mortality burden are explored.

## 4. Proposed Methodology:

### 4.1. Introduction:

In this project, the phase changing gel heater pad is replaced with an actual heater with resistance coil with battery. The sleeping bag-like pouch or also called as baby swaddling cloth is designed in unique way to maintain the heat inside the compartment and help maintain the baby's body temperature to 37-38°C for up to 8 hours.

### 4.2. Mechanical Construction:

The cloth-wrap structure is as follows:



Fig1: Mechanical description

**Baby compartment:** This area is designated to place the baby. The material is made up of Nylon knitted PU fabric, which is irritant free for babies.

**Head Support:** This is cushioned support to held the baby's head stiff and straight.

**Heater compartment:** This area is designated to keep the heater separated from baby compartment.

**Charging provision:** The heater with battery is projected outside for easier connection and disconnection of charger.

**Baby monitoring area:** This transparent display area is given to monitor the baby abdomen without getting out the baby.

**Safety straps:** This gives additional safety to keep the baby intact while carrying.



Fig 2: Heat pad &amp; charger

This pad consists of the pad heater with heater coil along with PCB for battery charging and discharging.

#### 4.3. Electrical Construction:

**Heater:** The heater is an electric pad heater. These are heating pads that use electric current to generate heat. The current passes through a resistance wire, which creates heat due to the resistance to electrical flow. These heaters produce very little heat. So, there is no risk of overheating in the device.



Fig 3: Heat pad

**Safety:** An additional electrical safety device called thermostat is used along. A thermostat will open the circuit if in case the temperature exceeds 40°C.



Fig 4: Thermostat



**Battery:** A 9.6V rechargeable battery is used as the source of energy of the heater.



Fig 5: Battery

**Microcontroller:** A PIC16F1939 is used as the microcontroller (IC). This IC has Enhanced Mid-range Core with 49 Instruction, 16 Stack Levels & Flash Program Memory with self-read/write capability.

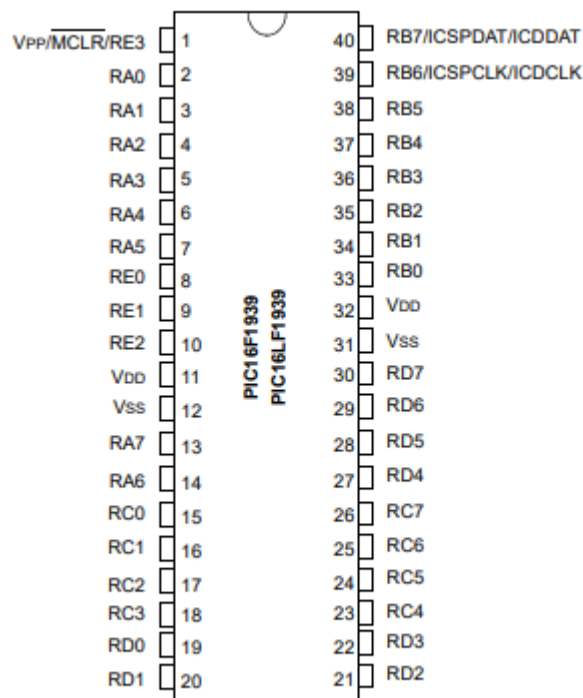
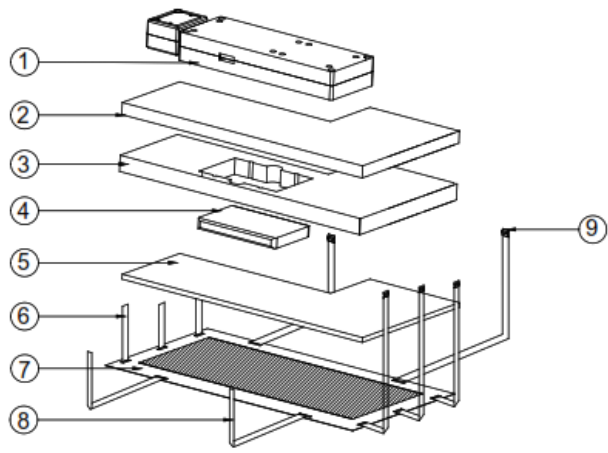
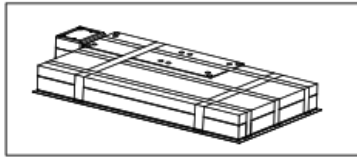
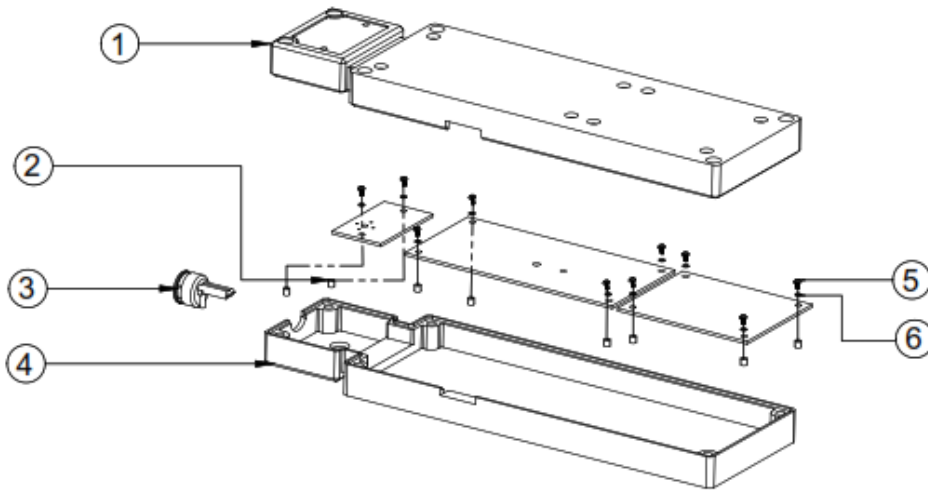


