Mortality and Longevity in Neonates: A 3 Years Retrospective Study of Neonatal Intensive Care Unit Deaths in a Referral Hospital in India

Prakash Babu Kodali¹, Vineela Kellellu², Ramya Vallabhuni³

¹MPhil Scholar, Centre for Public Health, School of Health Systems Studies, Tata Institute of Social Sciences, Mumbai, Maharashtra, India, ²MPH Student, Department of Public Health, School of Medical Sciences, University of Hyderabad, Hyderabad, Telangana, India, ³Senior Research Fellow, Division of Infectious Diseases, St. John’s Research Institute, Bengaluru, Karnataka, India

ABSTRACT

Introduction: Child mortality is one of the most common public health problems which majority of public health programs tries to address. Although child mortality has been reduced in the past decade, at the same time neonatal mortality raised significantly reflecting itself as a public health problem. The current study tries to epidemiologically study various causes of neonatal mortality in Neonatal Intensive Care Unit (NICU) and quantify how those various causes influence the longevity of the neonates.

Methods: The study draws itself from the secondary data analysis from the data obtained from the 3 years NICU death registers of the hospital. Data analysis by descriptive statistics, correlational analysis, and multivariate regression analysis is done using Statistical Software for Social Sciences.

Results: A total number of deaths n = 5119, males = 3130, females = 1989. Mean age = 4.16 days, mean weight = 1.913 kg. 66.49% of deaths because of cardiac arrest (CRA), cardio respiratory failure (CRF), respiratory failure (RF). Birth weight of the neonate is positively correlated with number of days lived \( r = 0.039, P \leq 0.05 \). Multivariate regression analysis between independent variable (number of days lived) and independent variables: For CRA, CRF, and RF \( b = -15.829, t = -6.552, P < 0.01 \). For sepsis and meningitis \( b = -12.624, t = -5.202, P < 0.01 \). For birth asphyxia and hyaline membrane disease \( b = -16.997, t = -6.991, P < 0.01 \). For other causes \( b = -16.541, t = -6.824, P < 0.01 \). For weight of the neonate \( b = 0.241, t = 2.530, P < 0.05 \). For gender of the neonate \( b = -0.027, t = -1.60 \).

Conclusion: Neonatal mortality is most of the times sidelined though accounts for the majority of infant and child mortality in the country. The study reflects on the various causes of neonatal mortality for a 3 years span among the children admitted into NICU. The study results reflect the need for placement of appropriate technologies, increased focus on basic aseptic techniques in the hospital and implementation of long-term sustainable public health programs to reduce neonatal mortality, especially in the deprived sections of the community.

Key words: Low birth weight, Meningitis, Neonate, Neonatal mortality, Neonatal Intensive Care Unit

INTRODUCTION

Child mortality is one of the most talked about public health challenges in the world, and reducing child mortality is one of the prime goals set to be achieved by the millennium development goals. In India with several of its programs (immunization programs, ICDS scheme, etc.) concentrated in and around reducing child mortality there has been a significant development in this area. According to recent world bank statistics as of 2015 India’s child mortality stands at around 48 deaths per 1000 live births¹ which decreased substantially from that of 115 per 1000 live births in 1990.² Even though the decrease looks great in terms of numbers, still the target set by millennium development goals is yet to be reached. In the first 5 years of child the initial 1 year is considered to be crucial, and the majority of deaths take place during this initial 1 year. Thus, it can be said that Infant mortality contributes for a major share of child mortality.

