

Addressing Quality of Care in Pediatric Units using a Digital Tool: Implementation Experience from 18 SNCU of India

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ABSTRACT

Lack of quality care is associated with newborn mortality and stillbirth. India launched the Special newborn care unit (SNCU) Quality of Care Index (SQCI) for measuring quality indicators in SNCU. The USAID Vriddhi project provided support to the use of SQCI in 19 SNCU across aspirational districts of Jharkhand, Uttarakhand, Himachal Pradesh, Punjab and Haryana. The objective was to provide holistic support to quality care processes by generating analyzed quarterly reports for action with the goal toward sustainability by capacitating SNCU personnel and program officers to use SQCI, over a 1period from April 2019 to June 2020. The composite index has seven indicators and converts them into indices, each having a range from 0.1 to 1, to measure performance of SNCU.7 of the 18 SNCU improved their composite scores from the first to the last quarter. Rational use of antibiotics showed improvement in 12 SNCU. Survival in newborns >2500 g and <2500, low birth weight admission and optimal bed utilization had the most variations between and within facilities. Based on quarterly data analysis, all facilities introduced KMC, 10 facilities improved equipment and drug supply, 9 facilities launched in-house capacity building to improve asphyxia management. The SQCI implementation helped to show a process of using SQCI data for identifying bottlenecks and addressing quality concerns. The project has transitioned to complete responsibility of SQCI usage by the district and facility teams. Use of an existing mechanism of quality monitoring without any major external support makes the SQCI usable and doable.

KEYWORDS: quality of care, quality improvement, inpatient newborn care, India, digital tool

INTRODUCTION

Globally, >2.5 million newborns died in 2017 from preventable causes, most notably prematurity,

complications around the time of birth, infections and congenital conditions [1]. Preterm and small-for-gestational-age infants in low-income and

middle-income countries bear the highest relative risk of mortality [2, 3]. Most of these occur in low-resource countries of Africa and Southeast Asia. These deaths occur commonly due to surroundings related with lack of quality care at birth and treatment immediately after birth and in the first days of life [1]. Every year, 30 million newborns require special or intensive newborn care in a hospital setting. These newborns can survive provided they are given high-quality inpatient care at the right time and in the right place, including follow-up care and family-centered care [1].

It is estimated that 113 000 maternal deaths, 531 000 stillbirths, and 1325 million neonatal deaths annually can be prevented in 75 high burden countries through closure of the quality gap [4]. Inpatient quality care can save millions of vulnerable babies [5]. A review estimated that failure to improve birth outcomes will result in 116 million deaths by 2035 [6]. Quality of care, however, is repeatedly stymied by health system bottlenecks in resource poor settings—specifically shortage of health workers [7, 8], equipment and lack of competence to handle small and sick newborns [7]. Therefore, there is an urgent need for quality improvement in systems and processes through the routine use of health and program data to meet patient and program requirements [9].

However, a lack of standardized indicators to measure quality of newborn care in facilities remained a huge gap in systems improvement [10]. Inferences drawn about quality from few measures are likely to be uninformative and misleading [11, 12]. Moxon, *et al.* [13] compared the Service Provider Assessment (SPA), WHO Service Availability and Readiness Assessment (SARA), and EmONC assessment to measure inpatient newborn care service readiness and found gaps in measurement of complex care, and special newborn care units (SNCU)-based mortality and morbidity, leading the authors to suggest having proxy indicators for complex care and harmonizing indicators for basic service readiness. A SNCU-based system to monitor structures and processes was emphasized in other studies also [13–15].

India has one of the highest neonatal (28 per 1000 live births) and early mortality rates (22 per 1000 live births) along with a high and stagnant

perinatal mortality of 26 per 1000 live births [16], necessitating an urgent need for closure in quality and equity gaps. There has been rapid scale up of Special Newborn Care Unit (SNCU) across the country through SNCU-Based Newborn Care (FBNC) program as a solution to boost secondary level newborn care at district level in India. While NICU are established at the tertiary level (Level 3 of the Indian health system structure), SNCU are meant for Level 2 facilities which are district or civil hospitals without provision for ventilation or pediatric surgery. Despite improvement in infrastructure—894 SNCU established in district and state hospitals admit >1 million newborns every year—quality care, according to the national child health review, is at a premium in neonatal care units [17]. Human resource shortage in neonatal units is stark with only 53% having an appropriate number of physicians and less than half having a requisite number of nurses [15]. Although evidence-based guidelines are available, compliance to them varies at the point of care [18]. The admission and treatment of so many babies generates a plethora of data ranging from demographic information, anthropometric and vital statistics, admission criteria, treatment profiles, outcome status, bed occupancy and others. The data get registered in the SNCU online software on regular basis and is meant to improve quality of care in SNCUs. To overcome the challenges on effective use of the data for improving quality of care a simple, consolidated and focused Microsoft Excel-based tool SNCU Quality of Care Index (SQCI) was developed from the pool of SNCU data by a team of national child health experts which was recommended for wider use by the national government in 2016. However, the available data were not being used adequately to improve SNCU service quality, according to a UNICEF evaluation [19]. A holistic support to newborn care, quality improvement approach, capacity building for data use and mentorship were some of the key recommendations of the evaluation [19].

