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BMJ Open Quality

October 2023 Volume 12 Supplement 3

Volume 12 Supplement 3 Pages s1–s54

South Asia Edition

Quality Healthcare

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BMJ OPEN QUALITY

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October 2023

BMJ OPEN QUALITY SOUTH ASIA EDITION

Guest Editorial Board

BMJ Open Quality

Improving the quality of healthcare in resource-constrained settings: is improving undergraduate medical education quality the way out?

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To cite: Datta V, Shukla A, Meena JL. Improving the quality of healthcare in resource-constrained settings: is improving undergraduate medical education quality the way out? *BMJ Open Quality* 2023;**0**:e002582. doi:10.1136/bmjoq-2023-002582

Accepted 13 September 2023

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We understand that the future of the health system of any country rests on the skill and knowledge set of its medical students. These individuals will eventually take over the reins of their countries' complex and adaptive health systems. Poor quality of care and compromised patient safety in LMIC settings often has its origins in skill and knowledge transfer during the undergraduate medical curricula. It requires an in-depth understanding of the various challenges in delivering quality medical education in such settings to identify high priority areas for remedial actions. There are numerous policy, place and process related factors which affect the quality of medical education. India is one of the largest and most populous countries in the world, with a diverse and complex health system. The quality of undergraduate medical education (UME) in India is crucial for ensuring the competence and professionalism of future doctors, who will serve the health needs of millions of people. The potential factors affecting the quality of medical education in India can be grouped under the following subheads.

COMPETITION AND THE COST OF MEDICAL EDUCATION

Students enter the medical school after facing a stringent entry-level assessment system in India called the NEET Examination. This year over 2.1 million medical aspirants applied for the NEET to seek admission[1] to state-managed and private medical institutions across India for seats which number a little over 0.1 million.[2] Besides the ever-increasing number of students vying to enter medical schools, the next aspiration of the candidates is to secure a seat in a government medical college. The competition becomes, even more, tougher as the seats in government medical colleges are nearly 50%–60% of all seats available. A total of 56 383 MBBS seats in government medical colleges and 52 465 MBBS seats in private medical colleges are available for the year 2023–2024. For students who do not succeed to make it to government medical colleges, the cost of medical education is expensive. Often the costs in these private institutions range from 7 to 10 million INR for the entire course duration.

INFRASTRUCTURE CHALLENGES

There has been a rapid expansion in the infrastructure to increase the number of medical schools in India. The numbers have increased from 387 to 706 as of now.[3] The country has seen a phenomenal increase in medical seats, which have gone up from 51 348 in 2014 to 108 848 in little over 9 years.[4] Many states in India have upgraded the existing district hospitals to medical colleges. This has been made possible by a centrally sponsored scheme in which the central government contributes nearly 60%–90% of the total expenditure incurred in setting up of such medical colleges. Till date over 101 such medical colleges have been started. There has been a change in policy allowing public-and-private partnerships to set up new medical colleges. Existing medical colleges of eminence can set up campuses with permissions to start immediate admissions as against a 3-year holding period as per the previous policy. Many states have been providing land on subsidy and facilitating the setting up of medical colleges by private players in a bid to meet the gap in the numbers of medical seats in remote and rural settings across India. Despite these facilitatory factors, medical colleges face significant challenges. Operating and maintaining a medical college according to the contemporary National Medical Commission (NMC) guidelines has become a major challenge for many institutions. Institutions located in tier

1 and tier 2 cities and rural settings face deficits in the numbers of experienced faculty, staff nurses and above all requisite footfalls from patients. As a result, they often struggle to provide high-quality learning and training environments in these setups.

QUALITY OF MEDICAL EDUCATION

With the recent introduction of the competency based medical education curriculum and the attitude, ethics and communications modules greater emphasis is now placed on hands on skills, soft skills and communication in undergraduate medical curriculum. To impart these skills to a medical student there is a need for a well-trained team of faculty who are conversant and trained in these processes of teaching training. Till date many medical teachers in recently opened medical colleges are not fully trained in implementing these modules to the undergraduate medical students. Besides this, factors such as availability of skills and simulation lab, clinical material and strict compliance to implementing these modules can act as confounding factors to the overall impact of these modules.[5]

FINANCING FOR MEDICAL EDUCATION

Setting up a medical college for 150–250 medical students can be a very cost intensive exercise. It often costs upwards of nearly US$70 million. The major chunk of this cost is towards sustaining human resources (doctors and nurses) who are vital for the operational system of the medical college. For a private sector investor, the recovery of the capital invested can take as long as 7–10 years. In absence of governmental subsidy, these colleges often compromise on the numbers of full-time faculty, human resources or look towards meeting this expense by increasing the cost of services both in service provision (hospital side) and teaching side (medical college fees). The Increased costs often do not translate to high quality education or patient care in these understaffed set ups.

Numerous other bottlenecks also afflict the system which are beyond the scope of discussion in this editorial. The readers are referred to relevant sources on these important aspects.[6]

Multiple factors need to be addressed as priorities to improve the quality of UME in the region. Efforts to strengthen infrastructure and provide adequate resources are essential. Governments and educational institutions should prioritise investments in modern facilities, equipment and technology. Collaboration with international partners can facilitate knowledge exchange and resource sharing. Embracing virtual learning platforms and telemedicine initiatives can help overcome resource limitations and ensure access to quality education.

Curriculum reform is crucial to align medical education with evolving healthcare needs. Regular review and updating of curricula should incorporate the latest medical advancements, technological innovations and societal considerations. Emphasising problem-based learning, case-based discussions and simulation exercises can foster critical thinking, clinical reasoning and practical skills among students.

At the policy level, the NMC Bill, 2019, with the goal of boosting visibility, accountability and quality in the governance of medical education paves the way for quality medical education in India. The commission intends to improve the number of medical seats and lower the cost of medical education to encourage more students to pursue careers in healthcare. Numerous other reforms like restructuring of medical licensing systems, ranking of medical colleges and standardising entry requirements at medical schools across the country are under the purview of NMC.

The union government has modified appointment rules which now allow national board-trained doctors to be appointed as faculty in medical colleges to offset the deficit in faculty numbers.[7] Investing in faculty development programmes is essential to empower educators and enhance teaching quality. Offering competitive remuneration packages and career advancement prospects can attract and retain experienced educators, ensuring a stable and competent teaching faculty. Collaborative practice and effective communication are essential for delivering comprehensive patient care. By incorporating interprofessional education, medical schools can prepare students to work as part of a multidisciplinary team, enhancing the quality and coordination of healthcare services.

In conclusion, improving the quality of UME is pivotal for overcoming the bottlenecks that hinder healthcare advancements in Indian settings. By addressing the challenges related to infrastructure, curriculum, faculty development, financing and interprofessional education, we can nurture a generation of competent and compassionate healthcare professionals who can deliver high-quality care to the diverse populations of the region. Governments, educational institutions and stakeholders must collaborate to prioritise these efforts and ensure that healthcare systems are equipped to meet the evolving healthcare needs of the population. Investing in delivering high-quality medical education which is relevant, affordable and community centric would go a long way in creating medical professionals who would be equipped with skills and knowledge to face the evolving challenges in the health landscape of South Asian settings.

Contributors All the authors contributed equally to the conceptualisation, research and drafting of the manuscript. All have reviewed and approved of the final presubmission manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Commissioned; internally peer reviewed.

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Improving the longevity of intravenous cannulas in sick neonates admitted to NICU in a tertiary care centre: a quality improvement project

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To cite: Vadapalli S, Valvi C, Nagpal RS, *et al*. Improving the longevity of intravenous cannulas in sick neonates admitted to NICU in a tertiary care centre: a quality improvement project. *BMJ Open Quality* 2023;**12**:e002372. doi:10.1136/bmjoq-2023-002372

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjoq-2023-002372).

Received 21 April 2023
Accepted 26 October 2023

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ABSTRACT

Background Neonatal intravenous cannulation, especially in preterms, is more challenging than in children or adults. Placement of an intravenous cannula is painful and many cannulas need frequent changing due to complications. Each attempt at cannulation creates an entry for skin flora to cause systemic bacteraemia. This study was undertaken at a level III NICU. The team attempted to prolong the existing cannula longevity to reduce the frequency of intravenous cannulation thereby reducing handling and pain.

Objectives To improve the longevity of peripherally inserted intravenous cannula in sick neonates in NICU from the current 25.7 hours to 36 hours or more, over a span of 6 weeks.

Materials and methods The quality improvement (QI) team comprised resident doctors and staff nurses. A fishbone analysis was used to identify factors that affected the longevity of intravenous cannulas. Five WHYs technique was used to identify the cause behind early cannula removal. Both techniques identified the fixation technique used at the study centre for target intervention. Plan-Do-Study-Act cycles were planned to explore different fixation techniques to improve cannula longevity. The unpaired t-test and the χ^2 tests were applied to analyse statistical significance.

Results We achieved significant improvement in cannula longevity from 25.7 hours to 39.6 hours just by improving the fixation technique over 6 weeks with a p=0.0006.

Conclusions The QI study was successful and is adopted for routine practice. Such initiatives would greatly impact babies in low-resource settings and in transit.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Intravenous cannulation is a cause for pain and a potential risk of sepsis in neonates. More the number of cannulas needed, more the pain, more the risk of sepsis and more the expenditure of consumables and man-hours.

WHAT THIS STUDY ADDS

⇒ This study finds that good mechanical fixation alone can significantly improve cannula longevities. Although mechanical fixation improves longevities of all cannulas, maximum impact is seen on cannulas used for clear-fluid infusions.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The authors propose that improving mechanical fixation of cannulas would have great impact at low-resource facilities, especially in transit and referral.

INTRODUCTION

Neonatal intravenous cannulation, the most basic of procedures in NICU, required by almost all babies at some time during their NICU stay, is different from intravenous cannulation in children or adults. Preterm and low birthweight babies make insertion and maintaining of intravenous cannulas especially difficult. Frequent movement and smaller surface area for anchoring, lead to frequent dislodgement of inserted cannulas. This makes reinsertion unavoidable, necessary but painful procedure for neonates.

Every cannulation comes with pain and increased risk of sepsis.[1] and many cannulas get removed after occurrence of complications, most commonly infiltration.[2] Each attempt at cannulation creates a wound, a door for entry of skin-based bacteria, causing local cellulitis and even systemic bacteraemia[3] and neonatal sepsis—a leading cause of neonatal mortality.[4]

Peripheral intravenous cannulas are simple, inexpensive and convenient for short durations of intravenous therapy, against central lines or peripherally inserted central catheters (PICCs) which maybe left in situ longer. Changing of cannulas remains a problem, particularly in busy public hospitals.

The average life of intravenous cannulas varies across neonatal units. Studies show average longevities of intravenous cannulas between 20 and 40 hours[5] but the longevity of peripheral cannulas at the study centre

was 25.7 hours, far below average longevity documented at other centres.[6] This meant that neonates at the study centre needed changing of their cannulas daily (more frequently) and, therefore, needed more handling and endured greater pain.

Improvement in cannula longevity translates to reduction in handling of neonates, fewer pricks, lesser pain, fewer complications, faster recovery and discharge, reduction in workload for overworked resident doctors and staff nurses, and reducing the hospital's expenses on recannulation. The study centre, therefore, decided to improve its cannula longevity.

AIM STATEMENT

To improve the longevity of peripherally inserted intravenous cannulas in sick neonates admitted to NICU (Neonatal Intensive Care Unit) of this tertiary care unit from the current 25.7 hours to 36 hours or more, over a span of 6 weeks—between first week of January and second week of February 2022.

METHODS

This study was begun at a level III NICU, in western Maharashtra, India, in January 2022. The unit is staffed by resident doctors enrolled in a postgraduate training programme. The unit has a bed strength of 58, and a turnover of 200–250 babies per month, requiring an average insertion of 42 cannulas per day. This study was planned as a quality improvement (QI) project. Patients were not directly involved in designing, conducting, reporting or dissemination of any plans of this research.

A QI team was formed, with the following members and designated roles, as shown in table 1.

The cannula fixation technique in practice at the NICU was as follows:

Butterfly flap fixation

1. All equipment was collected in a sterile tray. After surgical handwashing, sterile gloves were donned by the resident doctor and the assisting staff nurse. The baby was given a sucrose-swab.
2. The chosen site was cleaned with three swabs—a spirit swab, a swab dipped in povidone-iodine and finally a spirit swab, allowing the area to air-dry after each application.
3. Cannula was inserted, keeping the device parallel to skin surface, to prevent a second puncture to the vessel.
4. Confirmation of cannula position was done by slowly flushing the cannula with 0.9% normal saline using a 1cc/2cc syringe. Smooth injection, causing no discolouration, pain or swelling confirmed the cannula being in situ.
5. A transparent sterile dressing was applied over the cannula, covering it from the point of insertion till the wings.
6. A strip of adhesive tape (Micropore) was crossed over the wings of the cannula. Another strip of adhesive tape was used to stabilise the cannula wings onto the skin (figure 1).

Micropore is a paper-based adhesive tape (1 inch wide), with a gentle glue, suitable for neonatal skin. However, the authors noticed that butterfly-flap fixation allowed a lot of movement of cannulas with the movement of the baby as shown in figure 1.

Fishbone analysis and five WHYs technique were used to formulate a list of factors that affected the longevity of intravenous cannulas, as summarised in figure 2.

The team concluded that achievement of better fixation of cannulas was the target of their QI project through PDSA (Plan-Do-Study-Act) cycles. At the end of each PDSA cycle, ideas were either Adapted, Adopted or Abandoned. The QI team had team meetings every week where team members celebrated little victories, analysed failures, troubleshot for problems and brainstormed for newer alternatives.

These cycles and their outcomes are summarised in table 2.

Table 1 The QI team member and their roles

No	Team member	No of members	Role
1.	Resident doctor	1	► Insertion of cannulas ► Documenting the date/time of insertion
2.	Staff nurses	2	► Assisting cannula insertion ► Administration of drugs and injectables ► Monitoring for cannula complications ► Recording time of removal of cannula
3.	Head nurse	1 (team leader)	► Ensuring smooth communication between members ► Planning team meetings
4.	Paediatric faculty of the medical college	1	► Providing technical input ► Ensuring administrative stability ► Ensuring supply of consumables

QI, quality iImprovement.

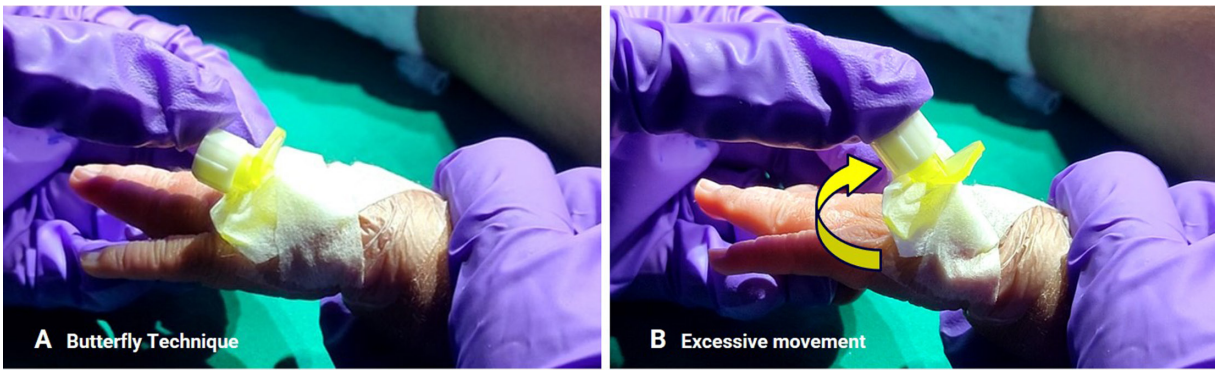

Figure 1 (A) Butterfly-flap fixation and (B) excessive movement of the inserted cannula.

A total of 139 cannulas were charted over 6 weeks (first week of January till second week of February 2022). Twelve inserted cannulas were excluded from analysis—all these cannulas were usable but had to be removed at the time of baby's transfer/death.

At the beginning of the study, the unit had an average life of intravenous cannula at 25.7 hours (recorded by averaging the longevities of 67 cannulas inserted in 20 randomly chosen neonates during the first week of the QI project, first week of January 2022). These 67 cannulas could have been inserted by anyone working in the NICU at that time and not necessarily the resident member of the QI-team—a measure to eliminate bias and to estimate the unit's true average longevity.

Between weeks 2 and 6 of QI, 60 cannulas were inserted only by the resident member of the QI team, to ensure all

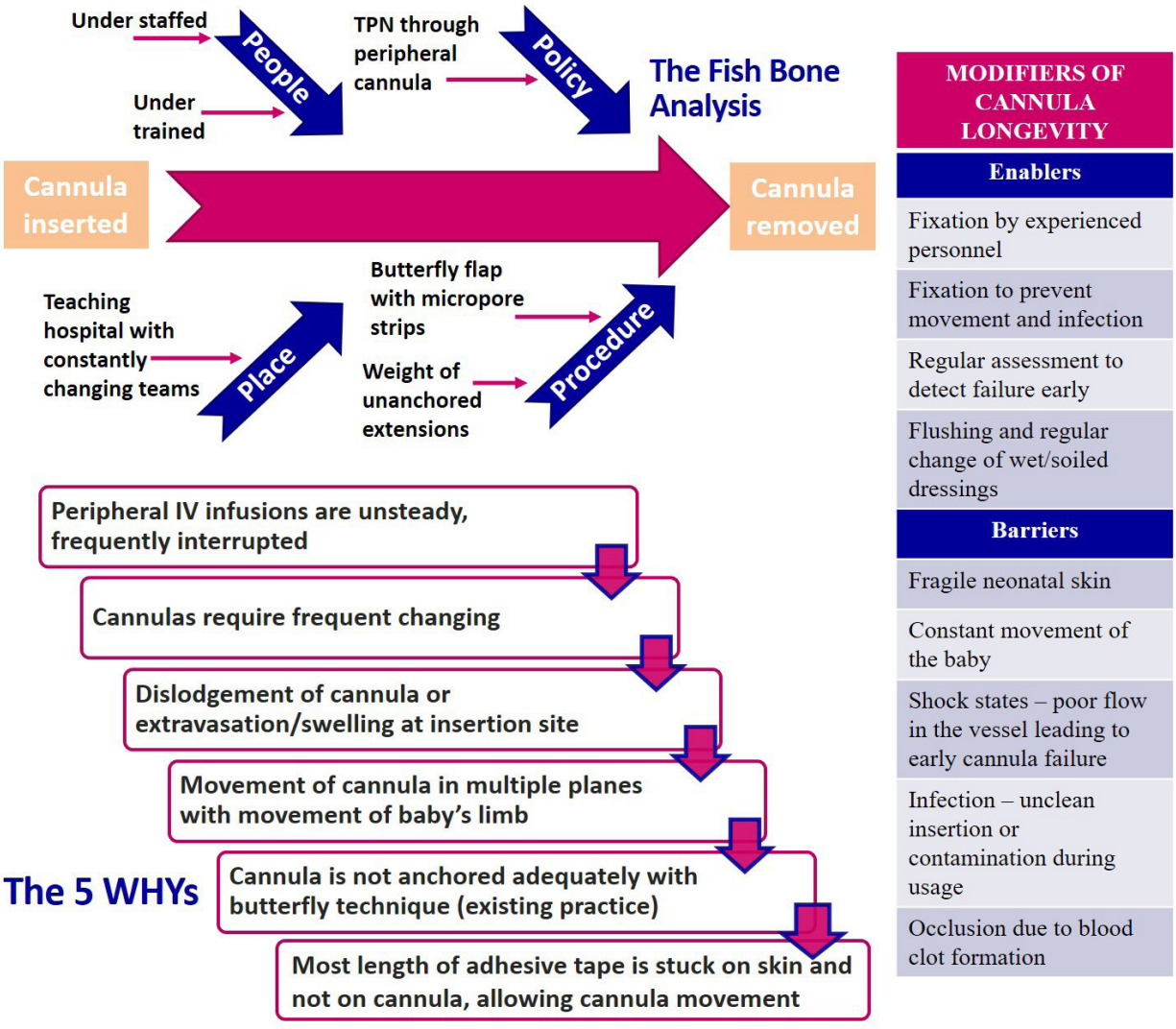

Figure 2 Fishbone analysis, five WHYs and modifiers of cannula longevity. IV, intravenous; TPN, total parenteral nutrition.

Table 2 The PDSA cycles (online supplemental file 1)

Sr. no.	QI week	PDSA idea (Idea with duration)	Study Merits	Limitations	ACT Outcome (discussed in weekly team meeting)
1	First	Baseline			Plan to try broader strips of Micropore on the butterfly flap
2	Second	Broader strips of Micropore on the butterfly flap (4 days)	Better fixation than narrower strips	Hub and wings did not get immobilised together	Idea of broader strips of Micropore on the butterfly flap— Abandoned Plan to try Fixomull to strap the limb with the splint/limb
3	Second	Strips of Fixomull to strap the limb with the splint/limb (3 days)	Better fixation, lesser skin peeling at the time of removal	Hub and wings did not get immobilised together	Idea of using Fixomull to strap the limb with the splint/limb— Abandoned Plan to try Tegaderm flaps on wings and hub
4	Third	Tegaderm (sterile transparent dressing) flaps on wings and hub (3 days)	Completely transparent seal, easier to monitor cannula complications Better anchoring of cannula	Difficult to apply—material folds on itself—lot of wastage of material	Tegaderm flaps on wings and hub proved difficult to be applied, material wastage was a concern—idea Adapted Fixomull was a better choice to be used in overlapping flaps to anchor the cannula wings.
5	Third fourth, fifth, sixth	Fixomull flaps on wings and hub (Tried for 1 week, successful, continued till the end)	Better anchoring of cannula, best by far		Fixomull flaps were a success—idea Adopted—continued for the remaining weeks Fixomull flaps continued for the remaining weeks Plan to add a compulsory 10 cm, three-way extension with the cannula and fixation of the same with the splint/limb
6	Fifth, sixth	Compulsory use of a 10 cm three-way extension with the cannula and fixation of the same with the splint/limb (tried for 1 week, successful, continued till the end)	No movement at the point of insertion due to movement of the infusion lines		End of fifth week Fixomull flaps continued for the remaining weeks Idea of adding a compulsory 10 cm, three-way extension with the cannula and fixation of the same with the splint/limb—Adopted Plan to try fixation without splints

Continued

Table 2 Continued

Sr. no.	QI week	PDSA idea (Idea with duration)	Study Merits	Study Limitations	ACT Outcome (discussed in weekly team meeting)
7	Sixth	Fixation without a splint (Tried for 1 week—unsuccessful Discontinued after 1 week)	More comfortable for the baby, reduction of weight on the limb	More movement of the limb allowed causing more frequent dislodgement of cannula Loss of area on which the 10 cm three-way extension could be anchored	Splints did not significantly change the cannula-longevity but having a splint gave additional surface area to anchor the 10 cm, 3-way extension line and prevented unnecessary application of adhesive tapes to the neonate's delicate skin. Hence omission of splints—Abandoned

PDSA, Plan-Do-Study-Act; QI, quality improvement.

cannulas analysed were inserted according to the decided protocol. All 60 cannulas were used to calculate longevities and for all statistical inferences of PDSA cycles.

The authors had originally planned for the sustenance phase to start immediately after the end of testing the PDSA cycles which however got delayed due to an unforeseen shortage of manpower in the unit. Sustainability was studied between April and October 2022. During this period, effectiveness of 'Fixomull-Fixation' was studied by averaging 30 randomly chosen cannulas every month, one cannula chosen every day for monitoring longevity.

All inserted cannulas were 24G plastic devices of various brands available in government supply. The unit had considered using 26G cannulas but rejected the idea after trying a few numbers due to poor quality of products available in supply.

Patient parameters recorded for each inserted cannula were sex, gestational age, weight at time of cannulation, content infused through cannula—namely total parenteral nutrition (TPN), clear fluids or others (blood products, antibiotics, bolus injections, inotropes), and whether cannula was usable at the time of removal or was removed due to dislodgement/extravasation. Respective cannula hours were calculated for each cannula.

The team finally decided on the following improvised technique for cannula insertion, as shown in figure 3.

Fixomull-Fixation

The first four steps (till figure 3A, figure 3B decribed by point 2 and 3 of decription of the Butterfly Flap Fixation) are identical to the procedure described earlier (figure 1).

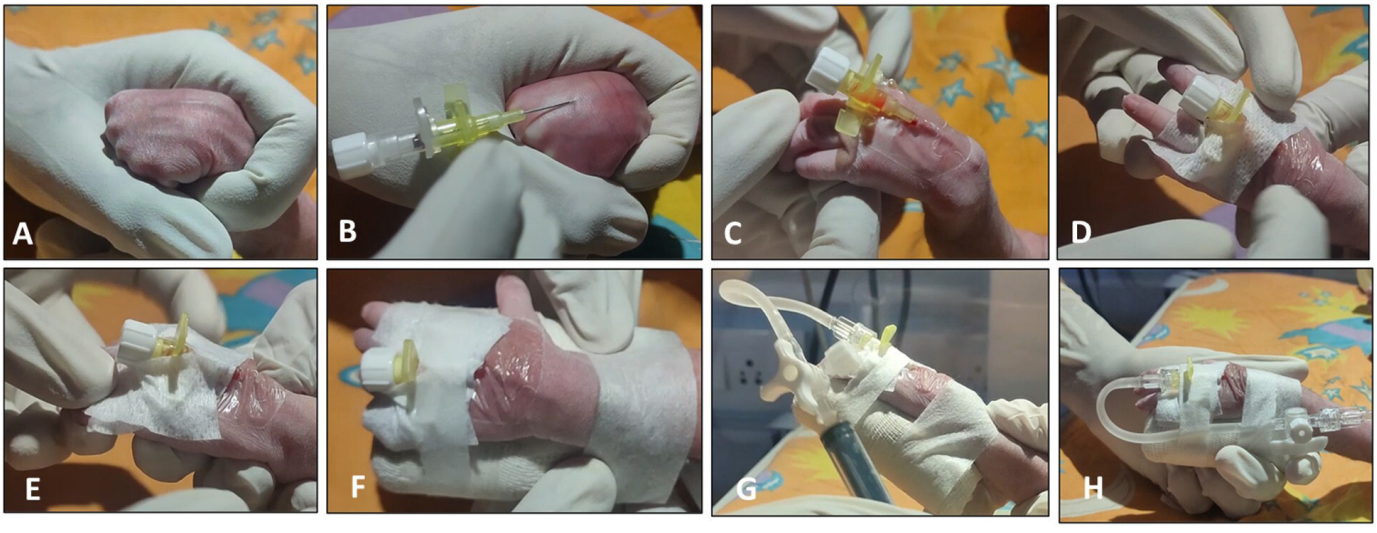

Figure 3 Technique of cannula fixation finally adopted by the unit at the end of PDSAs—called the 'Fixomull-Fixation' in this article and analysis. PDSA, Plan-Do-Study-Act. Parts A&B are corresponding to the 2nd and 3rd point in the description of the butterfly flap technique described previously. The suggested edit is as follows.The first four steps (till figure 3A, figure 3B) are identical to the procedure described for insertion with butterfly flap technique (figure 1).

5. A transparent sterile dressing is applied over the cannula covering it from the point of insertion till the wings (as shown in figure 3C).
6. Two pieces of quadrangular adhesive dressings (Fixomull) of size 3 cm×3 cm, are used to immobilise the wings of the cannula over the skin, overlapping over each other (as shown in figure 3D,E).
7. The point of insertion of the cannula is kept exposed for examination for any signs of extravasation or swelling. Fingertips are left exposed to monitor for any signs of vascular compromise.
8. A compulsory splint is applied to immobilise the joint over which cannula is inserted (as shown in figure 3F).
9. A compulsory 10 cm extension with a three-way stop cock is attached to the cannula and fixed to the splint (as shown in figure 3G,H).
10. An adhesive tape is applied over the extension tubing to prevent disconnection of extension from the cannula hub, and therefore, reduce any movement at the point of entry of the cannula into the lodging vein.

Fixomull is a cloth based woven adhesive dressing available in 10 cm×10 m.

Once the unit finalised the fixation technique, new batches of residents had to be trained for the same. This was accomplished in a compulsory orientation session taken for all newly joined at the NICU, with a video-clip of Fixomull-Fixation. New joiners were rotated with the previous team for a period of 1 week where they learnt fixation under supervision of the previously trained team. The unit continues to train new residents in this manner.

