Delivery outcomes and patterns of morbidity and mortality for neonatal admissions in five Kenyan hospitals

by Jalemba Aluvaala,1,2 Dorothy Okello,3 Gatwiri Murithi,3 Leah Wafula,3 Lordin Wanjala,3 Newton Isika,3 Aggrey Wasunna,2 Fred Were,2 Rachael Nyamai,4 and Mike English1,5,6

1KEMRI-Wellcome Trust Research Programme, Nairobi, Kenya
2Department of Paediatrics and Child Health, University of Nairobi, Nairobi, Kenya
3Kenya Paediatric Association
4Ministry of Health, Government of Kenya
5Nuffield Department of Medicine, University of Oxford, Oxford, UK
6Department of Paediatrics, University of Oxford, Oxford, UK

Correspondence: Jalemba Aluvaala, KEMRI-Wellcome Trust Research Programme, P.O. Box 43640 - 00100 Nairobi, Kenya.

Tel: +254-722-217034. E-mail <jaluvaala@ kemri-wellcome.org>

ABSTRACT

A cross-sectional survey was conducted in neonatal and maternity units of five Kenyan district public hospitals. Data for 1 year were obtained: 3999 maternal and 1836 neonatal records plus tallies of maternal deaths, deliveries and stillbirths. There were 40 maternal deaths [maternal mortality ratio: 276 per 100 000 live births, 95% confidence interval (CI): 197–376]. Fresh stillbirths ranged from 11 to 43 per 1000 births. A fifth (19%, 263 of 1384, 95% CI: 11–30%) of the admitted neonates died. Compared with normal birth weight, odds of death were significantly higher in all of the low birth weight (LBW, <2500 g) categories, with the highest odds for the extremely LBW (<1000 g) category (odds ratio: 59, 95% CI: 21–158, \( p < 0.01 \)). The observed maternal mortality, stillbirths and neonatal mortality call for implementation of the continuum of care approach to intervention delivery with particular emphasis on LBW babies.

KEYWORDS: Neonatal morbidity and mortality, maternal mortality, still births, hospital care, developing countries.

INTRODUCTION

Global reports indicate that the highest risk of neonatal death is in Sub-Saharan Africa, with Kenya among the 10 countries contributing most deaths [1]. With high coverage of basic interventions [2], up to 71% of neonatal deaths could be averted with >82% of this effect attributable to facility-based care [3]. However, national, and thus global, reports are based on limited data on neonatal case-mix and outcomes; the available data are largely derived from episodic, limited-scale surveys [4]. Further, the national hospital information management system (HMIS) in Kenya has been shown to have poor-quality data [5]. There are particularly few data exploring possible variability in neonatal case-mix...
and outcomes. This study, therefore, sought to use data (collected specifically for the study separate from the national HMIS) from five Kenyan hospitals, from a continuum of care perspective [6, 7], to (i) profile maternal characteristics, (ii) determine delivery outcomes (still births and maternal mortality), (iii) document the causes of neonatal admissions and (iv) examine the effect of birth weight on neonatal mortality.

**METHODS**

This was a cross-sectional survey conducted in neonatal and maternity units of five Kenyan urban public hospitals in November and December 2013. Data were abstracted retrospectively from admission registers covering a 1 year period (October 2012–September 2013). These included data from all inborn neonatal admissions plus maternal data abstracted from a sample of 800 deliveries per hospital. In addition, for stillbirths, live births and maternal mortality, a tally of the total number of events over the 1 year period was obtained. The data were entered directly into REDCap® electronic data capture tools. Data quality was checked in real time by checks built into REDCap. In addition, at the end of each day, these data would be transmitted to a central server in KEMRI-Wellcome Trust where a STATA version 12 (Stata Corporation, Texas, USA) check file was run and a list of potential errors generated and sent back to the sites for verification and correction. Analyses were also done in STATA version 12. Pooled results are presented with 95% confidence intervals (CI), while the association between birth weight and neonatal mortality was examined using a random effects logistic regression model. The effect of clustering at hospital level was taken into account in these analyses.

**RESULTS**

A total of 3999 maternal records were sampled but variation in missingness was observed across the maternal characteristics resulting in different denominators. Teenage (13–19 years) mothers accounted for 19% (745 of 3938, 95% CI: 12–26%) of these records. Primi gravidae mothers constituted 42% (1661 of 3959, 95% CI: 38–45%) and grand-multiparous (≥5 live births) were 2.4% (96 of 3959, 95% CI: 0.4–5%) of the sample. Overall, <10% of the mothers were human immunodeficiency virus positive (7%, 230 of 3462, 95% CI: 3–19%) but within hospitals this ranged from 2 to 16% (13 of 659, 95% CI: 1–3%, and 120 of 736, 95% CI: 14–19%, respectively). By contrast, syphilis, tested by Venereal Disease Research Laboratory (VDRL) test, was positive in 1% (29 of 3467, 95% CI: 0.3–1.2).