As there was a need to use the available data to improve quality of care and build capacity of health workers and officials to use the data as highlighted by the UNICEF evaluation, the current implementation was undertaken. Since January 2019, the USAID

Vriddhi project has been providing technical support to the use of SQCI in 18 SNCU across aspirational districts (AD) of Jharkhand, Uttarakhand, Himachal Pradesh, Punjab and Haryana. AD are a special focus of the Government of India (GOI) as these are poor performing districts in terms of health and development. With the goal to institutionalize SQCI in SNCUs of AD, the support aimed to specifically (i) demonstrate a mechanism of using SQCI for improvement by engaging the state, district and facility and (ii) generate analyzed quarterly reports for action. The current article reports on 1 year of implementation.

METHODS

SQCI tool description

SQCI is a GOI recommended decision making tool that makes use of already available SNCU online data to generate seven specific indices on key indicators to assess mortality outcomes, gaps in clinical practices and optimal utilization of services in SNCUs. The tool was developed by a team of national neonatal and child health experts and has been developed using reliable indicators that measure quality of care. Optimal utilization of services is reflected from avoidance of unnecessary admissions, admission of small babies and bed occupancy. Adequacy of clinical practices could be assessed from admissions of inborn babies with birth asphyxia (which indirectly means lack of skills for resuscitation) and use of antibiotics. Outcomes could be assessed from survival of normal and low weight babies separately. The index has seven indices each having a range of 0.01–1.0. Performance grading is categorized into: good (0.71–1.0), satisfactory (0.4–0.7) and unsatisfactory (<0.4). The indices are color coded for better understanding and ease of tracking progress (Table 1).

Implementation sites

The SNCU are located in district hospital (DH) or at a similar level. Jharkhand is the only state from where a maximum number of SNCU were selected because it also has a larger share of AD (Table 2).

Process of support

The project supported in the computation of SQCI scores, analysis and identification of gaps which was shared at the state and district level through review mechanisms. As a first step, officials from all the five states were oriented on the SNCU quality care index. The state National Health Mission M&E officials were given demonstration of calculating SQCI at the end of each month and quarter.

The project team members in each state oriented the district officials and the SNCU in charge on the use of SQCI as a monitoring tool. Handholding was done on an ongoing basis with quarterly inputs on gaps identified by the tool. SQCI was discussed in periodic review meetings and Child Death Review meetings at the district and state level. This helped the states in taking necessary steps for quality improvement in the SNCUs. A year of regular handholding culminated in independent use and analysis of SQCI starting from April 2020.

Data management and analysis

Monthly data were entered by the SNCU data entry operator in a web portal. The Vriddhi data team computed the scores at the end of a quarter while a senior child health expert analyzed the results, and informed all Vriddhi state teams. The state team leads subsequently presented the results and analysis at state and district review meetings. After the second quarter, the state, district and SNCU functionaries were oriented and supported in the computation and analysis. Handholding continued throughout the year. From April 2020, the state NHM M&E officers and data managers started to independently conduct the computation and analysis.

For the present analysis, composite scores were analyzed. Additionally, SNCU-wise performance on individual indicators was analyzed based on their quarterly scores and categorized into five analytic categories as shown below. We use the terms good, satisfactory, poor interchangeably with high, medium and low.

Remained high or medium: scores that were consistently good (0.7–1.0) or consistently satisfactory (0.4–0.7) across all quarters.

Improved: scores that achieved high level (0.7–1.0) at the last quarter from either medium or low.