Fig 6: Microcontroller



Material Details				
SLNO	Part No	Description	Qty	Unit
1	20-05-105	nice 2020 - Mirra Infant Seeside Warmer Power Supply Box Assembly	1	No
2	76-00-147	nice 2020 - Power Supply Box PU Foam	1	No
3	76-00-146	nice 2020 - EVA Foam	1	No
4	91-00-252	Rechargeable Li-Ion battery - 10.8V,5700mAh	1	No
5	76-00-130	Aero Gel Sheet , Tk-6mm , Colour - White	1	No
6	76-00-149	nice 2020 - Thermal Pad Assembly strap - L-1000mm	3	No's
7	20-10-211	nice 2020 - Heater Plate	1	No
8	76-00-148	nice 2020 - Thermal Pad Assembly strap - L-630mm	2	No's
9	86-00-236	nice 2020 - Thermal Pad Assembly Buckle	5	No's
10	76-00-143	nice 2020 - Thermal Pad Assembly Pouch (Refer PgNo:2)	1	No



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Material Details				
SLNO	Part No	Description	Qty	Unit
1	99-00-721	nice 2020 - Power Supply Box Top	1	No
2	20-20-030	nice 2020 - Power Supply Box PCB Spacer	10	No's
3	99-00-723	nice 2020 - Power Supply Box 3 Pin Socket	1	No
4	99-00-722	nice 2020 - Power Supply Box Bottom	1	No
5	95-00-056	SCR M3x6mm PNPL	10	No's
6	86-16-002	Nice Washer	10	No's

Fig 7: Thermal pack construction

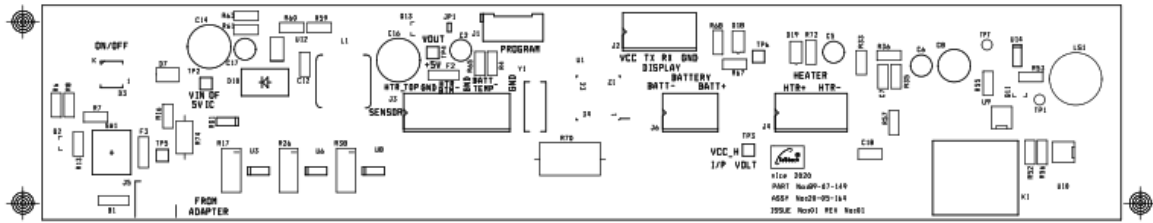


Fig 8: PCB Schematics

## 5. Experimental setup and discussion:

The cloth-wrap warmer was used with baby doll of actual baby size along with temperature sensor to monitor the actual temperature inside the cloth-wrap. The experimental setup is as follows:



Fig 9: Experimental setup

The experiment results indicate that the internal temperature of cloth-wrap maintains to the temperature range of 37.5-38°C, which is capable of withstanding baby's body heat and maintain the temperature, thus capable of preventing hypothermia.

## 6. Conclusion:

Thus, the cloth-wrap warmer using an electric heater pad is developed to assist the clinicians in help preventing the newborn babies falling into hypothermia. Considering the loss of many lives of newborn babies due to hypothermia in their early birth stage, this project may help many babies to pursue their life for longer age.