Extremely low birth weight (LBW) babies (<1000 g), very LBW babies (1000 to <1500 g) and all LBW babies combined (<2500 g) constituted 0.4% (14 of 3826, 95% CI: 0.02–0.7%), 1.3% (48 of 3826, 95% CI: 0.7–1.7%) and 10% (394 of 3836, 95% CI: 7–14%) of all sampled deliveries, respectively. Gestation at delivery was poorly documented (51% missing) and therefore not reported. There were 37 still births per 1000 births (559 of 15 050, 95% CI: 34–40 per 1000), but with variation across hospitals (range 11–43 per 1000). Forty maternal deaths [maternal mortality ratio (MMR) 276 of 100 000 live births; 95% CI: 197–376] were recorded; the highest number of maternal deaths per facility was 14, lowest 4.

A total of 1836 inborn admissions to the neonatal units were documented (Table 1). These admissions comprised 13% of live births (1836 of 14 491, 95% CI: 12–13%). Gestation at delivery was universally missing from the neonatal unit admission registers. Most admissions were on the first day of life (72%; 1246 of 1736, 95% CI: 66–97%). Diagnoses are presented as disease episodes, meaning patients with multiple diagnoses contributed a count in each diagnosis. The top three diagnoses at admission were birth asphyxia (30%), prematurity/LBW (28%) and neonatal sepsis (14%). A fifth (263 of 1384, 19%, 95% CI: 11–30%) of the neonatal admissions died (Table 2). Extremely LBW and very LBW accounted for 3% (43 of 1576, 95% CI: 2–4%) and 9% (144 of 1576, 95% CI: 5–16%) of admissions with case fatality of 84% (32 of 38, 95% CI: 45–97) and 61% (77 of 126, 95% CI: 42–77%), respectively. All LBW accounted for 38% (604 of 1576, 95% CI: 28–50%) of admissions and 68% of deaths (179 of 263, 95% CI: 63–73%).
| Characteristic                      | H1 $n^a = 211$ | H2 $n^a = 693$ | H3 $n^a = 235$ | H4 $n^a = 400$ | H5 $n^a = 297$ | Total $n^a = 1836$ |
|------------------------------------|----------------|----------------|----------------|----------------|----------------|-------------------|
|                                    | $n^c$ | Est.$^d$ | $n^c$ | Est.$^d$ | $n^c$ | Est.$^d$ | $n^c$ | Est.$^d$ | $n^c$ | Est.$^d$ | $n^c$ | Est.$^d$ |
| Age days (med, IQR)                | 208   | 0 (0–1) | 693   | 0 (0–0) | 198   | 1 (1–1) | 341   | 1 (0–2) | 296   | 0 (0–0) | 1736  | 0 (0–1) |
| Sex (%, 95% CI)                    |       |         |       |         |       |         |       |         |       |         |       |         |
| Female                             | 87    | 43 (36–50) | 331   | 49 (45–53) | 94    | 44 (38–51) | 125   | 37 (32–43) | 111   | 38 (32–43) | 748   | 43 (36–52) |
| Total                              | 202   | 677      | 212   | 335      | 294   | 1,720    |       |         |       |         |       |         |
| Birth weight$^e$ (%, 95% CI)       |       |         |       |         |       |         |       |         |       |         |       |         |
| Extremely LBW                      | 3     | 1.5 (0.3–4) | 18    | 2.7 (2–4) | 2     | 1.4 (0.2–5) | 7     | 2.6 (0.7–5) | 13    | 4.4 (2–7) | 43    | 3 (2–4)  |
| Very LBW                           | 34    | 17 (12–22) | 41    | 6.2 (4–8) | 9     | 6.3 (2–10) | 34    | 13 (9–17)  | 26    | 8.8 (6–12) | 144   | 9 (5–16)  |
| LBW                                | 65    | 32 (26–38) | 151   | 23 (20–26) | 29    | 20 (14–27) | 77    | 29 (23–34) | 95    | 32 (27–37) | 417   | 27 (20–34) |
| Normal                             | 93    | 46 (39–53) | 423   | 64 (56–67) | 91    | 64 (56–72) | 137   | 51 (45–57) | 157   | 53 (47–59) | 901   | 57 (46–67) |
| Macrosomia                         | 8     | 4 (1–7)   | 32    | 5 (3–6)   | 11    | 8 (3–12)   | 14    | 5 (3–8)    | 6     | 2 (0.4–4)  | 71    | 5 (3–7)   |
| Total                              | 203   | 665      | 142   | 269       | 297   | 1,576     |       |         |       |         |       |         |
| Admission diagnoses$^f$ (%, 95% CI) |       |         |       |         |       |         |       |         |       |         |       |         |
| Birth asphyxia                     | 90    | 43 (35–49) | 177   | 26 (22–29) | 81    | 35 (28–41) | 106   | 27 (22–31) | 105   | 35 (30–41) | 559   | 31 (23–39) |
| Premature/LBW                     | 94    | 45 (38–51) | 158   | 23 (20–26) | 69    | 29 (25–35) | 114   | 29 (24–33) | 91    | 31 (25–36) | 526   | 29 (21–38) |
| Neonatal sepsis                    | 15    | 7 (4–11)   | 90    | 13 (11–16) | 52    | 22 (17–28) | 88    | 22 (18–26) | 14    | 5 (2.3–7.1) | 259   | 14 (8–25)  |
| Newborn RDS                        | 15    | 7 (4–11)   | 70    | 10 (8–12)  | 35    | 15 (10–20) | 24    | 6 (3.6–8.3) | 43    | 15 (11–19) | 187   | 10 (7–15)  |
| Jaundice                           | 7     | 3 (1–6)   | 53    | 8 (6–10)   | 2     | 1 (0.1–3)  | 62    | 16 (12–19) | 11    | 4 (2–6)    | 135   | 7 (3–17)   |