The unit protocol is to administer infusions through a syringe pump, using a 50cc/20cc syringe coupled with a 50 cm/100 cm extension line, attached to the 10 cm extension fixed with the cannula at the time of cannulation. For flushing cannulas, 0.9% normal saline is injected using a 1cc/2cc/5cc syringe. Saline is pushed slowly in a single push. In case of resistance, flushing is withheld and a second opinion is sought from another staff member. If the second opinion is 'difficult-flush', the cannula is replaced. The unit does not have a protocol on using heparin-lock on peripheral cannulas, only on central catheters.

The unit aimed to achieve an improvement in cannula longevity as the primary outcome. A secondary outcome that the unit aspired to achieve was reduction in total number of cannulas used and hence cutting down on number of pricks that a baby would require during NICU stay.

Unpaired t-test was applied to analyse statistical significance of Fixomull-Fixation. Various patient-specific parameters were individually studied to find their association with cannula longevity. A χ^2 test was used to determine how Fixomull-Fixation impacted reasons behind cannula removal.

RESULTS

The QI team achieved an increase in cannula longevity from existing 25.7 hours to 39.6 hours over a period of 6 weeks, that is, 50% increase in 6 weeks—first week of January–second week of February 2022. The maximum monthly average of cannula-longevity was documented at 42.1 hours (July 2022, sustenance phase). The change in fixation brought about an absolute increase in cannula longevity in all cannulas irrespective of baby's birthweight or gestational age or contents being infused through the cannula.

The authors attribute this result, to improved mechanical fixation of cannulas, which was statistically significant (p=0.0006 at 95% CI of −20.772 to −5.028).

The statistically significant categories of intravenous cannulas are discussed below. Figure 4 gives a graphical representation of the same.

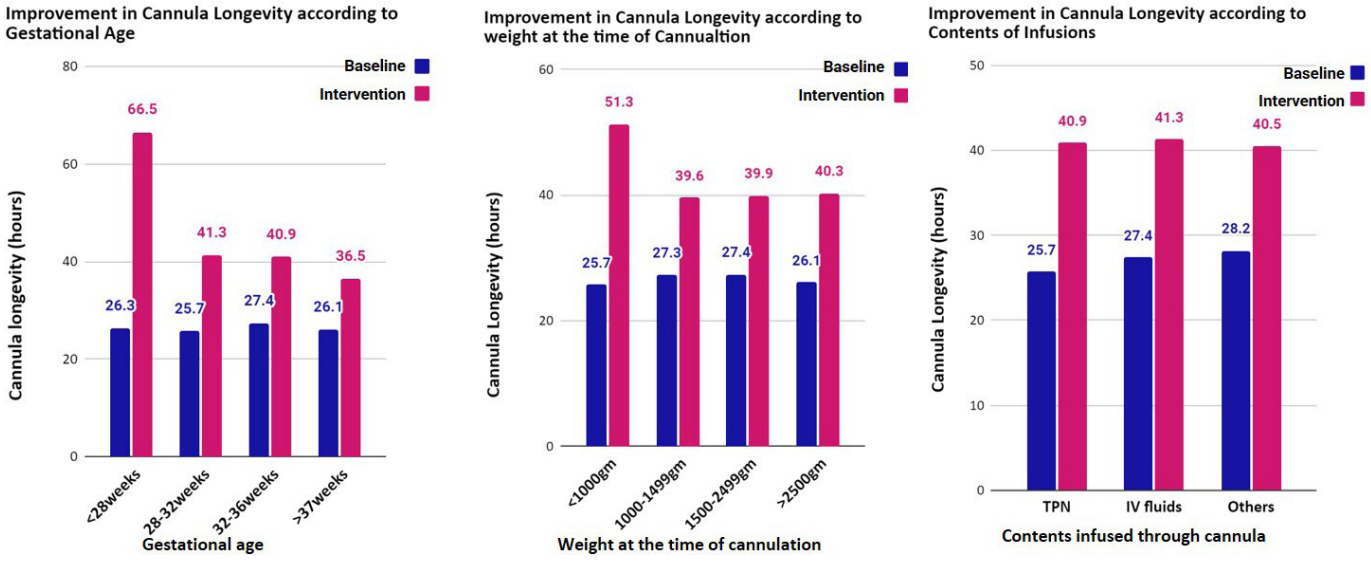

Figure 4 Improvement in cannula longevity. IV, intravenous; TPN, total parenteral nutrition.

- Maximum impact of Fixomull-Fixation was appreciated in cannulas used for infusing clear intravenous fluids. Longevity of these cannulas increased from 27.4 hours to 41.5 hours (p=0.0292 at 95% CI −26.239 to −1.561).
- In babies of birthweight < 1000 g, cannula longevity increased from 25.7 hours to 51.3 hours (p=0.0039 at 95% CI −42.399 to −8.801).
- In babies of gestational age < 28 weeks, cannula longevity increased from 26.6 hours to 66.5 hours (p=0.0101 at 95% CI −69.770 to −10.630).
- In babies of gestational-age 28–32 weeks, cannula longevity increased from 25.7 hours to 41.4 hours (p=0.0128 at 95% CI −27.774 to −3.426).

The most common reason behind removal of cannulas remained extravasation (76%). Other causes of removal were blockage (11%), leakage (4%) and end of cannula requirement (9%).

The patient demographics and impact of Fixomull-Fixation on cannula longevity are summarised in table 3. Its sustainability and trends of average cannula longevity over months following the QI study were as shown in figure 5.

Where, baseline longevities are average cannula longevities in first week of January 2022 and postintervention longevities are those documented at the end of week sixth week of the QI project. 'Intervention' is 'Fixomull-Fixation' defined earlier.

The unit achieved a near 50% increase in cannula longevities which translated to approximately 33% reduction in the number of cannulas required in the NICU. This translates to a 33% reduction in the number of pricks, and therefore, pain that a baby is subjected to during NICU stay. Also, longevities of all cannulas improved, irrespective of the contents infused through them.

Table 3 Demographics, number of cannulas (Num), average cannula longevities (ACL) and impact of intervention

		Baseline	With accepted intervention	Impact of Fixomull-Fixation (p value)	95% CIs (%increase)
Total patients		21	31		
Total cannulas	Num	67	60		
	ACL	25.7	39.6	**0.0006***	**−20.772 to −5.028***
<1000 g	Num	27 (40%)	7 (12%)	**0.0039***	**−42.399 to −8.801***
	ACL	25.7	51.3		
1000–1499 g	Num	19 (28%)	26 (43%)	0.1936	−30.968 to 6.368
	ACL	27.3	39.6		
1500–2499 g	Num	16 (24%)	23 (38%)	0.1921	−31.565 to 6.565
	ACL	27.4	39.9		
>2500 g	Num	5 (8%)	4 (7%)	0.3052	−44.497 to 16.097
	ACL	26.1	40.3		
<28 weeks	Num	21 (31%)	2 (3%)	0.0101	−69.770 to −10.630
	ACL	26.3	66.5		
28–32 weeks	Num	26 (39%)	33 (55%)	**0.0128***	**−27.774 to −3.426***
	ACL	25.7	41.3		
32–36 weeks	Num	13 (19%)	17 (29%)	0.1448	−32.880 to 5.880
	ACL	27.4	40.9		
>37 weeks	Num	7 (11%)	8 (13%)	0.2765	−29.977 to 9.177
	ACL	26.1	36.5		
TPN	Num	38 (58%)	8 (13%)	0.0699	−34.694 to 4.294
	ACL	25.7	40.9		
Itravenous fluids	Num	25 (36%)	38 (64%)	**0.0292***	**−26.239 to −1.561***
	ACL	27.4	41.3		
Others	Num	4 (6%)	14 (23%)	0.503	−50.057 to 25.457
	ACL	28.2	40.5		
Males	Num	36 (54%)	38 (64%)	**0.0009***	**−28.705 to −6.695**
Females	Num	31 (46%)	22 (36%)	**0.0455***	**−25.887 to −0.713**

*p value <0.05 at 95% confidence interval, implying statistical significance of the fixomull-fixation as an intervention
TPN, total parenteral nutrition.

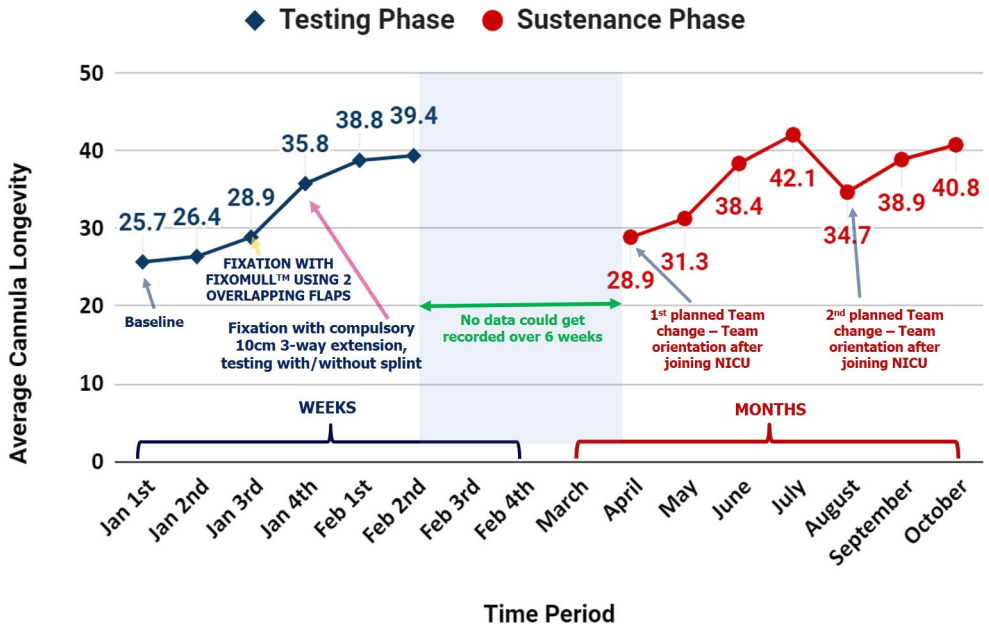

Figure 5 Trends of cannula longevity during the QI testing and sustenance phase. QI, quality iImprovement. NICU, Neonatal Intensive Care Unit.

DISCUSSION

This study has been undertaken and reported and according to the SQUIRE 2.0 (Standards of QUality Improvement Reporting Excellence 2.0) guidelines[7].

Mean longevities of cannulas used for various fluids (clear fluids, TPN, inotropes, blood products, antibiotics, etc), inserted in neonates of various gestational ages and birthweights improved individually, but not all of them were significant improvements.

The most common reason for removal of cannulas in the unit remained extravasation injury. This is a non-modifiable factor in any NICU with babies having fragile skin, thin and easily distensible subdermal tissues and thin walled, delicate blood vessels as demonstrated by Odom *et al*.[8] Cannulas used for clear intravenous fluids were found to have benefited the most from mechanical fixation when compared with cannulas used for TPN and other injectables. This was because clear infusions were least irritant to the neonatal blood vessels.

Cannulas used for TPN showed local inflammation and extravasation because of the high osmolarity of the infused fluid and many had to be removed though they hadn't been dislodged. This finding is also consistent with a study by Fessler and Rejrat,[9] which described the complication of venous lines with high osmolar solutions like TPN getting infused in neonatal ICUs. Administration of blood products, injectables such as antibiotics and electrolyte corrections given as short boluses left cannulas unused for long stretches of their indwelling time. This led to cannula blockage and flushing the cannula regularly with saline could not be adequately practiced in the unit. Usefulness of intermittent flushing in maintaining the patency of intravenous cannula as demonstrated by Uma *et al*[10] and a standard practice in many units, could not get consistently practised at the study centre.

The most significant impact of the Fixomull-Fixation came to be seen on cannulas infusing clear fluids. Statistically significant p values could be documented only for clear-fluid cannulas, because the number of cannulas in the baseline and during PDSAs was comparable for cannulas used for clear fluids only. However, baseline longevities of all cannulas and the absolute increase in average cannula longevities were, respectively, comparable for all cannulas included in the study. Therefore, this QI study infers that improving mechanical fixation of cannulas had a key role improving the longevities of intravenous cannulas, whatever be the choice of infusion.

Dalal *et al* demonstrated that splints have no effect on longevity of cannulas.[11] However, splinting cannulas remained a constant practice in this study. An advantage of using splints that the QI team found was that splints provided an additional surface for anchoring the 10 cm three-way extension, thereby reducing the direct strapping to the baby's limb, and therefore, making the assembly relatively more comfortable for the neonate.

The impact of mechanical stabilisation was best appreciated in neonates of 28–32 weeks gestation (with p=0.01) and less than 1000 g birthweight (with p=0.003). In babies <28 weeks of gestation, cannula longevities increased from 26.3 hours to 66.5 hours (2.5×increased longevity). These tiny infants are relatively less active than neonates of higher weights and greater gestational maturity. The authors infer from the study that anchoring cannulas firmly to the baby reduced movement of cannulas at the point of insertion and hence improved cannula longevities tremendously.

Sex of neonates had no impact on longevity of cannulas—Fixomull-Fixation was equally effective in male and female babies (with p=0.0009 and p=0.04, respectively).

An increase in cannula longevity from 25.7 hours to 39.6 hours translates approximately to one cannula a day to 2 cannulas in 3 days. This is a 33% reduction in the number of pricks that a baby must endure during the NICU stay. Documenting an improvement in pain outcomes or reduced duration of NICU stay due to lesser trauma/local site infection was beyond the scope of this QI study but is certainly an area of interest for the team.

At the time when the QI was in progress, the unit had been facing a shortage of manpower and was forced to reduce use of PICC lines due to a lack of personnel trained in inserting them. This led to an increased dependency on peripheral cannulas. Hence, the authors believe that the highest motivation to work on improving cannula-longevities came from a need becoming a necessity.

Planning and improvising fixation techniques was achieved in 6 weeks after which the unit laid down a written protocol for inserting and fixing intravenous cannulas. The entire staff was trained to insert and anchor cannulas according Fixomull Fixation method. Improvement in average longevity of intravenous cannulas was sustained over the coming months.

The only deterioration in cannula longevities was noted at the time of rotation of resident doctors in the NICU when trained teams were replaced by teams needing orientation. The QI team decided that future teams be oriented to Fixomull-Fixation a little ahead of their tenure in NICU since these rotations at the teaching institute are planned in advance.

Strengths

Fixomull-fixation is easy to replicate and sustain even in the face of changing teams which is inevitable in teaching hospitals. It led to near 50% increase in cannula longevity, therefore, substantially reducing the average number of cannula insertions required per day, bringing down the numbers of cannulas that the hospital procured.

The unit found Fixomull Fixation to be sustainable. The unit did not require any additional funding to carry out the QI or the sustenance phase. In fact, the unit reported an approximate reduction of 33% in the requirement of cannulas, compared with numbers required prior to the QI initiative. Although the unit did not undertake a formal cost analysis of the QI and sustenance periods, there is indirect evidence of the adopted practice being cost-effective.

Limitations

The unit noticed that administering TPN through peripheral cannulas led to a significantly greater number of extravasation injuries to the neonates. However, PICCs could not always be planned for all candidate babies, due to financial constraints and unavailability of personnel trained in inserting PICCs. The unit planned for its babies to be shifted to enteral nutrition more aggressively, in order to come down on the requirement of TPN and PICCs. Therefore, cannulas through which TPN was administered could not be compared reliably between cannulas having butterfly-flap fixation and Fixomull-Fixation

Once the unit is adequately trained in inserting PICCs, the authors would like to explore the possibility of achieving an even higher average longevity of intravenous cannulas, and reach a 60-hour or the ideal 72-hour target.[12] Further, the authors would also like to study any improvement in the numbers of grade 3/4 extravasations with Fixomull-Fixation, which was beyond the scope of this study.

CONCLUSIONS

Fixomull-Fixation was found to be more technically sound, with a simple learning curve and proved to be a sustainable practice. Better mechanical fixation of intravenous cannulas improved cannula longevity from 25.7 hours to 39.6 hours making the QI project a success. The unit achieved a near 50% increase in cannula longevities and a near 33% reduction in the total number of cannulations needed.

The study inferred that improvement in mechanical fixation did not prevent cannula complications arising due to the nature of fluid infused through cannulas or due to disuse of cannulas for a long time. Thus, mechanical fixation is an independent factor, modifying longevity of cannulas.

The authors also propose that improving mechanical fixation is likely to have a profound impact on peripheral centres and low-resource settings and particularly during transit in a referral chain, especially in India where there is a perpetual shortage of manpower trained to handle newborns in remotely located health facilities.

Contributors SV: Patient care, design of the PDSAs, analysis of data and documenting of results. CV: Critical review of the results and editing of the primary manuscript. RN: Patient care and overall monitoring of patient outcome in the NICU. RD: Patient care in NICU, critical review of the procedures undertaken and ensuring supply of comsumables in the NICU. AK: Guidance and critical review of final manuscript. There are no external contributors to this article besides the authors.

Funding Publication of this article is made Open Access with funding from the Nationwide Quality of Care Network Special Issue Name: South Asia Edition.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Consent obtained from parent(s)/guardian(s).

Ethics approval This study involves human participants and was approved by intavenous cannula insertion is a fundamental procedure in NICUs. The Initiative to improve the cannula longevity was undertaken as an organic process in the day-to-day fiontioning of the NICU with the materials already available in the unit and with the processes that the unit members were already familair with. It was only after the success of the initiaive and its adoption into everyday routine that the unit realised the further reaching impact of the intervention. Therfore, ther institutuinal ethics committe was not involved into the quality improvment initiative during planning or execution. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been

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BMJ Open Quality

E-IMNCI: a novel clinical diagnostic support system approach to strengthen effectiveness and quality of IMNCI implementation in India

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To cite: Alwadhi V, Bajpayee D, Kumar N, *et al*. E-IMNCI: a novel clinical diagnostic support system approach to strengthen effectiveness and quality of IMNCI implementation in India. *BMJ Open Quality* 2023;**12**:e001857. doi:10.1136/bmjoq-2022-001857

Received 14 February 2022
Accepted 25 April 2023

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ABSTRACT

Integrated management of childhood illness is a globally proven primary care strategy to improve child survival and is being implemented worldwide in countries with high burden of child mortality. Its implementation as Integrated Management of Newborn and Childhood Illness (IMNCI) in India has been challenging.

The primary objective of the present work was to assess the feasibility, acceptability and use of an adapted Integrated E Diagnostic Approach (IeDA) that provides e-Learning and improved clinical practices of the primary level health service provider auxiliary nurse midwives (ANMs) to deliver IMNCI services. This India-specific approach was contextualised to the Indian IMNCI programme based on 7 years of IeDA implementation learning from West Africa.

The Integrated Management of Neonatal and Childhood Illness pilot was implemented across 80 front-line workers, 70 ANMs and 10 medical officers) in 55 facilities of 3 blocks of Ranchi district, Jharkhand. This report evaluated the feasibility of its use by ANMs only. Based on the results, it can be concluded that it is possible to implement the newly developed application. A total of 2500 cases were managed by ANMs using the application till May 2020. All ANMs used it to provide treatment to the children. 63% of ANMs used it to provide medications, 83% for counselling and 71% for follow-up as per the recommendations. The app is highly acceptable to ANMs for use as a clinical case management tool for childhood illness. There were some improvements in case management in both the age group (0–59 days and 2–12 months) of children. 78% of caregivers responded with their desire to revisit the health facility in future, highlighting the contribution of an e-tool in improving the perception of the caregiver.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Integrated Management of Newborn and Childhood Illness (IMNCI) is a cost-effective and efficient strategy to improve child survival and is tried and tested across various parts of the globe. Terre des hommes initiated Integrated E Diagnostic Approach (IeDA) in West Africa (Burkina Faso) in 2014 through an android based digital job aid, with the goal of reducing child mortality by enabling a better quality of health services through mobile health tools, quality improvement processes and a data management strategy. IeDA helps the primary healthcare workers improve their level of adherence to the Integrated Management of Childhood Illness clinical guideline. E-platforms have been advocated by WHO based on the country's assessments for accelerating IMNCI implementation.

WHAT THIS STUDY ADDS

⇒ This is the first study from India on use of e-platform for improving the quality of IMNCI implementation. The study demonstrates the major strength of Integrated Management of Neonatal and Childhood Illness (E-IMNCI) in making use of evidence-based clinical management decisions to reduce preventable deaths due to childhood illness. Also, the capacity building of front-line workers focused on communication, counselling, management and tracking of illness will increase the effectiveness of care and simultaneously reduce cost.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The E-IMNCI tool using the country-based approach can be used for capacity building and improvement in quality-of-service delivery. This approach gives the human face to the digital application, thus is more conducive to sustainability and taking to scale. The real time data submission and analysis could be used for policy decision-making and programme purpose.

INTRODUCTION

Integrated management of childhood illness (IMCI) is a globally proven, primary care strategy to improve child survival and is being implemented worldwide in countries with a high burden of child mortality.[1 2] India adopted and implemented IMCI, which addresses a child's overall health with interventions in homes, communities and facilities for children under 5.[3] With the adaptation of the change in name

from IMCI to Integrated Management of Neonatal and Childhood Illness (IMNCI), the duration of training was reduced from 11 days to 8 days, and 50% of the period of training (4 days) was dedicated to newborns. IMNCI formed the central strategy of the Reproductive Child Health (RCH) II programme. By June 2010, it had been implemented in 223 of India's 640 districts, and more than 200 000 workers had been trained.[4] IMNCI strategy includes capacity building of health workers, health system strengthening and improving community and family practices, all of which need to be implemented in a coordinated manner.[5 6] After 2010, there are no other implementation reports available from the country.

A rapid assessment of IMNCI undertaken in 12 districts of 7 states showed that home visits under IMNCI reached only 64% of births and the newborns who remained unreached were likely to be the ones who were the most vulnerable.[7] Skills of assessing and classifying illnesses based on guidelines were conflicting in different studies conducted in Haryana, Gujarat, West Bengal and Maharashtra. The implementation of IMNCI for community centred case management is constrained in the country with a poor capacity of workers, long duration of the training, the inadequacy of trainers/supervisors and absence of refresher training in addition to financial and human resources constraints.[8–12]

With the recent advances and expansion of access to new technologies, the use of Electronic Clinical Decision Algorithm in low-income countries has become feasible and holds the potential to overcome these challenges and improve the management of childhood illnesses.[13]

In a pilot study conducted in Tanzania, the use of an electronic version of IMCI (E-IMCI) on Personal Digital Assistants has shown to increase adherence to IMCI guidelines, reduce errors and improve the quality of care in the same consultation time as routine practice.[14] In another study, mobile technologies have improved communication with the caretaker and also improved impact of counselling.[15]

An evaluation of the large-scale implementation of the electronic Integrated E Diagnostic Approach (IeDA) at the primary care level also concluded that the use of e-tool was widely accepted and perceived as a powerful tool guiding daily practice.[13]

The primary objective of the present work was to develop and assess the feasibility and acceptability of Integrated Management of Neonatal and Childhood Illness (E-IMNCI) application, compliance with case management algorithms, data management and experiences of the community. The work was carried out under the leadership of the Government of Jharkhand with Terre des hommes and IPE Global's collaboration.

SOLUTION

E-IMNCI was developed as an adapted approach of IeDA, integrating capacity building that provides e-Learning and improved clinical practices for the primary level health service providers (ANMs and MOs). The E-IMNCI auxiliary nurse midwife application was installed in the tablets provided to the ANMs by the Jharkhand state government as a part of the existing health programme. The application of MO is also an android-based application. Two solutions were developed, but this study shares the findings from the tablet-based solution used with ANMs, as the number of medical officers (MOs) were small.

The application was developed according to the digital development principles and went through approval of its protocol by the State NHM—Child Health Technical Division to ensure complete alignment with the national IMNCI case management algorithms.

METHODS

The E-IMNCI pilot was implemented across 80 frontline workers, 70 ANMs and 10 MOs in 55 facilities in 3 blocks (Ratu, Angara and Namkum) of Ranchi district in Jharkhand.

A short IMNCI training (4 days) was imparted to 60 ANMs and 5 MOs from 52 facilities. The training also included hands-on skills building for using the application. The rest of the health workers were not able to be trained due to their deputation during the pandemic, however, they were followed up later.

A baseline assessment using a mixed-method approach with both quantitative and qualitative data was undertaken with 40 ANMs in October 2020. The baseline assessment included structured interviews and focused group discussions with 40 ANMs and 40 mothers/caregivers of under 5 children. ANMs were assessed for their knowledge and perceptions about IMNCI guidelines. The assessment also included observation of the ANMs handling real cases and simulated ones. IMNCI trained Health workers from 26 facilities were contacted, whereas availability of medicine and equipment were mapped from all the facilities during the baseline. The assessors included IMNCI trained supervisors proficient in using the e-tool.

An 'E-IMNCI' application was developed and provided to ANMs and MOs in January 2021. The 'E-IMNCI" application has learning resources such as chart books and video clips, decision-making tools for on-the-job assistance and patient records. E-IMNCI application also has a logistic management tool that allows ANMs to check stock availability and alerts when it falls below a critical level. The decision support tool was customised to the country's IMNCI guidelines. It helps in the registration, assessment, classification, identification of treatment, follow-up and referral of patients with two separate protocols, one for ANMs and one for MOs, with features to measure individual performance. The application automatically creates and maintains a patient file for each child managed at the health centre, including the history of all consultations made and treatments prescribed. The data collection mechanism has a simplified user interface and intuitive application workflow, and a system for generating reports for supervisors and decision-makers. The

data generated were collected on a CommCare platform and made available to decision-makers in the form of customised dashboards and can be linked to any existing data collection portal of the country.

A postimplementation assessment was conducted in 38 facilities after 4 months in May 2021 using a similar approach to the baseline. In this assessment, 52 ANMs and 51 caregivers participated and included 49 case observations to record any changes in knowledge and practices. The assessors ensured that no child leaves the facility without correct case management. Qualitative in-depth interviews were conducted with government health officials, postimplementation only. These interviews with key officials helped to understand the responsiveness of the initiative to system strengthening, suggestions and ways to scale up. Quality and accuracy were ensured by recording the interviews between the assessor and a few randomly identified respondents using a computer-assisted personal interviews device. Quality control telephonic checks were performed with 15% of interviewed respondents. SPSS 25.0 was used for data analysis for the quantitative surveys. In addition, for two segments, that is, health workers and caregivers, a t-test (one tailed) was carried out to understand whether the result of the postimplementation was significantly different than the baseline. For the observation of case management by the health workers, Mann-Whitney non-parametric test was conducted to check the significance of baseline and postimplementation due to the relatively small sample size.

Patient and public involvement

A total of 2500 cases were managed by ANMs using the application till May 2022 and the application is still in use. Mothers of children managed were interviewed both at baseline and after 4 months to assess their perception on the quality of services. Qualitative interviews with mothers/care givers helped to understand the experiences and level of satisfaction of mothers and care givers of under 5 children.

RESULTS

Participant characteristics

All the ANMs were posted in health facilities, 95% at health subcentres and the remainder at primary health centres. They were 20–59 years in age, with 80% in the 31–50 years age group. All the ANMs had undergone professional ANM courses with 75% having work experience of 10–15 years and 15% of ANMs with more than 30 years' experience. They all had the state provided tablets but had not used them. All of them were comfortable using smartphones and were using their phones to enter data for family planning programmes.

The E-IMNCI application was well accepted, and all the ANMs (100%) used it to provide treatment to the children. The application was also utilised by ANMs to provide medications, counselling and follow-up as per the recommendation (63%, 83% and 71%, respectively). However, only 10% suggested referrals recommended by the app (figure 1).

Knowledge and case management practices

Knowledge of ANMs on identifying clinical signs and symptoms improved. Seventy-five per cent ANMs correctly identified the order of E-IMNCI clinical case management, and 70% and 90% ANMs could recall assessment steps correctly for the infant and child in IMNCI case management (baseline vs postimplementation). 87.5% of all respondents (ANMs and MOs) agreed to the essentiality of referring to the IMNCI protocol postimplementation against 32% at baseline. At postimplementation, 100% ANMs checked records of the previous visit and counselled patients for a follow-up visit.

