Neonatal Outcomes in a Community Hospital in M'Bour, Senegal

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ABSTRACT

Background: Neonatal mortality accounts for up to 10% of the global burden of disease. Low-income countries, especially in Sub-Saharan Africa, suffer the highest rates of neonatal mortality. Identifying the causes is necessary to guide community-specific public health efforts. This study aimed to identify the most common neonatal conditions and outcomes in a community hospital in M'Bour, Senegal.

Methods: This retrospective chart analysis was carried out for 0-28 day old infants admitted to the M'Bour Hospital during 2014. Newborn weight, gestational status, maternal age, delivery location, neonatal diagnoses, and outcomes were tabulated. A logistic regression model was applied to examine the relationship between infant death and maternal age, preterm birth, and the most common diagnoses of asphyxia and infection.

Results: During 2014, 322 neonates were treated. 78.2% of the infants were discharged, 17.5% died, and 4.3% were transferred. Birth outside of the hospital carried 20.4% mortality compared to 14.0% for internal births. Mean newborn weight was 2452 grams, with 49% of the infants having low birth weight and 14.6% very low birth weight. Low birth weight carried a 24.9% mortality rate. The most common diagnoses at admission were prematurity (26.4% of cases), neonatal asphyxia (23.3%), infection (17.4%), and neonatal respiratory distress (15.8%).The two significant predictors of death were preterm birth (OR 1.93-2.57, $p<0.05$) and asphyxia (OR 2.34, $p<0.05$).

Conclusion: Neonatal asphyxia, preterm birth, and low birth weight were the main contributors to death. Future efforts to improve neonatal mortality in M'Bour, Senegal should address these conditions.

KEY WORDS: neonatal mortality, preterm birth, neonatal asphyxia, low birth weight

BACKGROUND

Neonatal mortality refers to death during the first 28 days of life.[1] Neonatal and congenital conditions account for almost 10% of the global burden of disease, a quantifiable measure of the global morbidity and mortality of specific diseases, injuries, and risk factors based on years of life lost and years of life lived with decreased health.[2,3] An estimated 3 million newborns die each year.[4] Since 1990, the global neonatal mortality rate has decreased by 37% from 33 to 21 deaths per 1000 live births; however there have been marked variations in neonatal mortality reduction between regions with sub-Saharan Africa and South Asia making the slowest progress.[3] Newborn deaths still constitute 44% of worldwide deaths among children under the age of five.[3,5] With improved childhood mortality associated with infectious disease, newborn deaths are expected to constitute an even larger percentage of overall deaths among children under age five.[6]

There is considerable variation in neonatal mortality between countries, ranging from 1.82 per 1000 live births in Monaco to 115 per 1000 live births in Afghanistan.[7] Eight of the nine countries with neonatal mortality rates above 40 per 1000 live births are in Sub-Saharan Africa.[3] This highlights the need for increased focus on neonatal care, particularly in areas such as Africa that have the highest risk for neonatal mortality.[3] In 2014, the WHO Every Newborn Action Plan was developed with the goal of ending neonatal deaths that are preventable with healthcare measures. Initiatives include improving access to maternal and newborn care, improving support of healthcare workers,

and fostering community engagement to improve newborn care.[5] There has been good progress to date, with 48 high-burden countries developing nationalized newborn health strategies.[8] From the Every Newborn Action Plan came a worldwide under-5 mortality goal of fewer than 10 per 1000 live births by 2035.