$^a$Total sample size.
$^b$95% CI adjusted for effect of clustering at hospital level.
$^c$Number with data available per variable.
$^d$Estimate.
$^e$Birth weight: extremely low birth weight (LBW): <1 kg, very LBW: 1 to <1.5 kg, LBW: 1.5 to <2.5 kg, normal: 2.5 to <4 kg, macrosomia: ≥4 kg.
$^f$These are disease episodes (only the top five are presented); a single patient may have more than one and thus counted in each separate diagnosis. med, median; IQR, inter-quartile range; RDS, respiratory distress syndrome.
A random effects logistic regression model with birth weight as the baseline category adjusted for sex and age at admission was fitted. The odds of death were significantly associated with extremely low birth weight (LBW) [odds ratio (OR): 59, 95% CI: 21–158, p < 0.001], very LBW (OR: 14, 95% CI: 9–22, p < 0.001) and LBW (1500 to < 2500 g; OR: 2.3, 95% CI: 1.6–3.3, p < 0.001) but similar for macrosomic babies (weight > 4000 g; OR: 1.05, 95% CI: 0.5–2.8, p = 0.76).

**DISCUSSION**

The MMR of 276 per 100,000 live births in these hospitals compares with a recent population level estimate for Kenya of 277 per 100,000 (95% CI: 175.4–414.1) in developed countries [8]. A higher risk population is expected to deliver in these hospitals, which may account for the recorded high proportion of teenage (13–19-year-old) mothers, who are known to have a higher risk of adverse neonatal and maternal outcomes [9–11].

Stillbirths have remained largely invisible; there were an estimated 2.65 million third-trimester stillbirths globally in 2008, 96% of which occurred in low- and middle-income countries [12, 13]. In the hospitals studied, there were 37 stillbirths per 1000 births, for whom death is likely to have occurred intrapartum [14]. However, these stillbirths may include early neonatal deaths, as misclassification between fresh stillbirths and early neonatal deaths is a challenge when enumerating still births [15].

The most common disease episodes were birth asphyxia (31%), prematurity/LBW (29%) and neonatal sepsis (14%) (Table 1). The number of patients with multiple diagnoses is not reported but previous work demonstrated considerable overlap in these three diagnoses [4]. In addition to many fresh stillbirths, the high numbers of birth asphyxia cases are of concern, contributing to a mortality of 10% in newborn units for normal weight admissions. Small babies remain a vulnerable population; a 2012 estimate suggested that 80% of neonatal deaths in Sub-Saharan Africa and South Asia were of this group [16]. We have shown that, even in hospitals where care should be available, 68% of neonatal deaths were of birth asphyxia (31%), prematurity/LBW (29%) and neonatal sepsis (14%) (Table 1). The number of patients with multiple diagnoses is not reported but previous work demonstrated considerable overlap in these three diagnoses [4]. In addition to many fresh stillbirths, the high numbers of birth asphyxia cases are of concern, contributing to a mortality of 10% in newborn units for normal weight admissions. Small babies remain a vulnerable population; a 2012 estimate suggested that 80% of neonatal deaths in Sub-Saharan Africa and South Asia were of this group [16]. We have shown that, even in hospitals

| Weight Category | Number of Cases | Case Fatality Rate |
|-----------------|----------------|-------------------|
| Extremely LBW   | 2/3            | 67 (9–99)         |
| Very LBW        | 19/33          | 56 (39–73)        |
| LBW             | 14/65          | 22 (11–32)        |
| Normal BW       | 15/87          | 16 (9–24)         |
| Macrosomia      | 3/8            | 38 (1–74)         |

Number of deaths and number of cases (case fatality rate).
Deaths are <2500 g. Perhaps even more important for planning long-term service development, 41% of deaths were of birth weight <1500 g.

