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Reducing hypothermia in newborns admitted to a neonatal care unit in a large academic hospital in New Delhi, India

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ABSTRACT

Neonatal hypothermia is a common and dangerous condition around the world. 70% of neonates born in Kalawati Saran Children's Hospital in New Delhi, India, and subsequently admitted to the neonatal intensive care unit (NICU) had a temperature below 36.5°C on admission. In July 2016, we formed a team of staff from the labour room, NICU and auxiliary staff to reduce hypothermia in babies transported to our NICU using quality improvement methods. We identified problems related to staff awareness of hypothermia and its dangers, environmental factors and supply issues in the labour room, and challenges with rapidly and safely transferring sick newborns to the NICU. We used the Plan-Do-Study-Act cycles to test and adapt solutions to these problems. Because infection is a common complication of hypothermia, we also instituted a training programme to improve handwashing skills among parents and health workers. Within 9 months of starting our quality improvement project, the proportion of neonates who were normothermic on admission increased from 27% to 75%, the number of cases of late-onset neonatal sepsis decreased from 15.2 to 5 cases/1000 patient days, and all-cause mortality fell from 4.2 to 2.6 neonatal deaths per week. Multiple factors can lead to neonatal hypothermia, and the most important factors will differ from facility to facility. Quality improvement methods provide health workers with the skills to identify the key factors contributing to hypothermia in their facility and to develop strategies to address them. Addressing processes of care can lead to improved thermal care and save lives.

PROBLEM

In June 2016, we collected data to learn whether hypothermia was a problem in babies admitted to the neonatal intensive care unit (NICU) in Kalawati Saran Children's Hospital (KSCH), and found that out of 93 admissions, 28 (30%) neonates were normothermic, 26 (28%) had cold stress (36°C–36.4°C), 36 (39%) had moderate hypothermia (32°C–35.9°C) and 3 (3%) had severe hypothermia (<32°C). We designed a quality improvement (QI) project to eliminate severe hypothermia and reduce

moderate hypothermia by 50% in the next 12 weeks. The purpose of this report is to describe how the team used QI methods to solve this problem.

KSCH is part of Lady Hardinge Medical College in New Delhi and is one of the largest tertiary care government hospitals in India. The Department of Neonatology caters to a delivery load of over 15 000 babies and over 2500 admissions per year. The department has 70 neonatal beds and trains 25 paediatric and 12 neonatology residents each year. The paediatrics outpatient department caters to between 700 and 800 patients with roughly 100–125 admissions per day. The per capita income in Delhi was roughly 95 000 rupees (US$ 1500) per year,[1] but most KSCH patients earn well below that figure.

BACKGROUND

Neonatal hypothermia on admission to the NICU is a common finding with multiple causes. Moderate and severe hypothermia increase the mortality and morbidity and predispose the fragile neonate to an increased risk of late-onset neonatal sepsis (LONS), intraventricular haemorrhage and worsening of respiratory distress.[2] Among children born in Nepal, hypothermia was an independent risk factor for early mortality. The risk was higher for premature neonates than for full-term babies.[3] Evidence from 36 observational studies has revealed that there is also an increased risk of mortality associated with hypothermia at NICU admission.[4] There is evidence of a dose effect on mortality, suggesting an increased risk of at least 28% for each 1°C below 36.5°C body temperature at admission.[5] Hypothermia at the time of admission to NICU is very common. In a study conducted in 11 European countries, hypothermia at admission in preterm neonates <32 weeks of gestation was

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reported to be present in 53% of the cohort.[6] Likewise, in a cohort of 8782 neonates admitted in the California Perinatal Quality Care Collaborative, 56% of neonates were hypothermic.[7] In low-income and middle-income countries (LMICs), the prevalence of hypothermia in community settings ranges from 11% to 92%, while in hospital settings the prevalence ranges from 8% to 85%.[8] A study from Mumbai, India, revealed a 37% prevalence of moderate hypothermia in neonates admitted to an NICU.[9]

Based on this evidence and the high prevalence of hypothermia in neonates admitted to our unit, we decided to use QI approaches to improve thermal care for newborns prior to their admission in the NICU.

