SPECIAL ARTICLE

Gains from Quality Improvement Initiatives – Experience from a Tertiary-care Institute in India

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Quality improvement (QI) in healthcare involves implementing small iterative changes by a team of people using a simple structured framework to resolve problems, improve systems, and to improve patient outcomes. These efforts are especially important in a resource-limited setting where infrastructure, staff and funds are meagre. The concept of QI often appears complex to a new careprovider who feels intimidated to participate in change activities. In this article, we describe our experience with QI activities to address various issues in the Neonatal intensive care unit. QI efforts resulted in improved patient outcomes, and motivated careproviders. QI is a continuous activity and can be done easily if the team is willing to learn from their experiences and use those lessons to adapt, adopt or abandon changes, and improve further. Our institute has also developed Point of Care Quality Improvement (POCQI), a free online resource for learning the science of QI, and also serves as a platform for sharing QI work.

Keywords: *Point of care quality improvement (POCQI), Run chart, QI tools*.

Quality improvement (QI) is defined as the combined and unceasing efforts of everyone involved in healthcare including providers, patients and their families, researchers, planners and administrators to make changes that will lead to better patient outcomes, better health system performance and better professional development [1]. Better quality of care (QoC) ensures that the healthcare provided is safe (avoids harm), effective (evidence-based best practices), patient centred (care that respects patients and their preferences), timely (avoids unnecessary delays), efficient (avoiding wastage) and equitable. QI also helps one to translate best clinical and scientific evidences into clinical practice. The key ingredient of any QI initiative is the 'change' (context specific improvement) that is proposed and the 'methodology' by which the change is introduced [1]. QI initiatives in low- and middle- income countries (LMIC) targeting small and sick neonates have shown benefits in the form of reduction in neonatal mortality and morbidity [2]. However, overburdened staff and lack of sufficient equipment were identified as the most common barriers during implementation [2].

While a number of approaches can be used for QI initiatives, some general principles hold true for all of them. These include a thorough understanding of the problem to be addressed, the system and processes that prevail within the unit, appropriate data collection, choosing suitable changes, executing them, and finally evaluating and measuring the impact of such changes. All these can be accomplished only with good leadership support, staff engagement, motivation and team work. In this article, we share a number of QI initiatives undertaken in the neonatal unit of our institute and elaborate our learning from them.

QUALITY IMPROVEMENT JOURNEY AT OUR CENTER

Setting: Our Neonatal intensive care unit (NICU) caters to an average of 2800 inborn neonates, in 10 bedded level III, 12 bedded level II, 8 bedded kangaroo care unit or in the rooming-in beds. Most neonates are born to mothers with high risk obstetric conditions and approximately a quarter of them require NICU admission. NICU team includes highly skilled nurses, four full-time faculty, fellows undergoing super-speciality neonatal training and rotating pediatric residents and other support staff.

Way back in 1980s, AIIMS NICU achieved a marked reduction in neonatal mortality rate (NMR) from 36.6 per 1000 live births in 1985 to 23.9 in 1986, just by introducing a few changes in routine practice- (use of intravenous cannula in place of butterfly needles, reducing intravenous fluid usage, stopping the use of

stock solution, not admitting caesarean babies for 'observation', meticulous adherence to asepsis and promotion of breastfeeding) [3]. This was in fact a quality improvement activity based on common sense and clinical acumen but little did we know about its science and implementation then. The data collected was part of the monthly morbidity and mortality report. Similarly, there are reports from other parts of country [4] and abroad [5] wherein implementation of simple interventions (*e.g.*, rational admission policy and antibiotic usage, curbing non-essential routine investigations and interventions, focus on asepsis and training of nurses) have led to reduced neonatal mortality. These are examples of 'lean principles' – whereby better patient outcomes was created by decreasing non-value added interventions/waste and fewer resources.

While there is no dearth of evidence, what afflicts most LMIC settings including ours is the struggle to implement them in practice: the knowledge-implementation gap. This is important because, while there may be many approaches to implement an evidence; the best approach in a given setting cannot be determined without understanding why certain practices and policies prevail within the setting and the sentiments of people whose behavior we wish to change [6]. We at AIIMS strived to implement evidence-based practices, succeeded in some, failed in many but did not formally analyze failures and perhaps focussed more on outcomes rather than processes.

Learning the science and art of QI: This outlook certainly got more refined when we embarked on a journey of providing quality care in a systematic way in August 2015, under the leadership of the Director of AIIMS. A team comprising of a faculty, a nurse educator and a resident from the pediatrics department attended a seminar on QI and brought home clinical wisdom and enthusiasm to initiate QI activities. They did their first QI project in NICU and tasted success. QI was infectious; with early and obvious improvements, more people wanted to be part of the process. Thus with more interest gathering, participatory learning sessions (3-4 hours each) were organized to guide members in the scientific way of doing QI. Initially five departmental teams participated at the first workshop wherein teams brought problems to work on and went home with an aim statement and to collect a few baseline data. They formed local teams and came up with change ideas. They were then taught to test these ideas in small Plan-do-study-act (PDSA) cycles and to see if the changes led to improvement. The teams met fortnightly to share progress and help out each other. More help came from agencies like USAID Applying Science to Strengthen and Improve Systems (ASSIST) Project and Institute of Healthcare Improvement (IHI), which hand-held many departmental teams, conducted workshops, webinars and arranged platforms for sharing QI work. Once a few QI projects were completed, there emerged champions and local leaders in various departments who then led the change movement. Frontline workers became involved and better patient outcomes, client satisfaction and a sense of fulfilment fuelled more QI projects. In the following paragraphs, we describe various QI activities done in the NICU.