**Conclusion**

The burden of maternal mortality, fresh stillbirths and birth asphyxia in these facilities suggests significant opportunity to earn the triple return on investment offered by improving referral and the quality of perinatal care [3]. In addition, given the disproportionately poor outcomes among LBW babies, enhancement of capacity to offer care for this vulnerable group is required.

**Funding**

This work was supported by the Kenyan Ministry of Health, The Wellcome Trust, The Consortium for National Health Research (Kenya) and The University of Nairobi. JA’s contribution was made possible by the Kenyan Ministry of Health and a grant from the Consortium for National Health Research (Kenya) to the SIRCLe Collaboration. ME has been supported by funds from The Wellcome Trust (076827, #097170). Additional funds from a Wellcome Trust Strategic Award (#084538) and a Wellcome Trust core grant awarded to the KEMRI-Wellcome Trust Research Programme (#092654) made this work possible. These grants supplemented salary support from the Ministry of Health (Kenya, to RN) and the University of Nairobi (to AW and FW). The Wellcome Trust and other funders had no role in developing this manuscript nor in the decision to submit for publication.

**Acknowledgements**

Permission to conduct the study in government hospitals was provided by the Director of Medical Services in the Ministry of Health. We would in addition like to acknowledge the hospitals’ medical superintendents for providing access and the research assistants and hospital staff who facilitated data collection. This work is published with the permission of the Director of KEMRI.

**References**

1. Oza S, Cousens SN, Lawn JE. Estimation of daily risk of neonatal death, including the day of birth, in 186 countries in 2013: a vital-registration and modelling-based study. Lancet Glob Health 2014;2:e635–44.

2. The Partnership for Maternal, Newborn & Child Health. 2011. A Global Review of the Key Interventions Related to Reproductive, Maternal, Newborn and Child Health (RMNCH). Geneva, Switzerland: PMNCH. http://www.who.int/rmnch/topics/part_publications/essential_interventions_18_01_2012.pdf (25 March 2015, date last accessed).

3. 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.

4. Aluvaala J, Nyamai R, Were F, et al. Assessment of neonatal care in clinical training facilities in Kenya. Arch Dis Child 2015;100:42–7.

5. Kihuba E, Gathara D, Mwanga S, et al. Assessing the ability of health information systems in hospitals to support evidence-informed decisions in Kenya. Glob Health Action 2014;7:24859.

6. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, et al. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. Lancet 2007;370:1358–69.

7. Lassi ZS, Majeed A, Rashid S, et al. The interconnections between maternal and newborn health—evidence and implications for policy. J Matern Fetal Neonatal Med 2013;26:3–53.

8. Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, et al. Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2014;384:980–1004.

9. Ramaiya A, Kiss L, Baratser P, et al. A systematic review of risk factors for neonatal mortality in adolescent mother’s in Sub Saharan Africa. BMC Res Notes 2014;7:750.

10. Aviram A, Raban O, Melamed N, et al. The association between young maternal age and pregnancy outcome. J Matern Fetal Neonatal Med 2013;26:1554–8.

11. World Health Organization. 2011. WHO guidelines on preventing early pregnancy and poor reproductive health outcomes among adolescents in developing countries. http://www.who.int/immunization/hpv/target/preventing_early_pregnancy_and_poor_reproductive_outcomes_who_2006.pdf (25 March 2015, date last accessed).

12. Frøen JF, Cacciatore J, McClure EM, et al. Stillbirths: why they matter. Lancet 2011;377:1353–66.

13. Lawn JE, Blencowe H, Pattinson R, et al. Stillbirths: Where? When? Why? How to make the data count? Lancet 2011;377:1448–63.

14. Saleem S, McClure E M, Goudar Shivaprasad S, et al. A prospective study of maternal, fetal and neonatal deaths in low- and middle-income countries. Bull World Health Org 2014;92:605–12.

15. Lawn J, Yakooob M, Haws R, et al. 3.2 million stillbirths: epidemiology and overview of the evidence review. BMC Pregnancy Childbirth 2009;9(Suppl 1):S2.

16. Lawn JE, Blencowe H, Oza S, et al. Every Newborn: progress, priorities, and potential beyond survival. Lancet 2014;384:189–205.