BASELINE MEASUREMENT

The temperature at admission to the neonatal ward was measured using a digital thermometer placed in the apex of the axilla before the neonate was removed from the transport incubator. The value was entered into the admission register by the staff nurse on duty. Subsequent data were obtained from the admission register using active surveillance. In addition, we also measured LONS, defined as clinical or biochemical evidence of neonatal sepsis presenting in the neonate after 72 hours of life,[10] and all-cause mortality using data from the admission register and death records. Data were reviewed weekly by the QI team.

DESIGN

In June 2016, we identified that 70% of neonates were hypothermic when admitted to the NICU. Staff in the NICU decided to use the WHO Point-of-Care Quality Improvement Model[11] to tackle this problem. We formed a team consisting of consultants from neonatology, obstetrics and gynaecology, postgraduate medical students posted in the labour room and neonatal ward, and nurses from the labour room and neonatal ward. The team was led by the neonatologist in charge of the NICU and was supported by external advisors from the US Agency for International Development (USAID) Applying Science to Strengthen and Improve Systems (ASSIST) Project, who provided guidance on using QI approaches.

The team set an aim of eliminating severe hypothermia and reducing moderate hypothermia by 50% in the next 12 weeks. We then used process flow diagrams and fishbone diagrams to identify factors contributing to hypothermia. These analyses identified a number of problems that could potentially contribute to neonatal hypothermia, including staff awareness of hypothermia and its dangers, environmental factors and supply issues in the labour room, and challenges with rapidly and safely transferring sick newborns to the NICU. The team used the Plan-Do-Study-Act (PDSA) cycles to test and adapt possible solutions to these contributing factors. As the problem of hypothermia at admission was severe, we often tested groups of change ideas. The team met weekly to discuss what they were learning from the various tests, review data on the percentage of newborns admitted with hypothermia and plan new tests of change. USAID ASSIST Project staff visited the team approximately once a month.

STRATEGY

Our team started by focusing on the labour rooms. Initially, we held discussions with doctors and nurses to discuss the dangers of hypothermia and the importance of keeping newborns warm. The team also identified some issues with equipment and supplies in the labour rooms and arranged to maintain a consistent supply of warm linen in which to receive and wrap newborns, placed thermometers in the labour rooms to encourage staff to keep the ambient temperature above 25°C, and placed a radiant warmer for newborns in the main operating theatre where 38% of neonates admitted to the NICU were born. We then focused on improving temperature management during transportation.

The key barrier during transportation was that the batteries in the three transportation incubators (TI) were often uncharged or lost their charge during transport. We trained staff on the importance of keeping the batteries charged and taped instructions on how to charge the TI. We also started reviewing the time it took to transport the newborn to the NICU and the temperature on arrival, and held discussions with staff to identify additional problems and try to develop solutions. These reviews helped us to identify practical barriers to keeping the batteries charged and to develop changes to overcome these barriers.

Between the reviews, each change was tested on a small number of babies using PDSA methodology to adapt the changes to our hospital. Initial PDSA cycles were very small and fast and were designed to give us information on how to make the change as feasible and simple as possible. Once we knew that a change was feasible, we used larger PDSA to learn if the change contributed to reduced hypothermia. For example, staff were unable to charge the battery when they were away from the NICU because the charging leads were kept in the NICU to prevent them from being lost during transport. The staff responsible for the TI equipment was reluctant to let the leads out of the NICU. So we used a series of small PDSA cycles to come up with ways of ensuring that the leads would not get lost. By testing different methods, we learnt that taping the TI leads was feasible and would prevent them from getting lost. We then did a larger PDSA for a week to see if having the leads taped to the TI led to fewer babies being hypothermic. Prior to taping the leads to the TI, a median of 28% of all neonates admitted to the NICU were normothermic, and the week we taped the leads this increased to 62%. Based on this test, we continued to keep the leads taped to the TI and tested other changes to further reduce hypothermia. Another practical barrier to keeping the batteries charged was that we only had three

TIs, and babies are born in seven places in the hospital, some of which are very far away. Consequently, the TIs were sometimes being used for multiple trips in a row without going back to the NICU for charging. To address this, we identified and set up additional dedicated TI 'charging bays' in different locations around the hospital where the TIs were often used. As we focused more on keeping the batteries charged, we realised that they were not holding a charge as long as they should have been. We therefore procured new batteries with a longer life to further help address this issue.