The postimplementation assessment showed that the assessment of signs such as feeding difficulty, convulsions, counting respiratory rate, umbilical sepsis, axillary temperature recording, signs of dehydration improved in the age group of 0–59 days. Skills for assessing chest indrawing and thrush needed further strengthening. Assessment steps for checking breastfeeding attachment, correct suckling and oral thrush showed a decline. These results are shown in table 1.

There was marked improvement in assessing general danger signs in the age group of 2–12 months. However, only 26% of ANMs assessed at least three danger signs for the age group 2 months to 5 years. The use of pulse oximeter (83%), assessing signs of dehydration (100%),

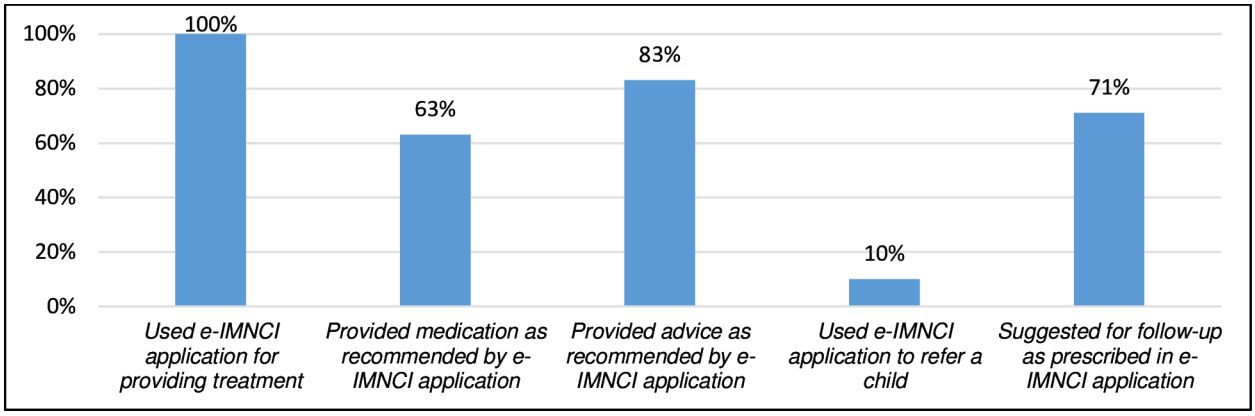

Figure 1 Usage of E-IMNCI app for case management. E-IMNCI, Integrated Management of Neonatal and Childhood Illness.

Table 1 Assessment of young infant (children aged less than 2 months) by ANMs

Assessment among children aged less than 2 months by ANMs					
	Baseline (N=11)		Postimplementation (N=6)		P value (one tailed t-test)
Particulars	n	%	N	%	
Asked about infant have any difficulty in feeding	7	63.6	6	100	0.051
Asked for convulsions	0	0	6	100	
Checked for severe chest indrawing	2	18.2	1	17	0.676
Respiratory Rate counting for 1 min	2	18.2	6	100	0.000
Checked for umbilicus red or draining pus	1	9.1	6	100	0.000
Checked for axillary temperature	0	0	3	50	
Checked for skin pustules	1	9.1	6	100	0.000
Asked about presence of diarrhoea	4	36.4	6	100	0.004
Asked if the infant is breastfed	9	81.8	6	100	0.147
Asked, if the infant usually receive any other foods or drinks	1	9.1	0	0	
Determined weight of infant	1	9.1	6	100	0.000
Checked for infant's attachment during breast feeding	3	27.3	0	0	
Checked for infant's suckling effectively	3	27.3	0	0	
Looked for oral thrush	3	27.3	0	0	
Checked for did mother have any pain while feeding	1	9.1	0	0	
	N=4		N=6		
Checked for infant movement	0	0	6	100	
Checked for sunken eyes	0	0	6	100	
Skin pinch test conducted	0	0	6	100	

ANMs, auxiliary nurse midwives.

assessment for the presence of stiff neck (59%) in cases with fever in the age group 2 months to 5 years have also improved. These results are shown in table 2.

The postimplementation assessment showed that using E-IMNCI application logistic management tool by the ANM's led to improvement in availability of the essential medicines and equipment required for delivering good quality care, at all the health facilities (table 3).

Experience of healthcare workers (ANMs) and caregivers

ANMs interviewed at postimplementation were very satisfied with the content, curriculum, method and duration of the E-IMNCI training. The ANMs mentioned various small videos and photos embedded in the app to be informative and easy to follow. 89.6% of them rated the interactive learning sessions as very good.

Regular submission of data on the application was seen, with 91% of the ANMs reporting the application based IMNCI format easier than the paper based. The average time to fill in an online application was 12 min during the end line assessment against the 24 min it took to fill when using paper-based formats during the baseline.

Ninety-one per cent of ANMs found the application-based case management format easier than the paper-based one. Fifty-eight per cent of ANMs reported that the use of the app had resolved the challenges they used to face like difficulty in understanding the IMNCI protocol, remembering the clinical steps, etc. One hundred per cent of the trained healthcare workers (HCW) could register a case using the E-IMNCI application and knew how to enter the vital signs and symptom of ailment as well as decide on the course of treatment using the application. Ninety-six per cent of HCWs knew how to navigate the application (moving back and forth, changing language, etc) and believed the IMNCI process had been made very interactive with the caregivers of the patient and user friendly with the help of E-IMNCI (figure 2).

There was a substantial improvement in the satisfaction level of mothers on staff behaviour and receiving medication (45% against 15% during the baseline). Seventy-eight per cent of caregivers responded with their desire to visit the health facility again in the future highlighting the contribution of application in improving the perception of caregivers.

Table 2 Assessment of children (aged 2–59 months) by ANMs

Assessment among children aged 2 months to 5 years by ANMs					
General danger signs	Baseline (N=26)	%	Postimplementation (N=43)	%	P value one tailed
Asked the mothers whether the child can drink or breastfeed	0	0	33	77	
Asked the mother whether the child vomited everything	0	0	22	51	
Ask: Has the child had convulsions	0	0	17	40	
Assessment of child with cough/difficulty breathing	N=15		N=18		
Asked the mother whether the child has 'cough' or difficulty breathing	15	57.7	18	42	0.896
Asked the duration of cough	1	4	11	61	0.001
Correct assessment of respiratory rate	10	66	18	100	0.065
Correct assessment of the chest indrawing done	8	30.8	16	89	0.417
Checked SPO2 (Oxygen Saturation)	0	0	15	83	
Assessment of sick child	Baseline (N=26)		Post-Implementation (N=43)		
	n	%	n	%	
Asked if the child has diarrhoea	9	34.6	21	49	0.255
Asked about history of fever in child	9	34.6	32	74	0.000
Looked for visible severe wasting	7	26.9	0	0	
Check for oedema on both feet	1	3.9	12	28	0.006
Check for the child's immunisation status	18	69.2	34	79	0.183
Check for palmar pallor	0	0	22	51	
Assessment of the child with diarrhoea	N=9		N=21		
Asked diarrhoea duration	0	0	12	57	
Looked for sunken eyes	0	0	21	100	
Assessed skin turgor	0	0	21	100	
Checked (lethargic or unconscious restless or irritable)	0	0	13	62	
Assessment of child with a history of fever	N=9		N=32		
Assessed the child's fever even if the child does not have a temperature of 37.5°C or above or does not feel hot now	1	11.1	29	91	0.000
Asking fever 'for how long'	0	0	26	90	
Checked for stiff neck	0	0	19	59	
If fever is present for more than 7 days—correctly asked	–	–	23	88	
Assessment of child's nutrition status	N=17		N=42		
Taken mid-upper arm circumference (MUAC) for children above 6 months	0	0	26	62	

ANMs, auxiliary nurse midwives.

DISCUSSION: WHAT DOES IT MEAN?

The acceptability of the tool and its usage in case management could be experienced in this study. The feedback from ANM reveals that the application-based IMNCI is very acceptable among ANM in India. The results show that the application interface is improving the adherence of ANM to IMNCI protocol, by providing them stepwise guidance. While 2500 cases have been managed till May 2022, further learnings will be derived later in the implementation with a subsequent assessment.

The training included steps of management using the features of the application. The method does not allow us to know the impact of training and intervention separately. The number of cases observed was limited at the facility, due to low footfall at the facility during the pandemic and the survey was conducted during the COVID-19 pandemic. In India, front-line health workers (FLWs), serve as an essential link to the public health system by bringing services to people's doorsteps. ANM is a primary healthcare provider to a local population

Table 3 Impact on availability of medicine and equipment at facilities

	Baseline (%) (N=52)	Postimplementation (%) (N=38)
Amoxicillin (tab/ injection/syrup)	50	82.7
Gentamicin (injection)	21.2	65.4
Cotrimoxazole (syrup/ tab)	50	71.2
ORS solutions	57.7	80.8
Zinc sulfate (tab)	34.6	46.2
Vitamin A syrup (bottle)	57.7	94.2
IFA syrup	53.8	90.4
Stadiometer	40	96.2
Weighing scale (salter)	97.5	98.2
Thermometer (digital)	97.5	92.3
Pulse oximeter (finger)	0	92.3

and the first point of 'medical' contact for beneficiaries covering a population of around 3000–5000 (~1000 households). ANMs at subcentres are the closest service provider to the community, within the health system and are pivotal in delivering IMNCI. Having competent peripheral health workers becomes critical[16] Despite the evidence-based guidelines, compliance varies at the point of care and adherence to IMNCI protocol remains a challenge. The use of IMNCI is seen to be limited by the extent of training, the insufficient supervision, the time it takes to follow the IMNCI chart booklet and the tendency to adhere to the protocol less rigorously over time.[17]

Effective implementation of IMNCI leads to improved prescribing patterns with reduced errors in correct case classification and prescriptions. However, there is heavy reliance on human memory and knowledge of the FLWs without significant real-time job aids and technology tools. Even though IMNCI trained health workers are supposed to consult the chart booklet and not depend on memory, this practice was not seen as prevalent in this study. It is known that decision-support systems can help comply with specific standardised recommendations at the point of care.[18 19] This work shows 'E-IMNCI' tool supports the HCWs in following the algorithm of Assess, Classify, Identify, Treatment and Follow-up according to IMNCI protocol, with an automatic dosage recommendation, based on the symptoms to reduce classification and prescription errors. However, there are still challenges to effective implementation of the strategy, and factors like the long duration of IMCI training, poor supervision and lack of follow-up after training, all affect the performance of HCWs.[20–22]

There is evidence that the IMCI package if used digitally, results in better service delivery and robust real-time reporting. Implementation of E-IMCI in low-income countries has shown that HCWs accept the electronic version enthusiastically and there is an improved adherence to the IMCI protocols. This work further strengthens the earlier work done in Tanzania,[23] following the use of the E-IMCI app there was improved efficiency and adherence to the IMCI steps since the app allows and navigates through the IMCI chart and does not rely on the HCW to determine the next step. The clinical case management and counselling skills of ANMs improved using the E-IMNCI application for some but not all domains. There were improvements in the assessment of some signs like counting respiratory rate and not others such as chest indrawing, looking for visible severe wasting and breastfeeding assessment. It is likely that some assessments are more difficult for health workers and need more handholding for building capacity. While many signs are based on observation, signs such as counting respiratory rate were supported through the electronic breath counter in the application leading to improvement. Similarly, Oxygen Saturation (SPO2) measurements improved as pulse oximeters were supplied by the project based on discussions with the authorities. The ANMs also found various small videos and photos of convulsions, and diarrhoea informative and easy to follow. They also found demonstrations using the app to be a very powerful counselling tool.

The postimplementation assessment revealed that within a short span of 16 weeks of implementation, ANMs

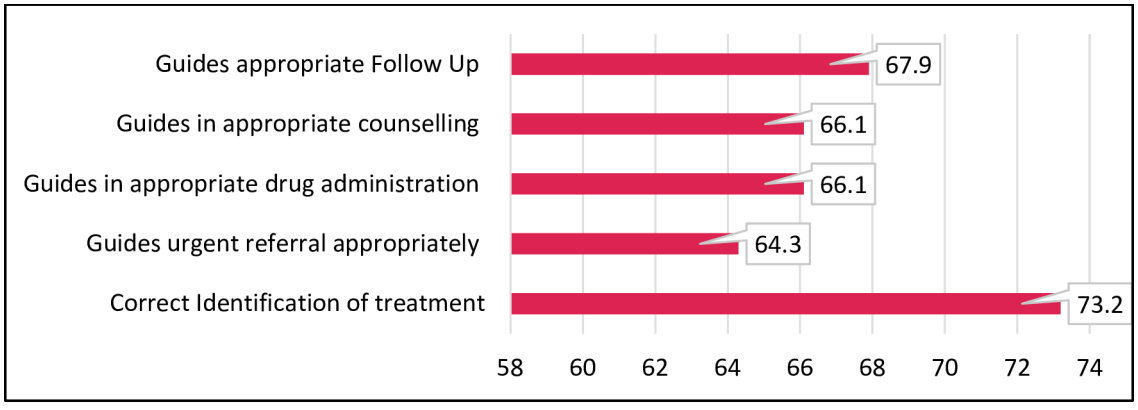

Figure 2 Perception of ANM about IMNCI protocol by using an E-IMNCI application. ANM, auxiliary nurse midwife; E-IMNCI, Integrated Management of Neonatal and Childhood Illness.

not only learnt to use the application but are also appreciating its usefulness in their regular job and have adopted it to a great extent. The observation of clinical management by health workers demonstrated that the practice of following IMNCI algorithms has improved at the respective health facilities and there is further scope for improvement with repeated use. While 64.3% of ANMs perceived that the app guides urgent referral appropriately, only 10% ANMs used the E-IMNCI application to refer a child as the number of cases requiring referral was small. One of the limitations of this work was the non-inclusion of the impact of the Hawthorne effect. This is unlikely to have a significant effect on case management quality as the same method was used for case management observations at baseline and postimplementation assessments.

The impact of the implementation was also seen as improved availability of medicine and equipment at facilities and is likely to be the result of the supportive supervision visits conducted by the project as the resource management tool integrated with the app has not been made fully operational with warehouse linkages. This work also suggests that a self-sustained process of learning can be built around the use of the application. The findings also corroborate that the real-time data submission with the help of this application became a reality paving way for timely and targeted consequent actions. In addition, with the challenges of a COVID-19 pandemic, the application has shown to be not only a great facilitator of IMNCI protocol but also helpful in the skill building of health workers. Thus, it is a great catalyst in building the eco-system of child survival through the community health infrastructure and catering to the need of underserved communities.

While we generated evidence on the usability and effectiveness of the app, we did not set up a system for the economic evaluation of the appropriateness and cost-effectiveness of the use of the app. Sustainability could not be assessed in the study even though the state government has expressed interest to continue using the app.

Similar work with a larger geographical area, increased number of health functionaries and prolonged duration of implementation with supportive supervision and full use of all features available with the app such as resource management tool can pave the way for countrywide scale up of e-initiatives.

DISCLAIMER

This work was made possible by the support of the American people through the US Agency for International Development (USAID) and its implementing partner Vriddhi (Scaling up RMNCHA) project. The contents of this paper represent the views of the authors and do not reflect the views of the USAID or the US government.

Acknowledgements We are grateful to the National Health Mission of Jharkhand, State Health departments, Facility in Charge, Terre des hommes Foundation, Dimagi and IPSOS for their support and cooperation.

Collaborators NA.

Contributors VA wrote the first and final draft, DB conducted the literature review, contributed to the design and implementation of the study and critically reviewed the draft manuscript. NK developed the tools and database, guided data analysis and tabular representation of the findings; AS supported in the data analysis and tabulation of data; KM supervised the research activity and provided complete oversight to the evaluation and assessment; PKS and JSM implemented the model in the state, supported in developing the study procedures and reviewed the results of the assessment; HK and AP conceptualised the design of the study and critically reviewed the manuscript. All authors have read and approved the manuscript. Guarantor, HK.

Funding This work was made possible by the support of the American people through the United States Agency for International Development under the terms of Cooperative Agreement Number AID 386 A 14 00001. The contents of this paper represent the views of the authors and do not reflect the views of the US Government.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by institutional review board, No: 10068/IRB/20-21. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available.

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BMJ Open Quality

Creating and sustaining a digital community of practice for quality improvement in South-East Asia during the COVID-19 pandemic

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To cite: Datta V, Srivastava S, Lalwani K, *et al*. Creating and sustaining a digital community of practice for quality improvement in South-East Asia during the COVID-19 pandemic. *BMJ Open Quality* 2023;**12**:e002370. doi:10.1136/bmjoq-2023-002370

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjoq-2023-002370).

Received 11 April 2023
Accepted 11 June 2023

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ABSTRACT

Introduction Ensuring quality of care in Low and Middle Income countries (LMICs) is challenging. Despite the implementation of various quality improvement (QI) initiatives in public and private sectors, the sustenance of improvements continues to be a major challenge. A team of healthcare professionals in India developed a digital community of practice (dCoP) focusing on QI which now has global footprints.

Methodology The dCoP was conceptualised as a multitiered structure and is operational online at www.nqocncop.org from August 2020 onwards. The platform hosts various activities related to the quality of care, including the development of new products, and involves different cadres of healthcare professionals from primary to tertiary care settings. The platform uses tracking indicators, including the cost of sustaining the dCoP to monitor the performance of the dCoP.

Result Since its launch in 2020, dCoP has conducted over 130 activities using 13 tools with 25 940 registration and 13 681 participants. From April 2021, it has expanded to countries across the South-East Asia region and currently has participants from 53 countries across five continents. It has developed 20 products in four thematic areas for a targeted audience. dCoP is supporting mentoring of healthcare professionals from five countries in the South-East Asia region in their improvement journey. Acquiring new knowledge and improvement in their daily clinical practice has been reported by 93% and 80% of participants, respectively. The dCoP and its partners have facilitated the publication of nearly 40 articles in international journals.

Conclusion This dCoP platform has become a repository of knowledge for healthcare professionals in the South-East Asia region. The current paper summarises the journey of this innovative dCoP in an LMIC setting for a wider global audience.

WHAT IS ALREADY KNOWN ABOUT THIS TOPIC

⇒ Community of practice (CoP) is a well-known mechanism to bring together like-minded professionals to share their experience of improving patient care using local innovations.
⇒ Sustaining the interest and motivation of participants over longer periods of time in CoP activities is challenging.
⇒ The exact operational process and costs for sustaining a CoP vary according to the health system in which it operates.

WHAT THIS STUDY ADDS

⇒ The study adds to the existing literature on CoP with a new perspective on the process of conceptualising and sustaining a CoP and its operational mechanisms especially amidst an ongoing pandemic in a Low and Middle Income country (LMIC) setting.
⇒ The study adds a preliminary analysis of financing of a CoP and how this supports the spectrum of activities required to sustain a CoP.
⇒ The study uniquely focuses on a simplified methodology of quality improvement implementation (Point of Care Quality Improvement) as a main driver for the creation and sustenance of the CoP.
⇒ This study also adds an element of impact assessment of the CoP using innovative measurement tools, which are being used for the first time in CoP in the South-East Asia setting.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study can help policymakers, programme managers and healthcare professionals alike to help develop a CoP as a cost-effective, formal or informal network for sharing and enriching local innovative practices to ensure safe and quality care for the community.

INTRODUCTION

India's health sector has undergone transformative changes in the healthcare delivery system in recent years, focusing on improving quality to fulfil Sustainable Development Goals (SDG) goals. Assuring quality in a vast

country like India is challenging as there is a considerable variation in terms of population, literacy, socioeconomic status and other health determinants. Quality improvement (QI) initiatives across the South-East Asian region are in the early stages of evolution, and there is a lack of focus on system-wide implementation.[1] It is documented that poor quality of care is a major contributor to mortality compared with lack of access to care.[2] This fact clearly outlines the need for incorporating a quality-centric approach in our health systems on an ongoing basis. India has embarked on a mission to achieve the global SDG/ENAP (Every Newborn Action Plan) targets by 2030 by specifically addressing the five intervention pillars of ENAP and including an additional pillar of care beyond survival. A major focus has been on interventions focusing on the quality of care to achieve the aforementioned goals.[3]

With the onset of the COVID-19 pandemic and ensuing travel restrictions, ongoing onsite clinical mentoring and capacity building undertaken by NQOCN were severely disrupted. This led to the loss of connection between the mentors and the peripheral teams. There was a risk of losing the gains achieved after years of hard work. With no immediate end to the pandemic in sight, NQOCN started to explore innovative means to establish reconnect between the facility teams and the national mentors. Within 3 months of the pandemic-led disruptions in travel, NQOCN conceptualised and launched an online point of care quality improvement (POCQI) community of practice (CoP).[1]

This narrative aims to recount the journey of the digital community of practice (dCoP), informing readers about the steps taken to initiate and maintain the CoP. Additionally, with nearly 3 years of continuous operation, this paper includes a section discussing the impact of the community using novel measurement metrics.

METHODOLOGY

We describe the results from our dCoP, which is focused on POCQI across the South-East Asia Region of the WHO. The CoP was launched in August 2020 and is currently operational in digital mode at the web address www.nqocncop.org. It has its digital footprints in 53 countries across five continents.

Process of establishing the dCoP

The dCoP was designed to unite people with various backgrounds, expertise and resources in QI. A team of 14 members from across India was selected to create a guiding document. This group thoroughly reviewed current guidelines, models and literature on CoP formation through multiple meetings. They then prepared a draft charter, which was reviewed by supporting partners and experts in the field. The finalised CoP charter outlined the mission, objectives, roles, responsibilities, membership criteria, partnerships, organisational structure and risk management strategies. This charter can be found online at www.nqocncop.org.

The dCoP was created with the goal of forming an inclusive platform that encourages interactive learning among individuals, facilities, stakeholders and government agencies to enhance healthcare quality. To accomplish this, the dCoP set the following objectives:

- Collaborate to improve healthcare that is safe, effective, patient-centred, efficient, timely and fair.
- Bring together local, national and international QI experts on one platform.
- Establish a collection of research documents, guidelines and innovations related to POCQI and QI.
- Foster a culture of QI and support health system strengthening in a country.
- Offer a safe and positive environment for brainstorming, developing and implementing innovative QI initiatives that result in meaningful change.
- Discover and nurture talented and promising QI practitioners.

The dCoP was developed as a multitiered structure (figure 1). It has an internal tier consisting of internal stakeholders (layer 1), a middle tier consisting of the participating community (layer 2) and an outermost tier consisting of supporting partners and external stakeholders (layer 3). The internal stakeholders were referred to as the core group and were responsible for the orderly conduction of the technical and operational activities of the dCoP. The external stakeholders included experts, dCoP members, media, advocacy groups, funding partners and governmental and international agencies.

The dCoP web platform, found at www.nqocncop.org, was created by a young college student. This online platform acts as a central hub for members to participate in dCoP events, access informational resources and network with others. Much of the content on the website is openly accessible, which encourages wider involvement and allows for sharing among various teams

The functional structure of the dCoP comprises five interconnected components (figure 1). At the heart of the system lies the dynamic, three-tiered dCoP, which is bolstered by a network of engaged stakeholders and partners. Periodically scheduled activities are organised for local and regional participants, ensuring consistent involvement. Internal stakeholders perform adaptive measures to tailor the functional mechanisms and content to the community's requirements, utilising active feedback and monitoring processes.

Activities

The dCoP conducts activities for all cadres of healthcare workers and the community. The dCoP activities include webinars, workshops, in-person meetings, podcasts, blogs and recorded sessions (details shown in table 1). It also actively supports two young professional networks of medical and nursing undergraduate students through capacity building, handholding, experience sharing and publications[4]

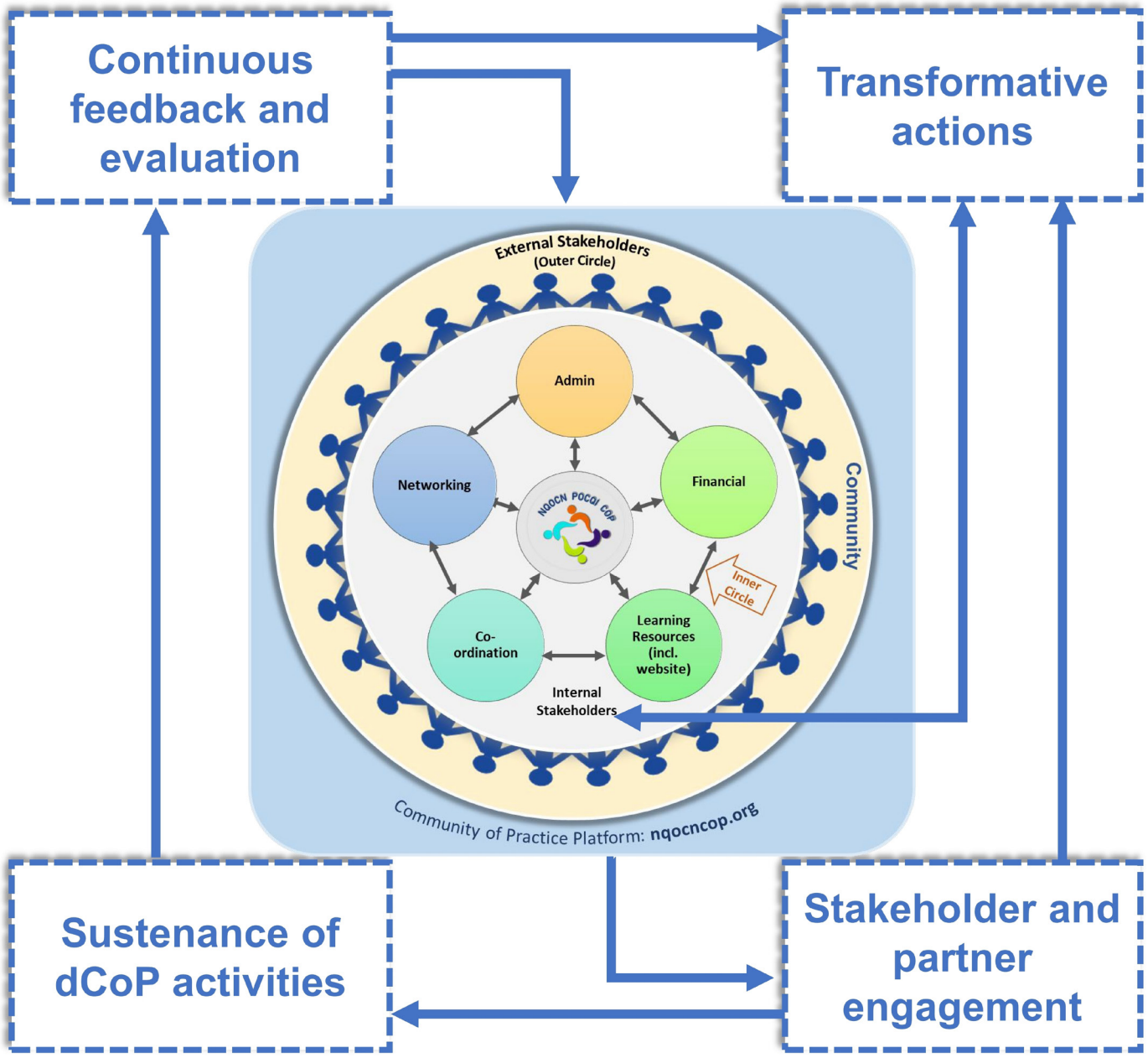

Figure 1 Structure and operational mechanism of the NQOCN digital community of practice. CoP, community of practice; dCoP, digital community of practice; POCQI, point of care quality improvement.

Data handling process

The dCoP manages various types of data, including information on its size and reach, participant backgrounds, engagement, activities, feedback from participants and mentors, online course data, CoP and QI project-related data and financial data. Specifics about the different indicators used by the dCoP can be found in the online supplemental appendix A.

Impact assessment of dCoP

(A) The dCoP performance and impact are assessed using a set of indicators pertaining to various aspects of the dCoP (table 2).

(B) Products developed: from the beginning of the dCoP, the team has focused on creating 20 products across four key areas: online collaboration platforms, development of online QI workshops, creation of online courses, development of QI resources and documentation and dissemination of learnings from the South-East Asia region. Further details can be found in online supplemental appendix B. NQOCN has published numerous original articles and QI reports that have the potential to be replicated and some of these were developed with technical assistance from BMJ Open Quality and financial support from UNICEF India . These are described in detail in table 3.

(C) Expenses for conceptualising, launching and maintaining the dCoP: the dCoP documents the costs associated with its sustainability since its inception in 2020. A breakdown of financial utilisation is presented in table 4.

