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ORIGINAL ARTICLE

Impact of a quality improvement intervention on neonatal mortality in a regional hospital in Burkina Faso

Paul Ouedraogo[a], Paolo Ernesto Villani[b], Lucia Tubaldi[c], Jenny Bua[d], Fabio Uxa[e], Carmen Dell'Anna[f], Francesco Cavallin[g], Merran Thomson[h], Cecilia Plicco[i] and Maria Paola Chiesi[i]

[a]Saint Camille Hospital, Ouagadougou, Burkina Faso; [b]Neonatal Intensive Care Unit, Health Department of Women and Children, Poliambulanza Foundation Hospital, Brescia, Italy; [c]Neonatal Care Unit, Hospital of Macerata, Macerata, Italy; [d]Neonatal Intensive Care Unit, Institute for Maternal and Child Health, IRCCS 'Burlo Garofolo', Trieste, Italy; [e]WHO Collaborating Centre, Institute for Maternal and Child Health, IRCCS 'Burlo Garofolo', Trieste, Italy; [f]Chiesi USA Inc, Cary, NC, USA; [g]Independent Statistician, Solagna, Italy; [h]Hillingdon Hospitals NHS Foundation Trust, Uxbridge, UK; [i]Chiesi Foundation, Parma, Italy

ABSTRACT

Background: The neonatal period is the most vulnerable time in terms of a child's survival, with mortality during this period accounting for approximately half of the deaths before the age of 5 years. The Neonatal Essential Survival Technology (NEST) project is a program aiming to reduce mortality by improving the quality of neonatal care in sub-Saharan Africa. This study presents the evaluation of the first phase of the NEST intervention program at Saint Camille Hospital Ouagadougou (HOSCO), Burkina Faso, in terms of the reduction in neonatal mortality.

Methods: This is a retrospective analysis, based on "pre-intervention" data collected in 2015, and "post-intervention" data collected in 2018, including all infants admitted to the neonatal unit of HOSCO. The intervention period (2016 and 2017) comprised a structured quality improvement process conducted by a multidisciplinary working group that focused on improving infrastructure, equipment, training and use of clinical protocols, team working within the neonatal unit and with other hospital departments, and communication with referring healthcare facilities. Mortality data were compared pre- vs. post-intervention using a logistic regression model.

Results: The analysis included 1427 infants in the pre-intervention period, and 819 post-intervention. In both time periods, more than 75% of admissions were infants with low birth weight, and nearly 50% were very low birth weight. Post-intervention, while there was a decrease in overall admission, the proportion of multiple births increased from 20% to 24% ($p = .01$). The overall mortality rate was 44.9% (641/1427) pre-intervention, and 42.2% (346/819) post-intervention (OR 0.90, 95% confidence interval (CI) 0.76–1.07; $p = .23$). Adjusting for clinically relevant factors, the intervention was not associated with a change in overall mortality (OR 1.39, 95% CI 0.91–2.12; $p = .13$), but was associated with a reduced likelihood of mortality in outborn infants compared to inborn infants (OR 0.57, 95% CI 0.36–0.92; $p = .02$).

Conclusions: The first phase of the NEST quality improvement program was associated with a decrease in mortality in outborn infants admitted to the neonatal unit at HOSCO. Long-term assessment is expected to provide a more comprehensive evaluation of the program in a low-income setting.

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Infant mortality; infant, newborn; quality improvement; global health; low income population

Introduction

Improving child survival was one of the United Nation's Millennium Development Goals [1], and although mortality in those under 5 years of age decreased overall, improvements in neonatal mortality were less marked. The neonatal period (defined as the first 28 days of life) is the most vulnerable time in terms of a child's survival, with mortality during this period accounting for approximately half of the deaths before the age of 5 years [2]. According to the United Nations Children's Fund (UNICEF), 2.6 million babies die annually during the first 28 days of life [3], with a further 2.6 million stillborn [3]. Importantly, three quarters of these deaths happen in the first week of life [2], with the risk being greatest on the day of birth [4–6].

CONTACT Maria Paola Chiesi info@chiesifoundation.org Chiesi Foundation, Parma 43122, Italy

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A large proportion of neonatal deaths occurs in low-resource settings, with sub-Saharan African countries accounting for approximately one in three neonatal deaths [7,8]. However, the vast majority are preventable, as more than 80% of newborn deaths are the result of premature birth, perinatal complications, or infections such as sepsis, meningitis, and pneumonia [3]. Given the importance of prompt access to quality care for newborns [9–11], UNICEF has emphasized two critical steps: increasing access to affordable healthcare, and improving the quality of that care [3].