CORRESPONDING AUTHOR:
Mr. Prakash Babu Kodali,
School of Health Systems Studies, Tata Institute of Social Sciences, VN Purv Marg, Deonar, Mumbai - 400 088, Maharashtra, India. E-mail: kodali.babu2015@tiss.edu

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The majority of mortality among both child mortality and infant mortality is accounted for neonatal mortality which occurs within the first 28 days of the life of the newborn. WHO estimates that around 40% of Child deaths under five takes place during neonatal period and for infant mortality it is higher than 50% which itself makes neonatal mortality an issue of concern. With around 28 neonatal deaths per 1000 live births, globally India stands first in terms of neonatal mortality rate (NMR). Although neonatal mortality and perinatal mortality are considered to be the problems of the developed world, reducing them will have a significant impact in the developing countries even, as they would reduce overall child mortality and ensure smooth transition into later stages of life. The launch of NRHM in 2005 marked a new era in the history of Indian Public health with landmark programs like ASHAs, Janani Suraksha Yojana (JSY), etc. Especially the programs like JSY, setting up of first referral units and up-gradation of Neonatal Intensive Care Units (NICUs) were directly influential on maternal and child health. Though there has been a reduction in neonatal and perinatal mortality explained to be associated with JSY, the reduction is very small. In the national wide sample surveyed in 2005, of 24,841 child deaths surveyed 17% of the deaths were in hospitals, reflecting the low level of hospitalization during 2005 and pre-NRHM years. After NRHM and implementation of its Interventions, the hospitalizations have increased, but there is a scarcity of data on hospital based neonatal mortality reflecting the need for further studies.

The current study tries to look into various causes of neonatal mortality over a span of three years in the NICU of the select referral hospital in Hyderabad. It tries to see how various factors influence neonatal mortality and tries to quantify how longevity of the neonate is influenced by various causes of NMR.

Objectives of the Study
1. To quantify the Neonatal mortality due to various causes in NICU in the study referral hospital
2. To understand how gender and weight of the neonate influence the mortality among neonates
3. To explore the extent to which longevity of the neonate is influenced by various causes of NMR.

MATERIALS AND METHODS

Place of the Study
The study was conducted in a renowned government children’s hospital which acts as a referral hospital for its nearby districts. This government hospital provides maternity services in the city, in addition to the high percentage of referral of high-risk pregnancies and sick newborns from other peripheral hospitals, in the Hyderabad.

Study Design
Retrospective analysis of hospital death registers for neonatal mortality over a span of 3 years from January 2011 to December 2013. The entire death register of the referral hospital during the time period is obtained, the deaths which came under the inclusion criteria were considered for the study. The data about the variables like gender of the individual, age in days, weight in kg, cause of death, duration of stay in hospital were obtained.

Inclusion Criteria
All new-born case records <28 days who were declared dead in Neonatal Unit of the Hospital (NICU).

Exclusion Criteria
>28 days, neonates admitted in Pediatrics Intensive Care Unit/General Ward of Pediatrics Department due to nonavailability of beds. New-born born in the hospital but referred due to non-availability of beds have also not been included.

Data Analysis
The data were analyzed using Statistical Software for Social Sciences (SPSS) version 21 manufactured by International Business machines corporation (IBM). Descriptive statistics with frequency tables and inferential statistics were used. Inferential statistics like correlation analysis and multiple linear regression analysis are used. Since for certain causes the number of deaths is a very few, for the ease of analysis the causes of death grouped according to the similarities of symptoms into four categories Cardiac Arrest, cardiorespiratory failure, respiratory failure (CRA/CRF/RF), Sepsis/Meningitis, Birth Asphyxia/hyaline membrane disease (HMD) and Others. The neonates are also categorized according to three groups 0-1.2 kg, 1.21-2.4 kg, >2.4 kg. Dummy variables were created where necessary during the analysis.

Ethical Approval
Ethical approval was obtained from the Institutional Review Board of School of Medical Sciences, University of Hyderabad. The name of the hospital is not revealed in the paper to maintain confidentiality. Permissions were obtained from the authorities of the hospital to utilize the data for the study.

RESULTS
The total number of deaths in the sample is n = 5119, males comprise of 3130 (61.14%) deaths, whereas females comprise of 1989 (38.86%) deaths. The mean age of the neonates is 4.16 days with a standard deviation of 6.04 days. The mean weight of the neonates is around 1.91 kg with a standard deviation of 0.87. The mean duration of hospital says before death is 1.76 days with a standard deviation of 3.09.

