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Original Article

Impact of Quality Improvement (QI) Initiatives on Neonatal Mortality in NICU: A Retrospective Analysis in Tertiary Care Centre in Western India

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Abstract

Introduction: The global "under-five mortality" has dropped 60% from 93 deaths per 1,000 live births in 1990 to 37 in 2020 in the last three decades. It is vital to adopt proven quality improvement initiatives to provide quality care to improve neonatal mortality and morbidity. Aim of the study was to assess the impact of the quality improvement interventions and strategies in reducing the neonatal mortality statistics.

Methods: The study was conducted in a 500 bedded Government Hospital in India. The management implemented various tactics, such as enhancing the existing infrastructure, upgrading equipment, augmenting the workforce, and implementing established clinical protocols, to enhance the quality of intensive care services provided in the NICU. The QI points were identified based on the shortcomings that were identified and shortlisted based on the working of NICU pre QI implementation. The outcome was measured as neonatal mortality indicators and the data was compared between pre and post implementation period.

Results: After implementing quality improvement measures, there were notable enhancements in the total floor area, availability of skilled personnel, and equipment. The number of total admissions to the NICU increased by 79%, and mortality reduced from 20.93% to 7.82%. There was a statistically significant decrease in disease-specific neonatal mortality rates, with a p-value of less than 0.001.

Conclusions: This study concludes that implementation of proper and comprehensive QI interventions and strategies in NICUs can help in decreasing the neonatal mortality.

Introduction

In India, the "under - five mortality" has dropped 40% to the present value of 35.73 per 1000 live births in 2020.[1] Kota is a south eastern city of Rajasthan in India that has about 19.5 lakhs inhabitants, 13.6% of the district's population belongs under 6 years age group2 and 26.7% belong to less than 15 years of age.[3]

Table 1: Comparison of demographic indicators of Rajasthan state and India.

S. No.	Indicator	India	Rajasthan
1.	Total Population[2]	121,08,54,977	6,85,48,437
2.	Life Expectancy[4]	69	68.5
3.	Sex ratio[4]	896	856
4.	Maternal Mortality ratio (MMR)[4]	122	186
5.	Under 5 Mortality Rate (U5MR)[5]	35	41
6.	Infant Mortality Rate (IMR)[5]	30	35
7.	Neonatal Mortality Rate (NMR)[5]	22	25

Quality improvement (QI) is now a central part of the work of clinicians throughout healthcare.[6] The Neonatal Intensive Care Unit (NICU) is a highly complex adaptive system that lends itself to the application of QI principles.[7]

Since there are very few studies in Indian subcontinent highlighting the impact of cumulative QI implementation on the change in mortality in NICU, our project focused on providing quality maternal, neonatal and paediatric health services, with the aim of improving the health care and mortality statistics in NICU.[8] The primary aim of the study was to assess the impact of the quality improvement interventions and strategies in reducing the neonatal mortality statistics including disease specific mortality statistics through a retrospective analysis of the pre- and post-implementation data.

Methods

The study hospital is a 500 bedded Government Tertiary referring and Teaching Hospital serving as central referring facility to the surrounding districts which covers about 20 – 25% of the state population. A total of 10,116 deliveries occurred in year 2021 in this hospital, out of which 55% were caesarean sections. Before the intervention, the delivery room was staffed by paediatric residents available only for high-risk case basis. The NICU was a 42-bed unit with about 3248 admissions in year 2019, of which 42.68% were outborn. Electricity was provided 24 hours a day but in case of blackout, manual operator dependant emergency generator was put in use. The NICU was with no central oxygen, suction, air supply and pulse oximeters, mechanical ventilators were available at around 7:1 patient ratio. Doctors were available in the hospital premises but not exclusively for NICU patient care. There were inadequate availability of infusion pumps, n-Bubble CPAP's, blood gas machine, designated hand hygiene areas and bedside x-ray. The bed occupancy ratio was 150 to 180%. The patient-to-nurse ratio was around 3:1. The overall building infrastructure was 45-year's old and the available space, walls, floor, roof and doors were not as per norms set by standard agencies.