TABLE 1. Components of SQCI

S.no.	Index	Formula for calculation
1.	<i>Rational admission index</i> —is the percentage of new born admitted in the SNCU that are discharged within 24 h of admission.	$1 - (\text{number of new born discharged in 24 h} / \text{total number of new born discharged})$
2.	<i>Index for rational use of antibiotics</i> —depicting the rational use of antibiotics in SNCU.	$1 - (\text{total number of newborns received antibiotics} - \text{number of newborns diagnosed as sepsis}) / \text{total admission}$
3.	<i>Inborn birth asphyxia index</i> —picks up SNCUs with high rate of in-born Asphyxia in the adjoining DH.	$1 - (\text{number of inborn admitted with birth asphyxia} / \text{total number of babies delivered in the hospital})$
4.	<i>More than equal to 2500 g death Index</i> —represents if there is any mortality of infants with ≤ 2500 g weight admitted in SNCU.	$1 - (\text{no. of deaths in newborns with birth weight } \leq 2500 \text{ g or more} / \text{total number of deaths})$
5.	<i>Low birth weight admission index</i> —indicates percentage of new born with weight < 1800 g being admitted to SNCUs.	$\text{No. of inborn with birth weight } < 1800 \text{ g admitted} / \text{total number of inborn admissions}$
6.	<i>Low birth weight survival index</i> —reflects upon the survival of all the low birth weight new born admitted with weight between 1000 and 1800 g.	$\text{No. of newborns with birth weight between 1000 and 1800 g discharged} / \text{Total number of new born with birth weight between 1000 and 1800 g admitted}$
7.	<i>Optimal bed utilization index</i> —6 admissions per bed per month is a desired number and optimal bed utilization index reflects optimum utilization of the available bed strength in the SNCUs.	$1 - (1 - \text{average admission}) $ Average admission = $(\text{total admissions} / \text{total number of beds} \times 6 \times \text{no. of months})$

TABLE 2. States and aspirational districts with SNCU

States	Number of aspiration districts	Aspirational districts with SNCU
Jharkhand	19	13
Uttarakhand	2	1
Punjab	2	2
Haryana	1	1
Himachal Pradesh	1	1
Total	25	18

Declined: scores that declined to low from medium or high, or scores that declined to medium from high at the last quarter.

Remained low: scores that were consistently in the 0.01–0.4 range.

Fluctuated: scores that fluctuated between low, medium and high over the quarters.

During the last quarter, one SNCU was converted to a COVID-19 ICU for which, data of all previous quarters are considered in the present analysis.

Ethical review

The SQCI tool is routinely implemented in SNCU. The current intervention was implemented to

improve SQCI data collection, analysis and action taken. Due permission was obtained from the state government health units. As routine data were used, the implementation did not require ethical approval. Although the routine data contained human records, all personal information are removed at the time of data analysis. Thus, anonymity and confidentiality of information is maintained. According to Indian Council of Medical Research (ICMR) guidelines, the data collected came under the category of 'research on publicly available information, documents, records, works, performances, reviews, quality assurance studies, archival materials or third party interviews, service programs for benefit of public having a bearing on public health programs and consumer acceptance studies' which are waived from voluntary informed consent process [20].

RESULTS

The composite index shows a shift toward improvement in seven SNCUs to a good performance score while one other SNCU improved to satisfactory score. During the last quarter, one SNCU was converted to a COVID ICU and hence there were no data for this period. State-wise comparison shows Uttarakhand and Punjab has consistently high performance while Haryana and Himachal maintain a mid-level performance throughout. Jharkhand improved SNCU performance in five facilities. It also showed erratic performance in three facilities (Table 3).

The graph presents the results of the specific indicators (Fig. 1):

Rational admission is one indicator in which all the SNCU had high scores throughout, indicating that there was no unnecessary admission.

Inborn birth asphyxia captures resuscitation practices in the labor room of the SNCU and is an indicator of the linkage between maternal and newborn unit. Overall, seven SNCU maintained good performance, eight maintained satisfactory performance, one declined from satisfactory to poor and two fluctuated between satisfactory and poor.

Rational use of antibiotic, indicating whether antibiotics are overused, was low in most facilities, however it improved in the majority [12] at the end of the last quarter. As for the rest, four had consistently

good performance, one satisfactory and one fluctuated.

Mortality in babies >2500g indicates overall clinical practices and management in the SNCU. There are varying levels of performance between and within the SNCU. While four SNCU improved overall, six others declined in performance in the last quarter. Furthermore, five SNCU maintained high scores, and three SNCU had fluctuating performance.

Mortality in low birth weight babies reflects whether practices such as optimal feeding/KMC/infection prevention are followed in saving small and sick newborns <1800g. It is seen that six SNCU maintained between good and satisfactory performance, six others were consistently low, three improved and three fluctuated.