Table 1 List of tools used by dCoP to conduct its activities and engage with the participants

Tools used	Communication direction	Thematic area (not exhaustive)	Number of activities conducted
Webinars 		► Quality improvement and patient safety related webinars include medication error, improving care using supplementation, genomics, public–private partnership and so on. ► Mentoring and skill-building webinars like author's speak sessions, medical documentation and so on. ► Clinical areas include fetal neurology, high-risk pregnancy, COVID-19 and related areas, neurodevelopmental disorders, paediatric hepatology, cardiology and so on. ► Sessions related to topics of social relevance, for example, gender-based violence.	► 69 Webinars have been conducted since inception
Workshops 		► Online point of care quality improvement workshops. ► Training of trainers workshops on QI. ► Nursing skills workshops. ► Psychological-safety workshops. ► Real-time labour room and neonatal ICU mentoring.	► 47 Workshops and follow-up sessions conducted
Discussion forum 		► Experience-sharing meetings. ► Members forum. ► Multi-partners forum.	► 5 Discussion forums
In-person meetings 		► Onsite workshops on POCQI. ► In-person meetings to develop add-on modules on patient safety and quality improvement.	► 7 In-person workshops and consultative meetings, 10 in-person meetings for the development of POCQI+Modules
Conference 		► International conference on healthcare quality and patient safety. ► Conference for nurses.	► 2 Conference have been organised
Virtual online mentoring sessions 		► Virtual clinical bedside ward rounds and quality improvement mentoring sessions of clinical teams from SNCUs, Madhya Pradesh, were conducted during COVID-19 pandemic.	► 13 Webinars were conducted with clinical teams

Continued

Table 1 Continued

Tools used	Communication direction	Thematic area (not exhaustive)	Number of activities conducted
Podcasts 		► NQOCN dCoP launched two series of podcasts, 'Voices from the fields' & 'Caring for Carers', to share the experiences of healthcare workers with a larger audience through our digital Community of Practice. The podcasts range from 10 to 20 min and have been developed and uploaded on the NQOCN POCQI dCoP platform.	► 2 Series of podcasts available on NQOCN CoP YouTube channel
Self-paced online course 		► The self-paced online course on the POCQI and Coaching for POCQI was developed in collaboration with the Aastrika foundation (A Nilekani Philanthropies Initiative).	► 2 Online courses on POCQI—(1) basic POCQI and (2) coaching for POCQI. These courses have had 35% and 14% completion rates over the last 18 months
Recorded sessions 		► Recorded sessions on NQOCN CoP YouTube channel.	► 68 Recorded sessions are uploaded on NQOCN CoP YouTube channel
BMJ-Open Quality South Asia Edition 		► NQOCN partnered with the BMJ publishing group and UNICEF India and started a dedicated South Asia Edition of the BMJ Open Quality Journal to build the capacity of healthcare workers to bring out and share their QI experiences with a larger audience worldwide by publishing their QI case studies and original research. These QI success stories are open to access and available on the web page of our dCoP.	► NQOCN, in collaboration with BMJ-OQ SA edition, has released 2 issues and published 38 research papers on quality improvement
Quality Post 		► A periodical newsletter to share knowledge, build a sense of community, engage members, inform about upcoming events and highlight achievements within a community of practice members.	► Currently, 3 Quality Post has been published on the NQOCN website
Blogs 		► Members of NQOCN share their experience on quality and patient safety anecdotes in the form of written blogs available on dCoP website.	► 11 CoP blogs are available on dCoP website
Social media handles 		► WhatsApp groups and other social media platforms have also been created for easy sharing and communication between QI experts and novice participants.	► NQOCN's Twitter, LinkedIn, Instagram and Facebook handles have been operational since 2021

CoP, community of practice; dCoP, digital community of practice; ICU, intensive care unit; POCQI, point of care quality improvement; QI, quality improvement; SNCUs, special newborn care units.

Patient involvement

No patients were involved in this work as the study focused on developing and sustaining the regional CoP for QI. Similarly, no patients were involved in developing the research questions, surveys, measurement indicators and study conduct.

Table 2 Indicators tracked to assess the impact of dCoP

Trackers	Indicators
General trackers	► Demographic indicators. ► Background indicators.
Platform trackers	► Traffic sources. ► Content access related to the device used. ► The geographical location of access.
Participant trackers	► Number of registrations. ► Number of attendees. ► Feedback from participants.
Social media trackers	► Availability on different platforms.
Dashboard of trackers	► Displays real-time performance metrics of the community of practice for activities conducted, – Types of activities. – Real-time feedback of participants, participant information. – Absolute numbers of participant registrations in dCoP activities.

dCoP, digital community of practice.

RESULTS

Following the establishment of the dCoP in 2020, it has sought to unite state, national and international QI experts on a shared platform. The dCoP has a presence across five continents, with significant representation in the South-East Asia region. Operating consistently since August 2020, the dCoP has been active for the past 32 months. It conducts different types of activities to keep its participants engaged and since its inception has conducted more than 130 activities, as shown in table 2. Through these activities, over the last 128 weeks, the dCoP has generated over 500 hours of content. To evaluate its performance and assess the real-time impact of its sessions, the dCoP employs various indicators, which include automated metrics built into the platform and additional data gathered through individual feedback mechanisms.

General trackers

Participant demographics

The majority (54.7%) of the participants belong to the age group of 46–65 years, followed by the 26–45 years age group (43.4%). The dCoP includes all healthcare professional cadres, ranging from frontline healthcare workers such as ANMs and ASHAs, medical professionals, management professionals, medical doctors, nurses and medical and nursing students.

Geographical reach

Due to the overwhelming response from the community, the dCoP expanded in April 2021 to become a Regional POCQI CoP for healthcare workers throughout the South Asia region. With this expansion, the platform has hosted numerous inter-country sessions focusing on neonatal and maternal health topics, particularly during the pandemic. QI experts from the Maldives, Bangladesh, Bhutan, Canada, the USA, Dubai, Qatar and the UK have participated. The dCoP has supported capacity-building for country teams from the Maldives and facilitated experience-sharing sessions with teams from Bangladesh and Bhutan. Moreover, coaching and basic POCQI workshops were conducted for teams from Indonesia, Sri Lanka and Nepal. Currently, the dCoP maintains a virtual presence in 53 countries across five continents. Further details can be found in online supplemental appendix C.

Digital platform trackers

The platform attracts more than 12 000 visitors (average) from around the world each year, with 42% accessing the dCoP website directly, 51% being redirected from Google and 4% coming from Twitter. The majority of participants (54%) use mobile phones to view the content available on the platform.

Since its inception, dCoP has held approximately one activity per week. These events have received around 25 000 registrations from across the globe. Out of these registrants, about 50% or over 13 000 participants have attended the dCoP activities, resulting in a 2:1 ratio of attendees to registrants—meaning that for every two registrations, one participant joined the sessions. In the 32 months since the dCoP's launch, the network has developed a group of over 240 national QI mentors who have conducted online QI training and consistent mentoring sessions with field teams throughout the region. Additionally, about 300 subject matter experts have shared their knowledge with online participants during this time.

Participant feedback metrics

Participant feedback is collected in real-time and automatically incorporated into the 'CoP Dashboard', which can be accessed through the CoP website (www.nqocncop.org).

Based on the feedback received, 93% of participants reported gaining new knowledge from the online webinars and over 80% applied the insights and learnings from the sessions to their daily clinical work. They also connected with other healthcare workers, policy leaders and programme managers. The sessions were found to be

Table 3 List of published QI initiatives with translational potential by network facilities of the dCoP

Clinical domains	Topics with potential impacts
Neonatology	Reducing healthcare-associated infections by improving compliance to aseptic non-touch technique in intravenous line maintenance: a quality improvement approach[16]
	Improving donor human milk collection in a hospital without a human milk bank: a quality improvement initiative at an urban tertiary-care teaching hospital[18]
	Quality improvement in Kangaroo Mother Care: learning from a teaching hospital[26]
	Implementing use of sucrose analgesia in a standalone private facility level 3 neonatal care unit using point of care quality improvement methodology[20]
Obstetrics and Gynaecology	Pre-identification of high-risk pregnancies to improve triaging at the time of admission and management of complications in labour room: a quality improvement initiative[21]
	Increasing adherence to plotting e-partograph: a quality improvement project in a rural maternity hospital in India[17]
Paediatrics	Institution of an antibiotic stewardship programme for rationalizing antibiotic usage: a quality improvement project in the NICU of a public teaching hospital in rural central India[19]
Zero neonatal hypothermia around birth	Reduced hypothermia from 38% to 6% without incurring any extra cost, saving approx. 86 newborn lives in a year.[27]
Late-onset Neonatal Sepsis (LONS) Reduction Bundles	Reduced LONS rate by 43% and CLABSI rate by 36% in 1 year[15]
Care Around Birth (CAB) bundles	CAB bundle implementation practice improved from baseline value of 33%-47% to a sustained median value of 51%-61% for various components of the CAB bundle[28]
Kangaroo Mother Care (KMC) Adoption & Scale-up Bundles	Large-scale adoption can reduce the mortality in neonates by about 40%, especially in premature neonates[29]
Perinatal Asphyxia Reduction Bundles	Can potentially reduce the rates of birth asphyxia by 31%–48% in a tertiary care setting[30]
Respectful Maternal Care (RMC) & Birth Companion	Can significantly improve the maternal and neonatal outcomes by ensuring greater demand for these services, thus helping these services expand their reach[31]
Primary Healthcare Worker (ASHA) QI Bundles	Can Increase work efficiency, effectiveness & job satisfaction among health care workers (HCWs). In addition, it will help improve patient outcome and overall faith in the health system.

CAB, care around birth; CLABSI, central line associated blood stream infections; dCoP, digital community of practice; KMC, kangaroo mother care; MMR, maternal mortality ratio; NMR, neonatal mortality rate; QI, quality improvement; RMC, respectful maternity care.

helpful in various areas, such as enhancing team communication (66.3%), improving clinical outcomes (54.9%), fostering better patient communication (47.8%), facilitating more effective communication with senior administration (36.4%) and implementing broader and more complex QI projects (29.9%).

Social media indicators

Since April 2021, dCoP has been actively engaging with a broader global audience through social media platforms such as Twitter, Facebook, Instagram, LinkedIn and YouTube to connect with more potential members. The dCoP consistently posts updates on these channels to promote events, interact with followers and offer an enriched experience for quality teams and individuals seeking fundamental and advanced knowledge related to QI.

Dashboard

A dashboard has been implemented on the dCoP platform, allowing for the real-time updating of event data, registered participants and attendees. This feature promotes transparency by showcasing the platform's progress. Participant feedback has also been integrated into the dashboard to assess the impact of the sessions and make improvements based on participants' suggestions.

QI initiatives with translational potential

Over the past 32 months, the dCoP has published articles on various QI initiatives from throughout the region. Some of the findings from these articles can be easily adapted by clinical teams in their local settings. A selection of these initiatives, along with their translational potential, is provided in table 3.

Table 4 Financial utilisation breakup

Phase (durations)	Total resources available (US$)	Resources/activity heads	Percentage
Phase 1: Pre-CoP activities & Conceptualization of CoP and initial phase of CoP (Aug 2020–Dec 2020)	73 149	Human resource	45%–55%
		Online activities content development	15%–20%
		Website development	10%–15%
		Online software and subscriptions	10%–15%
		Marketing and promotion cost	5%–10%
Phase 2: Expansion & Sustenance of CoP (Jan 2021–Mar 2023)	217 805	Human resource	40%–50%
		Expansion of activities and content development	20%–25%
		Online software and subscriptions	10%–15%
		Establishment of CoP secretariat	10%–15%
		Marketing and promotion cost	5%–10%
Total resources made available by funding partners for all phases (US$)		**290 954**	

CoP, community of practice.

Cost of developing and sustaining the dCoP

The dCoP activities have received support from WHO-SEARO, UNICEF India and other development partners, with a total of $290 954 in funding since its inception in August 2020.

To estimate the cost of establishing the CoP, the costs incurred during each of the two phases were calculated, as detailed in table 4. Based on the overall costs incurred, our preliminary analysis indicates that the initial phase of dCoP development necessitated substantial resource allocation and financial support. During this phase, the average monthly costs for operating the dCoP amounted to $14 600. In the subsequent sustenance and maintenance phase of the CoP, the average monthly cost was reduced to $8000.

DISCUSSION

A CoP in healthcare is a group of individuals who share a common interest or passion for a particular healthcare area and come together to collaborate, learn and share knowledge and the best practices. Members of a CoP typically have a shared goal or purpose, and they engage in ongoing conversations and activities related to their area of interest.[5]

In healthcare, CoPs can exist among a variety of groups, such as clinicians, researchers, administrators, or patients and their families. CoPs can be informal or formal, and they can take many different forms, including online forums, regular meetings or ongoing projects.[6]

In this paper, we share our experience of creating and maintaining a dCoP for POCQI across South-East Asia. In the context of a resource-constrained setting, we faced unique challenges in establishing and sustaining the community, particularly during the COVID-19 pandemic for over 32 months.

Building on the original concept of CoP by Lave and Wenger,[7] we aimed to create a digital platform for POCQI professionals to share experiences, exchange ideas and collaborate on QI initiatives. Our experience sheds light on the potential of dCoPs to overcome geographical and resource barriers, especially in the context of a pandemic. By sharing our challenges and successes in establishing and maintaining the community, we hope to inform other healthcare professionals seeking to create similar communities in their own settings. Our dCoP has a global footprint in 53 countries across five continents. It has over 13 000 participants to date and has generated nearly 40 international peer-reviewed publications using the POCQI method. The results of this work helped 93% of the dCoP participants acquire new knowledge and were reported to be useful for 80% in their day-to-day clinical work.

The operational process of our dCoP is similar to other contemporary CoPs like the Institute for Healthcare Improvement (IHI) Open School.[8] The Open School provides online courses and resources focused on QI, patient safety and leadership. The community includes students, healthcare professionals and educators worldwide. The Open School offers a variety of resources, such as case studies, webinars and discussion forums, to help members develop their skills and knowledge in these areas.

The Quality-of-Care Network[9] is an initiative jointly supported by WHO, UNICEF and UNFPA that aims to build and strengthen national institutions and mechanisms to improve the quality of care centred around mothers and newborns. Currently, it is present in 11 countries worldwide including Bangladesh and India from Asia, and another 11 countries would be joining it soon including Bhutan, Maldives, Sri Lanka, Indonesia, Myanmar and Timor Leste from the South-East Asia

region. It has extensively cited the work of NQOCN and its CoP on its platform[10]

In addition to these examples, there are many speciality-specific dCoPs in healthcare. For example, the Society of Hospital Medicine operates a dCoP called the Hospital Medicine Exchange (HMX).[11] HMX allows hospitalists to discuss their experiences and share best practices related to hospital medicine. The community includes over 20 000 members and offers a variety of resources, such as discussion forums, webinars and podcasts.

The other prominent global CoPs, like IHI, are interdisciplinary platforms focusing on improving healthcare quality and patient safety outcomes using initiatives like 'Triple Aim strategy'[12] and incorporating IT in healthcare delivery. Along with this, notable government initiatives like the Agency for Healthcare Research and Quality[13] provide various tools and resources like the 'Hospital Survey on Patient Safety Culture' and the 'Patient Safety Indicators' to help healthcare organisations improve the quality of care. Our dCoP was created with a similar objective as a national interdisciplinary platform for facilitating interactive learning between various individuals, facilities, stakeholders and government agencies to improve healthcare quality and promote evidence-based practices. Being a digital platform, it leveraged technology to connect its members and foster collaboration, thus allowing for greater access to resources and knowledge sharing, as evidenced by its evolving presence in the South Asian Region.

USAID report on Health Communication Capacity Collaborative[14] on maintaining a CoP mentions that at least one face-to-face and four virtual events a year are required to sustain a CoP. Based on these recommendations, our dCoP has conducted >1 activity per week and organised multiple workshops and an in-person conference in a year to maintain and sustain the dCoP for the past 2 years. Based on our experience of developing and operating the dCoP, it offers a promising way to drive system-level changes in a healthcare system. It does so by focusing on empowering healthcare professionals (HCPs), especially the frontline workers, and expanding the space for exchanging ideas on improving care in various settings within a health system.

Our analysis of the platform's impact on various QI initiatives revealed several notable successes. These include reduced late-onset neonatal sepsis rates,[15] improved adherence to infection control practices[16] and enhanced team communication and collaboration across various health facilities. Other outcomes which have been reported and published in contemporary literature by members of the CoP are increasing adherence to the use of e-partograph,[17] improving donor human milk collection,[18] development of an antibiotic stewardship programme,[19] use of sucrose analgesia in NICU[20] and pre-identification of high-risk pregnancies.[21] These outcomes not only demonstrate the potential of the dCoP platform to drive meaningful change in clinical practice but also highlight the importance of nurturing a culture of continuous learning and improvement among healthcare professionals.

Despite the platform's positive impact, several challenges and limitations emerged during the implementation process. Common challenges included technical difficulties with online software, limited access to reliable internet connections and the ongoing need for user training and support in conducting mentoring sessions. To address these issues, the dCoP platform adopted a user-centred design approach, integrating feedback from its members to make iterative improvements and enhance user satisfaction. A real-time CoP dashboard is available for users worldwide, showcasing the scale and scope of activities and benefits for healthcare workers. The dashboard can be accessed through the following link: https://tinyurl.com/nqocn-dashboard.

The central challenges faced by various communities of practice include accommodating diverse levels of expertise, encouraging participation from less experienced members and addressing concerns about revealing knowledge gaps.[22] To overcome these challenges, the dCoP features and rotates speakers from various healthcare professional cadres. This approach facilitates knowledge sharing, accommodates a range of experiences and emphasises the importance of effective collaborations in delivering high-quality healthcare services.

A significant barrier in the functioning and sustenance of CoPs, as identified by Terry and Nguyen, is addressing feelings of alienation, marginalisation, frustration and work pressure,[23] particularly among novice nurses and students. These feelings can further impact their full participation, hindering successful CoP sustenance. To address this issue, NQOCN collaborated with a group of medical and nursing undergraduate students, supporting the creation of the 'Be the Change' group. This initiative aimed to facilitate active participation and representation of the future generation of healthcare workers in QI projects, capacity building and knowledge sharing. The framework of collaboration with an autonomous, student-led group proved effective in overcoming the aforementioned barrier.

Other studies have highlighted that sufficient funding and proper allocation of funds are crucial factors in sustaining a CoP.[24] Since its inception, our dCoP has received financial support from UN agencies such as WHO and UNICEF. To promote transparency and ensure the effective use of funds for various platform activities, the organisation's governing board makes decisions based on mutual agreement. The adoption of digital tools and an online platform has led to cost reductions, contributing to the dCoP's enhanced sustainability. A detailed comparison of our dCoP with other contemporary CoPs can be found in online supplemental appendix E.

As we progress, the dCoP for QI aims to make a significant impact by extending its reach to all South-East Asian countries and enhancing the QI expertise within the existing health workforce. It is crucial to emphasise that QI is a multifaceted and intricate process involving

healthcare systems, patients, families, communities and broader society. In light of this, the dCoP will concentrate on the ecological aspects of quality and the multidimensional model of QI.[25] The ultimate objective is to establish and promote a network of QI-proficient healthcare professionals within health systems, supporting them with a comprehensive repository of research documents and knowledge products to maintain a culture of QI in their local environments. The dCoP remains committed to providing a psychologically safe and positive environment for brainstorming, developing and implementing innovative QI initiatives that lead to meaningful change.

In conclusion, the dCoP for QI has made significant strides in bringing together healthcare professionals, experts and stakeholders from diverse backgrounds to create a platform for collaborative learning and improvement in healthcare quality. By leveraging digital technologies, the dCoP has overcome geographical barriers, enabling the exchange of knowledge and resources across a vast network of participants.

Despite the challenges faced in its implementation, the dCoP has successfully adapted and evolved to meet the needs of its members, fostering a safe and positive environment for innovation and the development of QI initiatives. The platform's transparency, funding support and continuous user-driven improvements have contributed to its sustainability and impact.

As the dCoP moves forward, its focus on expanding its reach within the South-East Asian region and further promoting a culture of QI will be crucial in achieving its goal of creating a robust network of QI-proficient healthcare professionals. This network, supported by a wealth of research and knowledge products, will ultimately lead to meaningful and lasting changes in healthcare systems, benefiting patients and communities at large.

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Acknowledgements We would like to thank the following organisation and persons for their invaluable support in making this Community of Practice a reality and helping us in preparing this manuscript. We thank WHO South-East Asia Regional Office and UNICEF India for financially supporting our digital Community of Practice and its activities since its inception. ISQua, URC, Oxford University Hospitals (UK), 3M, MGIMS and Aastrika Foundation for providing technical support to the digital Community of Practice. Ministry of Health and Family Welfare, Govt. of India and various State National Health Missions for facilitating our work in different states of India. Quality of Care Network (QoC) and Global Learning Lab WHO for appreciating our work and publishing it for global reach. 'Be The Change' group—a medical and nursing students' network for their hard work in improving the quality of students' lives using quality improvement. Mr Varun Datta for his outstanding work in designing the dCoP platform. MOH Maldives and its QARD division for collaborating with our platform towards the cause of quality and capacity-build for the healthcare professionals of their country. Our special thanks to Ms Thasleema Usman, Commissioner QARD, for facilitating this collaboration. Dr Bani Singh for supporting the charter drafting and finalisation with the drafting committee. Dr Aashna Dhingra for coordinating the online course development on QI with the Aastrika Foundation. Ms Rashi Arora and Mr Harshit Sharma from the NQOCN Office for coordinating various activities during the inception and initial intensive phase of the digital Community of Practice. NQOCN members and the participants of the dCoP. Their contributions to the dCoP are deeply appreciated.

Contributors VD, SS, SKP, PV, JP, RM, RG, HP and NR were involved in the conceptualisation of the dCoP and its operational requirements. Along with these authors, RK, VS and PS guided in the development of dCoP activities. VD, SS, SKP, PV, JP, RG, KL, SJ, VB, AK, AS, SV, KS, CS, KhS and RM were responsible for conducting online and onsite CoP activities. VD, SS, KL, RG and SJ were responsible for developing the draft manuscript and analysing the data from the dCoP platform. KhS and SJ contributed to the initial draft of the manuscript and data collection. All listed authors reviewed and approved the final draft of the manuscript. VD is the guarantor for this manuscript.

Funding For developing and sustaining the dCoP, WHO's South East Asia Regional Office funded this initiative from its conceptualisation to its implementation and spread into a regional CoP. These activities were supported through the following APW grants (PO) 202522047 (2020–2021), 202712497 (2021), 202788173 (2021), 202664704 (2021–2022), 202988101 (2022), 202809227 and 202800494 (2022–2023). For some of the knowledge products and mentoring sessions, funding was provided by UNICEF India as SSFA grants under its output 101 (2020–2022) and IND/SSFA2020757 (2020). The funding agencies had no bearing on this study's methodology, data collection and analysis and results. The opinions expressed herein are those of the authors and do not represent the official views of their respective organisations.

Competing interests NR and RK are employed with the WHO-SEAR Office. They were responsible for the release of funds for developing and sustaining the dCoP described in the paper. VS is employed by UNICEF India. They were responsible for the release of funds for some of the knowledge products described in the paper. The remaining authors declare no competing interests. The views expressed here are those of the respective authors and they do not necessarily represent the decisions, policies or views of their respective organisations.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. All relevant data are available upon reasonable request from the corresponding author and also available as online supplementary material.

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BMJ Open Quality

Quality improvement initiative for a sustained increase in human milk donation during the hospital stay

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To cite: Jain S, Bansal A, Khurana S, *et al*. Quality improvement initiative for a sustained increase in human milk donation during the hospital stay. *BMJ Open Quality* 2023;**12**:e002133. doi:10.1136/bmjoq-2022-002133

Received 6 October 2022
Accepted 5 October 2023

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ABSTRACT

Background The demand for donors' human milk is much more than the availability of the same due to the myriad challenges faced during the collection process.

Methods Baseline milk volume donation done in a human milk bank facility located in tertiary care government institute in a low-middle income country was assessed. It was initially aimed to increase the absolute quantity of milk volume donation by 30% over a period of 6 months, which was subsequently continued following COVID-19 emergence (over another 12 months) along with a particular emphasis on the sustenance of milk donation activities.

Interventions Counselling of both the healthcare workers and stakeholders, standardising the timing of milk donation and other policies, equipment in proportion to demand and supply and addition of human resource were done as a multiprong approach to have sustained increase in human milk donation.

Results The median control line (MCL) showed a shift of 27.8%; from a baseline of 5032 mL to 6971 mL during intervention phase I comprising of five plan do study act cycles spread over a period of 6 months. During the sustenance phase I even though the monthly collection was non-uniform, there was a further 16% upward shift in MCL to 8122 mL. During the second intervention phase, each component of the Ishikawa diagram was worked on (people, policy, place, procedure) resulting in a more than 100% increase from sustenance phase I taking the MCL to 17 181 mL with an overall increase of 3.41 times from the baseline.

Conclusion Dedicated counselling and constant motivation have been conventionally considered as the utmost measure to increase milk volume donation in milk bank. Our study highlights the need to introduce scheduled timings along with sufficient equipment and manpower to overcome the shortage of milk donation in human milk bank facilities.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Counselling and education of mother's family and healthcare staff improve breast milk expression and donation.

WHAT THIS STUDY ADDS

⇒ Use of myriad modes of education and counselling aids, with structured donation time chart while preventing interference with other activities of mothers' childcare, more donation equipment and timing adds to amount of milk donation in a sustained manner.

HOW THE STUDY MIGHT AFFECT RESEARCH, PRACTICE, AND POLICY

⇒ Human milk donation in a milk bank can be sustained for the demand with multiprong approach.

BACKGROUND

Problem description

In-house human milk bank services were started in our centre in September 2016. The centre has a delivery load of 6500–7000 deliveries per year. Of the total delivery load, sick preterm neonates account for around one-third the load with a rapid turnover of approximately 2200–2500 neonates in 25-bedded neonatal intensive unit and 30-bed space for high-risk low birthweight babies. Milk bank was started to decrease the use of formula milk and, wet nursing for a sick delivery load of around 1500 deliveries per year in 16-bedded intensive care unit. With the increase in proportion of sick neonates there was difficulty in ensuring donor human milk (DHM) when it was needed. Moreover, there were issues of over-crowding in milk bank than the available area, waiting time of around 15–45 min before the pump would be available to mother. There was only one full time medical social worker and a part-time lactation councillor, part-time worker for running the pasteurisation cycles, dedicated to milk bank.

There was a need of standardised procedure and policy to have uniformity in availability of mother's milk in accordance with the demand and to ensure the same is sustained on all the days.