In 2012, the leading causes of global neonatal mortality were complications from preterm birth (1.03 million or 36% of deaths), intrapartum related conditions (0.66 million or 23% of deaths) and infections (0.66 million or 23% of deaths). Overall, Africa has the highest preterm birth rate (up to 18%), and these babies are at the highest risk for mortality, particularly those with low birth weight.[3,9]

In Senegal, the neonatal mortality rate in 2014 was 21.5 per 1000 live births, an improvement from the 36.7 per 1000 observed in 2002.[10] Prior studies focus on specific cities and towns within Senegal and demonstrate differing causes of neonatal mortality based on location. A study in the capital city of Dakar found the most common causes of neonatal mortality were premature birth, acute fetal distress and neonatal infections.[11] In the rural town of Niakhar, the most common causes of neonatal mortality from 2006-2012 were neonatal infections, prematurity and birth asphyxia.[12] These findings were a part of a large multi-site international review of mortality, which revealed marked variations in neonatal mortality rates both between and within several African countries.[12] The Every Newborn Action Plan highlighted the need to develop population-specific plans to address neonatal mortality. As such, there is a need to continue to quantify rates and causes of neonatal mortality in multiple regions within African countries in order to develop plans specific to those regions.

RESEARCH OBJECTIVES

The primary goal of this study was to analyze newborn demographics (birth location, age at admission, maternal age, birth weight), principal diagnoses and outcomes (discharged, transferred, or deceased) of a community hospital in M'Bour, Senegal during 2014. We also sought to examine the relationships between neonatal death and certain risk factors such as maternal age, infant term, birth weight and final diagnosis. These risk factors were chosen because they are major causes of neonatal mortality in other areas of Senegal as well as the developing world overall.[11-14]

Prior studies in Senegal reflect data from the large university hospital in Dakar and the rural town of Niakhar, with none focusing on medium-sized cities or community hospital settings such as M'Bour.[11,12] This study aimed to identify the primary causes of mortality encountered in M'Bour in order to help guide newborn care improvement efforts for this population as well as in similar community hospital settings.

METHODS

EPS M'Bour Hospital facility and services: The neonatal unit occupies one of the three patient rooms in the pediatrics building, which was constructed in 2012. The unit is equipped with two incubators (old), five neonatal beds and one table used for resuscitation and procedures. Neither life support nor continuous positive airway pressure is available for infants with respiratory distress or low birth weight. Parents can visit without restrictions, and there is a kangaroo mother care area, which is an intra-hospital maternal-infant skin-to-skin contact area. One General Pediatrician without specialized neonatology training, as well as occasional medical students rotating through the hospital, staff the unit along with nurses. The General Pediatrician also provided care for 3,875 outpatient visits and 780 admissions (including neonatal admissions) during 2014.

Data and sample: Data were drawn from the medical charts of 0-28 day old infants admitted to the Neonatology division at the EPS M'Bour Hospital in M'Bour, Senegal, from January 1, 2014, to December 31, 2014, and reviewed retrospectively.

Infant disposition outcomes were recorded as discharged, transferred or deceased. Other variables captured from patient charts included newborns age (hours), weight (grams), length (centimeters) and temperature (Celsius) at admission, as well as gestational status of the newborns (pre-term, term or post-term), mothers age at delivery (years), the infant delivery location (within vs outside of the hospital), admission duration, principal diagnoses at admission and final diagnosis.

Analyses: Descriptive statistics in the form of means and range for infant weight, length, temperature, admission duration, infant age at admission, age of neonatal death and mother age were calculated. Frequencies and percentages for birth term, low birth weight and very low birth weight (less than 2,500 and 1,500 grams, respectively), and neonatal principal diagnoses were calculated across the outcome variables.[15]

Finally, an additional logistic regression model was used to examine the relationship between mother's age (in years),

	Mean	Min	Max
Baby weight (grams)	2452.57	700	5500
Mother's age (years)	27.63	13	50
Baby length (cm)	48.28	35	60
Baby temperature (0C)	36.14	30.4	40
Age at admission (hours)	38	0	600

Table 1. Summary statistics describing infants in the sample.

infant death (reference = baby survived), preterm infants (reference = term and post term infants) and common diagnoses including 1) neonatal asphyxia, 2) infection and 3) combinations of neonatal asphyxia, infection and prematurity. Birth weight was not included in the regression model due to multicollinearity with birth term. All analyses were carried out in Stata 13.

All research was conducted in accord with prevailing ethical principles and reviewed by an Institutional Review Board.