Improving the Rates of Hand-hygiene – Our Initial QI

Hand-hygiene (HH) is the most effective strategy in reducing healthcare-associated infection in the unit. AIIMS NICU has a very strong culture of implementing asepsis routines including HH, yet the rates remained around 60% similar to most units with rates of 50% or less [7]. We wanted to implement measures in a step-wise fashion to improve compliance.

Implementation and evaluation: We designed a prospective before-after study [8]. The intervention consisted of 4 steps as listed: step 1: standard teaching of health care providers with posters, videos and self-learning module; step 2: face to face interaction with practical demonstration and appreciation of hand hygiene champions of the week; step 3: closed circuit television (CCTV) monitoring; and step 4: CCTV monitoring with individual feedback for the missed opportunities of hand hygiene. Each phase of intervention lasted 4 weeks. The compliance with HH was observed by trained research nurses for the 5 moments of HH at various opportunities. The baseline HH compliance in the unit was 61.8%, which improved significantly to 77% after implementation of all 4 steps in a stepwise manner (relative change 25%, 95% CI: 18% to 32%).

Learning and implications for practice: In this improvement effort, we focussed on the process – namely performance of HH and chose all the change ideas at the outset. There is a possibility that the improvement we saw reflected Hawthorne effect of being observed and fear of being monitored by CCTV cameras. While adherence to HH was monitored continuously, the improvement was not displayed to motivate everyone in the unit. We also did not analyze the possible causes of poor compliance, barriers in implementation or make efforts to sustain the improvement. However, the final study result motivated all.

Improving Exclusive Mother's Milk Feeding Rates among Preterm Neonates

Exclusive human milk feeding in preterm neonates is

associated with lower rates of necrotizing enterocolitis (NEC), sepsis, lesser rehospitalization rates and better neurodevelopmental outcomes [9]. Early expression of mother's milk particularly within 6 hours after delivery and frequent expression are associated with lactation beyond 40 weeks' gestational age [10]. However, in reality lactation is delayed for mothers delivering preterm babies due to various reasons like, being separated from the neonate, illnesses that preclude oral feeding, maternal anxiety and lack of support. Despite being very proactive for breast milk feeding in our NICU, we found that even on postnatal day 7 of life, only 12.5% of all admitted preterm neonates were on exclusive mother's milk feeding. We desired to increase the proportion of neonates receiving mother's own milk at postnatal day 7 from the current rate of 12.5% to 30% over a period of six weeks [11].

Implementation and evaluation: A QI team comprising of a faculty, two resident physicians, a nurse educator and two senior staff nurses explored the reasons for poor breastmilk expression using fish-bone analyses. Baseline data collected for initial 7 days included time of first expression of breast milk (EBM) in mothers delivering preterm neonates, daily amount of EBM and percentage of neonates on exclusive mother's milk feeding in NICU. Poor awareness among healthcare providers and lack of maternal counselling were identified as most important causes for the problem. Hence as a change solution, a comprehensive postnatal counselling was implemented wherein the bed-side nurse was assigned the responsibility to initiate the first milk expression within 6 hours of delivery. The mother was educated with videos on breast feeding and encouraged to pump every 4-hourly as soon as she was stable postpartum. Successive PDSA cycles focused on staff motivation and the primary nurse whose neonate achieved exclusive breast feeding on or before 7th day of life was awarded with a certificate. Run charts were displayed showing percentage of neonates each day on exclusive EBM. This QI also addressed the supply chain issues like the availability of breast pump and its accessories as well as a refrigerator for milk storage both in NICU and postnatal wards.

The NICU team finally succeeded in their efforts. While the time to first expression of breast milk was 48 hours in the baseline phase, milk expression began within 3 hours of delivery after the intervention. The proportion of neonates on exclusive mother's milk increased from 12.5% to 81% on day 7 of life. A re-evaluation one year after implementation showed that the success was sustained with exclusive EBM rates of 80% on day 7 of life.

Learning and implications for clinical practice: This QI initiative is an example wherein front-line workers (nurses in this case) were empowered for initiating milk expression and driving the entire QI to increase EBM use in NICU. The QI tools used in this initiative include fish-bone analyses and PDSA cycle for implementation of change ideas. The entire QI could be done with the available resources and with continued staff motivation, the team sustained their efforts even a year later.