Low birth weight admission is a measure of whether the SNCU is fulfilling the purpose for which it was established. The maximum fluctuation is seen here (seven SNCU). Consistently poor performance is seen in eight SNCU and three improved.

Optimal bed utilization shows the extent of utilizations. If there is overcrowding, then the number of beds should be added. Similarly less admission means that the delivery points may not be aware of the available facility. Performance varies—four improved, five maintained good performance, two maintained satisfactory performance, two were consistently low and five fluctuated.

ACTIONS TAKEN FOR IMPROVEMENTS

Based on feedback provided to the state, district and SNCU concerned, the following actions were taken for improvement in poorly performing indicators. For example, poor survival of LBW babies in six SNCU led to provision of KMC space to improve KMC practice. To improve inborn birth asphyxia in those SNCU which were performing poorly, holistic action comprising training on Navjat Shishu Suraksha Karyakram (NSSK), asphyxia management skills and resuscitation equipment was provided. NSSK is a GOI programme aimed to train health personnel in basic newborn care and resuscitation. Additionally, untied funds were used to ensure drug supply. SNCU facing severe shortage of staff were provided with the required staff (Table 4).

TABLE 3. Composite score of the SNCUs in 5 quarters

State	SNCU name/AD	Composite SQCI				
		April– June 2019	July– September 2019	October– December 2019	January– March 2020	April– June 2020
Haryana	SNCU GH Mewat	0.66	0.52	0.59	0.66	0.68
Himachal Pradesh	SNCU RH Chamba	0.65	0.50	0.60	0.53	0.44
Jharkhand	SNCU DH Bokaro	0.54	0.52	0.58	0.50	0.71
	SNCU DH Dumka	0.50	0.54	0.51	0.46	0.57
	SNCU CHC Ghatshila	0.57	0.57	0.25	0.54	0.77
	SNCU DH Godda	0.63	0.68	0.60	0.28	0.67
	SNCU DH Giridih	0.51	0.46	0.52	0.45	0.63
	SNCU DH Gumla	0.48	0.47	0.64	0.71	0.73
	SNCU DH Hazaribagh	0.53	0.56	0.64	0.58	0.60
	SNCU DH Latehar	0.32	0.62	0.52	0.56	0.36
	SNCU DH Pakur	0.59	0.26	0.71	0.69	0.73
	SNCU DH Palamu	0.47	0.49	0.47	0.41	0.50
	SNCU DH Sahebganj	0.62	0.65	0.67	0.58	^a Data unavailable
	SNCU DH Simdega	0.69	0.65	0.54	0.68	0.53
	SNCU DH West Singhbhum	0.58	0.35	0.68	0.63	0.56
Punjab	SNCU CH Firozpur	0.38	0.54	0.59	0.57	0.62
	SNCU CH Moga	0.65	0.72	0.69	0.71	0.72
Uttarakhand	SNCU FH Haridwar	0.68	0.76	0.74	0.77	0.71

^aThis SNCU was converted to a COVID-19 ICU from April 2020, hence no data available for this period.

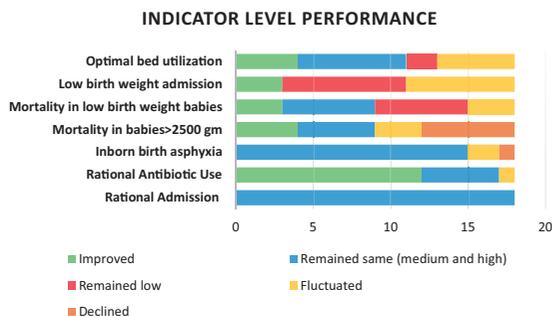


FIG. 1. Performance of SNCU on individual components.

Every state gave directives for introducing actions based on the analysis provided by the district program officer/SNCU in charge. While issues identified and actions taken were many, the following seeks to provide one such example from each state (Table 5).

DISCUSSION

The article showcases the utilization of the SQCI tool to improve inpatient care of small and sick newborns. SQCI tool is routinely implemented across most SNCU but the data are not used for improvement purpose. We tried to show a mechanism of using the available data. The mechanism that was implemented has enabled the authorities to identify the key quality of care issues and discuss the findings in review meetings and take corrective actions. The gaps reported in the UNICEF evaluation of SNCU have been attempted to be addressed through our implementation model. Thus, through mentorship, clinical practices were strengthened; by initiating training on resuscitation in labor rooms, the absence of linkage between the maternal and neonatal unit was plugged; by demonstrating a coordinated engagement between facility, district and state, sustainability was ensured.