Available knowledge

Since times immemorial wet nursing was being practised with challenges of cross infection. The way ahead to continuously meet the nutritional needs of these preterm infants is well equipped, standardised and self-sustainable human milk banking (HMB)

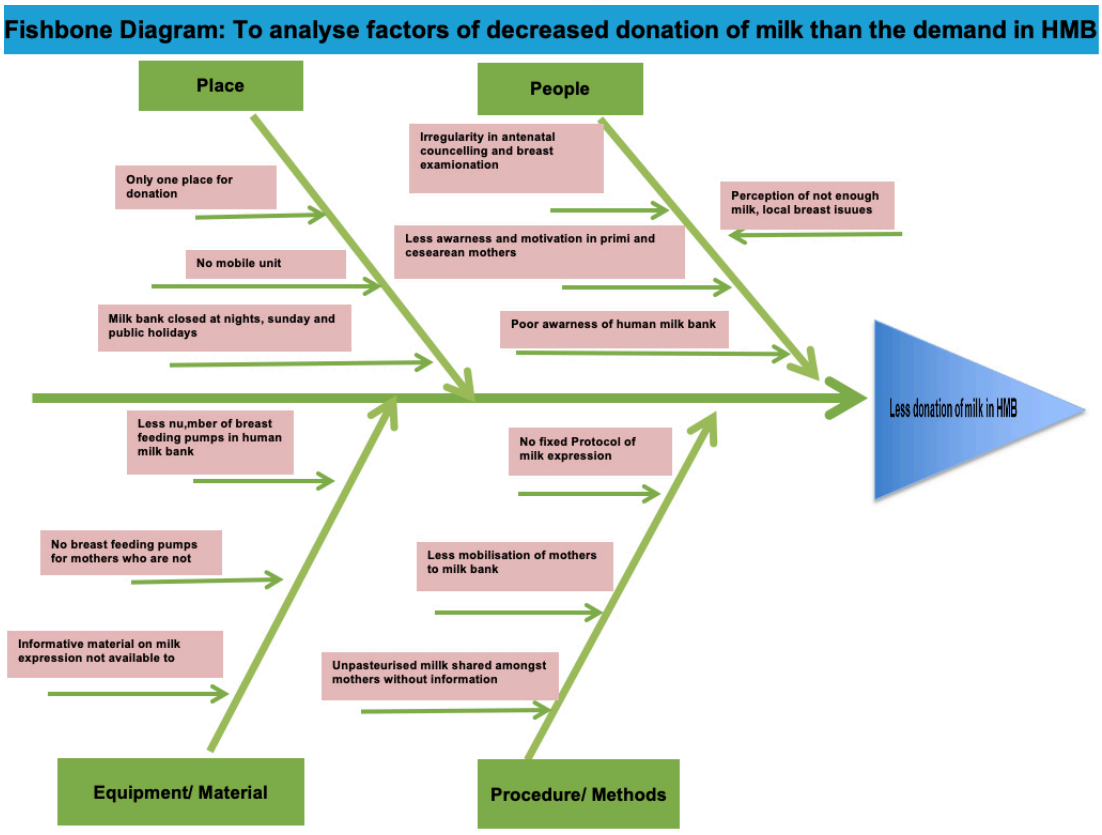

Figure 1 Fishbone diagram to analyse factors for decreased human milk donation. HMB, human milk banking.

services.[1 2] To address the same since 1980, the WHO and UNICEF had unanimously recommended and reiterated universal and safe availability of DHM for sick neonates when mothers own milk is not available urging setting up of HMB organisations,[3] such as Human Milk Banking Association of North America (HMBANA), European Milk Bank Association (EMBA), Italian Association of Human Milk Banks (AIBLUD), Global Alliance of Milk Banks and Associations (GAMBA) and Comprehensive Lactation Management Centres (CLMC) by the government of India. The main function of HMB organisations is to act as a reliable repository for surplus pooled and pasteurised DHM under standardised process of selection, collection, screening, pasteurisation and disbursal of DHM.[4]

HMB organisations globally face a varying degree of challenges not only in the form of economic and funding hindrances, but also for the availability of sufficiently trained human resource personnel for safe handling of DHM, professional and compassionate lactational support to donors keeping in view their demographic, sociocultural and religious factors.[4] As per the literature, LMICs share the maximum global burden of low birthweight and preterm births annually; out of which 40%–70% of sick hospitalised neonates are in want of DHM at a given point of time.[5 6] Of all births in India nearly 30%–50% preterm and sick babies in neonatal intensive care units (NICUs) lack access to breastmilk.[7] In a recent cross-sectional survey involving HMB organisations from a LMIC region; more than 60% of the participating units acknowledged the existent DHM demand–supply gap being faced by their operational milk banking services. DHM has the potential to benefit five million plus babies in India, but the demand is disproportionate to the requirement and when this study was planned there were only 30 HMB organisations in India.[7] Current concern of the HMB organisations in India is limited number of the same in the country with reduced amount of milk donation in these milk banks.[8] This quality improvement (QI) project was initiated with the intent to increase the donation in institutional HMB, to ensure an uninterrupted supply of DHM.

Specific aim

Initially the study was planned to increase the milk donation by 30% from the baseline (January–June 2019) over a period of 6 months (July–December 2019) and thereafter to check for sustenance of increased donation over next 6 months. However, in view of COVID-19 pandemic onset during the sustenance phase the study was halted and restarted after primary analysis of 6 months, whereby a new set of plan do study act (PDSA) cycles were planned after a period of sustenance check in view of inability to meet the initial aim.

METHODS

Context

This QI study was conducted in a tertiary level medical college hospital with level III NICU in North India with 25 intensive care beds, 30 beds for high-risk low

Table 1 Summary of phase I (post baseline phase I) (figure 1)

PDSA cycle and timeline	Plan	Do	Study (changes in the milk donation volume)	Act
PDSA-1 1–31 July 2019	Counselling of mothers of NICU neonates regarding regular donation of milk in HMB at fixed time periods when maximum mothers could benefit.	Daily counselling at (14:00–15:00 hours) by the resident doctor with frequent counselling of mothers of sick neonates. Poster display on disadvantages of inadequate milk expression.	(*It increased from 5812 mL to 7800 mL from baseline of June to first month of intervention*).	**Adopt** the PDSA cycle, and to involve immediate postpartum mothers from CLR for counselling.
PDSA-2 1–31 August 2019	Counselling of early post-partum mothers in CLR nursery along with NICU mothers.	Counselling extended to mothers in CLR nursery. Identifying mothers with local breast problems, engorged breast.	(*Milk donation decreased to 4330 mL*). **Possible causes:** less time for counselling at defined hours, individualised counselling reduced. More number of days on which milk bank was closed due to public holidays.	**PDSA cycle modified**. Plan to involve other personnel in counselling in next PDSA. More focus on mothers who can mobilise.
PDSA-3 1–30 September 2019	Sensitisation of staff who looked after mothers in wards. Involvement of other personnel. Focused counselling and motivation of mothers with good milk output.	Involvement of staff nurses in counselling mothers. Involvement of social worker in counselling. Helping mothers with engorged breast to mobilise early to milk bank.	(*Milk donation increased to 6520 mL though the quantity was lesser to beginning of the intervention phase*). Some mothers refused donation. Temporary difficulty in keeping a regular track of mothers involved in donation.	**Adopt** the PDSA cycle. To allay mother's concerns and fears. To keep track of involved mothers in the next PDSA cycle by maintaining a record.
PDSA-4 1–31 October 2019	Increment of catchment area by involvement of mothers of babies admitted in intermediate care nursery, postnatal, new gynae and private wards. Focused counselling of mothers with sore and flat nipples or engorged breasts. Use of IEC means.	Individualised counselling for mothers with local breast issues, formation of dedicated peer groups for helping mothers, encouraging mothers for increasing kangaroo mother care duration and, formation of WhatsApp group to keep track of new mothers (as bundle of care).	(*Milk donation increased to 7060 mL from 6520 mL in September*). Mothers felt more comfortable in discussing their concerns within peer groups. Time taken in counselling, exceeded allotted time to one group adding to waiting time of another group.	**Adopt** the PDSA cycle and to decrease waiting time for mothers and to do group counselling in next PDSA.
PDSA-5 1– 30 November 2019	To decrease waiting time for mothers coming from areas other than NICU. To club counselling of mothers from various areas.	Designated breast pump for NICU mothers. Group counselling of mothers started. Individual mother counselling abandoned unless person-specific issue.	(*Milk donation increased to 7560 mL*). Less waiting time for mothers. Easy tracking of new mothers with WhatsApp group, which was also used for motivational messages.	**Adopt** the PDSA cycle. Continued counselling once in morning hours and in evening hours in all areas.

CLR, clean labour room; IEC, Information, Education and Communication; NICU, neonatal intensive care unit; PDSA, plan do study act.

birthweight babies in postnatal ward and for around 2500 plus high-risk, preterm mother–baby dyad in need of support for human milk. Average nursing strength per shift for patients: nurse was 3:1 in the NICU, 4:1 in the intermediate care nursery and 15:1 in the wards. A dedicated lactation counsellor and a social health worker were also present in the morning shift on all working days. Unit had three consultant neonatologists, five

Table 2 Summary of phase II (postsustenance PDSA phase II) (figure 1)

PDSA cycle	Plan	Do	Study	Act
PDSA-6 (1–30 June 2021)	To increase number of breast pumps for stationing with mothers who were not mobile.	Three new breast pumps procured. New breast pumps stationed in wards along with the training of area nursing officers for operation of breast pumps. Three breast pumps kept in HMB for mobile mothers as was in phase I.	Changes in the volume of milk donation with factors behind the same. (*Milk donation raised to 7245 mL but the increase was not substantial*. Mothers from these areas were concerned about fear of contamination while breast pump usage and had reduced motivational drive due to reduced visits by milk bank staff.	**Abandon the PDSA cycle. Actions taken:** Reorganise the breast pumps in the milk bank facility. To reorganise the timings of milk donation from various areas.
PDSA-7 (1–-31 July 2021)	To reorganise the timings of milk donation from various areas. KMC timings of various areas were noted, and milk donation time preceded it so that both the processes were continued on any given day.	Avoid overcrowding and improve seating arrangement by introducing written schedule for milk expression three times a day. NICU and PNW1: 9:00 hours. Gynae ward and intermediate care nursery: 9:30 hours.	Changes in the volume of milk donation volume with factors behind the same. (*Milk donation increased to 15 050 mL*) Milk donation less on weekends due to half working day of staff on Saturdays.	PDSA cycle **modified and adapted**. Posters along with group counselling of mothers and nursing officers of various areas by HMB staff initiated for staggered timings and motivational messages shared with mothers through job aids.
PDSA-8 (1–31 August 2021)	To improve milk bank functioning facilities over the weekend for improving uniformity in services.	Milk bank timings increased from 13:00 hours to 17:00 hours on weekends.	Changes in the volume of milk donation with factors behind the same. (*Milk donation increased to 17 181 mL, MCL* figure 2).	**Adopt** the PDSA cycle and To alternate duties of lactation counsellor and medical social worker in the HMB over the weekend. To restrict area-wise counselling of mothers before forenoon on weekends and to focus mainly on smooth functioning of milk bank activities post lunch.

HMB, human milk banking; MCL, median control line; NICU, neonatal intensive care unit; PDSA, plan do study act.

fellow residents, three to four junior doctors involved in care of neonates.

Intervention

To tackle the identified problem, a multidisciplinary QI team was formed. It comprised of one consultant neonatologist, one neonatology fellow resident, one dedicated lactation counsellor, one social worker and experienced staff nurses of respective areas. Neonatologist served as supervisor and coordinated different changes and activities to be performed among members. Fellow neonatology resident worked as a team leader, led meetings and directed activities to achieve goals. Milk bank donation register was maintained by the social worker. The present study followed the WHO Point of Care Quality Improvement (POCQI) model. The study was conducted in three phases.

Observation phase (January 2019–June 2019)

Total milk donation per month during the 6 months period was calculated from the milk bank register maintained prospectively by a social worker, which formed the baseline data. Baseline milk donation was 5030 mL/month. A root cause analysis was done by means of a fishbone diagram (figure 1), to delineate possible contributing factors of inadequate milk donation.

The QI team identified various causes for decreased milk donation in the milk bank namely lack of awareness among mothers regarding donation, use of unprescribed non-pasteurised donor milk, less mobilisation of mothers

Table 3 Activities done in the intervention phase and sustenance phase to increase donation of milk in HMB

Phase of QI and activity	Target areas and structure of activities
Intervention phase	**Target areas: mainly related to policy and population** **Structure: how, where and when**
Counselling of mothers and family Involvement of staff nurses Involvement of medical social worker	► In NICU, extended in phasic manner to clean labour room, wards and step-down ICU ► Counselling in group with individualised focus on those with local breast issues and increased frequency in those with caesarean section ► Proven aids for group counselling with posters, videos were used along with scaling to use of social media in form of WhatApp group media ► Staff nurses of all the areas were taught in a structured manner for counselling the mothers and family ► Social worker was trained for breastfeeding counselling using various modes of communication in a structured manner
Sustenance phase	**Target areas: adding of equipment and human resource improvising in policy and population parameters**
Equipment Policy Policy and Human resource	New breastfeeding pumps were procured. The timetable was prepared for visit of mothers to HMB to decrease the waiting time and non-interference with kangaroo care timings Timings of milk bank services were increased with additional, adjustable work hours of human resource

HMB, human milk banking; NICU, neonatal intensive care unit.

and waiting period for mothers during milk expression in a milk bank. Some mothers had surplus milk output and they even donated it to others but felt reluctant to come to the milk bank for donation due to the above-mentioned reasons. Lack of awareness of milk expression benefits, and scarcity of professional counselling skills among healthcare personnel also compounded towards aggravating the existing problem. Also, it was found that personalised individual counselling was missing in primiparous mothers and those who underwent caesarean section, as these mothers are at higher risk of delayed establishment of lactation beyond the initial 48–72 hours.

Intervention phase (July 2019–December 2019)

All healthy postpartum mothers admitted in the hospital and willing to donate their breast milk were included after a written informed consent. They were screened for HIV, Venereal Diseases Research Labortary (VDRL), Hepatitis B and Hepatitis C and reviewed for medication intake contraindicated during breast feeding. A patient information sheet was provided in the vernacular language containing the basic details of the mother and the baby. The QI team then decided to perform multiple sequential PDSA cycles to tackle the identified problems. The elements of these PDSA cycles included dedicated regular education and counselling of mothers, skilled training and robust involvement of healthcare workers, use of information, education and communication means such as posters, video recordings, focused group discussions, informal peer group meetings, multimedia-WhatsApp group formation and education of mothers towards possible adverse effects of unpasteurised donor milk usage. These changes were tested and modified as a part of PDSA cycles. Changed ideas were then adopted, adapted or abandoned, depending on their feasibility and outcomes. Summary of these PDSA cycles is described in table 1.

Sustenance phase

To check the sustainability of QI project, the amount of milk donated from January 2020 onwards was planned to be recorded prospectively by medical social worker over a period of 3–6 months, however in view of onset of COVID-19 pandemic in the region led to ongoing policy changes in the milk bank collection processes. Hence, this phase was not considered as representative of post QI project sustenance phase.

The data were collected for milk collection from January 2021 onwards, once restrictions related to COVID-19 admissions were modified. The study had to be halted during the COVID-19 pandemic (onset of first wave) in the region; due to separate SOPs followed for COVID-19 infection as per the hospital policies keeping in view the need for social distancing and segregation policies. In view of the inability to meet initial Speciifc, Measurable, Achievable, Relevant, Time bound (SMART) aim over first 6 months period after baseline assessment, a new set of PDSA cycles (table 2) were planned after a period of sustenance check.

Study of the intervention

The intervention team led the monthly meetings and reviewed the collection of milk. During each meeting along-with discussion of progress of PDSA cycles, it was planned to identify and involve hospital areas from where fewer postpartum mothers came forward for milk donation and to tackle the problems that they were facing (table 3).

Process measures

The process measure was the total amount of milk donated per month, number of postpartum mothers coming from individual hospital area for donation, amount of milk donated by mothers with regard to maternal characteristics such as mode of delivery, parity, maternal age, duration of hospital stay and infant characteristics like birth weight and gestational age.

Outcome indicators were to percentage increment in milk donation and identification of maternal and/or infant characteristics that might have affected the milk donation.

Data analysis

Data were collected on the patient information sheet and transferred to the excel sheet. The continuous analysis was done on a QI Macros chart (statistical process control software package plugin for Microsoft Excel for Lean Six Sigma) to evaluate the trend of increase/decrease in the donation of milk per month in the milk bank.

Ethical considerations

The present study was conducted after taking approval from institutional ethical committee.

RESULTS

During the observation, implementation and sustenance phase data collected prospectively by lactation counsellor was entered into excel and process control charts were created to analyse effect of PDSA cycles (figure 2)

Observation vers intervention phase

Total milk donation in the observation phase was 30 182 mL; 5030 mL/month (±1831) and an average of 167 mL/day which increased gradually during the intervention phase to 41 830 mL, which is around 6971 mL/month (±1465) and an average of 227.2 mL/day. Trend of milk donation per day in each month, total milk donation in each month and applied PDSA cycles have been depicted in table 1. Total increment during phase I of the study was 27.8% against a target of 30%.

Intervention vers sustenance phase

In the sustenance phase, there was a continuous increment in the milk donation, which was 8260 mL (266 mL/day) in January 2021. The amount of milk collected from January 2021 to May 2021 (figure 2) was 8122 mL as per median control line (MCL), hence showing the sustainability of phase I activities. There was a decline during month of April to May 2021 in view of resurgence of COVID-19 second wave. It was therefore planned to procure more portable breast milk pumps to avoid overcrowding in HMB.

During PDSA cycles phase II, the amount of milk donated during the month of August 2021 was 16 630 mL, as compared with 5640 mL in the month of May 2021, prior to PDSA cycle phase II implementation, with MCL shift from 8122 mL to 17181 mL, an increment of double the initial volume that is, 2.1 times over a period of 12 months.

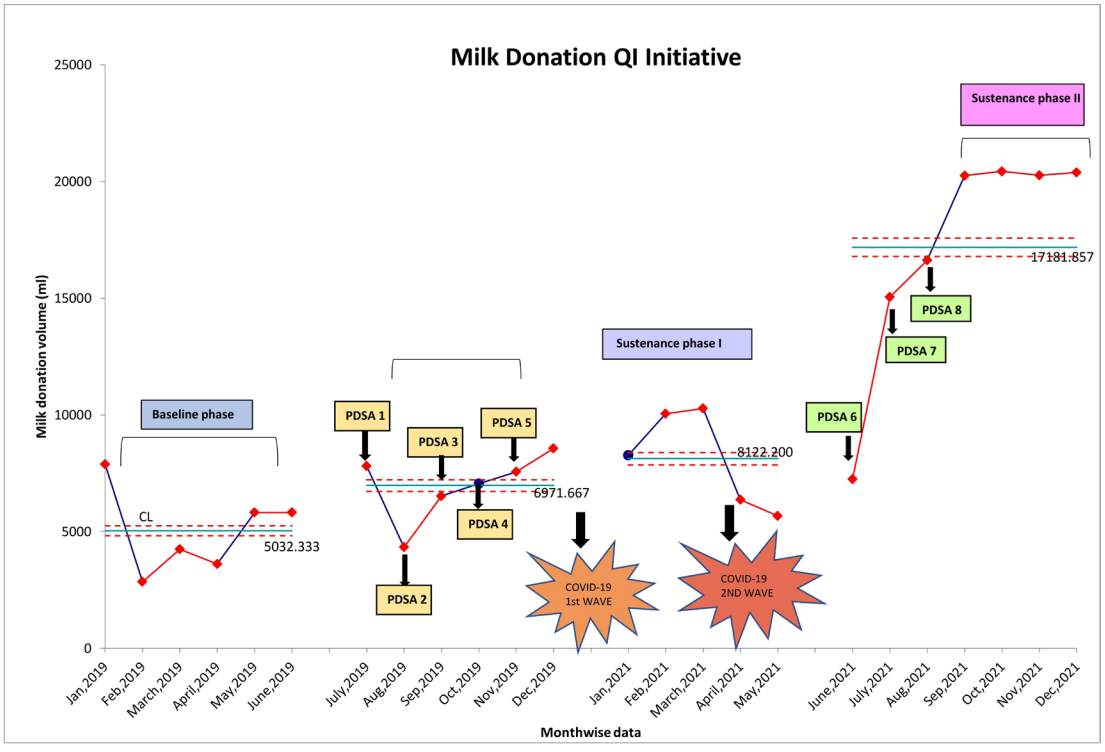

Figure 2 Milk bank QI statistical process control chart during baseline, intervention and sustenance phase. PDSA, plan do study act; QI, quality improvement.

During sustenance phase number of mothers who donated milk had decreased in phase I to 117 and increased in phase II to 530; but increase in milk volume was 28% more in intervention phase and 210% more in sustenance phase II.

DISCUSSION

Our results are consistent with other studies, which have also shown a positive impact of counselling on milk expression. In a study conducted by Sisk *et al* to determine the effect of lactation counselling on maternal stress and anxiety level and the amount of milk expression, it was found that 85% of women in the formula feeding group started expression of breast milk without any increment in the maternal stress or anxiety level.[9] Other studies concluded educating participant mothers about benefits of milk donation and so they felt more motivated and reported increased milk production.[10] In the current study, counselling was done using myriad modes like audio-video, charts, WhatsApp group of mothers, individualised to special need mothers, counselling of nurses and milk bank staff in all areas, which sensitised them to human milk bank, benefits of milk expression, resulting in increased milk expression and donation. Mothers waiting time in milk bank was reduced to nil with increase in breast milk pump and clarity on their timing to come for milk expression.

There are data from North India on improving milk expression in first 7 days of postnatal age, whereby education and sensitisation of healthcare workers using videos, webinars, teamwork, rewards of good work and sensitisation of the family for early and nocturnal milk expression has shown improvement in human milk expression from 12.5% to 80%.[11] Another study conducted in South India had shown an increase of 65% in exclusive human milk feeding from 44% of baseline with Mother Baby Friendly Initiative model. Structured capacity building, training of staff, behaviour modification with proven aids, conducive infrastructure and equipment improved exclusive human milk intake in babies during the hospital stay. In this study, Pooled Donor Human Milk (PDHM), after milk donation, and KMC were part of intervention and not the sole intervention.[12] Total increment following phase I and phase II PDSA cycle was 3.41 times from the baseline targeting education of healthcare staff and family, human resource, equipment, policy modification using structured time frame of activities.

The major *strength* of this QI initiative was that no extra space and healthcare personnel were employed for improving functioning of HMB facilities, and all the domains of Ishikawa diagram were targeted to sustain the milk donation to 2.11 and then 3.4 times the baseline value.

Limitation of the study was that socioeconomic and demographic factors were not analysed. These factors too have influence on milk donation practices. Outcome of increased donation in the form of neonatal outcome at discharge was not studied objectively.

CONCLUSION

The authors conclude that the QI initiative following repeated cycles of adapting, adopting and abandoning PDSA cycles based on local challenges and targeting major domains of policy, population, equipment and human resource in the form of targeted counselling of mothers using myriad modes, relocation of breast pumps for ease of use and readjustment of milk donation and milk bank operational timings served as a major tool in donation of milk in institutional HMB and sustain the same effectively.

Acknowledgements The authors would like to thank all the nursing staff of NICU, intermediate care nursery, labour room nursery and postnatal ward who played a major role in counselling of mothers. We would also like to pay our special regards to the lactation counsellor, and social worker who went an extra mile not just in maintaining records and gave dedicated counselling but also eagerly accepting to work extra hours on weekend to improve the services of HMB. Lastly all the mothers who had donated milk in the milk bank, without whom this study could have not been possible.

Contributors The study was designed by SJ, it was carried out by AB. During the sustenance phase, SK helped in PDSA cycles. Training of the staff and team mates was done by SJ and DC. SK helped in finalising the manuscript. All the authors contributed to finalising the study and manuscript. SJ is the gurarantor.

Funding Publication of this article is made open access with funding from the Nationwide Quality of Care Network.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Study was approved by institutional ethics committee.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data sharing not applicable as no datasets were generated and/or analysed for this study. All data relevant to the study are included in the article or uploaded as supplementary information. Data available on request due to privacy/ethical restrictions.

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BMJ Open Quality

Sustaining extended Kangaroo mother care in stable low birthweight babies in NICU: a quality improvement collaborative of six centres of Karnataka

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To cite: Murthy R, Kallesh A, Somasekhara Aradhya A, *et al*. Sustaining extended Kangaroo mother care in stable low birthweight babies in NICU: a quality improvement collaborative of six centres of Karnataka. *BMJ Open Quality* 2023;**12**:e002307. doi:10.1136/bmjoq-2023-002307

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjoq-2023-002307).

Received 8 February 2023
Accepted 21 September 2023

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ABSTRACT

Background Kangaroo mother care (KMC) is a proven intervention for intact survival in preterms. Despite evidence, its adoption has been low. We used a point of care quality improvement (QI) approach to implement and sustain KMC in stable low birthweight babies from a baseline of 1.5 hours/baby/day to above 4 hours/baby/day through a series of plan-do-study-act (PDSA) cycles over a period of 53 weeks.

Methods All babies with birth weight <2000 g not on any respiratory support or phototherapy and or umbilical lines were eligible. The key quantitative outcome was KMC hours/baby/day. A QI collaborative was formed between six centres of Karnataka mentored by a team with a previous QI experience on KMC. The potential barriers for extended KMC were evaluated using fishbone analysis. Baseline data were collected over 3 weeks. A bundled approach consisting of a variety of parent centric measures (such as staff awareness, making KMC an integral part of treatment order, foster KMC, awareness sessions to parents weekly, recognising KMC champions) was employed in multiple PDSA cycles. The data were aggregated biweekly and the teams shared their implementation experiences monthly.

Results A total of 1443 parent–baby dyads were enrolled. The majority barriers were similar across the centres. Bundled approach incorporating foster KMC helped in the quick implementation of KMC even in outborns. Parental involvement and empowering nurses helped in sustaining KMC. Two centres had KMC rates above 10 hours/baby/day, while remaining four centres had KMC rates sustained above 6 hours/baby/day. Cross-learnings from team meetings helped to sustain efforts. Extended KMC could be implemented and sustained by low intensity training and QI collaboration.

Conclusions Formation of a QI collaborative with mentoring helped in scaling implementation of extended KMC. Extended KMC could be implemented by parent centric best practices in all the centres without any additional need of resources.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Evidence from systematic reviews has shown that Kangaroo mother care (KMC) improves survival, breastfeeding rates, reduces hypothermia and nosocomial infections in the short-term and long-lasting positive effects on behaviour up to 20 years. Many quality improvement (QI) initiatives have been undertaken to sustain increased KMC duration in their individual units. These studies have tested various interventions such as awareness of staff and parents, foster KMC, simpler KMC documentation, increasing resources like KMC chairs and provision of beds to mothers, rewarding staff and parents sequentially.

WHAT THIS STUDY ADDS

⇒ Using a bundled approach encompassing parent-centric strategies aids in quick implementation of KMC. The collaborative model helped mutual learning between centres, served as a platform for sharing innovative ideas and helped scale up the intervention in multiple centres despite varied sickness and limitations in resources.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Bundled approach could be used to increase KMC duration in future QI initiatives to reduce implementation time. This collaborative initiative provides a framework for scaling up KMC in larger state or nationwide collaborations without any additional need for resources and can be replicated in similar contexts across the developing world.

INTRODUCTION

Problem description

Nearly 15 million preterm neonates are born each year, and more than 1 million of them pass away.[1] As per UNICEF, more than 35% of all neonatal deaths are caused by complications from preterm birth.[2] Many preterm infants who live experience sensory, cognitive and language impairments as a result of their early birth.[3] India is accountable for about 25% of preterm births and 42% of low birthweight (LBW) infants worldwide.[4] Kangaroo

mother care (KMC) is a simple, cost-effective and proven intervention for both survival and improved neurobehavioural outcomes of preterms.[5–7] The important component of KMC involves continuous and prolonged skin-to-skin contact between the caregiver, especially the mother and the baby. Although the effectiveness of KMC has been well documented, there is a huge knowledge-practice gap and poor implementation of the intervention in many units.[8] The common challenges for KMC implementation are low healthcare staff awareness, non-availability of mothers in the initial few days both in postcaesarean delivery and outborn settings, resistance to foster KMC (KMC by a family member), and lack of a structured policy.[8–10]

Quality improvement (QI) collaboratives help organisations identify and target implementation barriers by training them in QI processes, providing an infrastructure for addressing common barriers (provider concerns, leadership support, logistics, structural challenges), and developing an interorganisational support network from which participating centres can learn from each other's successes and challenges.[11 12] Most of the challenges for implementation of KMC are similar and possibly the solutions too. Collaborations between organisations is the need of the hour to help scale up KMC to improve preterm quality care.

Setting

A KMC QI collaboration was formed between six centres of Karnataka, India. All these six centres were tertiary care neonatal intensive care units (NICUs) with annual admission load ranging from 250 to 1200. All the centres admitted both inborn and outborn neonates with majority centres catering to the outborn population. The relevant information of the participating centres has been summarised in table 1.

Available knowledge and rationale

Evidence from systematic reviews has shown that KMC improves survival, breastfeeding rates, reduces hypothermia and nosocomial infections in the short term.[8 13] The KMC done in the initial few days can have long-lasting positive effects on behaviour even up to 20 years with less hyperactivity, school absenteeism, etc.[7] Many QI initiatives have been undertaken to implement and sustain increased KMC duration in their individual units. These QI initiatives have implemented KMC ranging from 2 months to 9 months. These studies have tested various interventions such as awareness of staff and parents, foster KMC, simpler KMC documentation, increasing resources such as KMC chairs and provision of bed to mother, rewarding staff and parents sequentially.[14–19]

Either supervision or high intensity training (>5 days training combined with >1 interactive method) alone or even in combination is unable to bring greater changes in quality care. While low intensity training combined with QI collaborative has a greater impact on improving quality care in low-income and middle-income countries.[12] With one of the centres already having a prior experience of QI in KMC,[16] we decided to form a QI collaboration to implement extended KMC across different centres.