Improving Life of Radiant Warmer Probes in NICU

Equipment used in the NICU are costly and failure or break-down of equipment or its parts affect patient safety and increase the cost of care. We found that there was frequent breakage of radiant warmer temperature probes in NICU with one particular unit requesting a new probe once in 9 days. We wanted to explore and rectify this equipment failure using QI methods.

Implementation and evaluation: A team was formed including faculty in-charge as team leader, 4 nurses and a resident doctor. The potential reasons for temperature probe breakage were evaluated using 5 whys (***Table* I**).

TABLE I FIVE WHYS ANALYSES FOR DERIVING THE ROOT CAUSE OF A PROBLEM*

Whys	*Question*	*Answer what caused the situation*
1.	Why only one NICU was having this specific equipment failure?	Because this NICU caters to stable growing preterm babies
2.	Why probes of stable babies are damaged more often?	Because, these babies are taken off the warmer more frequently for kangaroo mother care
3.	Why probes get damaged with frequent disconnection?	Because care providers do not know that probes are costly that they often allowed mothers to do the task themselves
4.	Why do care providers not aware of this?	Because no one provided in-service orientation of nurses on equipment maintenance
5.	Why was no orientation provided?	No one thought that this was important. This is the root cause of the problem in hand.

**Frequent damage of temperature probe of radiant warmers in NICU.*

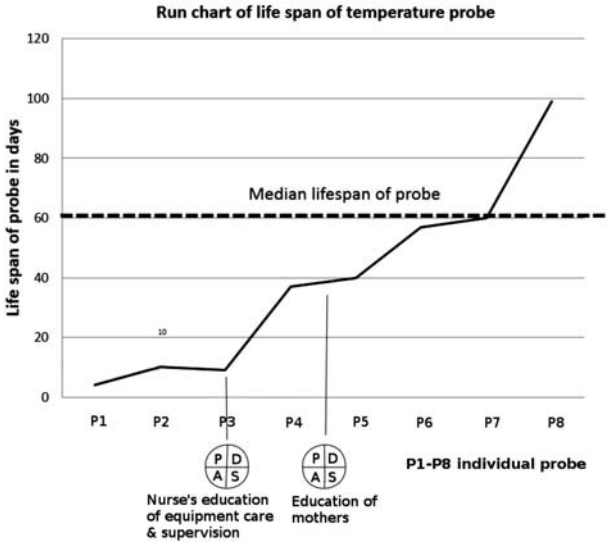

FIG. 1 *Annotated run chart showing life span (in days) of temperature probe in the NICU. P1-P8 on the x axis indicates an individual temperature probe. The dashed line indicates median life span.*

The 'SMART' (Specific, Measurable, Applicable, Realistic and Timely) aim was to increase the life span of temperature probe from the current lifespan of 9 days by 80% over a period of 8 weeks. The change ideas involved providing a refresher course for nurses on equipment care, supervising mothers and junior nurses while handling probes and tracking probe breakage. After implementing the PDSA cycle 1, the life of temperature probe increased up to 40 days, which was not as good as expected. Exploring the reasons, it was noted that mothers needed more support and can be taken as partners in QI. In 2nd PDSA cycle, the bedside nurses provided face to face education of mothers on taking care of warmer equipment and made it a point to discuss status of temperature probes during nursing hand-over in each shift. After the 2nd PDSA cycle, the minimum time interval between two temperature probe break-down increased to median of 60 days as indicated by run chart (***Fig.* 1**).

Learning and Implications for clinical practice: This QI initiative began because one astute nurse recognized that an order for new temperature probe was being placed too often. She had to convince the other staff that something was wrong. Unless people recognize the problems and are involved in initiating the change, there is often resistance. The team used 5-whys analyses to identify the major cause of probe breakdown. They came up with solutions, tested them to see if it worked and then implemented those that worked. Following this QI, recommendations were made in the unit to provide regular in-service training of nurses on proper equipment use and its maintenance. Involvement of mothers as partners in care as suggested by this QI initiative improved the success rate.

Prevention of Admission Hypothermia Among Preterm Neonates

Hypothermia is an important contributor of neonatal mortality and morbidity. During an audit, we observed that majority of inborn preterm neonates <32 weeks gestation admitted to our NICU were hypothermic with mean admission temperature of 35.6°C despite the use of plastic wraps, attention to warmth during resuscitation and transport. We wanted to improve the mean admission temperatures (AT) of preterm neonates from the existing baseline of 35.6°C to normal range (36.5-37.5°C) by implementing all the components of an evidence based thermoregulation bundle in a stepwise manner using PDSA cycles over a period of 11 months [12].