TABLE 4. Actions introduced to improve quality of care in SNCU (n = 18)

Actions introduced	Number of SNCU
Equipment and drugs	10
KMC chairs, refrigerator, RO, geyser	
Inverter, solar connection	
Drugs	
Resuscitation equipment	
Human resource	5
Pediatrician and staff nurses	
Documentation and reporting	18
Practices	
Regular KMC to LBW babies for 8 h daily introduced	18
Revision of sepsis screening and antibiotics protocol as per FBNC guidelines	5
Improvement in diagnostic lab facility	2
Optimal use of antenatal corticosteroids in premature labor	3
Sepsis prevention through ensuring hypochlorite solution, elbow taps in SNCU	2
Referral linkages with delivery points	3
Training and capacity building	9
Refresher training on NSSK given to SNs and ANMs of labor room to manage asphyxia	
Training on FBNC to staff nurse	
Resuscitation practices to labor room staff	
State Government action	18
Official letters issued by Mission Director per quarter on index wise feedback to all SNCU	

Ideally, indicators for quality of care should include structures, processes and outcomes [21–23]. But from the perspective of improving quality, performance of a unit should include those aspects which are amenable to change [24]. The SQCI tool does not measure structures, only a mix of processes and outcomes. The Vriddhi project adopted an innovative way to use the SQCI data. It demonstrated that through a mechanism of supportive supervision, a QI plan could be adapted to base actions through root cause analysis. Thus, the tool was used to identify gaps that require attention. In other words, the proper use of the tool leads to reflection and introspection of services and systems within a SNCU ultimately leading to actions. Systematic reviews on quality of newborn care mention lack of health information and lack of clinical review and audit as one of the major bottlenecks [25–27]. A case study in Malawi, similar to our experience, showed how audit and feedback mechanisms using available data were used to improve quality [28].

Our findings on improvement are mixed. There were a few facilities that improved over the year but not others. Even within the same facility, there were fluctuating trends on some indicators. Also, improvement did not happen linearly but showed fluctuating trends. This was mostly due to a mix of systemic and clinical factors. For example, most of the facilities had low mortality for good weight babies. However, six of these showed an increase in the number of deaths after April 2020. One of the reasons was that with the onset of COVID-19 pandemic, trained staff of SNCU were shifted to COVID duty and they were replaced by untrained staff who were not following SNCU protocols, perhaps resulting in nosocomial infection. This highlights the enormous pressure put by the pandemic on resources which are already scarce, indicating the need for an overall improvement of the existing health resource of some states.

Staff shortage was perennial in facilities in Jharkhand, compromising the quality of care.

TABLE 5. Specific actions taken per state

Facility	Issue	Root cause	Action
Pakur, Jharkhand	Low admissions	Non-availability of 24 h electricity	Installation of solar power backup and inverter
Ghatshila, Jharkhand	Low score in rational use of antibiotics index	Poor hand washing practices especially in winter due to non-availability of geysers	Installation of geyser
Gumla, Jharkhand	Low score in LBW admission and survival index	Shortage of nursing staff resulting in poor monitoring of babies	Initiation of recruitment process of nursing staff
Chamba, Himachal Pradesh	Low score in LBW survival index	Antenatal corticosteroid administration to pre-terms inadequate	Orientation of LR staff on antenatal corticosteroids
Mewat, Haryana	Low score in rational use of antibiotics index	Inappropriate understanding of FBNC sepsis management guidelines	Orientation of SNCU staff on FBNC sepsis management guidelines
Ferozepur, Punjab	Low score in LBW admission and optimal bed utilization index	Lack of space and shortage of HR in SNCU	Identification of space and shifting of SNCU in new MCH building, recruitment of pediatrician and nursing staff

Actions related to strengthening supplies and logistics are essential to improving care. It has been seen that health system bottlenecks and ill equipped infrastructure are major challenges in providing newborn care in developing countries including India [29, 30]. More often than not, an absence of vital equipment such as resuscitation equipment or lack of provision of essential therapy such as antenatal corticosteroid in preterm labor determines the survival of newborn [25, 28]. During our support, clinical practices were improved through capacity building and something as basic as filling positions in SNCU were started as a result of the SQCI reports. However, staff strength has still not reached the required criteria. Furthermore, where contractual rather than regular staff are employed, or where there is an absence of a head of a pediatric unit or where the SNCU in charge is not a qualified pediatrician as in some facilities in Jharkhand, indicators are generally low. This echoes findings from another study in which lack of dedicated doctors was a factor in low quality of care even after health systems strengthening initiative to improve newborn care [31].