No major costs were incurred during this project. No major equipment was procured, no additional staff were recruited and no construction was undertaken in the existing hospital building. The focus, instead, was on changing processes of care to make it easier for staff to do those things that contributed to keeping babies warm.

In addition to improving thermal control, we started a training initiative focused on improving hand hygiene in the final week in January 2017. To do so, we used Glo Germ (http://www.glogerm.com/) solution to conduct intensive handwashing sessions for mothers, health-care providers and ancillary workers. This started on 23 January 2017. We conducted four such sessions over the first 7 days and followed this up with hand hygiene monitoring on alternate days using the Glo Germ solution as a tool to check for effective handwashing. We also used anonymous Glo Germ application on equipment to check for appropriateness of surface cleaning and to give feedback to health workers. The team identified days and

areas where handwashing sessions would be conducted. A written record of these sessions was transfixed in the nurses' work area.

RESULTS

We collected data on hypothermia and analysed these on run charts. We also collected data on neonatal mortality in the labour rooms and NICU and analysed it on statistical process control charts. For the temperature data, we calculated the baseline median using the first 10 data points and recalculated the median whenever we identified a shift in the data using rules to define a shift as described by Anhøj and Olesen.[12] As a balance measure, we collected data on the proportion of babies admitted to the NICU each week with hyperthermia not due to infection and analysed these on a p-control chart.

From the baseline median of 27% in July 2016, normothermia increased to a median of 75% starting in the week of 17 February 2017 (figure 1). The percentage of neonates admitted with a temperature below 36°C decreased from a median of 38% in July 2016 to a median of 6% starting in the week of 17 February 2017 (figure 2).

We collected data on the number of deaths per week occurring in the labour room or NICU and plotted these on a c-control chart.[13] We recalculated the centre line whenever we identified a shift of eight points below the median. All-cause mortality decreased from a baseline mean of 4.2 deaths per week to a mean of 2.6 deaths per week (38% reduction). The shift started the week of
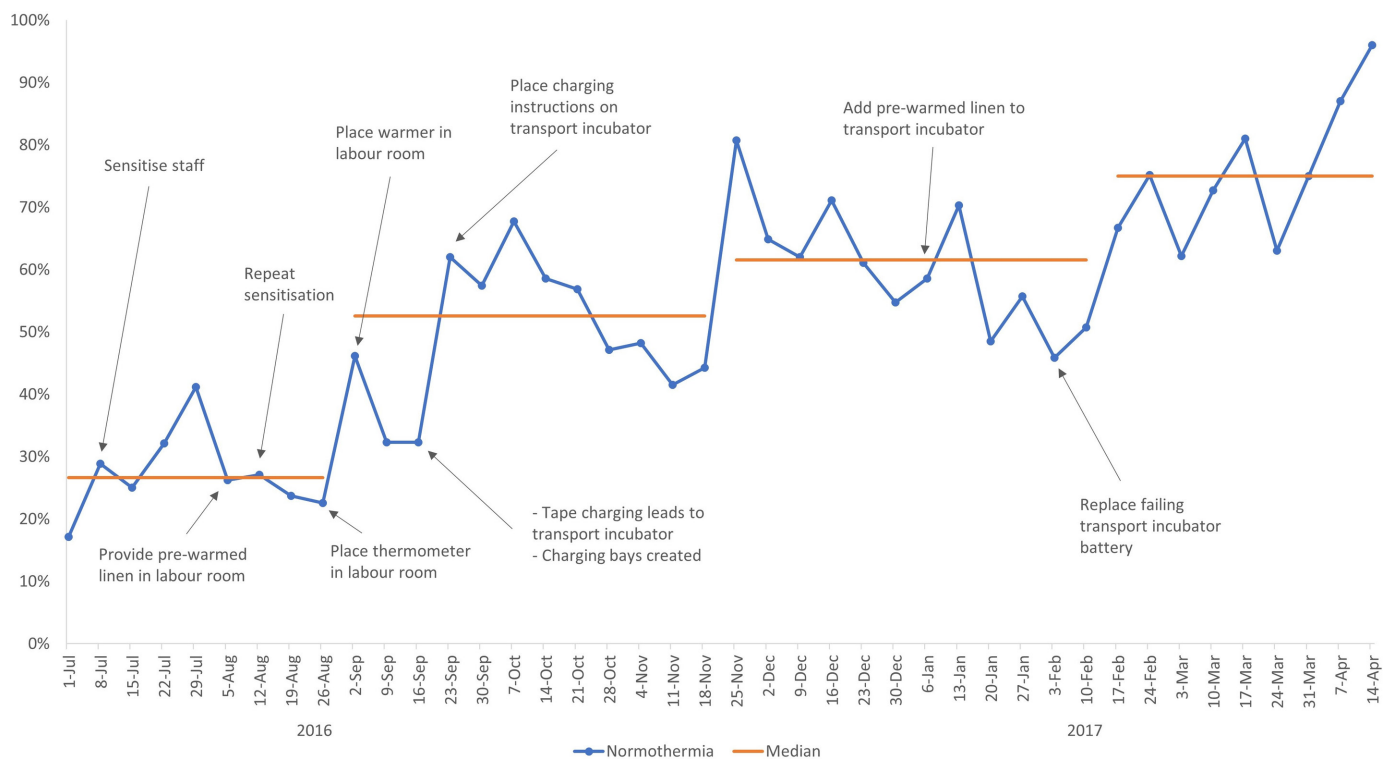