In the year 2020, the interventions were focused on improving these key areas, i.e., intensive care infrastructure, equipment, man power and clinical protocols. A multidisciplinary working committee comprising of subject experts from various medical colleges of the state and policy makers from Government of India and Rajasthan identified the key issues responsible for poor mortality indicators and suggested the strategies for the improvement of the standard of intensive care for the neonates in the hospital's NICU. This is a retrospective study conducted on neonates admitted in the NICU during study duration of pre intervention (01 Jan 2019 to 31 Dec 2019) and post-intervention era (01 Jan 2021 to 31 Dec 2021).

Quality improvement initiatives undertaken

1. Appointing additional dedicated human resources including faculties, senior residents, junior residents and nursing staff
2. Training of human resources
   a. Six day full training of NICU doctors and nursing staff to provide neonatal services.
   b. Family Centered Care (FCC) trainings.
   c. 4-day Facility Based Newborn Care (FBNC) training for NICU nursing staff.
   d. NRP training of doctors, and nurses.
   e. Regular and random quality checks once in every two months on NICU staff.
3. Round the clock presence of Neonatal Resuscitation Program trained qualified doctors and nurses at the point of deliveries.
4. Providing the basic equipment's at the point of delivery

in labour room and obstetric operating rooms including an infant radiant heat warmer, transport incubator, multipara monitors, emergency neonatal tray, which includes a self-inflating AMBU bag of two sizes, face-masks, suction device and catheters, cord clamps, emergency drugs, etc.

5. NICU beds were increased from 42 to 114.

6. To ensure adequate neonatal transport for investigations, for referral to higher centre and to shift back to native district health facilities, ALS ambulances, transport ventilator, transport incubators were equipped.

7. Strict following of aseptic protocol including hand washing techniques to day-to-day neonatal patient care were ensured.

8. Establishing, maintenance, optimization and regular use of central vascular access like PICC line, UVC, UAC.

9. Equipment's for neonatal care were provided as per standard protocols like radiant heat warmers, multipara monitors, ventilators, n-bubble CPAP's, pulse oximeters, HFO, HHHFNC ventilators, therapeutic hypothermia machine, invasive BP monitoring, Cerebral Function Monitor (CFM), advanced incubators, advanced phototherapy units, etc.

10. Investigations like ABG, bedside x-ray, USG, 2-D ECHO CRP-quantitative, procalcitonin level, capillary bilirubinometer were made available at the point of care.

11. Improving physical infrastructure including central oxygen, suction, air supply, three door entry, hand-washing stations, infection free roof, floor, walls and panels to level III NICU.

12. Provision of family participatory care by extra emphasis on KMC.

13. In-house Oto-Acoustic Emission (OAE) and Retinopathy of Prematurity (ROP) screening and high risk follow up clinic.

14. Establishing in house Central Sterile Services Department (CSSD) that included ETO, auto-clave machine, washing machines and dryer with dedicated team appointed for smooth day to day cleanliness and sanitation of wards and equipment's.

15. A team was constituted to oversee record keeping. An online inventory of all equipment's was established for the maintenance of equipment's. A system was established to call and inform for timely servicing of breakdown equipment's and it was ensured that there was no dearth of equipment at any point of time.

16. In-house vaccinations for NICU graduates.

17. Regular intra and inter- departmental neonatal death review meetings on monthly basis.

Outcome variables were compared between two time periods: pre-and post-intervention within each comparison group. Analysis for the two variables was performed: mortality and a disease specific mortality data. Variables included were NICU admission data and other baseline demographic and clinical data like- birth weight, gender, inborn-outborn status and mode of delivery, antenatal maternal co-morbidities, birth details, etc. The data was then entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0. Chi-square test was used for inferential purposes. P value of < 0.05 was considered as significant.

Results

1.Comparison and changes in infrastructure (Table 2)

The number of beds including level III beds and floor area were increased to overcome overcrowding and to improve care of critically sick neonates.