Implementation and evaluation: A multidisciplinary QI team was formed who analyzed the causes of hypothermia using fish bone analyzes (***Web Fig.* 1**). During an observation period of three months, a dedicated nurse observed the delivery room activities and a Pareto chart (***Web Fig.* 2**) was constructed to identify those few important practices that needed to change. The Pareto chart revealed that the application of plastic wrap at birth was not proper in a majority of cases. Residents explained that the cling wraps crumpled when they tried to wrap the babies. Thus the changes in PDSA cycle 1, included the use of plastic bags instead of cling wraps for resuscitation. However, a look at the run chart revealed that hypothermia was persisting. The team discussed the issues with resident physicians and nurses and noted that the plastic bag available in market was stiff and the cut ends remained open exposing the neonate. Also the delivery room (DR) nurses were not aware of this QI initiative. So in next cycle, the team reinstituted the use of cling wraps but used a new way of application. The delivery room nurses were educated on the importance of hypothermia and how they could contribute to the initiative. In cycle-3, thermometers were installed in DR to monitor room temperature and the team co-ordinated with nursing assistants to ensure prompt transfer from DR to NICU. Frequent feedback with run charts of AT and appraisal in monthly meetings were done to ensure compliance and staff motivation in the post-intervention phase (4 months).

We studied a total of 79 preterm neonates during this QI initiative and noted AT in the post-intervention period with mean AT of 36.5°C and a significant drop in the

incidence of moderate hypothermia (axillary temperature between 32-36°C) from 50% to 12.5%. We used a statistical process control chart for trending admission temperatures over time and demonstrated both a sustained increase in mean AT as well as decreased variability as reflected in the narrowing of the control limits (***Web Fig.* 3**). As a balancing outcome, we did not notice any episode of hyperthermia or increase in mortality among neonates.

Learning and implications for clinical practice: This is an example of a complex QI study where team members implemented a bundle of interventions in different regions of hospital namely labour room, obstetric operation theatre and NICU. When too many etiologies for a problem were noted in the fish-bone diagram, they used the Pareto's tool to identify those few important causes that contribute most. The Pareto tool also called as '80-20 rule' states that 20% of the causes are responsible for 80% of the problems and can help one to focus on the important few. The first PDSA was not successful but the team innovated a new method in the second cycle. Some problems need a multi-pronged approach or a bundle of interventions and one can simultaneous test 2 or 3 change ideas as opposed to serial testing. The other lesson from this QI was to involve all stake-holders from the multiple areas for success. While we used run charts [13] for tracking and display, we used the statistical process control charts (SPC) to understand the process better. The SPC charts have an upper and lower control line (±3 standard deviations) in addition to the central line which represents the mean as opposed to the run chart where central line represents median [14]. While both run charts and SPC charts can visually display data over time and inform whether changes have resulted in improvement, the SPC charts in addition tell us whether the process is stable over time. A stable process, has most points near central line, few points near control lines and none beyond control lines. If points are above the control line, it indicates a special cause variation due to changes introduced in the system that needs to be investigated. There are other pointers to special cause variation too [14]; and in our example we had eight successive points on the same side of the centre line as an indicator.

Sustaining an improvement is important and in our NICU we have implemented the following – regular monitoring of delivery room temperatures, a checklist to ensure that all resuscitation supplies and equipment are available and we use admission temperature as an indicator of quality resuscitation, which is regularly audited for feedback. Dutta, *et al*. [15] from India reported a similar QI initiative to improve admission hypothermia in neonates wherein they showed lesser hypothermia as well as reduced mortality and late onset sepsis. The entire QI could be done without major cost, with no additional staff or new equipment. All the change ideas focussed on making the existing system and process of care easier for staff to implement the interventions.

Reducing Breastfeeding Problems at Discharge

Breastfeeding problems are very common, almost 80% of mothers experience one or more problems related to breastfeeding like sore, cracked or flat nipples, painful or engorged breasts, difficulty latching, feeling of decreased milk output *etc*. while in hospital [16]. These problems, if not avoided or corrected with proper education and support can even lead to early cessation of breastfeeding.

Breastfeeding in our postnatal mothers is primarily assessed by resident doctors and counselling regarding specific or anticipated problems is done individually at the bedside. Our postnatal follow up clinic that runs all working days for 2 hours specifically caters to neonates who are followed up within a couple of days after discharge. We observed that up to 20-30% of mother-baby dyads presented with issues related to breastfeeding. Hence we designed a QI initiative to address this [17].

Our SMART aim was to reduce the incidence of breast feeding problems at discharge from baseline of 75% to at least 37.5% among mothers delivering term babies by implementing a post-partum education package over a period of four months from September 2016 to December 2016. A QI team was formed and two members (a nurse educator and neonatal resident) objectively assessed breastfeeding among eligible mothers in initial phase (4 weeks) using LATCH breastfeeding assessment scores [18] and collected data on breastfeeding issues. Fishbone analyses was done, and the team planned to introduce a learning package for mothers. The nurses in post-natal wards were involved in teaching activities (phase 2 lasting 4 weeks) which consisted of distributing pamphlets and video demonstration on breastfeeding. Mothers' perception and acceptability of the education package was then assessed on a 5-point Likert scale at the time of discharge. In the phase 3 (2 weeks), the team stressed on compliance with education package by having a checklist attached to neonate's file. Focused group discussions with postnatal nurses and mothers were conducted to obtain feedback and to identify barriers in implementation. In phase 4 (2 weeks), a lactation nurse provided one to one support to all postnatal mothers in addition and in phase 5 (4 weeks), videos were uploaded in mother's cell phone for repeated viewing and other measures were continued.