RESULTS

During 2014, a total of 322 infants were treated in the Neonatology division at the M'Bour Hospital. Mothers' ages ranged from 13 to 50 years, with a mean age of 27 years (SD 7.5 years). The mean newborn length was 48 cm, with a range of 35 to 60 cm. Newborn weight at admission ranged from 700 grams to 5500 grams, with a mean weight of 2452 grams. The WHO defines low birth weight as less than 2500 grams and the very low birth weight subcategory as less than 1500 grams; normal birth weight is 2500-4200 grams.[15] Newborn age at admission ranged from 0 hours to 600 hours, with a mean age of 38 hours (Table 1). Infant admission duration ranged from 0 days to 27 days, with a mean of 5.79 days and median of 5 days. The mean age of neonatal death was 6.7 days. Very early (days 0-3), early (days 0-7) and late (days 8-28) neonatal mortality accounted for 26.8%, 69.1% and 30.9% of the deaths, respectively.

The most common perinatal diagnoses were twin pregnancy (14.6% of cases), obstructed labor (11.2% of cases) and preeclampsia (9.6% of cases). 21% of cases had no signs of perinatal abnormalities. 51% of the newborns arrived after delivery in the maternity ward within the hospital, and 49% of the newborns were delivered outside of the hospital. The average newborn age at admission was 9.6 hours for internal births and 67.9 hours for external births. The neonatal mortality rate was 140 per 1000 births for infants born within the hospital and 209 per 1000 for those born outside the hospital. Infant age at admission was not a significant predictor of death (OR 1.00, p=0.2).

Table 2 shows descriptive statistics for infant outcomes. 251 (78.2%) of the infants were ultimately discharged, 56 (17.5%) died and 14 (4.3%) were transferred. 101 of all infants were born preterm, 212 were carried to term and 8 were born post-term. 49% of infants were less than 2500 grams (low birth weight), 14.6% of infants had a very low birth weight of less than 1500 grams and 2.8% of infants were macrosomic (above 4 kg). Of the very low birth weight infants, 53.2% were discharged, 38.3% died and 8.5% were transferred. Two infants had extremely low birth weight of less than 1 kg, both of whom died. Of the low birth weight infants, 70.7% were discharged, 24.84% died and 4.46% were transferred. All of the nine macrosomic infants were eventually discharged.

The most common principal neonatal diagnoses at admission were prematurity (26.4% of cases), neonatal asphyxia (23.3% of cases), infection (17.4%) and neonatal respiratory distress (15.8% of cases). Of the infants admitted with a principal diagnosis of prematurity, 70.6% were ultimately discharged, 5.9% were transferred and 23.5% died. Of the infants admitted with neonatal asphyxia, 83.1% were discharged, 2.8% were transferred and 14.1% died. Of the infants admitted with a principal diagnosis of infection, 92.6% were discharged, none were transferred and 7.4% died. Of the infants admitted with a principal diagnosis of neonatal respiratory distress, 58.1% were discharged, 7% were transferred and 34.9% died (Table 2).

Table 3 shows the regression models predicting the survival outcome of an infant after admission by most common final diagnosis (infection, asphyxia and multiple conditions). Infant birth term was a significant predictor of death, with the observed odds of a preterm infant dying being about twice that of a term or post-term infant ($p<0.05$). Model 2 shows that neonatal asphyxia was a significant predictor of death in the sample of infants. Infants with this diagnosis were also about twice as likely to have died compared to infants without this diagnosis (OR 2.3, p=0.05).

DISCUSSION

Failure to improve birth and neonatal outcomes will result in an estimated 116 million deaths by 2035.[3] The Lancet Every Newborn series states that "to count deaths

is crucial to change them" and calls for increased measurement frameworks to guide the development of population-specific plans to address neonatal mortality.[3,5] The series also indicates that progress will only be made through addressing context-specific problems.[5] Ideal plans to improve neonatal mortality in this population in M'Bour would address the main contributors: prematurity, low birth weight and neonatal asphyxia.