Performance was, thus, dependent on the stage of readiness a SNCU was in caring for sick babies and the presence of experienced and dedicated pediatricians. Facility readiness as an important index of quality care is mentioned in the literature [33, 34]. The DH in Uttarakhand and those in Punjab generally had high scores on most of the indicators which they maintained throughout the year. These are more developed states compared to Jharkhand. Strong leadership along with more staff strength in Uttarakhand ensured good performance on all indicators. Despite the overall good performance in low birth weight admission, these facilities performed poorly as admissions were mostly of inborn babies who were generally of good weight. Other Indian reports also suggest that the bulk of admissions to SNCUs are contributed by babies whose birth weights are >2500 g [30, 31]. There are concerns around using admission rates as indicators of quality [29]. However, there is evidence that over and unnecessary admissions for few hours solely for observation especially in caesarean delivered babies is a common scenario in SNCUs in India [15, 35]. Not

only this compromises with breast feeding and other benefits by keeping the baby separated from the mother, it also predisposes to infections, increases the work load of staff and also deprives admissions to those who actually need focused in-patient care.

Since the SQCI only has a limited number of indicators, it lends itself to easy analysis and interpretation. An advantage is the ease with which data can be assembled and analyzed without relying on any special technical help. A similar study in DHs identified the difficulty in measuring the quality of clinical care, especially adherence to guidelines as it required observation by a specialist [32]. This was addressed to an extent by the SQCI as it bypassed the requirement of numerous indicators by focusing on a few key care practices that were easily measured such as inborn birth asphyxia and antibiotic usage. As a particular indicator is analyzed, the reasons for the poor performance are identified which may include any number of health system bottlenecks. QI intervention studies found that simple interventions such as creation of a stepdown unit, involving mothers in infant care, and new antibiotic protocol reduced mortality in NICU [36, 37]. Based on SQCI scores, in our intervention, similar actions were introduced in SNCU having low birth weight survival. However, till June 2020, most SNCU show moderate scores on this indicating that to reach a higher score, actions introduced would need to be sustained. During the last quarter, rational use of antibiotics was high in most of the SNCU that previously had low scores. In the absence of lab facilities in several SNCU in Jharkhand, antibiotics were prescribed widely. With repeated mentoring and orientation on neonatal sepsis screening and diagnosis, the SNCU started prescribing rationally, suggesting that it takes time for a practice to be established.

Generation of SQCI reports and using the same for advocating actions at state review meetings has been a major lynchpin of Vriddhi's support in SNCU performance. Every quarter, based on the analysis provided, the governments of the states issued letters for addressing the gaps. Direct state action facilitated in acquiring supplies and HR and implementing in-house trainings. Continuous monitoring, hand holding in generating SQCI at district SNCU helped the data entry operators (DEOs), SNCU staff and

district officials on importance of SQCI for quality monitoring of SNCU, whereas previously there was an absence of mechanism of using the SNCU data for action, our intervention tried to strengthen this. Our implementation differs from other research studies as we did not introduce a new tool for quality improvement. Although our mechanism does not differ from similar interventions conducted in other studies drawing on the same principle of training, mentoring and reviews for improvement what our intervention contributes is the learning about engaging the state, district and facility functionaries in a cohesive way and as a coordinated unit.

A major limitation of the SQCI tool is that it has not been validated. During development of the index, trained neonatologists did an independent assessment of select SNCUs to obtain feedback on the reliability of SQCI. The overall feedback given by the experts corroborated well with the inferences drawn from the SQCI tool. However, reliability of the tool has not been measured. Another limitation is in the scoring system. A score of 0.7 means the same as a score of 0.9; however, in terms of quality of care, this can be a huge difference. Scores only give an indication of how well a service parameter is performing. Similarly, these are proxy indicators that provide a general idea of the existing health system bottlenecks. Clinically, the indicator may not be providing a correct picture. For example, based on the condition of a child after admission, a clinician may refer the child to a lower SNCU for basic care. In such a case, we cannot rule the admission to be irrational. Similarly, antibiotics can be used for the appropriate cases but the clinician may miss documenting the reason for its prescription. The index thus should be seen as a quality audit which initiates dialogue about actions in strengthening health systems, rather than as an end all and be all of clinical quality of care measure. Future research should look into validation and reliability of the tool and addition of indicators to the tool as well as long term evaluation to see effects of quality improvement on outcomes.