Figure 1 Percentage of newborns admitted to neonatal intensive care unit with axillary temperature over 36.5°C on arrival (July 2016–April 2017).
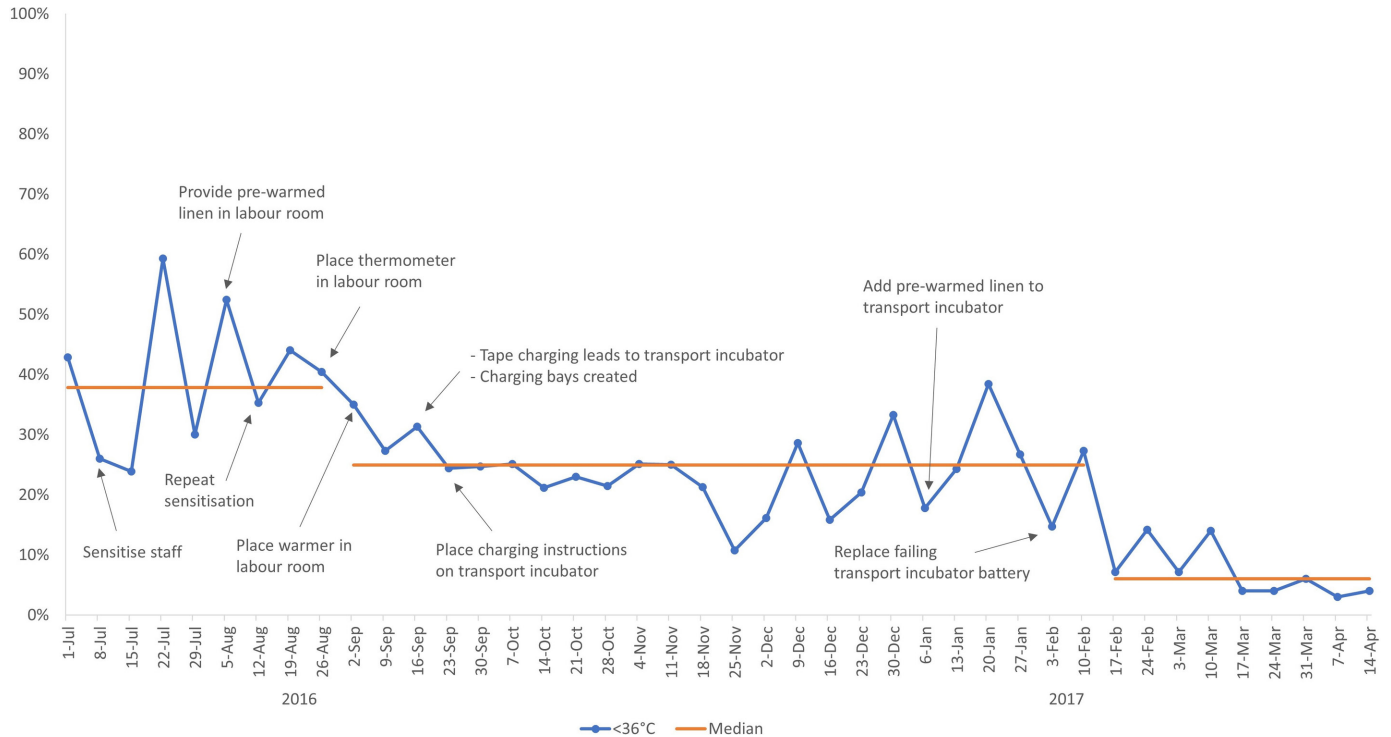
Figure 2 Percentage of newborns admitted to neonatal intensive care unit with axillary temperature below 36°C on arrival (July 2016–April 2017).