M'Bour Hospital treats primarily the highest acuity cases in the region, including high risk pregnancies delivered in the hospital as well as home and health post deliveries with poor outcomes. In Senegal, 38% of all deliveries take place at home.[16] Mothers and healthy infants that were not brought to the hospital are not reflected in this data, which likely increased the mortality rate in this hospital-based study compared to the region overall. Furthermore, the hospital is not well-equipped to handle the care of severely ill infants, lacking continuous positive air pressure breathing devices and other life support capabilities. Birth outside of the maternity ward of the hospital was associated with increased neonatal mortality, with 20.4% of such infants dying compared to 14.0% of infants born in the maternity ward. Neonatal mortality was most common during the first week of life (69.1% of deaths).

	Discharged	Transferred	Death
Total Sample	251	14	56
Percentage (%)			
Birth term			
Term (212)	82.08	3.77	14.15
Post-term (8)	100	0	0
Preterm (101)	68.32	5.94	25.74
Birthweight			
Extremely low (2)	0	0	100
Low (157)	70.7	4.46	24.84
Normal (155)	84.52	4.52	10.97
High (9)	100	0	0
Principal diagnosis			
Prematurity (85)	70.59	5.88	23.53
Neonatal asphyxia (75)	83.1	2.82	14.08
Infection (56)	92.59	0	7.41
Neonatal respiratory distress (51)	58.14	6.98	34.88

Table 2. Descriptive statistics for infant outcomes.

The most common contributors to neonatal mortality in this study were neonatal asphyxia, preterm birth and low birth weight, results consistent with those observed in previous related studies in Senegal.[11,12] Asphyxia and preterm birth were statistically significant predictors of death in this study, both of which increased the odds of death by roughly two. In rural, resource-poor hospitals in Tanzania, Ghana, and India, neonatal asphyxia was also found to be the most predominant cause of death, with prematurity and low birth weight as additional causes, indicating that many resource-poor hospitals throughout the developing world face similar challenges with regards to neonatal mortality.[14]

Despite the relatively high incidence of neonatal asphyxia in sub-Saharan Africa, a study in Nigeria showed that maternal knowledge of the risk factors and sequelae of the condition is low, particularly for mothers that received prenatal care outside of the teaching hospital.[17] A survey of international community health workers and policy-makers, including those in West-Africa, identified increased community efforts as a top priority to address neonatal mortality rates.[18] Increased prenatal and community education for expectant mothers could help improve outcomes in M'Bour, especially given the high frequency of home births. A large meta-analysis of studies in mostly developing countries found that such efforts led to improved rates of hospital attendance for births and corresponding decreases in neonatal death.[19]

Worldwide, 5-10% of neonates need help initiating breathing, but as few as 0.1% of all neonates require more aggressive measures such as medications and intubation.[20] Widespread use of basic resuscitation along with an increase in births in healthcare facilities has been shown to significantly decrease early neonatal mortality, with a greater impact than advanced neonatal care.[21] As seen in M'Bour, only about 15% of African hospitals are equipped to provide basic neonatal resuscitation (suction, stimulation, and bag and mask ventilation).[20] Furthermore, many health care personnel in African hospitals feel that they receive inadequate training in these skills, with one study showing only 35% of practitioners scoring above minimum competency and other studies reporting similar results.[22] To address this problem, a simulation-based resuscitation course known as "Helping Babies Breathe" is being implemented in 60 low-resource countries worldwide, including Senegal.

Odds of infant death	Model 1	Model 2	Model 3
Mother's age (years)	0.972	0.978	0.974
	(0.224)	(0.341)	(0.246)
Preterm	1.933*	2.567**	2.118*
*(ref = post and term infants)	(0.048)	(0.008)	(0.025)
Infection	0.498		
	(0.115)		
Asphyxia		2.343*	
		(0.026)	
Two or more conditions			0.736
			(0.448)
N	270	270	270

p-values in parentheses
** p<0.05, ** p<0.01, ***p<0.001*

Table 3. Logistic regression predicting odds of death of infant after treatment from mother's age, birth term, and by the most frequent final diagnoses

The program is based on the correspondence of observed improvements in early initiation of neonatal resuscitation with reductions in neonatal death during the first 24 hours of life.[23] Importantly, the vast majority of infants who receive early, high-quality resuscitation and survive have no significant developmental differences and no increased risks for neurodevelopmental disability compared to infants with no birth complications requiring resuscitation.[24] The one pediatrician at the hospital has received neonatal resuscitation training, but 49% of infants seen were brought in from outside birth facilities or homes. Furthermore, midwifes are usually the only practitioners present at births in the area, and not all of them receive neonatal resuscitation training.