Aim

We aimed to implement extended KMC for eligible babies (babies with no respiratory support/need of phototherapy/no umbilical central lines) admitted in the NICU of collaborative centres from a baseline of 1.5 hours (range) (40 min to 2.7 hours) per baby per day to above 4 hours per baby per day over a period of 8 weeks.

Table 1 Summary of the participating centres and demographic features

Hospital ID	Centre 1	Centre 2	Centre 3	Centre 4	Centre 5	Centre 6
Organisation type	Public sector	DNB teaching	Fellowship training	DNB teaching	Fellowship training	Medical college
No of admissions/month	120	80	50	30	20	130
Average patient occupancy/day	25	18	8	6	6	35
Patient:nurse ratio	8:1	5:1	3:1	3:1	2:1	4:1
Entry collaboration	January 2022	January 2022	January 2022	April 2022	June 2022	June 2022
Baseline KMC rate in hours/baby/day	0.6	2.9	2.7	1.6	1	2.7
No of parent baby dyads enrolled	845	187	84	51	22	254
Mean gestational age at birth (SD)	34 (2)	32 (1)	33 (2)	32 (2)	32 (1)	31 (3)
Mean birth weight (SD)	1689 (210)	1670 (275)	1554 (329)	1543(344)	1470 (290)	1450 (330)
Outborns (%)	460 (54)	51 (27)	53 (63)	11 (21)	6 (27)	37 (15)
Caesarean delivery (%)	321 (38)	153 (82)	68 (81)	46 (90)	21 (96)	162 (64)
Twin gestation (%)	66 (8)	40 (21)	3 (3)	6 (11)	3 (14)	27 (11)

DNB, Diplomate of National Board; KMC, Kangaroo mother care.

METHODS

Design

A multidisciplinary QI collaborative was formed between 6 centres of Karnataka, India. Each centre had a team of at least two nurses and two doctors. The study was conducted in the NICU and step-down wards from January 2022 to December 2022. Both inborn and outborn stable babies below the birth weight of 2 kg were eligible for the study. A stable baby was defined as a baby not requiring respiratory support, phototherapy for jaundice and or having umbilical central lines. The babies on respiratory support were also given KMC in the unit, but were not part of the data collection. Extended KMC was defined as KMC hours more than 4 hours per baby per day as per the national guidelines.[20] We used a point of care QI approach to implement KMC in stable LBW babies through a series of plan-do-study-act (PDSA) cycles.

All teams of centres except centre 6 were trained together at a QI Workshop held at Bangalore which helped to form the collaboration. The six collaborative centres were enrolled sequentially. Mentoring unit (centre 3) enrolled centre 1 and 2 first in January 2022. After implementation of extended KMC in the first two centres, centre 4 was enrolled in April 2022. Centres 5 and 6 were enrolled in June 2022. Due to lack of funding and non-availability of research staff, sequential enrolment into the collaboration was done.

Each centre had a team of 2–3 nurses and 2 doctors. Each of the participating sites chose a nurse-led team leader. Two nurses and one doctor ensured implementation of the bundle approach and entered data to the common database. Other doctor was a senior consultant who ensured team meetings and supervision of the data. The change package (bundled approach) that was given to them was based on interventions that helped implement KMC in the mentoring unit and the first two centres. Our collaborative faculty consisted of the mentoring team and senior paediatricians (with prior research/QI experience in KMC). Run charts of each centre were updated once every 2 weeks in a common whatsapp group. Monthly meetings on a virtual platform held every 4 weeks provided the teams with the opportunity for learning and served as a motivation. If there was a sudden dip in the rate of KMC in 2-weekly run charts, the team meetings with individual centres were held and supervised by the mentoring team. This assisted in creating a helpful communication system for early escalation and tackling of challenges.

Patients and public involvement

Patients and/or the public were not involved in the design, or reporting, or dissemination plans of this research. However, mothers were involved indirectly during implementation phase (PDSA 2) and during sustenance phase. In the implementation phase, mothers were the judges for the counselling competition for nurses. During the sustenance phase, mothers were trained on KMC on a weekly basis and mothers with prior KMC experience (after discharge) were involved for peer counselling of new parents.

Measurements

The key quantitative outcome was KMC hours per baby per day. The number of hours of KMC per baby was taken as a numerator. The number of eligible babies was taken as the denominator. Twin babies were taken as two eligible babies. We also recorded the percentage of parents completing extended KMC as another outcome indicator since May 2022. Audits were done by two nurses and was supervised by one doctor from each centre. KMC duration was uploaded in the common Google form of the collaboration on a daily basis. The number of KMC hours was calculated from 08:00 the previous day to 07:59 the next day. Descriptive statistics were used to describe the demographic variables. We obtained 2–3 weeks of baseline data to calculate the median. Monthly compliance rates were collected thereafter and displayed using run charts from Microsoft Excel software. We defined a shift according to evidence-based rules.[21] When we identified a shift, we recalculated the new median using the points that made up the shift and compared new data to this new median. We followed the Standards for Quality Improvement Reporting Excellence 2.0 guidelines for reporting.[22]

Strategy

During the baseline period (at least 2 weeks), the two nursing officers from individual centres collected daily data on KMC hours per baby per day from eligible infant–mother dyads on a predesigned Excel sheet. The data were supervised by doctors from individual centres and submitted to the core team of collaboration. The potential barriers for prolonged KMC were evaluated using fishbone analysis. After the baseline period, we implemented extended KMC sequentially over a period of 2 months through a series of two PDSA cycles. In each phase, the duration of KMC per baby per day was recorded daily and displayed in the run charts every 2 weeks. The collaborative meetings were held every 4 weeks with all the teams on a virtual platform which, If there was a sudden dip in the rate of KMC in 2-weekly run charts, the team meetings with individual centres were supervised by the mentoring team.

PDSA cycles

PDSA #1 (2–4 weeks)

A change package (bundled approach) was employed in the first PDSA based on the previous experience of centre 3.[16] The major process concerns addressed were staff awareness, availability of mothers and hesitation for foster KMC. The components of the bundle were staff sensitisation, issues related to mother's preparedness, availability of KMC chairs, structured counselling, promoting foster KMC, making KMC part of day to day practice and simpler KMC documentation. The staff sensitisation was the first component addressed by training sessions at

each centre virtually through live CME by the mentoring team (https://www.youtube.com/watch?v=3Vlu76uRr0I&t=36s). The session consisted of evidence, procedure and monitoring of KMC. In addition, applying QI principles for implementation of KMC was also discussed. The recorded session was used to train the nurses who missed the session. Following that, the remaining components of the bundled approach were ensured simultaneously.

Available mothers were convinced that sponging should suffice instead of bath as in one of the centres bathing facilities were not available for mothers and in few centres there was a cultural taboo to delay mothers' bath in the initial few days. A structured counselling was followed by playing a video explaining the benefits of KMC to the parents on the first visit (https://www.youtube.com/watch?v=U0yBG59Afds). Foster KMC was promoted by explaining the importance of KMC in daily NICU counselling sessions. Entry restrictions were removed for fathers or other close family members willing to do KMC as earlier entry was there only for a fixed period of time. The visiting restriction display outside NICU was modified to allow fathers or other close family members at any time for doing KMC. The posters encouraging foster KMC were placed at the counselling room.

KMC was made part of the daily routine by prescribing it in the treatment chart. A poster competition on KMC for nurses also instilled a lot of enthusiasm.

Nurses recorded KMC hours in the respiratory rate column and calculated total KMC hours at the end of the day with input-output calculations. The total KMC hours were then transferred to the daily dashboard of the unit which served both as a visual reminder and an acknowledgement. These data were transferred to the common Google form of the collaboration every day by the nursing officer.

PDSA # 2 (2–4 weeks)

In PDSA 2, the bundled approach of the first PDSA was adopted and the major process concern of parental awareness was addressed. Hence, attempts were focused towards parental involvement. The 'parental awareness session on the importance of KMC' was conducted by doctors at each centre once a month (all centres). A unique competition of KMC counselling was conducted at two centres (centres 1 and 2) where nurses had to counsel a mother on KMC. The judges were a panel of parents doing KMC and the audience consisted of parents of admitted babies in NICU. As KMC mothers participated in the session just as much as the participant did, the competition served as an interactive learning experience for them. The success of extended KMC was celebrated by nurses and parents by cutting a cake which helped in further parental motivation.

Sustenance phase

The bundled approach especially sensitisation, foster KMC and simpler data collection helped to implement extended KMC. Parental involvement was key in ensuring sustenance of KMC. Parental involvement was continued by weekly sensitisation sessions (every wednesday afternoons) by nursing officers at each centre. These sessions were also facilitated by mothers who had previous KMC experience (after discharge). This peer counselling served as a platform for promoting foster KMC and raising awareness on KMC. Monthly celebrations by cake cutting were also continued by nursing officers with mothers at all centres. KMC continued to be prescribed in treatment chart by doctors, while nurses documented in the nursing monitoring sheets, thus KMC became part of daily routine at all centres. One of the factors helping sustenance was a simpler data collection method of updating on a daily dashboard and uploading the results on the collaboration's common Google form (which was accessible via mobile devices). Knowledge attrition was one of the concerns raised during team meetings. This was addressed by using a questionnaire to assess knowledge of the nursing officers once in 3 months. The initial recorded video of KMC sensitisation was used to retrain staff if the scores were less than 80% on the questionnaire. The nursing officers promoting maximum KMC were identified as KMC champions on a monthly basis and were rewarded with prizes and certificates. The housekeeping staff in one of the centres (centre 1) assisted in helping mothers for KMC (placing and removing) as the high patient: nurse ratio was a concern. The 2-weekly display of run charts of each centre in whatsapp group served as a motivation. The centre having a sudden dip was also identified and a team meeting was done supervised by the mentoring team. The monthly team meetings were held on a virtual platform to assess the progress of KMC and discuss challenges. These meetings were chaired by senior paediatricians (with research experience in KMC) across the country on a 3-monthly basis. They not only motivated the teams but also guided the collaboration with their experience. Two centres were given lead to present the results of collaboration at both national and international level. The rewards instilled enthusiasm among the collaboration.

Currently, extended KMC is being sustained in six centres. Two more new centres are in the baseline phase of data collection and will be part of collaboration. The key interventions and drivers are summarised in figure 1. The SOP of key steps of the collaboration is summarised in online supplemental material.

RESULTS

A total of 1443 neonates below 2 kg were part of the QI initiative across 6 centres. There were a total of 145 (10%) twins and 618 (43%) were outborns. The demographic features of enrolled neonates are summarised in table 1.

The fishbone analysis revealed lack of healthcare professional awareness, non-availability of mothers, no formal counselling and thus lack of parental awareness as major concerns for KMC (online supplemental figure 1).

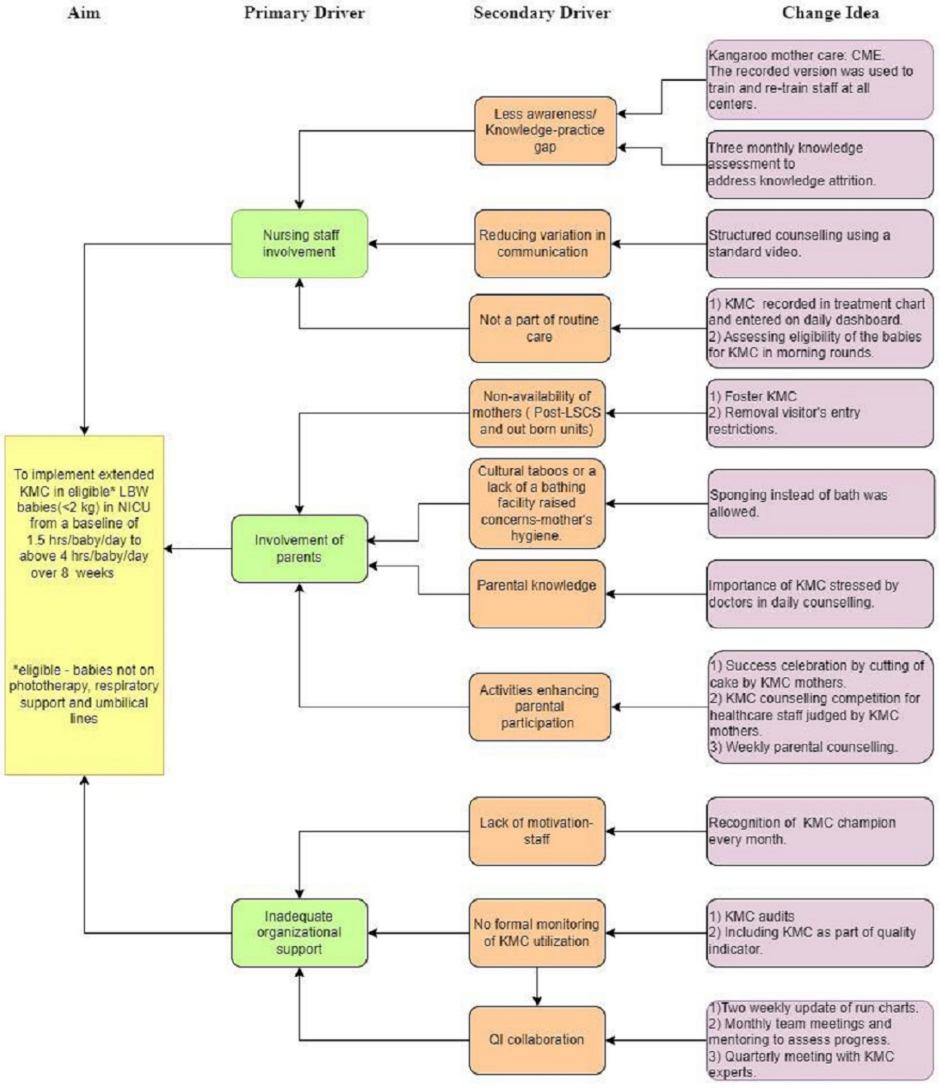

Figure 1 Driver diagram depicting key drivers and interventions. CME, Continuing medical education; KMC, Kangaroo mother care; LBW, low birth weight; LSCS, lower segment caesarean section; NICU, neonatal intensive care unit.

Figure 2 depicts the improvement of KMC rates over time as run charts. centre 1 (figure 2A) had a baseline KMC rate of 0.6 hour/baby/day (40 min). We identified a shift of 10 data points after the baseline period. We recalculated the median based on this and found the new median of 6.1. This shift suggested improvement with a bundled approach. We identified an additional shift of 10 data points after 18 weeks. We recalculated the median based on this and found the new median of 10.4. This shift suggested improvement with weekly parental sensitisation sessions. We identified an additional shift of 10 data points after 27 weeks. We recalculated the median based on this and found the new median of 14. This shift suggested improvement with recognising and rewarding nurses as KMC champions. Centre 2 (figure 2B) had a baseline KMC rate of 2.9 hours/baby/day. We identified two shifts in the run chart of centre 2 after baseline period and 18 weeks, corresponding to improvement with bundled approach and during sustenance phase with recognising and rewarding nurses as KMC champions (Centre 2 had done this strategy first). Centre 3 (figure 2C) was in the sustenance phase and ensured mentoring other centres. Centre 4 (figure 2D) had a baseline KMC rate as 1.7 hours/baby/day. We identified three shifts in the run chart of centre 4 after the baseline period, 12 weeks and 31 weeks corresponding to improvement with bundled approach, improvement with sustenance phase by weekly parental sensitisation sessions and recognising KMC champions respectively. Centre 5 (figure 2E) had a baseline KMC rate as 0.8 hours/baby/day. We identified two shifts in the run chart of centre 5 after the baseline period and after 16 weeks corresponding to bundled approach and sustenance phase respectively. Centre 6 (figure 2F) had a baseline KMC rate as 2.7 hours/baby/day. Similarly, we identified two shifts in the run chart of centre 6 after the baseline period and after 17 weeks corresponding to bundled approach and sustenance phase, respectively.

The components of the bundle and its compliance in each centre are summarised as table in online supplemental material.

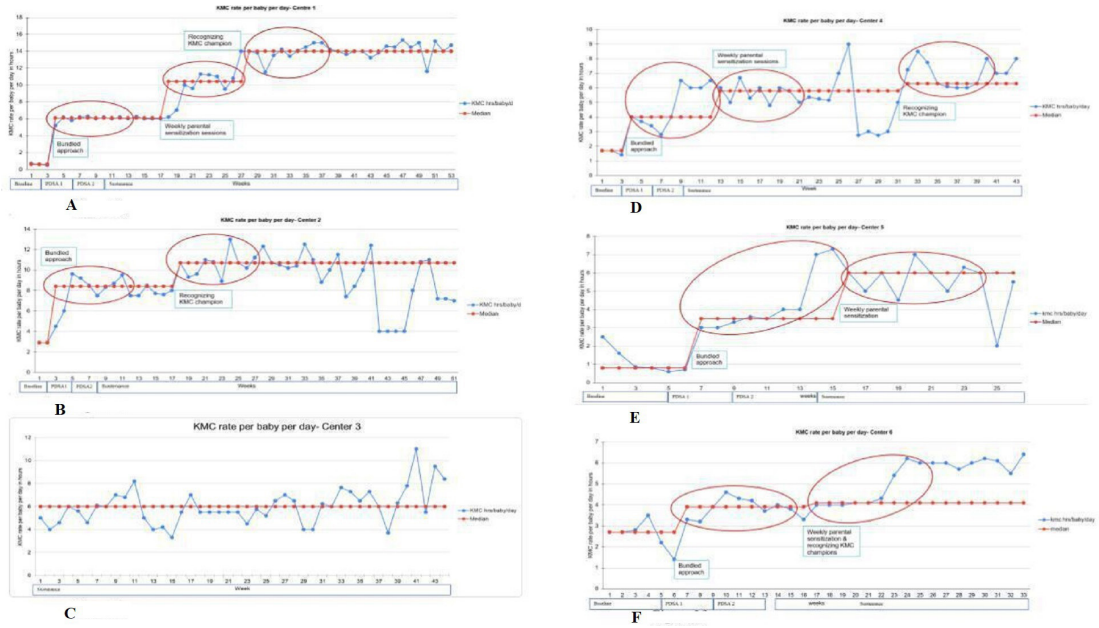

Figure 2 Run chart depicting KMC rate in hours per baby per day. (A) (centre 1), (B) (centre 2), (C) (centre 3), (D) (centre 4), (E) (centre 5), (F) (centre 6). The Oval shows a signal of shift. KMC, Kangaroo mother care; PDSA, plan-do-study-act.

Lessons and limitations

In NICUs, the healthcare professionals tend to focus predominantly on respiratory care and fluid management. Often the knowledge-implementation gap exists with developmentally supportive processes of stable growing LBW babies such as KMC. Poor utilisation of KMC has multifactorial reasons ranging from low nurses' awareness, staff shortage and inadequate support from leadership, to non-availability of mothers in outborn units, lack of awareness, challenges of accommodation or cultural practices from parents' side.[8–10] The QI collaboration ensured addressing these multiple problems based on a common bundle approach across all six centres and also addressed few unique challenges of individual centres with team meetings.

One of the unique strategies of the collaboration was employing a bundled approach for implementation of KMC. Bundle is a package of evidence-based best practices that, when implemented collectively, improve the reliability of their delivery and maximise the patient outcomes.[23] Instead of the conventional approach of testing individual strategies in each PDSA cycle, bundled approach was tested in the first PDSA. The components of the bundle were derived from the previous QI experience of the mentoring team.[16] The bundled approach reduced the implementation time across different centres from the previous 9 months to 8 weeks. Healthcare professionals training was an easier strategy employed without much need of resources. The initial training of centres happened on a live virtual platform. The recorded link helped to train nurses who missed the sessions due to leave or night shifts. To assess knowledge attrition after the training, the collaboration ensured 3-monthly assessments of nurses and retraining was done if the scores were less. Making KMC an integral part of daily prescriptions of LBW neonates made sure KMC is reviewed each day in the rounds, improved communication among all healthcare professionals and ensured regular documentation in the patient case notes. The strategy of recognising 'KMC champions' monthly, made nurses feel encouraged and motivated. Parental awareness was ensured by weekly awareness sessions by nurses (Wednesdays). The daily dashboards, run charts and posters in a few centres served as visual reminders. Foster KMC was exceptionally successful in predominant outborn units and fathers showed equal enthusiasm for kangaroo care. Parental involvement through competitions and monthly success celebrations ensured integrated efforts to sustain KMC.

Although most of the strategies were similar across all centres, few strategies had to be implemented based on the local context. One centre did not have access to a mother's hygiene/bath. Sponging was allowed instead of bathing. This strategy was also employed if there was a cultural barrier for early bathing of mothers in the first few days. One centre had issues with a higher patient to nurse ratio. Housekeeping staff were motivated to drive KMC by motivating and helping mothers in picking for KMC or placing them back in warmer. One centre had issues with availability of KMC chairs and collaboration influence for early procurement of these special chairs was fruitful. One centre had issues with hesitation by female nurses to foster KMC by fathers. Continued success of KMC and peer counselling by other centres allayed the hesitation.

The collaborative model helped mutual learning between centres, served as a platform for sharing innovative ideas and understanding different ways of improving the predefined indicators. The root of the issue that the collaboratives seek to address is deficiencies in the clinical processes and organisational structure of the health system. The collaborative model involves multiple sites

working on the same issue concurrently, and the approach promotes learning from peers who are all experimenting with various ways to enhance shared indicators.[11 12] Participation in QI collaborative activities may improve health professional's knowledge, problem-solving skills and attitude; teamwork; shared leadership and habits for improvement. Interaction across QI teams may generate normative pressure and opportunities for capacity building and peer recognition.[24] Shared experience of working as a part of the collaborative with regular mentoring seemed to improve the effective team functioning at each centre. Constant efforts were put through regular meetings by the collaborative team members to maintain the teams' motivation and to build and sustain their confidence. Bundled approach with regular training of nurses, staff encouragement, foster KMC and regular parental involvement were key in sustaining KMC. Majority of challenges faced were similar across different centres with few differences which we were able to overcome with strategies customised to each centre. The 2-weekly updates of run charts helped identify early dips and team meetings led by the mentoring team helped identify sudden change within the team and thus ensured sustenance. The monthly presentation by each team helped cross learning, gave a sense of peer pressure and also empowered them on KMC. The collaborative features such as having a standard change package, collaborative faculty (mentoring team), learning sessions interaction at the start of project at each centre, monthly conference calls, team initiated calls (whenever there is a sudden dip of KMC rate in 2-weekly data), site visits (three centres), written progress on monthly basis, collaborative extranet, etc were the key components which helped in the success.[25]

Limitations

Major challenge faced by the collaborative was lack of funding to equip and support teams to manage data collection and handle the challenges. With more centres interested in joining the collaborative, designing standardised ways of implementation, tracking the data and sustaining will be a greater challenge. Different centres with variable patient groups, facilities, manpower and experiences warrant the need for innovative ideas to sustain KMC over a longer period of time. The babies on respiratory support were also given KMC but they were not part of data collection of the collaboration. Other components of KMC such as feeding and early discharge were also ensured. But formal data collection was not part of the collaboration.

This collaborative initiative paves way for the determined collaborations to design methods to explore KMC with other aspects of neonatal care and outcomes. It provides a great opportunity to weave KMC within the existing health system, and the collaboration initiative model can be an effective method of implementation to scale up the intervention. The findings from this implementation research project will provide inputs to policy makers to formulate KMC QI collaboration for state or nationwide scaleup and thus resulting in achieving the goal of reducing neonatal mortality.

CONCLUSIONS

We were able to implement extended KMC across all six centres through bundling of raising nurses' awareness, simplifying documentation, making KMC as a prescribed intervention and promoting foster KMC. We could sustain by continuous parental involvement, developing local champions and low intensity training. Mentoring and regular motivation for each other through collaboration served as a backbone for continuous improvement. We believe our experience could be replicated in similar contexts across the developing world. Also, policy-makers could use this experience as a framework for larger state or nationwide collaborations.

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Acknowledgements Data analysis and driving QI: Team from SNR hospital-Dr. Srinath CS, Dr. Kamalakar; Sarji hospital—Ms. Asmath, Dr. Prashant, Dr. Dhananjay Sarji; Ovum woman & Child Specialty Hospital, Hoskote—Ms. Gayathri, Ms. Anusha Bai; Chinmaya Mission hospital—Dr. Sushma; Ovum Woman & Child Specialty Hospital, Banaswadi—Dr. Nayana Singhekar, Dr. Vimal Kumar; KMC Manipal-Mrs Pratima, Mrs Dakshayani, Mrs Sujatha, Mrs. Supritha. Dr. Tanushri Sahoo, Assistant Professor, AIIMS Bhubaneshwar and Dr. Suman Rao, Professor, St. Johns Medical College, Bangalore for guiding the collaboration.

Collaborators Dr. Srinath CS, Dr. Kamalakar; Sarji hospital—Ms. Asmath, Dr. Prashant, Dr. Dhananjay Sarji; Ovum woman & Child Specialty Hospital, Hoskote—Ms. Gayathri, Ms. Anusha Bai; Chinmaya Mission hospital—Dr. Sushma; Ovum Woman & Child Specialty Hospital, Banaswadi—Dr. Nayana Singhekar, Dr. Vimal Kumar; KMC Manipal-Mrs Pratima, Mrs Dakshayani, Mrs Sujatha, Mrs. Supritha.

Contributors RM: designed data collection tool, data collection, assisted in data analysis, drafted initial manuscript. AK: data collection, assisted in data analysis, assisted in drafting the initial manuscript, critical inputs to the manuscript and approved the final manuscript. ASA: conceptualised the study, supervised data collection, data analysis,critical inputs to the manuscript, drafted the initial manuscript and guarantor. SKB: supervised data collection, assisted in drafting the initial manuscript, critical inputs to the manuscript and approved the manuscript. PV: supervised data collection, critical inputs to the manuscript andapproved the final manuscript. DC, MJ, PR, DH, SNC, JP and HG: data collection, critical inputs to the manuscript andapproved the final manuscript.

Funding Publication of this article is made open access with funding from the Nationwide Quality of Care Network.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the Institute Review Board (IRB no. sarjiethics/2022/004) for multicentric QI collaboration. The mothers were explained about the QI initiative in their own understandable language and verbal consent was obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information.

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BMJ Open Quality

Observation of a quality improvement initiative to contextually adapt and use Robson classification in real time to collect data around CS delivery and to develop strategies to reduce CS rate

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To cite: Kumari P, Singh M, Sinha S, *et al*. Observation of a quality improvement initiative to contextually adapt and use Robson classification in real time to collect data around CS delivery and to develop strategies to reduce CS rate. *BMJ Open Quality* 2023;**12**:e002315. doi:10.1136/bmjoq-2023-002315

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjoq-2023-002315).

Received 9 February 2023
Accepted 23 May 2023

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ABSTRACT

The rising trend in caesarean section (CS) rate is a global concern and, in this hospital too, it rose from 21.5% in 2010 to 32.6% in 2018. The team followed the point of care quality improvement methodology and conducted a series of Plan–Do–Study–Act cycles to contextually modify and adapt Robson classification into the existing workflow to improve the process of documentation and data collection for CS in the first 6 months (January 2019–June 2019) and then to use these data to develop strategies to reduce CS rate below 30% in the next 18 months.

To evaluate the impact of developed strategies, the team plotted the data on Statistical Process Control (XmR) chart. The baseline mean CS rate was 32.6%. The team observed a shift in the CS rate data twice, between April 2020 and December 2020 and between August 2021 and February 2021 with the mean 27.8% and 28.9%, respectively. October 2021 onwards, the team also observed a sustained reduction in the CS rate in women undergoing CS who had one previous CS. The mean CS rate reduced from 94% to 86%.

The reductions in the CS rate were not sustained and followed by an increase again. The project highlighted the complexity of the factors related to CS delivery and the multidimensional barriers of sustaining the reduction in the CS rate. This is a well-sustained ongoing QI intervention and the team is further working on identifying the underlying factors to improve the efficacy of the interventions to sustain the reduction in the CS rate.