30 December 2016 (figure 3). We also collected monthly data, beginning in June 2016, on the number of cases of LONS and deaths attributed to LONS per 1000 patient days. These decreased from 15.2 infections/1000 patient days to 5.0 infections/1000 patient days and from 2.53 deaths/1000 patient days to 0.71 deaths/1000 patient days, respectively (figure 4). The proportion of babies admitted each week with hyperthermia increased from 0.9% to 3.7%. The shift occurred the week of 5 October 2016.
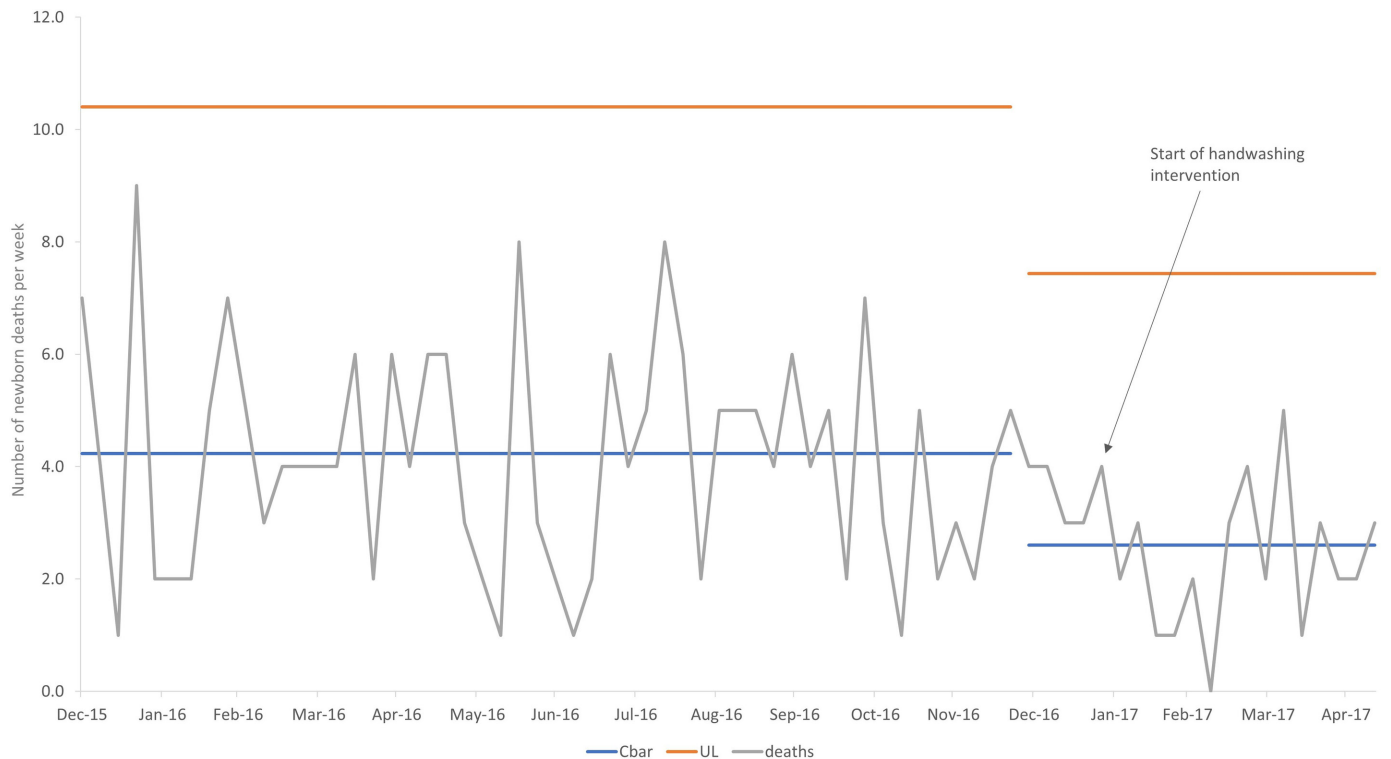
Figure 3 c-Control chart of number of newborn deaths per week in labour room and neonatal intensive care unit (December 2016–April 2017). Cbar, Centre Line; UL, Upper Control Limit.
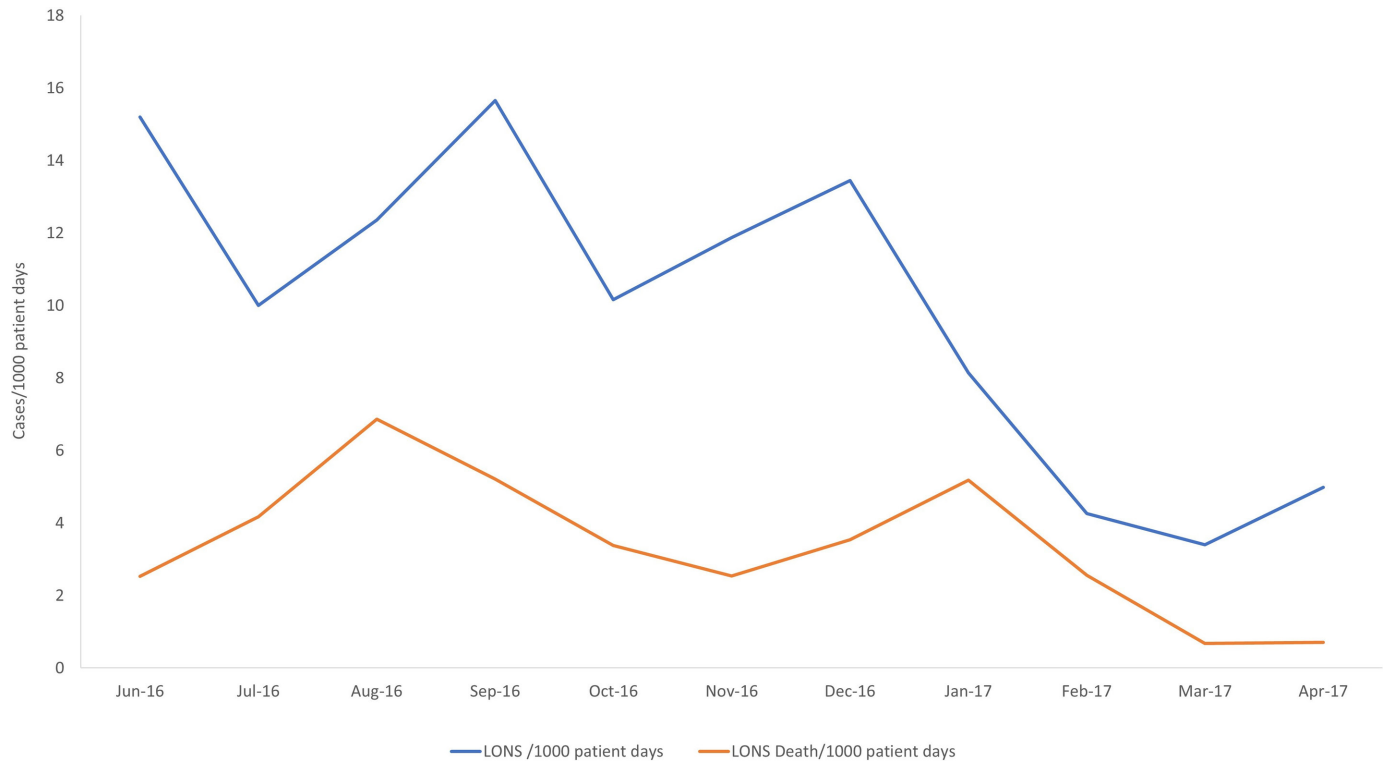
Figure 4 Cases of late-onset neonatal sepsis (LONS) and LONS deaths/1000 patient days (June 2016–April 2017).