S. No.	Parameter	Year 2019 (pre-intervention)	Year 2021 (post-intervention)
1.	Total NICU square floor area (sq. ft.)	3,800	10,900
2.	Number of neonatal beds	42	114
3.	Number of level III neonatal beds	12	22
4.	Availability of central oxygen, suction and air	No	Yes
5.	Designated hand-washing area	No	Yes
6.	In-house Central Sterile Service Department	No	Yes
7.	Three door entries	No	Yes

Table 3: Change in manpower

S. No.	Parameter	Pre-intervention year 2019 (Manpower to bed ratio)	Post-intervention year 2021 (Manpower to bed ratio)	Increase in percent (%)
1	Doctors	6 (0.142)	24 (0.210)	32.38
2	Nursing staff	25 (0.595)	84 (0.736)	19.11
3	Ward cleaning staff	2 (0.047)	12 (0.105)	55.23
4.	Security staff	3 (0.071)	9 (0.078)	08.97

Table 4: Comparison of working equipment's status

S. No.	Parameter	Pre-intervention year 2019 (Equipment to bed ratio)	Post-intervention year 2021 (Equipment to bed ratio)	Increase (in %)
1.	Infusion pump	60 (1.428)	324 (2.842)	49.7
2.	Mechanical Ventilator	10 (0.238)	48 (0.421)	79.1
3.	Infant Radiant Heat Warmer	51 (1.214)	195 (1.710)	73.8
4.	LED Phototherapy units	27 (0.642)	84 (0.736)	67.8
5.	Multi para monitors	12 (0.285)	76 (0.666)	84.2
6.	n- bubble CPAP	00 (0.000)	48 (0.421)	4800

Table 5: Comparison of baseline variables

S. No.	Parameter	Year 2019 (pre-intervention)	Year 2021 (post-intervention)
1.	Total deliveries in hospital	11298	10116
2.	Total admissions in NICU	3248	5826
3.	Bed occupancy percentage (%)	130	96.6
4.	Inborn: Outborn	1862:1386	3985:1841
5.	Male: Female	1728:1548 (*2 ambiguous)	3177:2908 (*5 ambiguous)
6.	Vaginal: Caesarean delivery	6064:5234	4552:5564
7.	Preterm (<37 weeks)	1132	1826
8.	Low Birth weight (<2.5 Kg)	1486	2015

Table 6: Comparison of Neonatal mortality statistics

S. No.	Parameter	Year 2019 (pre-intervention)	Year 2021 (post-intervention)	Change in percentage (%)
1.	Total admissions	3248	5826	+79.37
2.	Total deaths	680	456	-49.11
3.	Unit death percentage	20.93	7.82	-13.11
4.	Out born deaths	361 (53.08%)	214 (46.92%)	-6.16
5.	Male: Female	349:331	236:220	-

Table 7: Distribution of disease wise neonatal mortality

S. No.	Parameter	Year 2019 (pre-intervention)		Year 2021 (post-intervention)		p-value
		Admissions*	Deaths	Admissions*	Deaths	
1.	Perinatal asphyxia with Hypoxic ischemic Encephalopathy	521	92 (17.65%)	568	50 (8.80%)	< 0.001
2.	Sepsis/ Pneumonia/ Meningitis	917	182 (19.84%)	1841	164 (8.91%)	< 0.001
3.	Respiratory Distress Syndrome	392	78 (19.89%)	756	22 (2.91%)	< 0.001
4.	Prematurity and LBW	1132	256 (22.61%)	1826	184 (10.07%)	< 0.001
5.	Others (MAS, Major Congenital Malformation, NNJ, TTNB, CHD)	862	72 (8.35%)	1214	36 (2.96%)	< 0.001

LBW: low birth weight, MAS: meconium aspiration syndrome, NNJ: neonatal jaundice, TTNB: transient tachypnoea of newborn, CHD: congenital heart disease.

The cumulative number of column 3 and 5 (2019 and 2021 admissions respectively) is not equal to total number of admissions due to overlapping of more than one disease diagnoses in a single patient. The deaths column included only the single major contributory cause of death.