This hospital represents the general population of North India seeking care in public healthcare facilities. Therefore, despite being a single-centre study, the population served and interpretations drawn from this study are generalisable to other hospitals with similar settings.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The rising trend in caesarean section (CS) rate is a global concern and this is rising significantly over the past few decades.
⇒ The challenge is to keep CS rates low while maintaining safe outcomes for the mother and newborn.
⇒ Implementation of effective measures to lower the CS rate demands a thorough study of each case to identify the most frequent patient group undergoing this procedure.

WHAT THIS STUDY ADDS

⇒ The team followed the point of care quality improvement methodology to improve the documentation process around CS delivery and to use this data to develop strategies to reduce CS rate in the hospital.
⇒ The team incorporated the developed strategies into the daily practice and reduced CS rate in the hospital.
⇒ However, this project highlighted the complexity of the factors related to CS delivery and the barriers to sustain the reduction in the CS rate.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Despite being a single-centre study, the population served and interpretations drawn from this study are generalisable to other hospitals with similar settings. The lessons learnt can be used to develop further strategies to optimise and sustain the reduction in CS rate.

PROBLEM

Bhagwan Mahavir Hospital is a secondary care public sector hospital in New Delhi, India catering to a low-income and middle-income population. The average number of deliveries per month is 300. The hospital provides 24×7 labour room services. The pregnant women (PW) delivering at LR consists of both low-risk and high-risk pregnancy. One postgraduate senior resident (SR), one undergraduate junior resident (JR) doctor and two staff nurses (SN) in a shift provide all the services. These include labour monitoring, conducting vaginal and caesarean section (CS) delivery and other emergency operative services, and follow-up of mothers after delivery. The LR team keeps on changing due to rapid turnover of SR and

JR in the hospital. Consultant on duty takes the round of patients in LR in the morning and remains available in the hospital till 16:00 hours and on on-call till 9:00 hours next morning. This hospital has an emergency and an elective operation theatre, 10 bedded NICU adjacent to LR, a 12 bedded common ICU and a blood bank. There is no HDU and dedicated ICU for PW.

The rising trend in CS rate is a global concern and, in this hospital too, it rose from 21.5% in 2010 to 32.6% in 2018. This was much higher than the average for India (17.2%)[1 2] and the WHO recommendation on CS rate (10%–15%).[3] As the CS rate of this hospital was higher than the national average and WHO recommendation, the team decided to work on optimising the CS rate in this hospital. The team followed the point of care quality improvement (POCQI)[4] methodology to know the various factors contributing to the rising CS rate and to develop strategies to reduce unnecessary CS.

The team aimed to contextually modify and adapt Robson classification[5 6] to collect data for the number and indication of all CS done in the hospital in 6 months (January 2019–June 2019) and to use this data to develop strategies to reduce the CS rate below 30% in next18 months.

BACKGROUND

The CS rate is rising significantly over the past few decades. In India, the rate increased from 8.5% to 17.2% between 2005–2006 and 2015–2016.[1 2] WHO proposes that no improvement has been observed in maternal and neonatal outcomes in CS rates above 10%–15%.[3] However, no recommendation for a specific CS rate in a facility can be developed because of wide heterogenicity in the indications for CS, the availability of CS services and its utilisation.[3]

This potentially life-saving procedure is not without risk and might become life-threatening in the index or future pregnancies for both the mother and child. The challenge is to keep CS rates low while maintaining safe outcomes for the mother and newborn. Implementation of effective measures to lower the CS rate demands a thorough study of each case to identify the most frequent patient group undergoing this procedure.[7]

A systematic review comparing different classifications to study the most frequent patient group undergoing CS concluded that the Robson classification is optimal for monitoring CS.[8] WHO recommended it as a global standard tool for monitoring CS in 2017.[6]

The Robson classification[5 6] classifies all delivering women into 10 groups based on 5 basic obstetric characteristics; parity, number of fetuses, previous CS, onset of labour, gestational age and fetal presentation. Every pregnant woman admitted to deliver in the facility is classified into one of the 10 groups to compare the CS rate in each group (online supplemental file 1-Robson classification).

Robson classification has been used in many studies from developed and developing countries including South-East-Asia Region to analyse CS rate and its indications.[9–13] Most of the studies have used this classification retrospectively and collected data for a one-time analysis of rate and indications of CS. There are very few studies that have been done prospectively[13 14] to develop recommendations to improve CS practices. In this QI initiative, the team contextually modified and adapted the Robson classification to collect data on real time using the POCQI[4] methodology.

BASELINE MEASUREMENT

The team reviewed the CS-related records in the birth register and the operation theatre logbook. These registers had the record of numbers and indications for CS. However, indications were not categorised uniformly based on characteristics like parity, number of fetuses, previous CS, onset of labour, gestational age and fetal presentation. From these data, it was difficult to assess the common indications for CS, the group of PW undergoing most of the CS and to analyse the data to develop strategies to reduce unnecessary CS.

DESIGN

The department formed a QI team which included a consultant obstetrician, two postgraduate resident doctors and two SNs. The team members were directly involved in conducting and documenting the CS done in this hospital. The team decided first to focus on improving the documentation practice and data collection around the CS and then to analyse these data to develop strategies to reduce unnecessary CS. They analysed the problem of poor documentation around the process of CS with the help of process flow chart and fishbone analysis. On analysis, the team observed that there was no proper documentation practice to collect data for number and indication of each CS done, to categorise the indication of CS uniformly, to enlist the common indications for CS and to identify the group of women undergoing most of the CS and a departmental strategy to optimise CS rate. The team never did any clinical audit for indications of CS done in the hospital.

The team decided to contextually modify and adapt Robson classification into the existing workflow to improve the process of documentation and data collection for CS and then to use these data to develop strategies to reduce CS rate below 30%.

The Robson classification[5 6] classifies all PW admitted for delivery into 10 groups. The QI team referred to the Robson classification Implementation Manual[5] to understand the different groups of Robson classification and its use. The team oriented the doctors and staff working in the labour room and maternity operation theatre about this classification and its use. A copy of Robson classification was distributed for ready reference. The team made a form based on the Robson classification to collect data for the number and indication of CS done over the month

Table 1 Plan–Do–Study–Act (PDSA) cycles

	Plan	Do	Study	Act
PDSA-1 (2 January 2019–8 January 2019)	The SR on duty to categories all PW into 1 of the 10 Robson groups and to write the group no on case sheet. The SN on duty to note the group no for each delivery in the birth register. The consultant to check the completeness and correctness of group no on case sheet at the time of clinical rounds and again at the time of discharge of the patient.	For 1 week as planned A print out of Robson's ten groups classification was kept for ready reference.	At the end of the week the QI team reviewed this improvement process and observed that all PW delivered in that week were not correctly categorised into the ten groups. Some were misclassified and some were missed. On discussion the team felt that it might be because of the reason that the process and the concept was very new to the LR team.	The team decided to guide and supervise the LR team on this new process and to rectify any incorrect or missing data on the case sheet as a routine as the LR team keeps on changing. The team adapted and continued this process.
PDSA-2 (4 February 2019–10 February 2019)	To incorporate the Robson form into the doctor's duty report book to collect daily data for no of CS done in each group by the same team who performed the CS between 9:00 and 9:00 hours. The consultant obstetrician to supervise the data collection daily the following morning for its correctness and completeness and to get filled the missing data, if any.	For a week as planned. The consultant obstetrician in the team, oriented the postgraduate duty doctors about the form and the way to fill it.	Duty doctors found this additional step in their workflow convenient and not time-consuming but they had to refer to the Robson classification frequently. Some of the doctors missed the data entry in the Robson form which they completed next morning in the presence of the consultant. For the consultant obstetrician it was not taking much time to verify the data daily in the morning rather it provided an opportunity to discuss the process again and again. It helped in orienting the newly joined resident doctors and other doctors in the department to understand this new improvement process.	The team adopted and continued the same process for a month. At the end of the month, they had the record of all CS done daily in a month with proper categorisation into one of the ten groups according to Robson classification. Both the new processes were continued in a similar way. Gradually duty doctors were able to document the process more efficiently, had very few missing data and required minimal corrections.
PDSA-3 (6 April 2019–12 April 2019)	To fill the revised Robson form to mark the indication for CS in each group	For a week as planned.	The revised Robson form worked well and duty doctors found it easy to mention no of CS against the indication for CS. In case of any doubt, they discussed it in the following morning and completed the form. The consultant obstetrician supervised the whole process of data collection.	The team adopted the revised Robson form and continued the new processes for another 3 months.
PDSA-4 (July 2019)	To analyse the indication of emergency CS done in last 24 hours. To record the no of unnecessary CS in a month.	For a month as planned.	This intervention seemed effective and the team got to know the factors contributing to unnecessary CS delivery.	The team developed strategies to address these factors.
PDSA-5 (1 August 2019–7 August 2019)	To post one additional SR to support the LR team for conducting CS delivery and other emergency surgical procedures between 14:00 and 21:00 hours and to assist them as and when required.	For a week as planned.	This change idea worked very well. The SR on duty in LR had not to leave the LR for operative procedures and was present full time to monitor the labouring patient in LR. They felt supported in decision-making for mode of delivery in difficult situation. The other routine services were managed despite posting one SR for LR duty.	The team adopted this change idea and started posting an SR on 14:00–21:00 hours duty routinely.

LR, labour room; PW, pregnant women; SN, staff nurse; SR, senior resident.

and named it as 'Robson form' (online supplemental file 2).

STRATEGY

The QI team conducted a series of Plan–Do–Study–Act (PDSA) cycles (table 1) first to contextually modify and use Robson classification in real time for data collection and second to use this data to develop strategies to reduce the CS rate in the hospital.

It is an established practice in our hospital that an on-duty postgraduate resident doctor writes a duty report after a labour room shift duty. In the duty report, the duty

doctor summarises the work done in a shift. A consultant obstetrician checks and discusses this duty report daily the following morning. Other obstetricians and resident doctors are also present during the discussion. The team incorporated the the Robson form in the duty report. Through PDSA cycles 1–2, the QI team streamlined the process of documentation of number of CS done in each Robson group daily in the hospital.

At the end of 3 months, the team analysed the data for the quality of data collection, the type of population served by the hospital, the CS rate of each group and how each of the individual 10 groups contributed to the overall CS rate in this hospital with the help of Robson Interpretation table[15] (online supplemental file 3).

The team observed that the groups contributing most to overall CS were women with one previous CS (group 5.1) and women with first pregnancy (groups 1 and 2). Thus, the rate of both primary and repeat CS were high in the hospital. However, the indications for CS in these groups were not clear from the data collected in the Robson form. Knowing the indication for CS is the first prerequisite to develop any strategy to reduce CS delivery. Hence the team revised the Robson form (online supplemental file 4) and included common indications of CS in each group. They tested the feasibility of using this revised form in the PDSA-3 and then adopted.

At the end of the 6 months, the team had the data of all CS done in a month with proper categorisation and common indications of CS in each group. January 2019–March 2019 data were updated for indication of CS in each group with the record in case sheets. In these 6 months, the team contextually adapted the Robson classification and successfully achieved the aim to collect data for the number and indication of all CS done in the hospital. Newly recruited doctors and SN were oriented about this improvement process.

The team reviewed the monthly data for number and indication of CS. The most frequent indications for unplanned or emergency primary CS were suspected fetal distress, non-progress of labour (NPOL), cephalopelvic disproportion (CPD) and failed induction of labour (IOL). The common indication for repeat CS was planned or elective repeat CS and women not giving consent for trial of labour (TOL). Many of the indications for CS were medically indicated and done as planned CS.

In first step, the team decided to discuss the indication of unplanned CS done in the last 24 hours for its eligibility and correctness to identify unnecessary CS for 1 month in PDSA-4. In this PDSA, the team analysed the indication of emergency CS done in last 24 hours with respect to per operative findings and neonatal outcome for abnormal electronic fetal monitoring parameters suggesting fetal destress on cardiotocography (CTG), partograph findings for the indication of NPOL and prolonged labour, indications of repeat CS in women with previous one CS, TOL given or not in cases of CPD, eligibility of indication as failed IOL, and the number of CS and IOL done without consulting the consultant on duty. If all team members agreed to the indication of CS as justified in view of good fetomaternal outcome it was considered necessary. If any of the member found the indication unjustifiable the indication was considered unnecessary and avoidable. The team recorded the number of unnecessary CS month wise.

Majority of cases justified the indication of CS but at the same time the team felt some of the CS were done due to the fear of delivering a compromised baby in a busy labour room with limited human resource, not feeling confident in monitoring the labour in slow progress especially in cases of women with first pregnancy where labour takes longer time, not confident in instrument assisted delivery, doing CS for all breech presentations, fear of baby getting admitted in neonatal intensive care unit (NICU), limited availability of NICU beds in the hospital, unindicated and incomplete IOL, pregnant woman and their relative not willing to take slightest of maternal or fetal risk.

The team developed following strategies to address these issues:

- Resident doctors to involve consultant on duty mandatorily to take decision for IOL and CS.
- To formulate admission policy and to admit low-risk cases not before 40+3 weeks of gestation for delivery.
- To monitor labour by intermittent auscultation in low-risk cases and to use the CTG in high-risk cases only.
- Real-time charting of progress of labour and other parameters in partograph and to start the plotting only when woman goes into active labour.
- Judicious administration of oxytocin to augment labour.
- To allow the pregnant PW for TOL to go into the active labour before taking them for CS for failed TOL.
- To make departmental policy to induce low-risk patient not before 40+3 weeks and to individualise for high-risk patients.
- To review the indications for IOL to avoid unnecessary induction thereby CS for failed induction.
- To conduct training sessions on real-time partograph plotting, on fetal monitoring and CTG interpretation to avoid overdiagnosis of fetal distress, on instrument-assisted (forceps/vacuum) delivery and assisted breech vaginal delivery to reduce the rate of primary CS.
- To keep record of prolonged labour, scar rupture, neonatal resuscitation and stillbirth as balancing indicator.
- To involve the PW and their relatives in the counselling process and decision-making during antenatal visits and in LR.
- To present and discuss the monthly data with the team members.
- To post one additional doctor from the existing pool of doctors in LR between 14:00 and 21:00 hours to conduct CS and other emergency operations (PDSA-5).

As the another common group undergoing CS were the PW having previous one CS delivery; the team evaluated

the data collected in the modified Robson form for indications of repeat CS. The most common indication of repeat CS in women with previous one CS was elective/planned repeat CS (ERCS). Other indications were women not giving consent for TOL after CS (TOLAC) and failed TOL. Only a few women delivered vaginally after CS. To reduce the number of repeat CS the team emphasised on:

- To evaluate the PW with previous one CS delivery in the antenatal period for their eligibility for TOLAC.
- To counsel the eligible candidate for TOLAC in the antenatal visits and at the time of admission in LR to increase their willingness.
- To evaluate the indication of ERCS and failed TOLAC to avoid unnecessary repeat CS.
- To follow the strategies to minimise primary CS thereby the repeat CS in subsequent pregnancy.

The team incorporated these strategies into the daily practice to reduce CS rate in the hospital. Later the team also evaluated the indications for planned CS in the Robson classification and tried to optimise the CS rate in these groups wherever possible. The consultants assured the resident doctors in making a decision and in counselling the patient and their relatives in difficult situations.

Sustenance phase

QI team met regularly in the first week of every month with other members of the department to discuss the impact of developed strategies on CS rate and the way forward.

The SRs are collecting monthly data in the modified Robson Form and for unnecessary CS as per their duty roster. Additionally, they are collecting monthly data for instrumental delivery, VBAC, breech vaginal delivery, neonatal resuscitation, stillbirth and scar dehiscence/rupture as the balancing indicator. The data were entered in a Microsoft Excel spreadsheet for compilation, analysis and comparison. The team used tables and run charts to display and interpret the serial measurement of process and outcome indicators. The team used Statistical Process Control (XmR) chart[16–18] to assess the effects of revised clinical protocols on CS rate. They analysed the data whenever there was a shift in the mean.

The new doctors and staff joining the department were oriented about this improvement process at the earliest. The leaders at all levels were kept in the loop and informed since starting and no leaderships issues were encountered. October 2021 onwards the team is also participating in a collaboration of medical colleges and district hospital in their endeavour to develop strategies to optimise CS rate in Delhi using Robson classification.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, of this report. The objective of the study was to improve documentation and data collection practices, and data analysis to reduce unnecessary CS, and to provide quality care in the hospital.

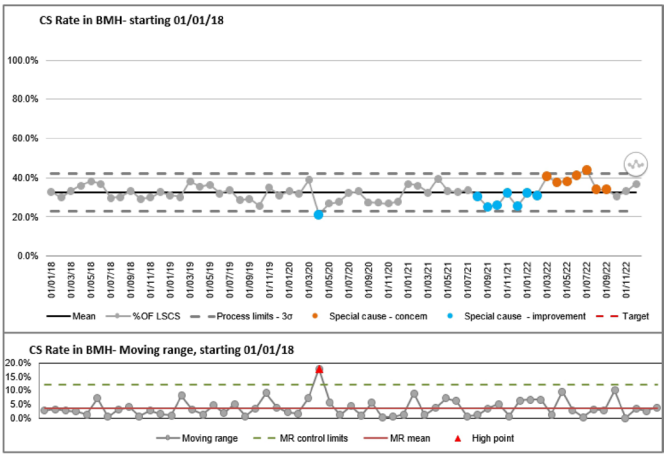

Figure 1 XmR chart for % women delivering via CS. BMH, Bhagwan Mahavir Hospital; CS, caesarean section.

RESULTS

The team started this project in January 2019 and since then collecting month-wise data for number and indication for CS in the Robson form and following the strategies to reduce the CS rate. As the data collection was real time and verified routinely the next morning, there were no missing or incomplete data.

To evaluate the impact of developed strategies, the team analysed the monthly data on total delivery, total CS delivery, CS rate in each group and balancing indicators (online supplemental file 5 table-2).

The team plotted the month-wise data for CS rate from January 2018 (baseline data) to December 2022 on an Statistical Process Control (XmR) chart.[16–18] The mean CS rate in 2018 was 32.6%. This was set as the baseline. The monthly CS rate went below 30% many times during this period. The lowest observed CS rate was 21%. The team observed a shift in the data twice, between April 2020 and December 2020 and between August 2021 and February 2021 with the mean 27.8% and 28.9%, respectively. However, these reductions in the CS rate were not sustained and followed by an increase again. The mean CS rate during the observation period was 32.5% (figure 1).

October 2021 onwards, the team also observed a sustained reduction/shift in the CS rate in women undergoing CS who had one previous CS (group 5.1). The mean CS rate reduced to 86% from 94% (figure 2).

There was no sustained reduction in CS rate in other groups. However, the number of avoidable CS decreased and number of VBAC, breech vaginal delivery, instrument assisted deliveries increased following the interventions. There were no significant changes in fresh stillbirth, neonatal resuscitation, scar rupture, maternal death, near miss and referral data.

LESSONS AND LIMITATIONS

This is a well-sustained ongoing and a challenging QI project. The team is working on this project since January 2019 without any additional cost or resources.

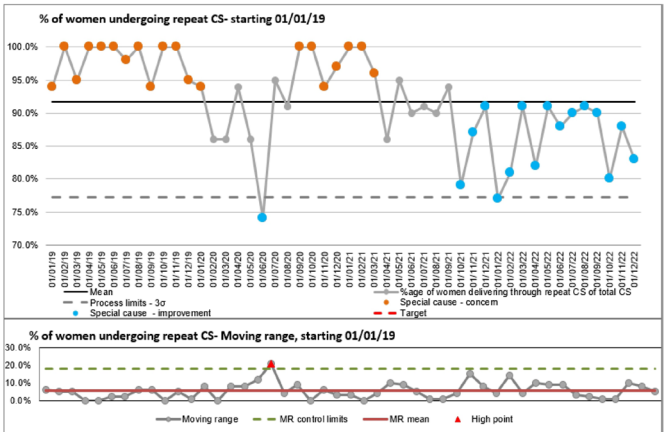

Figure 2 XmR chart for % women undergoing repeat CS. CS, caesarean section.

Robson classification is a global standard tool for monitoring CS. The team contextually modified this and improved the documentation process in the hospital successfully. Since Robson classification is not an audit of the appropriateness of indications for CS, the team designed a mechanism within the existing workflow for continuous clinical audit of indications for CS to achieve an optimum level of CS rate.

The team assessed monthly CS rate in the hospital, common indications for CS, CS rate of each group, most frequent patient group undergoing CS and how each of the individual 10 groups contributed to the overall CS rate using this classification. Based on the data, they developed and implemented strategies to reduce CS rate below 30%. Lacking a clear understanding of what might be a medically justifiable CS rate for this hospital the team picked a figure of 30% as a goal.

Following the implementation of the strategies, the team observed monthly CS rate below 30% many a times and a significant reduction twice in the observation period. There was 8% reduction in CS rate in women undergoing CS who had one previous CS (group 5.1) and well sustained until. The other groups did not show any sustained reduction. The number of avoidable CS decreased and number of VBAC, breech vaginal delivery, instrument assisted deliveries increased following the interventions.

The team achieved its aim to reduce the CS rate below 30% in first 18 months and thereafter too, but failed to sustain the achieved reduction. These reductions never met the recommended CS rate (10%–15%), and followed by an increase in the mean CS rate. The rise in CS rate corresponded with the changing LR team, joining of newly recruited fresh pass-out postgraduate SRs in the department, their variable clinical and surgical skills, changing demographic profile of the PW coming to the hospital, and increasing number of PW coming with previous one or two CS delivery.

The project highlighted the barriers of sustaining the reduction in the CS rate. This is a government run public sector hospital where CS delivery on demand and for profit is not done. The team evaluated each indication to avoid unnecessary CS in the hospital routinely. The new data collection and documentation process, and the developed strategies were in place throughout the observation period but the team observed variations in the CS rate. The mean CS rate remained quite high (mean 32.5%). The QI interventions to collect data for number and indications of CS accurately and implementing strategies to optimise CS rate did not work completely in this facility. The poor effect of these interventions in sustaining reduction in CS rate might be due to the complexity of the factors related to CS delivery. Identifying the underlying factors could improve the efficacy of these interventions to reduce the CS rate and to sustain it.

Worldwide, the frequency of CS continues to increase, and interventions to reduce unnecessary CS have shown little success. Many decisions to use CS are driven by the clinical or psychological needs of the mother or by the clinical needs of the baby, or by both. The team should evaluate all possible drivers for overuse of CS delivery which are related to PW, families, communities, the society, health professionals, healthcare systems, and the organisational design and cultures. Accordingly team should focus on developing interventions to target each driver. These interventions should be tailored to the local contexts and should address the concerns of women and health professionals and the limitations of the health facility.[19 20]

As a way forward to reduce the CS rate, the team is critically evaluating all drivers of overuse of CS and participating in a collaboration of medical colleges and district hospital of Delhi to work together to develop strategies to reduce CS rate. The team might learn from other facilities experience on reducing the CS rate and adapt those learnings in the hope to reduce the CS rate to less than a safe threshold value over a period of time ensuring good maternal and perinatal outcomes. Considering the rapid turnover of resident doctors and their variable skills the team is focusing on training the new residents and to use the available resources more efficiently. They are improving the counselling process to provide women and families a more meaningful medical dialogue and effective emotional support. The team has also started allowing birth companion in labour room. Presence of a birth companion during labour shortens the labour duration and reduces the likelihood of emergency caesarean delivery.[19] The team hopes that with time they will see positive results as aimed.

This hospital represents the general population of North India seeking care in public healthcare facilities. Therefore, despite being a single-centre study the population served and interpretations drawn from this study are generalisable to other hospitals with similar settings. The lessons learnt can be used in similar settings.

CONCLUSIONS

Rising CS rate is a major concern for both public and private sector hospitals globally. At the same time, reducing

the CS rate to an optimum level is very challenging. Underuse leads to maternal and perinatal mortality and morbidity. Conversely, overuse of CS has not shown benefits and can create harm. The factors causing the rise in CS rate are multidimensional requiring interventions at multiple levels. QI methodology provides an opportunity to improve health services at different level. The team hopes that the learnings from this QI intervention will lead them and other facilities to use CS services judicially ensuring good maternal and perinatal outcomes.

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Acknowledgements We acknowledge the contribution of the Nationwide Quality of Care Network (NQOCN), India for providing us training on POCQI methodology. We also acknowledge the mentoring support from NQOCN, India for conducting and sustaining this QI project, drafting the manuscript and for reviewing the manuscript before submission.

Contributors PK, MS and SS conceptualised the project and provided leadership to carry out this quality improvement work. PK, SS, PS, CM and SB were responsible for conduction of the improvement process and data collection. PK, PS, CM and SB were responsible for data collection and compilation. PK, MS and RR contributed in drafting of the manuscript. All authors revised it critically and approved the submission. MS and PK contributed in the data analysis and revision of the manuscript. All authors have approved the final version. PK, guarantor.

Funding Publication of this article is made open access with funding from the Nationwide Quality of Care Network.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This project was a quality improvement initiative designed to improve the service for patients. It was undertaken using improvement science methodology. The interventions made were designed to improve the documentation processes around caesarean section (CS) delivery in the hospital and to develop strategies to optimise CS rate.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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BMJ Open Quality

Quality improvement initiative improves the empiric antibiotic prescribing practices in a tertiary care children's hospital in India

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To cite: K, Pemde H, Kumar V, *et al*. Quality improvement initiative improves the empiric antibiotic prescribing practices in a tertiary care children's hospital in India. *BMJ Open Quality* 2023;**12**:e002181. doi:10.1136/bmjoq-2022-002181

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjoq-2022-002181).

Received 4 November 2022
Accepted 19 August 2023

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ABSTRACT

Introduction Infections are a common cause of paediatric morbidity. Antibiotics are vital in treating them. Erratic prescribing practices are an important cause for the development of antibiotic resistance. Our objective was to estimate the effectiveness of educational interventions to improve empirical antibiotic prescribing practices among paediatric trainees. We aimed to improve the compliance to antibiotic protocols and to sustain it over 6 months.

Methods It is a time interrupted non-randomised trial conducted in a tertiary hospital in India. Initially, 200 admitted children were selected randomly. Their antibiotic prescriptions, adherence of prescriptions to the then existing antibiotics guidelines, course during hospital stay and the final outcome were noted. The existing antibiotic policy and its use were reviewed. It was then considered essential to prepare a fresh antibiotic policy based on national guidelines, local sensitivity patterns and with inputs from microbiologists. This was distributed to the residents through seminars, posters and cellphone friendly documents. Compliance to the policy was also tracked twice a week. The adherence to guideline was recorded in the subsequent 6 months.

Results The adherence of empirical antibiotic prescriptions was 59% before intervention which improved to 72% in the first month, 90% in the second month, 86% and 78% in the third and sixth months, respectively. There was no significant difference in duration of stay and the outcome at discharge in the patients in adherent and non-adherent groups.

Conclusion Educational interventions and frequent monitoring improved antibiotic prescribing practices among residents with no negative impact on patient outcomes. Quality improvements need persistent reinforcement and frequent monitoring to be sustainable.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Improving antibiotic prescribing is critical to effectively treat infections, protect patients from unnecessary side effects, and combat antibiotic resistance.

WHAT THIS STUDY ADDS

⇒ Designing a locally accepted antibiotic policy and educating the doctors is of paramount importance to improve prescribing practices. Our study shows that the adherence increased from 59% before intervention to 78% after intervention at 6 months.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Adherence to guidelines should be monitored and updated regularly to maintain the improvement.

INTRODUCTION

Problem description

In a developing country such as India, infectious diseases are the most common cause of morbidity and mortality.[1] Antibiotics are crucial in treating them. Misuse and overuse of these drugs can lead to emergence of multidrug resistant micro-organisms.