A total of 330 mother-infant dyads were enrolled in all the phases of QI. Incidence of breastfeeding problems at discharge gradually decreased from phase 1 (baseline) to phase 5 from 72.6% to 6.8% (P<0.001) (***Web Fig.* 4**). Compared to baseline, the proportion of mothers with LATCH score >8/10 at end of final phase (RR 3.8; 95% CI 2.7-5.5, P< 0.001) as well as each of the individual phases were significantly greater. The compliance with discharge checklist increased from 29.8% to 100% and mothers felt that the educational package had utility as well as acceptability, with 43-65% of mothers strongly agreeing in favor of the education bundle.

Learning and implications for clinical practice: This QI initiative addressed breastfeeding problems in postnatal mothers by successful implementation of educational intervention driven by stepwise rapid cycle PDSA based approach. As outcome measures of improvement, the team used percentage of mother-infant dyads with problems at discharge and LATCH score to objectively assess breastfeeding. As process measures, they tracked the compliance with the interventions using a checklist. The team used p-chart (p stands for proportion) to monitor the proportion of mothers with breastfeeding problems. Similar to a control chart, p-chart also has a central line which corresponds to the mean proportion and 2 control lines corresponding to three standard deviations (SD) around the mean. A special-cause variation that requires investigation is indicated by point (s) outside the control limits. ***Web Table* 1** lists the various QI projects done at AIIMS NICU.

MOVING FORWARD WITH QI ACTIVITIES

After multiple QI efforts, the NICU nurse educator emerged as a champion who further supervised more QI work like, increasing the duration of kangaroo care for preterm neonates in NICU, decreasing medication errors, antibiotic stewardship and streamlining of post-natal follow up clinic. QI had also been topics of dissertation work for postgraduates in the department; the QI work on preventing admission hypothermia, resolution of breast feeding problems in the post-natal ward (both discussed above) and improving oxygen saturation targeting among neonates on oxygen therapy are dissertation work done by postgraduates. An ongoing QI dissertation work focuses on implementing potentially best practices in the first week of life among preterm neonates to reduce the incidence of bronchopulmonary dysplasia.

Dissemination and capacity-building: AIIMS, a WHO Collaborating Center for Newborn health disseminates QI to other organizations through its on-line resources, face-to-face workshops and the Point of Care Continuous Quality Improvement (POCQI) module. A dedicated website (*http://aiimsqi.org/*) on quality improvement provides free resources for teaching and learning QI, and as a platform for capacity building of teams and sharing QI work. The site also has short videos and posters of various QI projects done in the Institute. Many SEARO (South East Asian Regional Organization) countries participated in a Regional Workshop for Improving Quality of Hospital Care for Maternal and Newborn Health in May 2016 at New Delhi and have initiated QI work in their areas. QI project power-point template is freely available in the site that teams can use as a framework for QI work.

Teaching and Research in QI: QI is taught to undergraduates and nursing students at AIIMS. Postgraduates are encouraged to be part of QI teams in clinical areas and as topics for research or dissertation work. A good starting point for a dissertation or thesis on QI work is a single-centre prospective study with a pre-post design. The focus should be on implementation rather than testing whether certain practices are effective or not. So careful planning is essential to understand the existing processes, to identify how and why the current practices differ from recommended or evidence-based practice and to involve all stake-holders who may influence implementation. The team should identify the data that needs to be collected to measure improvement before study begins. Broadly this includes process measures (measurement of processes to see if the changes are being implemented), outcome measures (impact of the changes on patient or provider outcomes) and balancing measures (unexpected outcomes or changes both beneficial or harmful that are introduced either in the same system or other parts of system due to improvement efforts) [19]. For example, if a team plans to implement skin-to-skin care (STS) at birth for neonates, exclusive breastfeeding rates at discharge can be taken as outcome measure, the percentage of eligible mother-baby dyad experiencing STS, number of STS checklists filled per month and time to first breastfeeding can be process measures and incidence of acute life threatening event in neonate (desaturation or bradycardia) during STS can be chosen as balancing outcome. Published guidelines are available for reporting QI work in order to improve the completeness and accuracy of reporting so that improvement efforts can be reproduced at other suitable settings [20]. It is equally important to publish QI work to share one's improvement experiences, so that others working on similar problems can adopt or adapt the change ideas without wasting time, effort and money testing the same ideas.