In Burkina Faso, the neonatal mortality rate is currently 25 deaths per 1000 live births [2,12], with limited perinatal care playing an important role in neonatal survival [13]. The government of Burkina Faso introduced free healthcare for pregnant women and children under the age of 5 years in 2016 [14]; however, out of pocket payments exist in public hospitals, and parents pay for care in private hospitals. Burkina Faso is projected to miss the World Health Organization Sustainable Development Goal 3.2 target of reducing neonatal deaths to 12 deaths per 1000 live births by 2030 [15].

Prior to 2014, the Chiesi Foundation (an Italian nonprofit organization) and Medicus Mundi, Italy supported a number of neonatal training visits to the Saint Camille Hospital Ouagadougou (HOSCO) in Burkina Faso, which resulted in an improvement in neonatal mortality [16]. However, further needs were identified, including the possible benefits of a broader and structured approach.

The Neonatal Essential Survival Technology (NEST) project [15] is supported by the Chiesi Foundation; the program works to reduce neonatal mortality in partnership with local health providers and governments by improving the quality of care in a number of sub-Saharan African countries, including Burkina Faso, Benin, and Burundi. Following a structure assessment of the neonatal service [17], the implementation of NEST commenced at HOSCO in 2016–2017. This study presents the evaluation of the first phase of the NEST intervention program, in terms of the reduction in neonatal mortality.

Materials and methods

Study design

This is a retrospective analysis, based on "pre-intervention" data, collected over the period January to December 2015, and "post-intervention" data collected between January and December 2018. All infants admitted to the neonatal unit of HOSCO during the pre-intervention and post-intervention periods were included in the study.

Setting

HOSCO is a tertiary private hospital located in Ouagadougou, the capital city of Burkina Faso. The main catchment area is the eastern part of the city, but HOSCO receives referrals from hospitals and community healthcare facilities across the entire city, which has a population of approximately 2.8 million [18]. Every year, around 4–5000 births occur at HOSCO. The neonatal unit cares for a high-risk population, many of very low birth weight (VLBW), with the majority of admissions being of neonates born in centers outside HOSCO and subsequently referred [15,19].

Interventions

Using a structured quality improvement process, a multidisciplinary working group (composed of the local healthcare staff, local decision makers, and experts from the Chiesi Foundation team) identified strengths and weaknesses of the care being provided in the HOSCO neonatal unit (Addendum Figure 1), and agreed appropriate strategies for improvement. A series of interventions were implemented during 2016 and 2017 that focused on improving infrastructure, equipment, training and use of clinical protocols, team working within the neonatal unit and with other hospital department, and communication with referring healthcare facilities (Addendum Table 1).

Data collection

Data were retrieved from hospital medical records. Available data included inborn/outborn, sex, birth weight, singleton/multiple birth (i.e. one vs. two or more babies in a single birth), age at admission, length of stay, and outcome (alive/dead). Data extraction was performed by a researcher who was not involved in clinical activity or in the study design. This researcher could not be masked to the intervention period.

Statistical analysis

Continuous data were expressed as mean and standard deviation (SD), and categorical data as number and percentage. Continuous data were compared between pre- and post-intervention periods using

Student's *t*-test, with categorical data evaluated using Chi-square test. Mortality was compared post- vs. pre-intervention periods using a logistic regression model, adjusting for clinically relevant factors at admission (inborn/outborn, singleton/multiple birth, sex, birth weight, and age at admission). The interaction term "period × place of birth" was also included in the model to evaluate different effects of the intervention among inborn and outborn infants. Effect sizes were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). All tests were two-sided and a *p* value less than .05 was considered statistically significant. Statistical analysis was performed using R 3.5 software (R Foundation for Statistical Computing, Vienna, Austria) [20].

Ethics considerations

The study was approved by the Institutional Review Board of Saint Camille Hospital of Ouagadougou, which waived the need for written informed consent given the retrospective nature of the study and the use of anonymized data from hospital records.

Results

The analysis included 1427 infants admitted to HOSCO's neonatal unit during the pre-intervention period, and 819 infants admitted during the post-intervention period. In both time periods, more than 75% of admissions were infants with low birth weight, and nearly 50% were VLBW. Infant characteristics at admission are reported in Table 1. From pre- to post-intervention, the proportion of outborn infants admitted to the neonatal unit decreased from 78% to 74% ($p = .02$), while the proportion of multiple births increased from 20% to 24% ($p = .01$). No statistically significant differences were observed in sex, birth weight, or admission age (Table 1).