While more costly and difficult to implement in resource poor settings, surfactant use and more advanced resuscitation measures have been shown to further decrease neonatal mortality.[25,26] Between 2006 and 2013, a hospital in Johannesburg increased the use of continuous positive airway pressure from 20.3% to 62.9% and surfactants from 19.2% to 65% in very low birth weight infants weighing 750-900 grams. These changes significantly increased survival in those neonates from 20.4% in 2006 to 52.4% in 2013.[26]

Similar to prior studies in Sub-Saharan Africa, preterm birth was a significant predictor of death in this study.[27] A large retrospective study analyzing risk factors for prematurity and low birth weight in Tanzania identified young maternal age, late start to antenatal care, short maternal stature (a sign of poor maternal nutrition), and poverty as potentially modifiable risk factors.[27] Poverty is widespread in Senegal, with roughly 60% of households classified as poor or vulnerable.[28] This impacts not only access to maternal nutrition but also access and willingness to seek health care, as the healthcare system is completely privatized in Senegal. Other measures that have been shown to improve outcomes for preterm infants include steroid administration for preterm labor and kangaroo mother care, which were not studied in this analysis.[25] Kangaroo mother care within the pediatric hospital as well as close proximity to emergency obstetric care contributed to improved neonatal outcomes in a resource-limited district hospital in Burundi, both of which are employed at the M'Bour Hospital.[29]

Low birth weight carried nearly a 25% mortality rate in this study. While preterm birth and/or low birth weight together accounted for over half of neonatal deaths in a recent study in East Africa, these variables each have different prognostic ramifications, yet they do often act synergistically.[30] The study found slightly premature babies with low birth weight to have the highest risk of death with an odds ratio of nearly [20]. Pre-pregnancy BMI and maternal growth during gestation were shown to be the most important determinants of birth weight in a low resource setting in Ghana.[31] As with preterm birth, nutritional education for expectant mothers could potentially help improve neonatal outcomes in M'Bour, as there are currently no such resources in the area. However, access to adequate nutrition remains a problem for many in Senegal.[32]

Limitations to this study included missing or incomplete data in the medical charts. In particular, exact sources and types of infection were not included in most charts. Data of gestational age at birth were not available, so the gestational status of the neonates was approximated using length and weight measurements as well as physical exam characteristics. Outcomes for patients that were transferred or discharged against medical advice were unknown, and data regarding stillbirths was not available. Furthermore, adverse events following discharge were unknown. Despite some missing data, there was still an adequate sample size to perform the logistic regression and statistical analyses.

Future work includes analyzing the treatment protocols in place in this neonatology division, with emphasis on the treatments of neonates admitted with prematurity, low birth weight, and asphyxia. Further study of obstetric care

in relation to neonatal outcomes could also provide useful information. Longitudinally tracking the causes of neonatal mortality would also be useful for further study, especially as treatment protocols evolve over time.

CONCLUSION

Neonatal asphyxia (OR 2.3, p<0.05) and preterm birth (OR 1.9-2.6, p<0.05) were significant predictors of death in this study. Low birth weight and very low birth weight were also highly associated with mortality, with 24.8% and 38.3% of those infants dying, respectively. Cost-effective measures such as neonatal resuscitation equipment and educational programs such as Helping Babies Breathe would be reasonable first steps toward improving these outcomes. Beneficial future work could also include Public Health efforts to improve maternal nutrition as well as education regarding dangerous neonatal conditions.

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