LESSONS AND LIMITATIONS

We were able to successfully use QI approaches to keep babies warm and reduce deaths from LONS and all-cause mortality. This was the first time our team had used QI methods. We started by training staff on the general importance of keeping babies warm, but we did not see any real improvement until we started to identify specific barriers to thermal care and developed practical solutions to those barriers. Using diagnostic QI tools, such as flow charts and fishbone diagrams, and reviewing the causes when babies arrived at the NICU cold helped us identify these barriers. Making iterative tests using PDSA cycles helped us to refine the solutions until they were effective and efficient.

Some of the challenges we faced in this work were due to the novelty of using QI approaches at the hospital and the difficulty in trying to get people to change their behaviour. We were able to overcome these challenges by holding weekly team meetings to address people's concerns. We also created fora for telephonic discussions and put updates on a bulletin board so everyone knew what was happening. We made sure to celebrate and publicise successes. If we were to undertake this project again, we would probably start by working with just one or two birthing areas before scaling up what we learnt from these initial sites.

We believe that some aspects of this work are not generalisable to other hospitals, while other elements are likely to be very generalisable. For example, the specific changes that we made to keep the TI battery charged are unlikely to be relevant to other units. Conversely, we believe that

the key elements of the QI approach, such as working in a team, looking for the causes of problems, and testing and adapting different solutions, are highly generalisable to other hospitals in India and other LMICs.

CONCLUSION

Neonatal hypothermia is a common and dangerous condition, particularly in LMIC. Multiple factors contribute to making babies cold, and multiple stakeholders in the health system have different levels of involvement in these factors. This complexity means that QI approaches are particularly well suited to solve this problem.

By forming a team that included staff from the labour room, staff who transported the sick babies and staff from the NICU, we were able to identify the factors contributing to hypothermia at each location and systematically address these factors. There was a 2.8% increase in the proportion of neonates arriving at the NICU with hyperthermia, but this lasted for less than 10 min as all neonates were put in temperature-controlled incubators and normothermia was restored quickly. We do not believe there was any clinical impact of this transient hyperthermia.

This work has dramatically reduced hypothermia among neonates admitted to our NICU, and along with the concurrent training programme to improve hand hygiene among hospital workers and parents has contributed to a 38% reduction in mortality in these babies. This reduction in mortality is the equivalent of saving 1.6 lives per week or 83 lives per year in this NICU. To put this figure into

perspective (and further demonstrate the shocking inequities in healthcare around the world), 10 states in the USA have fewer than 83 infant deaths per year.[14]

Because the majority of changes focus on making the system easier for staff people to do the right things to keep babies warm, we believe it will be sustainable. This hypothesis will be tested when winter comes to Delhi later this year.

We believe that this work could readily be replicated in other hospitals. The specific factors in the labour room or during transportation that lead to hypothermia differ from facility to facility, but the approach of forming a team, analysing and measuring the problem, developing and testing change ideas, and then sustaining the successful changes is generalisable. In fact, the authors are currently involved in two QI networks in India focused on improving newborn care, and some of the hospitals are focusing on reducing neonatal hypothermia. We hope to scale this work up and spread across the country as we identify common contributing factors.

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