In summary, the Vriddhi project demonstrated a mechanism of using SQCI for action through analysis, monitoring, handholding and reviews. SQCI helped the districts to advocate for their

requirements like increase in the bed allocation, procurement of drugs, instruments and equipment like C-PAP machines. Our implementation addressed gaps identified by the SNCU evaluation [18]. Independent use of the tool through this mechanism by state, district and SNCU managers will lead to sustained improvement over time. Survival of small and sick newborns and asphyxia management needs urgent attention through enhanced capacity building and precision supervision. Sustained communication efforts along with maintenance of supplies and equipment are needed for improving utilization of SNCU among the community. Alongside, recruitment and regularization of human resource, hiring pediatrician for SNCU and leadership trainings are essential. The SQCI implementation has been handed over to the states who have standardized the processes with minor state-specific variations. It had been extended to 11 additional facilities by the states and will likely be scaled up to all the districts. Capacity enhancement of the State Child Health Cell, Monitoring & Evaluation Cell and District SNCU nodal officers and data managers on all relevant aspects of SQCI and making them self-reliant in dealing with SQCI and SNCU improvements will continue the process put in place by Vriddhi project. Our recommendation would be capacitate these functionaries in every state who subsequently would be responsible for executing the use of SQCI in all the SNCU.

CONCLUSION

The issue of quality of services is very high on the policy agenda. The use of SQCI through a systematic mechanism of analysis, monitoring and review without any major external support for QI facilitates usage of data for evidence-based decisions.

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DATA AVAILABILITY

Data will be made available on request.

REFERENCES

1. WHO. Survive and Thrive: Transforming Care for Every Small and Sick Newborn. Geneva: World Health Organization; 2019.
2. Blencowe H, Cousens S, Oestergaard MZ, *et al.* National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. *Lancet* 2012;379:2162–72.
3. Katz J, Lee AC, Kozuki N, *et al.* Mortality risk in preterm and small-for-gestational-age infants in low-income and middle-income countries: a pooled country analysis. *Lancet* 2013;382:417–25.
4. Bhutta ZA, Das JK, Bahl R, *et al.* Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? *Lancet* 2014;384:347–70.
5. Lawn JE, Davidge R, Paul VK, *et al.* Born too soon: care for the preterm baby. *Reprod Health* 2013;10:S5.
6. Lawn JE, Blencowe H, Oza S, *et al.* Every Newborn: progress, priorities, and potential beyond survival. *Lancet* 2014;384:189–205.
7. Dickson KE, Simen-Kapeu A, Kinney MV, *et al.* Every Newborn: health-systems bottlenecks and strategies to accelerate scale-up in countries. *Lancet* 2014;384:438–54.
8. Moxon SG, Lawn JE, Dickson KE, *et al.* Inpatient care of small and sick newborns: a multi-country analysis of health system bottlenecks and potential solutions. *BMC Pregnancy Childbirth* 2015;15:S7.
9. WHO. Operations Manual for Delivery of HIV Prevention, Care and Treatment at Primary Health Centres in High-Prevalence, Resource-Constrained Settings. Quality Improvement. 2008. Chapter 11, 282–307. <https://www.who.int/hiv/pub/imai/om.pdf?ua=1> (22 September 2020, date last accessed).
10. Moxon SG, Ruysen H, Kerber KJ, *et al.* Count every newborn; a measurement improvement roadmap for coverage data. *BMC Pregnancy Childbirth* 2015;15:S8.
11. Ekelem I, Tausch H. Defining quality of care indicators for neonatal intensive care units independent of maternal risk factors. *J Natl Med Assoc* 1990;82:345–50.
12. Profit J, Zupancic JA, Gould JB, *et al.* Correlation of neonatal intensive care unit performance across multiple measures of quality of care. *JAMA Pediatr* 2013;167:47–54.
13. Moxon SG, Guenther T, Gabrysch S, *et al.* Service readiness for inpatient care of small and sick newborns: what