Available knowledge

A study done by Kotwani and Holloway found high antibiotic consumption in the capital metropolitan city of India: 43 390 defined daily doses (DDD) per 1000 patients in the public sector, 125 544 DDD per 1000 patients in private pharmacies, and 81 467 DDD per 1000 patients in private clinics.[2] Data from the Indian Council of Medical Research (ICMR) antimicrobial resistance surveillance network show that more than 70% Enterobacteriaceae are resistant to third-generation cephalosporins.[3] In 2010, India was the world's largest consumer of antibiotics for human health at 12.9×10^9 units (10.7 units per person).[4]

Rationale

Behaviours related to use of antibiotics need change to decrease the incidence of antimicrobial resistance. India has achieved remarkable reductions in smoking in buildings and workplaces through regulation and behaviour change communications. Similar campaigns could work to educate the public and physicians about the dangers of uncontrolled antibiotic use, as has been the case in high-income countries, but more research is

needed to see how well this could work in hospitals in India.[5] Worldwide, several methods and interventions have been used to improve the use of antibiotics by physicians including using a checklist for indication of use of antibiotics, educational interventions (seminars, index cards), declaring official antibiotic policy and dissemination of antibiotic policy using the intranet .[3 5 6]

There may not be a one-for-all method in ensuring adherence to the policy in different hospitals. Every clinical unit would require its own method of implementation and improvement in compliance to it. In 2017, the faculty and residents in our hospital were involved in quality improvement training using point-of-care quality improvement method.[6] This motivated us to undertake this study. We decided to review and improve the use of antibiotics in our paediatric medical units.

Specific aims

Our objective was to improve antibiotics prescribing practices of resident doctors working in our unit. We aimed to improve the compliance to antibiotic protocols by 50% and to sustain it over 6 months by implementing an educational programme, supplemented by frequent monitoring and re-emphasis on the compliance.

METHODS

Context

This quality improvement initiative was undertaken at Kalawati Saran Children's Hospital attached to Lady Hardinge Medical College in New Delhi, India (LHMC). It has 380 beds with more than 25 000 inpatients and more than 250 000 outpatient visits per year. This study was conducted in one of the three paediatric medical units. All data were collected by anonymising patient identifiable information.

The first prescriptions at admission are written by the residents who are the first point of contact to the patients. They are generally rotated through the different units of the hospital for training purposes (figure 1). The institutional (LHMC) guidelines for antibiotics use were prepared in 2015 and the residents could also access the guidelines issued by ICMR, New Delhi, and by National Center for Disease Control, New Delhi (NCDC) on the internet. We did not have a formal written antibiotics policy of our unit.

The data on antibiotic compliance were collected from 1 November to 31 December 2017 and this was used as a control group . We included children admitted to our unit (from outpatient department and emergency services) between the ages of 0 and 18 years and who received antibiotics at admission for any infectious disease. Children who already had a culture report or had received antimicrobials previously in a different healthcare centre were excluded.

Two hundred cases which met our inclusion criteria were selected from the unit's admission register using random number tables and their inpatient files were accessed. The provisional diagnoses, the antibiotics prescribed at admission, the changes in treatment during the course of stay, the reasons for change in antibiotics and the final outcome were noted. The prescriptions were considered adherent to guidelines if they adhered to any one of the three guidelines viz the guidelines from LHMC, ICMR or NCDC. These guidelines were selected as they were standardised, updated and accessible to all.

Interventions

Adherence to either one or more of the existing guidelines was found to be 59% only. In order to improve the adherence, it was decided first to find the reasons behind this inadequate adherence. A multidisciplinary quality improvement team was formed consisting of faculty (paediatrics, neonatology and microbiology), residents and the nursing officers to coordinate this quality

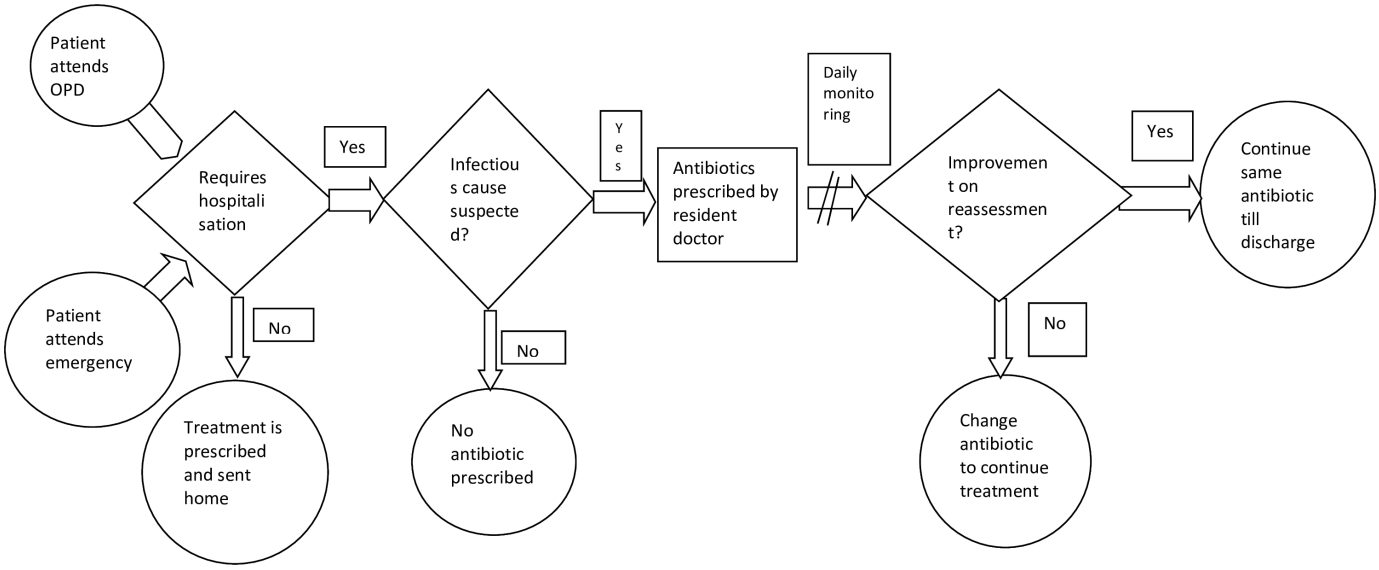

Figure 1 Process map of antibiotic prescribing at admission in hospital and its monitoring. OPD, out patient department.

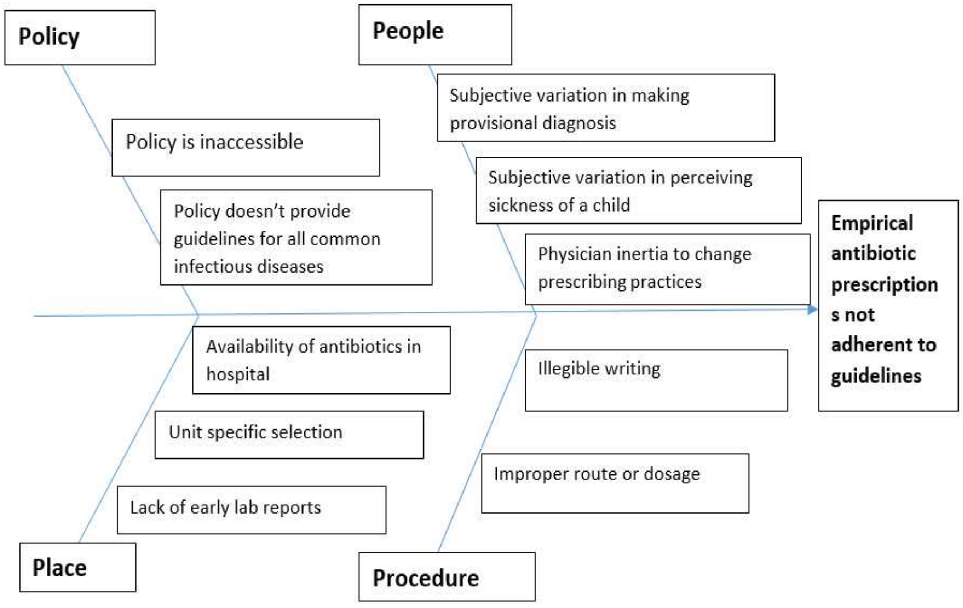

Figure 2 Fish bone analysis of the cause for non-adherence to guidelines.

improvement initiative. The team formulated a Specific Measurable Achievable Relevant Time-bound (SMART) aim—to increase the adherence of first prescription of antibiotics to the guidelines from current 59% to greater than 90% in 6 months' time. The team conducted a root-cause analysis to detect the causative factors for non-adherence to the guidelines. A fish bone analysis (figure 2) also illustrated the various possible reasons for non-adherence. The most important and easily remediable reasons we found were that there existed a hospital policy but it was not easily accessible at the workplace where patients came into first contact for prescribing antibiotics and that the policy did not cover all the common illnesses which present to our hospital.

The team decided to create a written policy on the recommended empirical antibiotics for all the common infectious illnesses. While formulating the policy, we found that no single guideline could give us the appropriate empiric antibiotic regimen for all the common diagnoses. So we consulted the guidelines by NCDC and ICMR in addition to the guidelines of our own hospital for designing it. The experts in the field of pulmonology and severe acute malnutrition were also consulted because a considerable fraction of inpatients tend to suffer from severe acute malnutrition and respiratory infections. The culture and sensitivity patterns of common organisms of the previous 5 years (2013–2017) were reviewed and used in finalising the policy.

The policy was then scrutinised by our team and the other faculty in the unit. The policy was also approved by the head, department of paediatrics in our hospital. This empirical antibiotic policy designed and customised for our hospital is given in online supplemental Annexure 1. The primary intervention was to formulate the empirical antibiotic policy specific to our unit which included all the common diagnoses and to introduce it to all the residents through an educational seminar. We planned to display the posters of the policy at prominent places in the hospital ie the paediatric emergency room, doctors' duty room and treatment rooms in the unit. We also sent a downloadable portable document format (pdf) copy of the policy through social media to each resident (plan-do-study-act, PDSA cycle 1). Our major strategy for implementation was education, auditing, feedback and frequent reminders (figure 3).

The first PDSA cycle consisted of adopting the policy as the policy of the unit, circulation of the policy through a seminar and also to distribute it in the form of pasting the posters in the areas where patients are seen first (ie, emergency room and also in the treatment room of our unit) and pdf documents for easy access and quick reference. In September 2018, a seminar was conducted to introduce the antibiotic policy to all the residents and the faculty. The seminar provided an overview of the guidelines, discussed the rationale behind the guideline recommendations and identified situations where local practice diverged from the national guidelines due to the hospital microbial culture and sensitivity patterns. It also provided the results of the baseline study that we had conducted a few months previously as well as the recent studies conducted around the country regarding the dramatic rise of antimicrobial resistance.

Any new residents posted to the unit had an induction which provided the antibiotic policy and stressed on the importance of following it so as to maintain the effects of implementation.

Following the introduction of antibiotic policy, 50 random cases were selected at the end of first, second, third and sixth months and their adherence to the antibiotic policy was noted in terms of percentage. A χ^2 test was applied to know the statistical significance of the change.

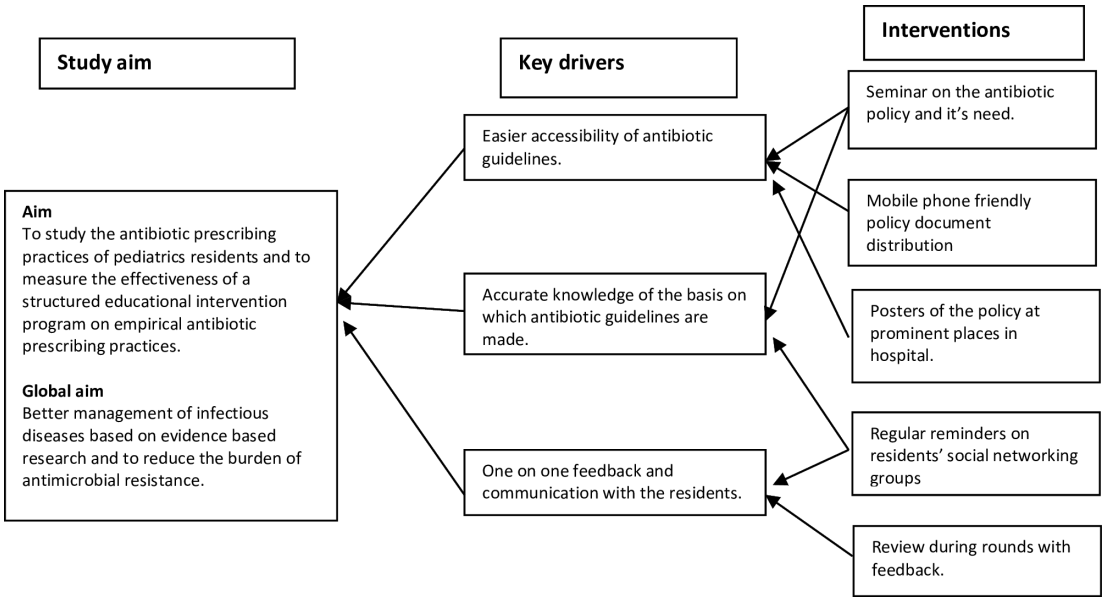

Figure 3 Key drivers in achieving the study aim and the implemented interventions.

After noting the results at the end of first month, the team reviewed the progress. The adherence to the new policy increased, but the change was not statistically significant. A meeting was called at the end of first month and the residents were requested to give their verbal feedback regarding barriers for the implementation. Also their queries, suggestions, situations where they found difficulties in following the policy were reviewed and their possible solutions were also discussed.

We decided to have reinforcements such as weekly reminders to follow the antibiotic policy and the need to follow it was sent in the official online/WhatsApp group for doctors of the unit (PDSA cycle 2).

We started a biweekly review of the antibiotic prescriptions in morning rounds. The reasons for non-adherence were discussed and the residents were instructed and educated for appropriate choice of antibiotics. The adherence to antibiotic policy was reviewed at the end of second, third and sixth months. We also compared the change in antibiotics after admission, and the final outcome at discharge.

RESULTS

The primary outcome was measured as the proportion of prescriptions adherent to the antibiotic policy. Hospital staff of 10 consultants, 64 residents and 24 nurses were targeted to participate in this programme. We planned an educational intervention and since the residents rotated into the unit change every 3 months, this seemed the best way to study the impact of our intervention on the prescribing behaviours of residents.

The median age of the patients in the whole cohort was 12 months (range 2 days to 17 years). Among them 58.75% were males. The cases were evaluated at baseline and followed up till the conclusion of their treatment—either till the child became well and was discharged or succumbed to the clinical consequences.

In the preintervention period, the adherence to guidelines was 59%. After the intervention (first PDSA cycle), at the end of the first month even though the adherence increased to 72% (p=0.09), it was not significant statistically. A review meeting was held to discuss the possible hindrances in implementation of the antibiotic policy. The residents were provided with the evidence regarding the causes of development of antimicrobial resistance, its effects on human health, the ways to tackle it and the necessity of antibiotic policy. This led to a significant rapid change in the adherence to the policy. Following this, the second PDSA cycle was done using significant reinforcement measures in the form of reviewing the adherence in the morning rounds (at least twice weekly on the day following the admission days, ie, Tuesdays and Fridays) and it led to an increase in adherence to 90% (p=0.04). The improvement persisted at the end of third and sixth months as 86% and 78%, respectively (p<0.05). Overall, the postintervention antibiotic compliance was 81.5% (p<0.00001). The run chart of the adherence to antibiotic policy is shown in figure 4.

We also reviewed whether the empirical antibiotics were changed and the reasons for that. We found that the common reasons for change in the antibiotics were non-improvement of clinical status, worsening clinical condition, availability of culture and sensitivity report, in this order. The children in the non-adherent group were more likely than the children in adherent group to have their antibiotics changed during the course of their treatment (figure 5).

On subgroup analysis, we found that the adherence improved drastically postintervention in bronchiolitis, fever without focus and acute gastroenteritis compared with the preintervention period. The change in

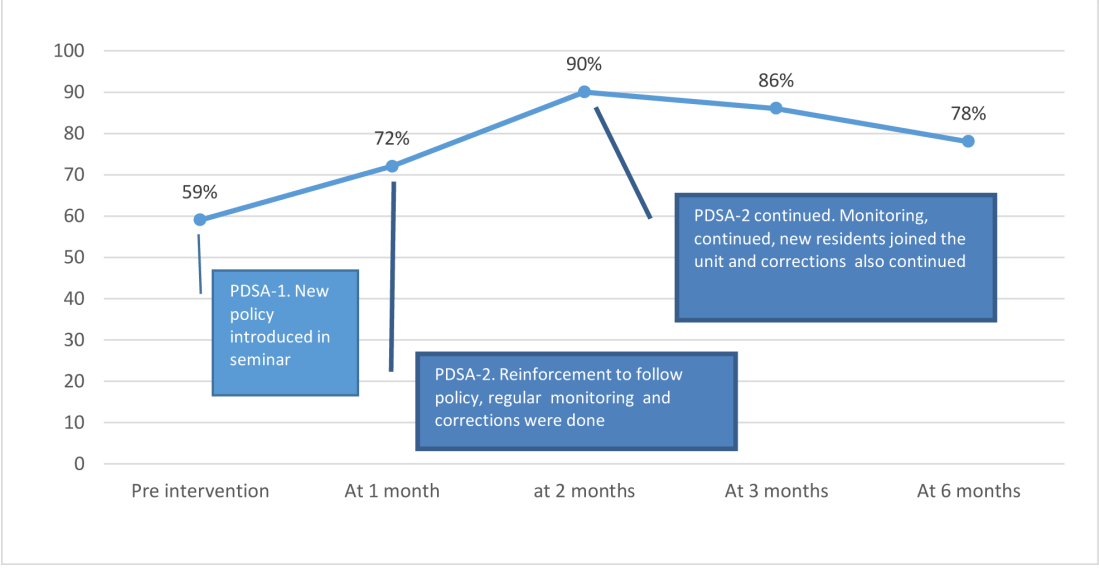

Figure 4 Run chart showing adherence (in percentage) to antibiotic policy during the study. PDSA, plan-do-study-act.

adherence in pneumonia and sepsis, however, varied in different months.

The diagnosis of pneumonia has never achieved a 100% adherence and the rates of non-adherence were also high in sepsis (figure 6). Bronchiolitis which had a higher percentage of non-adherence before intervention saw a drastic change with >90% adherence in the subsequent phases. Peritonitis, fever without focus, liver abscess and acute gastroenteritis saw a rapid and drastic improvement in their adherence postintervention.

The difference in duration of stay among the adherent and non-adherent groups remained insignificant. It implies that there was no clinical harm or increase in the duration of stay if antibiotics were used according to the unit policy. There was no change in the final outcome (ie, discharge or death) of the patients in both the adherent and non-adherent group which re-emphasises the preceding point of prescribing the antibiotics according to the policy.

The reasons put forward by the residents as the reason for resistance to change their previous prescribing practices were fear of under treatment, over estimation of severity of clinical condition and the feeling that these policies are not ideal in an overcrowded government tertiary care centre. All these challenges were overcome by frequent open discussions and spending some time together analysing the evidence behind why antibiotics are advised in the policy.

DISCUSSION

Summary

Our study is a single-centre, hospital-based, non-randomised controlled trial with an interrupted

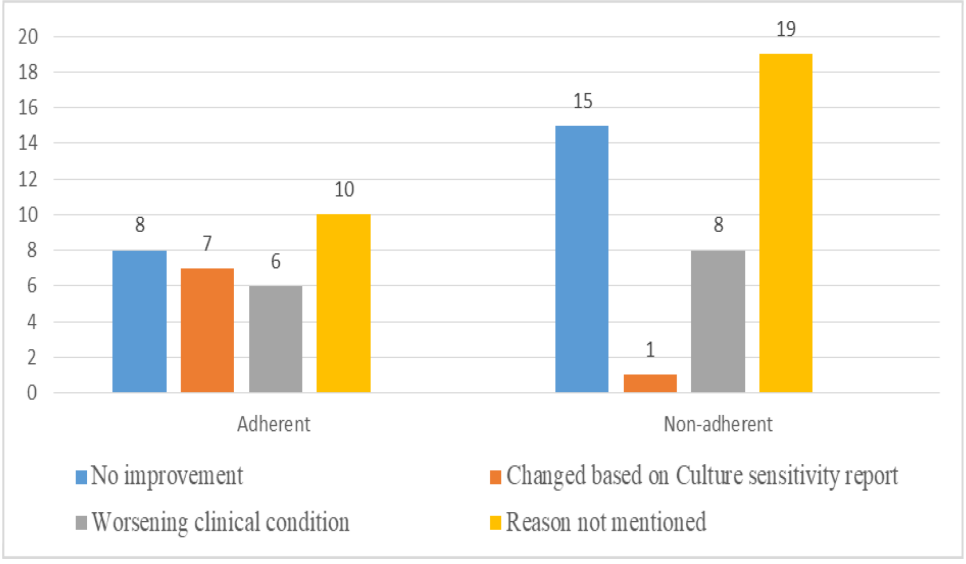

Figure 5 Reasons for changing antibiotics in the adherent versus non-adherent group.

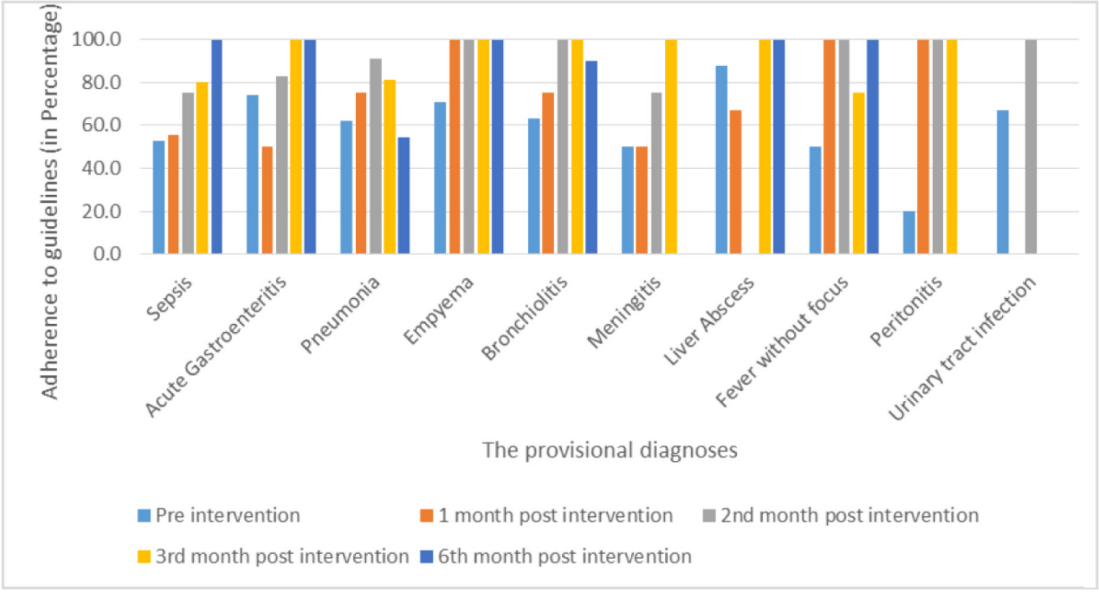

Figure 6 Diagnosis wise change in adherence to guidelines for empiric use of antibiotics during the study.

time-series analysis. Two hundred patients were enrolled in the study to note the baseline data before the intervention. After the introduction of antibiotic policy, 200 cases were again enrolled, 50 each at the first, second, third and sixth months. The root cause analysis revealed deficiencies in the policy and also the lack of accessibility to it. Quality improvement efforts included a new antibiotic policy, wide dissemination and availability at the point-of-care and frequent reinforcements using regular reviews and monitoring. This led to an improvement in adherence to the policy from 59% to 72% in the first month, which later changed to 90% by the end of second month, and 86% and 78% in the third and sixth months, respectively.

Interpretation

Similar to our intervention of making a policy and implementing it with frequent reinforcements, Stocker *et al* used a mandatory checklist requiring indication and recording likelihood of infection at start of antibiotic therapy, review of the continuing need for therapy at 48 hours and 5 days, and documenting the reasons for continuation and possible target pathogen. The use of appropriate empiric antibiotic therapy courses for culture-negative infection-like symptoms increased from 18% (10/53) to 74% (42/57; p<0.0001), duration of therapy <3 days increased from 18% (10/53) to 35% (20/57; p=0.05) and correct targeting of pathogen increased from 58% (7/12) to 83% (20/24; p=0.21).[7]

Ambroggio *et al* in their study found a significant improvement in appropriate first line antibiotic prescribing for uncomplicated pneumonia by the emergency team from 0% to 82% and in the ward team from 30% to 90% over a span of 3 months after a series of interventions including educational seminar, providing summary of guidelines, index card, and changes in electronic medical record prescription system.[8]

Hadi *et al* found that after the creation of the hospital's official antibiotic guideline, the proportion of patients treated with antibiotics decreased from 88% to 54% (effect size –34% points, 95% CI –25% to –43%). The amount of antibiotics used decreased to almost half from 99.8 to 53 DDD/100 patient-days.[9] Thus, having a formal policy made this difference.

Chandy *et al* found that the hospital antibiotic policy guidelines disseminated through a booklet and intranet access in all outpatient, departmental offices and ward computers resulted in a significant decrease in antibiotic use .[4]

We also found that the change of antibiotics during the course of treatment was more likely in the non-adherent group than in the adherent group. We could not find other studies to compare these observations.

We found that the final outcome at discharge in both adherent and non-adherent group was similar. A Cochrane review to estimate the effectiveness and safety of interventions to improve antibiotic prescribing to hospital inpatients and to investigate the effects of two intervention functions (restriction and enablement) found that the duration of antibiotic treatment decreased by 1.95 days. It also showed interventions to be associated with improvement in prescribing practices according to antibiotic policy in routine clinical practice. The risk of death was similar between intervention and control groups (11% in both arms), indicating that antibiotic use can be reduced without any increase in mortality.[10]

Though the most appropriate techniques for quality improvements in antibiotic use in paediatric population are not completely elucidated, our data suggest that clinical guidelines and educational interventions created by a multidisciplinary team can have a significant impact on antimicrobial use. Easily accessible antibiotic policy posters, smartphone friendly document of the antibiotic policy and frequent reminders to residents and faculty regarding usage of antibiotic policy contributed to the increase in compliance in this study.

In our study, the compliance improved in initial months and again dropped. Change in residents who decide on the initial choice of antibiotics, reduced reminders on antibiotics policy and difficulty in making specific diagnosis at the first point of contact with healthcare especially in case of pneumonia may be the reasons for drop in compliance. Thus, for sustaining compliance among residents we need to improve the skills of making a specific diagnosis and enhancing their confidence in the unit policy, continue regular daily monitoring of compliance and also revisiting the reasons for non-compliance and their prompt solutions. Fall in adherence in the end could also be due to seasonal influenza and other diseases which increase antibiotic prescriptions making adherence weak. The change in outcome might not be easily seen as antimicrobial resistance is multifactorial and rational use is just one of them.

Limitations

There are several limitations to our study. First, the interventions were started in peak season for respiratory viral illnesses in September 2018 whereas the baseline data were collected from July 2017 to February 2018 and sustainability of intervention has been documented between October 2018 and March 2019. Also, there is only one point of comparison before the intervention and four points after intervention. Due to frequent rotation of the residents every 3 months, the impact on knowledge was not possible. Observation of the effects beyond 6 months would be beneficial in understanding the sustainability of the results of educational intervention.

Ours is a project involving educational intervention. With trainee residents getting rotated to different units every 3 months, we could not check the knowledge change but just measured the change in prescribing patterns.

Many of the senior paediatric consultants in our hospital were involved in the development of the antibiotic policy. The 'buy-in' effect of these key opinion leaders might have played an important role in our success. However, this also demonstrates that everyone should be involved in implementation of policies intended to be influenced by several factors and even subjective decisions.

CONCLUSIONS

We found that quality improvement interventions can lead to improved antibiotic prescribing practices of resident doctors for hospitalised children and it has no negative consequences. The use of specific antibiotics at an appropriate dose, frequency and duration is important for timely management and to prevent antimicrobial resistance. Although the medical professionals were willing to follow the antibiotic policy, it needed constant and persistent reinforcement and monitoring to keep the improvement sustainable. While the hunt is still on for the best methods for antimicrobial stewardship, the quality improvement initiative offers a plausible way in the right direction and can be easily reproduced in many other secondary and tertiary centres.

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Contributors All authors were included in: conception and design of the work, data analysis and interpretation, drafting the article, critical revision of the article and inal approval of the version to be published. Kushala was involved in the above and with data collection as well. Dr Harish Pemde is responsible for the overall content as the guarantor for the article.

Funding Publication of this article is made open access with funding from the Nationwide Quality of Care Network.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the institutional ethics committee (approval no: LHMC/ECHR/2017/96).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Analysed data are available in the manuscript.

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