LEARNING FROM QI AT AIIMS

What started as small projects in a few departments

mushroomed into several projects wherein several other departments like Rajendra Prasad Ophthalmic Sciences Centre, Emergency medicine, Pediatrics, Obstetrics, Cardio-Neuro centre and Jai Prakash Narayan Apex Trauma Institute also participated. QI made people recognize the problems in their system, utilize various tools (process mapping, fish-bone analyses, 5 whys) to understand the cause, come up with changes or solutions tailored for their system, test the changes in small scale over a short period or on few patients (PDSA cycles), and adapt/adopt or abandon the changes and finally implement them. People understood that not all changes lead to improvement and collecting data to assess baseline performance and reassessing performance over time using annotated run charts or statistical process control charts help in differentiating day-to-day variations from improvement. Importantly, the teams learnt the scientific way of doing QI activities. There was a lot of learning from each project (both success and failure) that people shared in common meetings. Salient learning points are given below:

Bottom up approach: We created a culture for QI in the unit by building conviction among front-line workers. The human element is the most important component of any QI success story and staff motivation and engagement is essential to work towards a common goal [21]. Each team member contributes to improvement and in many situations, we observed practical change ideas not from leaders but from front-line staff. In our case, NICU nurses identified the problem of frequent temperature probe breakdown and came up with change ideas like empowering the bedside nurse to help mothers with milk expression; the housekeeping staff volunteered in hypothermia QI and offered timely and quick transport of neonates to NICU, and mothers of admitted neonates joined as partners in some QI initiatives.

Understand the system and eliminate waste: Traditionally, the solution to most problems are handled by increasing human or material resources; but in healthcare system in which resources are limited, focussing one's attention to understanding the system to identify the root cause and eliminating the redundant and wasteful processes can help to utilise resources effectively [22]. In our case, breastfeeding counselling by multiple team members with different messages, lack of supplies in the delivery room despite their availability etc. could be rectified when the counselling became more standardized using pamphlets/videos and a checklist was used for arranging supplies in the delivery room. Behavioral change of healthworkers is also important in eliminating waste and facilitating this change will require education, training, motivation and feedback.

Step-up and then scale-up: It is very essential that initial projects be simple, doable, patient-centric and under the control of the team members. Disease processes or problems with multifactorial etiologies take time or produce no improvement at all. Undertaking such projects at the outset would demotivate staff who may feel over-burdened and incapacitated. Our team felt comfortable to use the Institute for Healthcare Improvement's Plan-Do-Study-Act (PDSA) cycle for rapid cycle improvement and changes were accomplished through small and frequent PDSAs [23]. Only change ideas that were tested on a small population and adapted for local context were implemented on a large scale. Building sustainability in each project is so important [24], that improvements are maintained in long run and the changes become a new norm in the unit. This involves making changes in the system itself, use of visual reminders, posters, score cards and identifying champions who would lead the change movement. In our NICU, the following system changes were implemented to sustain the improvements; regular in-service training on equipment handling for nurses and residents, installation of room thermometers in delivery room and tracking of temperatures each shift, charting admission temperatures in the NICU admission register as a quality indicator, and use of videos for breastfeeding counselling.

Celebrate and share success: Having QI meetings both within and between departments helps to show case activities and rally slow movers to gain pace. The QI teams from various departments attended learning sessions and workshops organized by AIIMS from time to time where they had the opportunity to learn from experts, presented their work and shared their experiences. The teams also met face-to-face with other teams, participated in webinars and conference calls, and presented their work at conferences. Teams learnt that they could learn and achieve more by collaboration than working in silos [25].

Time and patience surpasses hurdles: We understood early that problems have to be solved by a team of people and getting people on board could sometimes be challenging. Such factors include staff misunderstanding the principles of QI, feeling over-burdened with data collection, fear of being monitored or blamed for poor performance or just an inertia to change. In our hand hygiene QI, we noticed nurses' resentment against being monitored, in our exclusive breast feeding QI, only a couple of nurses from one NICU were involved. Thus initially like-minded ones teamed up but with time even the disinterested become passionate about change. Nurses participating in QI mentored fellow nurses, and

Box I KEY MESSAGES FOR ORGANIZATIONS PLANNING QI ACTIVITIES

Leadership support with a vision for quality improvement. Leaders should encourage and motivate staff involved in QI and also support shared goals for performance.

Capacity building of staff for QI by training them in the art and science of QI. Encourage teams to attend learning sessions and workshops. Allow staff to set aside time for improvement activities apart from their work.

Empower teams to run and manage systems and introduce changes at their level.

Dedicate time and resources to measure performance over time. All QI work should be data driven.

Encourage all team members to openly discuss both success and failure. Allow collaboration between teams in the organization.

with time came up with ways to collect or add essential data in the nursing flow sheet itself thus decreasing additional paperwork and burden.