Of note, 7.5% (313/4183) of infants born in HOSCO were admitted to the neonatal unit during the pre-intervention period compared with 6.3% (215/3400) during the post-intervention period ($p = .05$). Overall, the mean length of stay was 6.7 days (SD 8.0) in the pre-intervention period and 12.4 days (SD 17.5) in the post-intervention period (mean difference 5.7, 95% CI 4.4–7.0; $p < .0001$). One of the main interventions was the introduction of "kangaroo mother care", which allows mothers to stay with their babies to establish breastfeeding before discharge home, rather than discharge home directly from the neonatal unit before breastfeeding is fully established. When the length of stay in the kangaroo mother care room is excluded, the mean length of stay on the neonatal unit was 7.4 days (SD 8.5) in the post-intervention period (mean difference 0.7, 95% CI 0.1–1.4; $p = .04$).

The overall mortality rate was 44.9% (641/1427) in the pre-intervention period, and 42.2% (346/819) in the post-intervention period (OR 0.90, 95% CI 0.76–1.07; $p = .23$). Information on outcome was not available in one infant. Adjusting for clinically relevant factors (Table 2), the intervention was not associated with a change in mortality overall (OR 1.39, 95% CI 0.91–2.12; $p = .13$), but was associated with a reduced likelihood of mortality in outborn infants compared to inborn infants (OR 0.57, 95% CI 0.36–0.92; $p = .02$).

Discussion

Quality of care plays an important role in improving neonatal outcomes [15,19,21,22], and the high levels of neonatal mortality in many resource-limited

Table 1. Characteristics of infants admitted to the neonatal unit of Saint Camille Hospital Ouagadougou (Burkina Faso) during the pre-intervention (January to December 2015) and post-intervention (January to December 2018) periods.

	Pre-intervention	Post-intervention	*p* Value
No. of admissions to neonatal unit	1427	819	–
Place of birth			.02
Inborn	313 (21.9)	215 (26.3)	
Outborn	1114 (78.1)	604 (73.7)	
Birth[b]			.01
Singleton	1144 (80.2)	618 (75.6)	
Multiple	283 (19.8)	200 (24.4)	
Sex[c]			.22
Female	670 (47.1)	361 (44.3)	
Male	751 (52.9)	453 (55.7)	
Birth weight, g[a,d]	1819 (842)	1822 (841)	.93
Low birth weight (<2500 kg)	1104 (77.5)	624 (76.6)	.64
Very low birth weight (<1500 kg)	633 (44.5)	395 (48.5)	.07
Admission age[e]			.48
On the day of birth	1162 (81.8)	657 (80.5)	
Later on	258 (18.2)	159 (19.5)	

Data expressed as no. (%) or [a]mean (SD). Data not available for [b]1, [c]11, [d]7, and [e]10 infants.

Table 2. Multivariable analysis of mortality among infants admitted to the neonatal unit of Saint Camille Hospital Ouagadougou (Burkina Faso) during pre-intervention (January to December 2015) and post-intervention (January to December 2018) periods.

	Odds ratio (95% confidence interval)	*p* Value
Period: post- vs. pre-intervention	1.39 (0.91–2.12)	.13
Place of birth: outborn vs. inborn	1.48 (1.08–2.03)	.02
Birth: multiple birth vs. singleton	0.85 (0.68–1.06)	.15
Sex: male vs. female	1.27 (1.05–1.53)	.01
Birth weight (per 100 g)	0.88 (0.87–0.90)	<.0001
Admission on day of birth vs. later on	1.14 (0.90–1.44)	.29

The interaction term "period × place of birth" was statistically significant and suggested a reduced likelihood of mortality due to the intervention in outborn infants compared to inborn infants (OR 0.57, 95% CI 0.36–0.92; p=.02).

countries can, in part, be attributed to poor quality of care [15,19,21]. Effective implementation of quality improvement is possible in low income settings [22], with appropriate strategies including the identification of quality gaps, followed by the development of action plans (and their implementation) to overcome barriers [23,24].

This study reports neonatal outcomes after the first phase of the NEST quality improvement intervention at HOSCO. The neonatal unit provides care to a population of infants at high risk of adverse outcome [15,19]. The majority of admissions are referred after birth from hospitals across the city, and many are of VLBW. Our findings indicate a decrease in the overall number of admissions, and in the proportion of outborn infants admitted, although the proportion of VLBW neonates and of multiple births increased. While there was no reduction in overall mortality, reduced mortality was observed among outborn infants.