Discussion

The sick neonates during their stay in NICU experience various stressors and negative influences, which have a detrimental effect on their growth and neurodevelopment, especially in the preterm infants.[9] There are some studies which showed that instituting proven QI initiatives and reducing the infant's exposure to various stressors and implementing the family-centred care approach help us in increasing better neonatal outcomes.[10]

The neonatal mortality was decreased significantly from 20.93% to 7.83% in post-intervention period. By improving infrastructure, equipment, training, clinical protocols, teamwork, and communication with healthcare facilities, mortality rates decreased from 44.9% to 42.2% in Burkina Faso and from 26% to 18% ($p < 0.01$) in Mozambique. In South Sudan, prioritizing neonatal care, enhancing resources, training, establishing a dedicated resuscitation area, and monitoring low birth weight (LBW) neonates separately resulted in reducing the mortality rate from 18.5% (2011) to 11.1% (2014).[11-13]

In the present study, we found significant increase in admissions of RDS patients and significant decrement of RDS specific fatality rate post QI implementation. This can be attributed to the increased referral of both high-risk mothers and sick premature neonates requiring surfactant. The timely use of n-Bubble CPAP, surfactant, regular monitoring with good quality of care of these premature neonates helped in significantly decreasing the RDS case fatality rate in our centre. The approach of establishing interventions like CPAP and surfactant therapies and training of doctors and nursing staff would optimise the care of preterm infants with RDS and decrease their mortality and morbidity.[14] It was mandated to include family members especially mother in NICU during KMC, feeding practises and daily handling of neonates. A study by Gooding JS et al concluded that inclusion of parents in all ward rounds, handling and breast milk feeding are areas that could add to quality and safety.[15]

The present study had highest number of admissions in the prematurity and LBW category accounting up to 20 – 22%. The case fatality rate for prematurity and LBW in our centre decreased from 22% to 10% by 2021 which was similar to a study conducted in South Sudan from 2011 to 2014 showed a decrease in mortality in LBW babies from 18.7% to 11.1%, while the study conducted in Mozambique in 2016 showed a decrease in the mortality rate for prematurity from 43% to 33%.[12, 13.]

As per National Neonatal Perinatal Database Report, the incidence of sepsis was 30 per 1000 live births,[19] whereas other study showed an incidence of 2.7% – 17% of all live births.[16,19] Our centre encountered sepsis at around 22% in 2019 and 30% of admission in 2021, while the deaths specific to sepsis significantly decreased by half of pre-intervention period, which can be seen as a result of increased emphasis given to the aseptic protocols, point of care sepsis

screen diagnostics, use of BACTEC, early identification and prevention of sepsis post QI implementation. But the sepsis specific mortality rate decreased from 19.84% (pre-intervention) to 8.91% (post-intervention) which is similar to study conducted in Mozambique where the mortality rate for sepsis decreased from 39% to 28% after QI intervention.[13]

Various community-based studies conducted in West Bengal, 2006 (9.8%), urban Hyderabad, 2009 (10.9%), Maharashtra, 2011 (6.4%), rural Karnataka, 2012 (9.4%), rural Uttar Pradesh, 2013 (16.6%) reported incidence of birth asphyxia ranging from 2% to 16.6%, with the reported case fatality rates ranging from 38.5% to 74%.[20] About 2.8% and 5.6% of all live births had moderate and severe asphyxia, respectively, in a large hospital-based study; the case fatality rate was relatively low at 8.7%.[19] The mortality rate for asphyxia decreased from 34% to 19% in a regional hospital from Mozambique post intervention in 2016.[13] The present study observed decrement of the total admissions and case fatality rate for moderate to severe perinatal asphyxia and the case fatality rate was lesser than the national estimates. This was mainly due to increased awareness, timely attending of neonatal calls by specialist NRP trained doctor at point of deliveries, use of neonatal therapeutic hypothermia machine and protocol-based management.

The strength of our study is that it covers a large geographical area of western India and represents a large sample. This study covers all type of rural and urban residing population belonging to all type of socioeconomic status. This study included whole year of both pre- and post-interventional period that ruled out the bias due to seasonal variation in mortality and mortality. The main limitation of the study was that the primary outcome was based only on mortality profile and immediate morbidity outcomes. The inclusion of long-term morbidity outcomes coupled with mortality indicators would have been a better measure. If the study would have been multi-centric and prospective, the strength of the results of the study might be more informative.

Conclusions

This study concludes that implementation of proper and comprehensive QI strategic interventions in NICUs can help in decreasing the neonatal mortality. It also impacts positively by decreasing the disease specific mortality in NICU.

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