Organizations striving to improve their outcomes should initiate and support quality improvement activities. The important requisites for successful QI ventures are listed in ***Box* I.**

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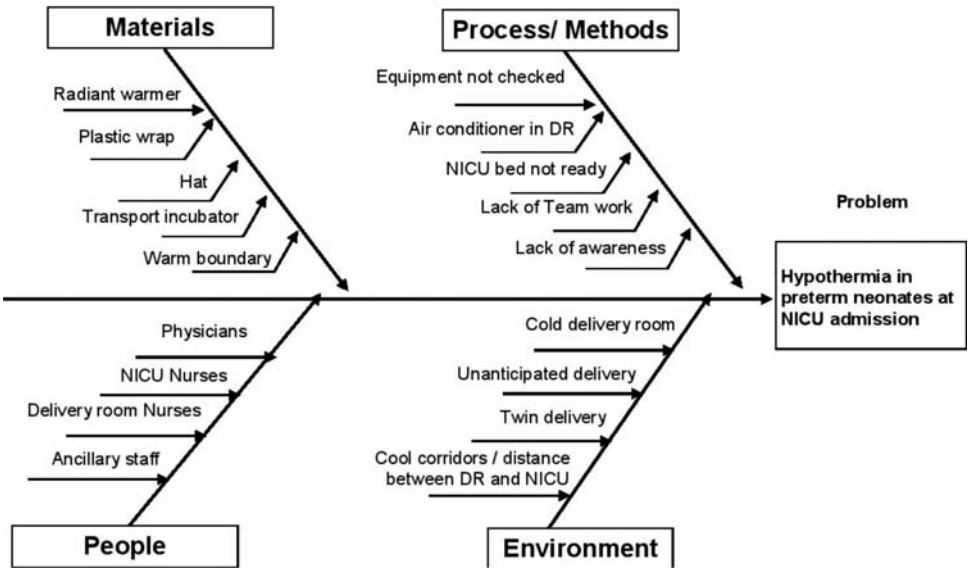
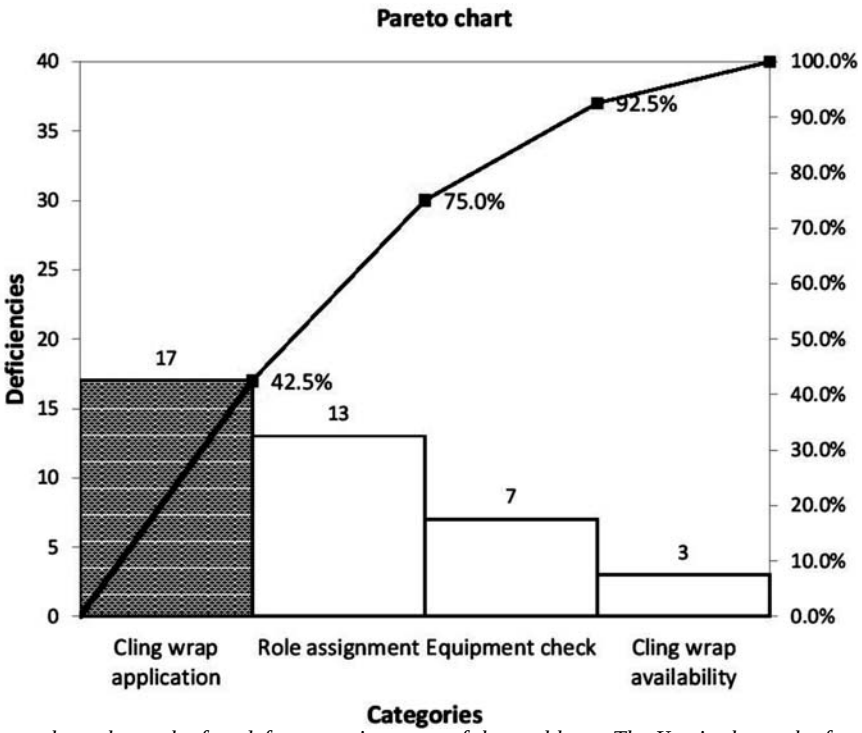
WEB TABLE 1 LIST OF VARIOUS QI PROJECTS UNDERTAKEN AT AIIMS NEONATAL INTENSIVE CARE UNIT