Table 1 shows the distribution of neonatal deaths according to their age and gender. Of the total 5119 deaths around 1402 (27%) individuals fall under the weight groups 0-1.2 kg, 2140 (41.8%) under the age group 1.21-2.4 kg, and 1577 (30.8%) fall under the category >2.4 kg. Around 29.91% (595) of females fall under the lower weight category of 0-1.2 kg, whereas about 25.78% (807) of males fall under this category. 43.16% (1351) of males fall under the moderate weight category of 1.21-2.4 kg whereas only 39.6% (789) of the females fall under this category.
DISCUSSION

Neonatal mortality where the babies born die within the first 28 days of birth is the major contributor for Infant mortality rate. Infant mortality rate and under-5 mortality are majorly focused indicators of child health, which showed a dramatic decrease post 2000. However, converse to it the neonatal mortality rose from 38% of the total mortality in 2000 to around 41% of the total deaths in 2009 reflecting its importance as the public health problem. To enhance the chances of survival of neonates at the tertiary care level NICUs are established. The study draws on the 3 years mortality data from NICU of the study hospital. It can be seen that majority of the deaths due to various causes are among the males, and deaths among females are relatively fewer. This male-female difference among neonatal mortality rates is evident in the research around the world which shows that provided optimum situation the female child is more likely to survive the neonatal stage. The weight of the neonate is one of the most common predictors of the neonatal mortality and the babies with the low birth weight are considered to be at higher risk of dying in the first one month of life. In the study, it was observed that mean weight of the neonates is 1.91 kg with a standard deviation of 0.8 kg which clearly indicates that more than half of the neonatal deaths are among the neonates who weigh <2 kg of weight. Moreover deaths due to CRA, CRF, and RF which as the major causes of mortality according to this data are high among the neonates with age 1.2-2.4 kg, this was in accordance with the earlier studies. More than one-third of deaths due to birth asphyxia and HMD occurred in the lower weight groups, indicating that babies with lower weight are a higher risk of death due to birth asphyxia. The above variables strengthen the argument that the weight of the neonate is influential in deciding the survival and longevity as noticed by the strong correlation. Even multiple regression analysis provided significant results which showed that considering all the other variables constant the unit increase in the weight of the neonate increases the neonate’s longevity by 0.241 days. This significant relationship of neonates birth-weight (which reflects the nutritional status) with that of its longevity and its risk toward other acute and chronic illness is in line with other studies, reflecting once again the strong need to improve mothers nutritional status before and during pregnancy.

We tried to calculate longevity for various causes of mortality common among neonates. The extent to which various causes of neonatal mortality influence the longevity of the neonate/number of days lived by the neonate was calculated using the multiple linear regression analysis. The average longevity of the neonate who is female with CRA/CRF/RF is 3.524 days, whereas it is 3.497 days for males. The average longevity of a neonate who is female with Sepsis/meningitis is 6.726 days, whereas it is 6.699 days for males. The average longevity of a neonate who is female with birth asphyxia and HMD is 2.353 days, whereas it is 2.326 for males. The average longevity of female neonates who died with “other causes” of NMR is around 2.88 days whereas it is 2.78 days for males. The study shows that the highest longevity is among the neonates who were affected with sepsis/meningitis, whereas the lowest longevity is among the neonates who are affected with birth asphyxia/HMD. Which could be explained by the fact that majority of the times birth asphyxia and HMD are developed soon after the birth whereas meningitis/sepsis are developed in

**Table 2:** The distribution of neonatal mortality due to various causes across different weight groups

<table>
<thead>
<tr>
<th>Weight of the neonates (kg)</th>
<th>Cause of death</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRA, CRF, RF</td>
<td></td>
</tr>
<tr>
<td>0-1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sepsis, meningitis</td>
<td></td>
</tr>
<tr>
<td>1.21-2.4</td>
<td>Birth asphyxia, HMD</td>
<td></td>
</tr>
<tr>
<td>&gt;2.4</td>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1410</td>
<td></td>
</tr>
</tbody>
</table>