These results are encouraging. Pre-intervention, the neonatal unit was overcrowded, lacked appropriate basic facilities including kangaroo mother care, equipment, guidelines, and protocols, and dedicated trained nursing and medical staff (Addendum Figure 1). Further, communication and team working were poor, both within HOSCO and with referring hospitals and health centers. During 2016–2017, the NEST project focused on stepwise improvements in: infrastructure (including a reduction in the number of cots in the neonatal unit to reduce overcrowding, and a dedicated kangaroo mother care unit); appropriately trained dedicated neonatal staff; the development and implementation of clinical guidelines and protocols; improved communication within the neonatal team and with the wider hospital; enhanced team working and training for HOSCO maternity services; and the establishment of an informal network with referring centers, with shared education leading to improved communication (Addendum Table 1). In a number of other low-income settings, the introduction of dedicated staff and appropriate training was associated with improved neonatal outcomes [16,25–27]. At HOSCO, these enhancements, coupled with an overall reduction in admissions to the neonatal unit, may have permitted the provision of better-quality neonatal care post-intervention. Within HOSCO, the improved collaboration between the neonatal unit and other departments (especially the delivery room and maternal ward) led to a reduction in the number of inborn babies admitted. In addition, the development of an informal network between HOSCO and referring centers likely improved the immediate care at birth, reduced the number of outborns transferred to the HOSCO neonatal unit, and contributed to the reduced mortality among outborn infants. A particular contributor to the acceptability and sustainability of the program has been the collaboration between the Chiesi Foundation and the staff at HOSCO, with local stakeholders (and particularly the local champion, who is the director of HOSCO) supporting this quality improvement program.

While the current implementation of NEST at HOSCO seems encouraging, it is expected that the overall effect of the interventions will become apparent in the next few years. An increased number of VLBW, infants from multiple pregnancies, increased length of stay and limited change in overall mortality, may suggest that "sicker" babies were admitted to the neonatal unit after the intervention; therefore, future observations are needed to assess the longer-term impact of NEST. In addition, we specifically selected objective, measurable parameters to assess the impact of the interventions, with a focus on the proportion of neonates admitted, the length of stay, and mortality. Although such parameters can be helpful in quantifying the result of the changes, they do not capture some of the more intangible benefits for both mothers and infants (and even potentially for the staff). For example, kangaroo mother care has been shown to provide a range of psychological benefits to the mother, reducing stress levels compared to conventional care, instilling a sense of empowerment and confidence, and leading to improved bonding between mother and child [28]. The reduction in

maternal stress has been shown, in turn, to improve the development outcomes of neonates at the age of 12 months [29]. Furthermore, increased maternal stress correlates with an increased risk of post-partum depression [30]. It is possible, therefore, that our analyses underestimate the benefits of the changes that were implemented.

The program has faced challenges including the impact of political instability and terrorism on staff recruitment and retention, the functioning of HOSCO's neonatal service, and the wider healthcare network within the city of Ouagadougou. Nursing and medical staff shortages has impacted the rate at which education, training, and quality improvements can be implemented and monitored, undoubtedly slowing progress in the program's ability to impact neonatal outcomes including mortality.

This study has some limitations. First, it is a retrospective study, thus availability and quality of data were limited. Second, generalizability of the findings is limited to similar settings. Third, the impact of each component of the intervention could not be separately assessed.

Further quality improvement steps still need to be implemented at HOSCO. Continued development of the network represents an important next step in the program which may potentially further impact this outcome. Improvements will include the formalization of the collaboration between HOSCO, other hospitals in the city, and the referring centers, with well-defined roles and procedures and shared goals [15]. The focus on recruitment and retention of dedicated trained neonatal staff has led to proposals to develop specialized postgraduate neonatal education for nurses and midwifes in collaboration with local universities [15]. Appropriate recognition and remuneration of trained neonatal nursing staff and the establishment of a HOSCO based education team has been also identified as an important future step. In addition, while data are collected regularly, a structured data collection system is required to improve the quality of audits and thus permit the identification of modifiable factors and missed opportunities [15,31,32]. Furthermore, national guidelines and protocols for neonatal care are warranted, with adaptation of international protocols and algorithms to the local setting [15].

In conclusion, in this retrospective analysis, the first phase of the NEST quality improvement program was associated with a decrease in mortality in outborn infants admitted to the neonatal unit at HOSCO. Long-term assessment is expected to provide a more comprehensive evaluation of the intervention in a low-income setting. In addition, the next phase is expected to bring further quality improvement steps – including formalization of the clinical network, advanced education in neonatal care, recruitment and retention initiatives, implementation of a structured data collection system, continued audits and quality improvement, and definition of national guidelines/protocols for neonatal care.

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Disclosure statement

PO, PEV, LT, JB, FU, and FC: no relevant conflicts to disclose. CDA is a full employee of Chiesi USA, an affiliate of Chiesi Farmaceutici. MT: undertakes paid consultancy work for Chiesi Farmaceutici SpA and is a technical advisor for the NEST Project, Chiesi Foundation. CP is an employee of the Chiesi Foundation and Chiesi Farmaceutici SpA. MPC is the coordinator of the Chiesi Foundation, and is a shareholder of Chiesi Farmaceutici SpA.

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