However, this device cannot be considered as alternate to the traditional warmers. This device cannot treat the babies to recover from hypothermia state.

The primary objective of this device is to prevent the babies from falling into hypothermia state.

This project can be further developed with baby monitoring and alarm system to alert the user/clinician in case of any critical conditions.

Based on the above, this project is concluded as successful and useful to the hospital and healthcare environment.

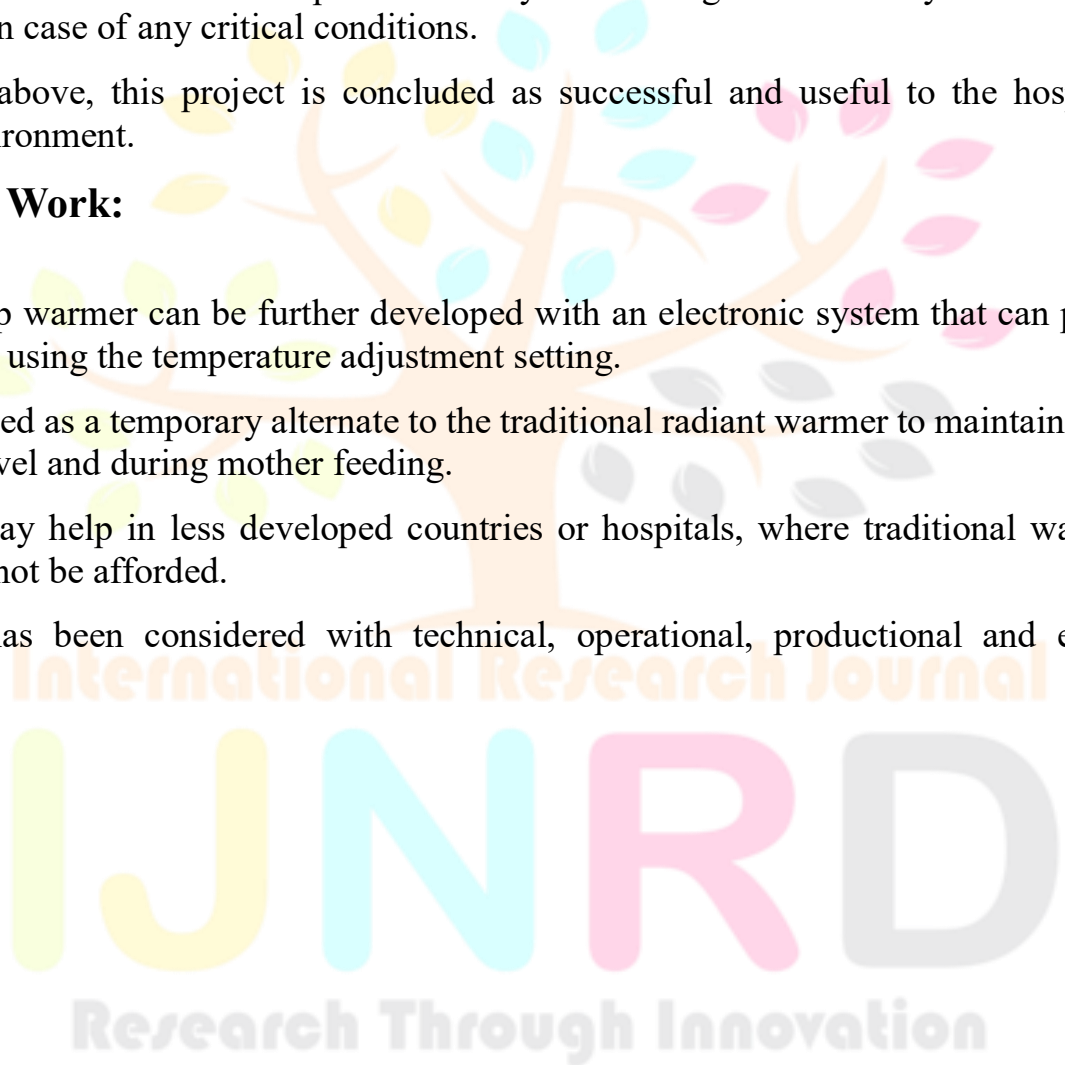
## 7. Future Work:

This cloth-wrap warmer can be further developed with an electronic system that can provide a controlled heat using the temperature adjustment setting.

This is developed as a temporary alternate to the traditional radiant warmer to maintain the body heat during travel and during mother feeding.

This project may help in less developed countries or hospitals, where traditional warmers & incubators cannot be afforded.

This project has been considered with technical, operational, productional and economic feasibility.



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