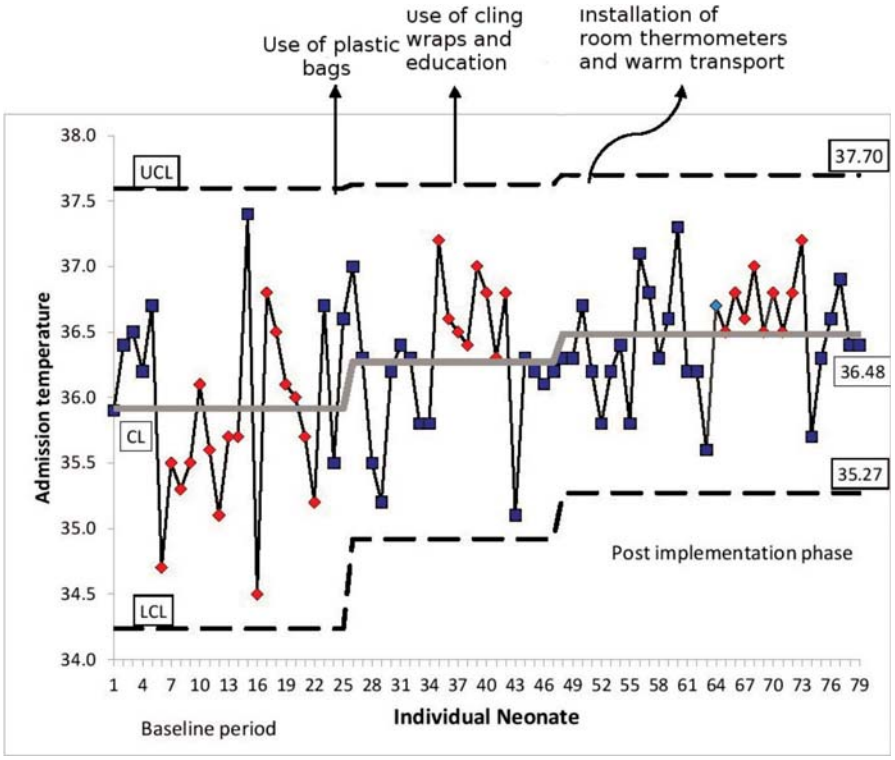
Quality improvement project	*QI tools used*	*Key learning points*
Improving the rate of hand-hygiene in the unit	Simple before after study where interventions were implemented in steps	• Did not use QI methodology but motivated staff to strive for improvement
Improving exclusive mother's milk feeding rates among preterm neonates	Fish bone analysis Interventions done in PDSA cycles Run charts to study improvement	• Entire QI could be done with available resources • Front line workers can drive the change movement themselves if empowered
Improving life of radiant warmer probes in NICU	5 whys PDSA cycles Run charts	• Involve all members who influence an improvement as partners in QI • Front line workers not only can contribute change ideas but initiate and drive QI
Prevention of admission hypothermia among preterm neonates	Fish bone analysis Pareto chart PDSA cycle Run charts Statistical process control charts	• Where problems need a multi-pronged approach or a bundle of interventions, one can simultaneous test 2 or 3 change ideas in a PDSA • To sustain an improvement, changes in the system need to be implemented
Reducing breastfeeding problems at discharge	Fish bone analysis PDSA cycle p-chart	• Tracking process measures is as important as studying outcomes.



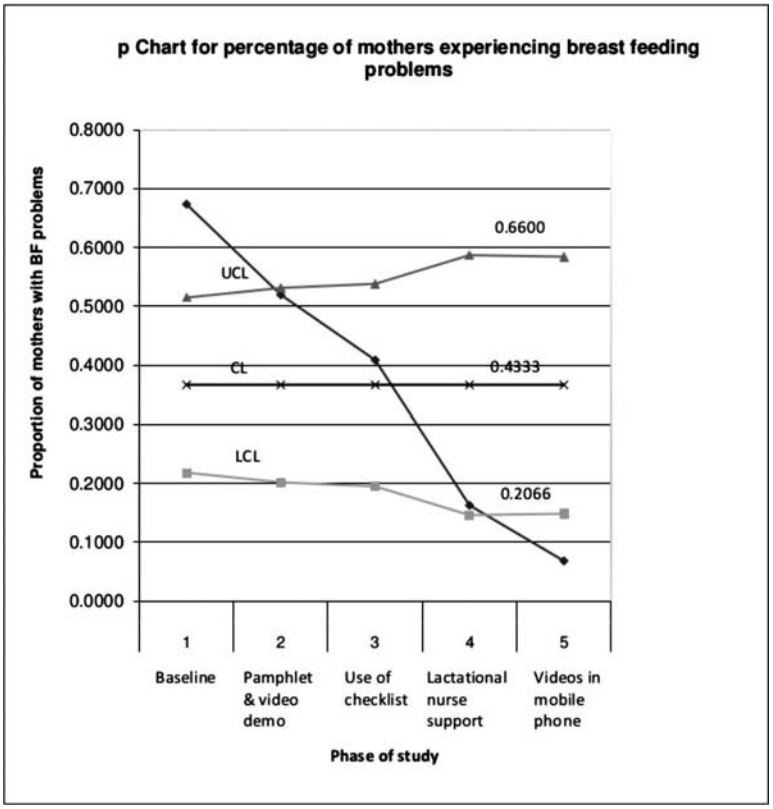
WEB FIG. 1 *Fish bone diagram showing possible contributors to admission hypothermia in a preterm neonate.*



WEB FIG. 2 *The Pareto chart shows the few defects causing most of the problems. The Y-axis shows the frequency of deficiency identified in each of the categories.*



WEB FIG. 3 *Statistical process control chart of admission temperatures of all neonates enrolled in the study. UCL: Upper control line (+ 3 SD), LCL: lower control line (-3 SD), CL: Control line (mean).*



WEB FIG. 4 *p-chart showing the proportion of mothers with breastfeeding problems at discharge during various phases of QI. UCL: Upper control line (+ 3 SD), LCL: lower control line (-3 SD), CL: Control line (mean).*