**Table 3:** The distribution of neonatal mortality due to various causes across gender of neonates

<table>
<thead>
<tr>
<th>Gender of the neonate</th>
<th>Cause of death</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRA, CRF, RF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sepsis, meningitis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Birth asphyxia, HMD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Mâle</td>
<td>3130</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1978</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5108</td>
<td></td>
</tr>
</tbody>
</table>

CRA: Cardiac arrest, CRF: Cardiorespiratory failure, RF: Respiratory failure, HMD: Hyaline membrane disease

**Correlation Analysis**

The correlation analysis was done between the weight of the neonate at birth and the age at death (representing the number of days lived/longevity) of the neonate. Weight of the neonate at birth (mean = 1.91 kg, standard deviation [SD] = 0.87 kg) is positively correlated with age of the neonate at death (mean 1.76 days, SD = 3.09 days) (r = 0.039, P ≤ 0.05).

**Multivariate Linear Regression Analysis**

Age of neonate at death is the dependent variable, cause of the death, weight of the neonate and gender are independent variables. Constant $b_0 = 19.350$, $t = 7.983$, $P < 0.01$. For CRA, CRF, and RF $b = -15.829$, $t = -6.552$, $P < 0.01$. For sepsis and meningitis $b = -16.824$, $t = -5.202$, $P < 0.01$. For birth asphyxia and HMD $b = -16.997$, $t = -6.991$, $P < 0.01$. For other causes $b = -16.541$, $t = -6.824$, $P < 0.01$. For weight of the neonate $b = 0.241$, $t = 2.530$, $P < 0.05$. For gender of the neonate $b = -0.027$, $t = -1.60$.
later days because of infections. Nevertheless, these longitivility
statistics reflect the seriousness of the situation and need for
better infrastructure and technologies in place to prevent the
deaths due to birth asphyxia better technologies to clear the
airways and prevent the development of birth asphyxia are to
be institutionalized with continuous surveillance and monitoring.
Moreover, a high percentage of deaths because of meningitis
and sepsis call for the public health approaches to prevent
them. Even though institutional deliveries are promoted as the
means to prevent neonatal sepsis, the institutional deliveries in
this geographical region of the country (Andhra Pradesh) being
more than 90% this points out that it is not just institutional deliveries that could prevent deaths due to neonatal sepsis but
the proper basic aseptic techniques such as hand washing,
appropriate cord care at hospital level as important factors in
preventing sepsis/meningitis. The study reflects the strong
evidence showing the relationship between birth weight and
neonatal mortality. Although improvement of birthweight to
reduce neonatal mortality is highly recommended in several
earlier studies, from the reflection of the study results this study recommends the need for focusing on the concept of
continuum of care by improving maternal nutritional status in
order to improve survival chances of the neonate.

Limitations

Being a study with a retrospective design the study might not be
able to give any projections of cause-specific mortality for future
but for sure gives the idea of what all are the major contributors
for neonatal mortality and where they should be tackled. The study might not be able to establish any specific cause specific
relationships but for sure strengthens the existing studies which
projected them.

Recommendations

The higher neonatal mortalities in NICUs call for immediate
interventions to be in place in order to prevent them. There is
a need to develop better, cost-effective technologies which can
be installed even at public hospitals which can undoubtedly
reduce neonatal mortality in public hospitals. Furthermore, there
is need to re-emphasize and extend focus on the concept of
continuum of care as a means to reduce Neonatal Mortality.

CONCLUSION

Though accounts for the majority of infant and child mortality
in the country neonatal mortality is most of the times sidelined.
Considering the reducing IMR and under-five mortality now
there is a need to shift the focus on reducing neonatal mortality.
The study reflects upon the various causes of neonatal mortality
for a 3 years span among the children admitted into NICU.
The study results reflect the need for placement of appropriate
technologies, increased focus on basic aseptic techniques in
the hospital and implementation of long-term sustainable public
health programs to reduce neonatal mortality, especially in the
deprived sections of the community who are most vulnerable.

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