- do we need and what can we measure now? *J Glob Health* 2018;8:010702.
14. Neogi SB, Malhotra S, Zodpey S, *et al.* Challenges in scaling up of special care newborn units—lessons from India. *Indian Pediatr* 2011;48:931–5.
 15. Neogi SB, Khanna R, Chauhan M, *et al.* Inpatient care of small and sick newborns in healthcare facilities. *J Perinatol* 2016;36: S18–23.
 16. Sankar MJ, Neogi SB, Sharma J, *et al.* State of newborn health in India. *J Perinatol* 2016;36:S3–S8.
 17. Ministry of Health and Family Welfare, Government of India. National Child Health Review Cum Workshop 2017, 10–11 October 2017, New Delhi, India.
 18. Datta V, Srivastava S, Singh M. Formation of quality of care network in India: challenges and way forward. *Indian Pediatr* 2018;55:824–7.
 19. LSTM Center for Maternal and Newborn Health. Special Newborn Care Units to help reduce newborn deaths in India 2007–2017 Evaluation of UNICEF's Support to the SNCU Based Newborn Care (FBNC) Programme in India, 2019. https://www.unicef.org/evaldatabase/files/SNCU_Evaluation_Final_Report_India-2019.pdf (18 November 2020, date last accessed).
 20. Indian Council of Medical Research. Ethical guidelines for biomedical research on human participants. Indian Council of Medical Research, New Delhi 110 029, 2006. http://icmr.nic.in/ethical_guidelines.pdf (15 July 2020, date last accessed).
 21. Beal AC, Co JP, Dougherty D, *et al.* Quality measures for children's health care. *Pediatrics* 2004;113:199–209.
 22. Hernández-Borges AA, Pérez-Estévez E, Jiménez-Sosa A, *et al.* Set of quality indicators of pediatric intensive care in Spain: Delphi method selection. *Pediatr Qual Saf* 2017;2: e009.
 23. Boesveld IC, Hermus MAA, de Graaf HJ, *et al.* Developing quality indicators for assessing quality of birth centre care: a mixed-methods study. *BMC Pregnancy Childbirth* 2017; 17:259.
 24. Giuffrida A, Gravelle H, Roland M. Measuring quality of care with routine data: avoiding confusion between performance indicators and health outcomes. *BMJ* 1999;319: 94–8.
 25. Enweronu-Laryea C, Dickson KE, Moxon SG, *et al.* Basic newborn care and neonatal resuscitation: a multi-country analysis of health system bottlenecks and potential solutions. *BMC Pregnancy Childbirth* 2015;15:S4.
 26. Dickson KE, Kinney MV, Moxon SG, *et al.* Scaling up quality care for mothers and newborns around the time of birth: an overview of methods and analyses of intervention-specific bottlenecks and solutions. *BMC Pregnancy Childbirth* 2015;15:S1.
 27. Vesel L, Bergh AM, Kerber KJ, *et al.* Kangaroo mother care: a multi-country analysis of health system bottlenecks and potential solutions. *BMC Pregnancy Childbirth* 2015; 15:S5.
 28. Liu G, Segrè J, Gülmezoglu A, Working Group for the UN Commission of Life Saving Commodities Antenatal Corticosteroids, *et al.* Antenatal corticosteroids for management of preterm birth: a multi-country analysis of health system bottlenecks and potential solutions. *BMC Pregnancy Childbirth* 2015;15: S3.
 29. Shah HD, Shah B, Dave PV, *et al.* A step toward healthy newborn: an assessment of 2 years' admission pattern and treatment outcomes of neonates admitted in special newborn care units of Gujarat. *Indian J Community Med* 2018;43:14–8.
 30. Chawla D, Suresh GK. Quality improvement in neonatal care - a new paradigm for developing countries. *Indian J Pediatr* 2014;81:1367–72.
 31. Lachman P, Jayadev A, Rahi M. The case for quality improvement in the neonatal intensive care unit. *Early Hum Dev* 2014;90:719–23.
 32. Horwood C, Haskins L, Phakathi S, *et al.* A health systems strengthening intervention to improve quality of care for sick and small newborn infants: results from an evaluation in district hospitals in KwaZulu-Natal, South Africa. *BMC Pediatr* 2019;19:29.
 33. van den Broek N, Graham W. Quality of care for maternal and newborn health: the neglected agenda. *BJOG* 2009; 116:18–21.
 34. Raven J, Hofman J, Adegoke A, *et al.* Methodology and tools for quality improvement in maternal and newborn health care. *Int J Gynaecol Obstet* 2011;114:4–9.
 35. Neogi SB, Malhotra S, Zodpey S, *et al.* Assessment of special care newborn units in India. *J Health Popul Nutr* 2011; 29:500–9.
 36. Bhutta ZA, Khan I, Salat S, *et al.* Reducing length of stay in hospital for very low birthweight infants by involving mothers in a stepdown unit: an experience from Karachi (Pakistan). *BMJ* 2004;329:1151–5.
 37. Pinto MCFG, Bueno AC, Vieira AA. Implementation of a protocol proposed by the Brazilian National Health Surveillance Agency for antibiotic use in very low birth weight infants. *J Pediatr* 2013;89:450–5.