Original Article

Admissions and mortality over a 5-year period in a limited-resource neonatal unit in Ghana

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SUMMARY
Objective: To review admissions and deaths at the neonatal intensive care unit (NICU) of the Korle Bu Teaching Hospital (KBTH), Ghana from 2011 to 2015, for the purposes of documentation of outcomes and identification of areas for improvement.
Design: A retrospective descriptive study of NICU Admissions & Discharges from 2011 to 2015. All data in the NICU Admissions & Discharge books were transferred into a spreadsheet and analysed.
Setting – The NICU of KBTH provides secondary and tertiary care for premature and critically ill term babies in the southern half of Ghana.
Results: Over the 5-year period, 9213 babies were admitted to the NICU. Admission weights ranged from 300 to 6700g with median of 2400g. Overall mortality rate was 19.2%. Mortality rates were progressively and significantly higher in babies with lower admission weights and earlier gestations.
Conclusions: We report a high NICU mortality rate of 19.2%, compared to the worldwide range of 3.1% to 29%. This wide range of outcomes is attributable to differences in the severity of illness of patients and to the organisation of resources devoted to obstetric and neonatal care. To substantially improve perinatal and neonatal outcomes, there is a need for wider coverage and better quality of health care; and to consider rationing of care. Complex interventions are necessary to improve outcomes, not just an increase in the allocation of particular resources.

Keywords: Intensive Care, Neonatal; developing countries; mortality rate
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INTRODUCTION
The measurement of institutional neonatal admissions and mortality is important for several reasons - to document workload and outcomes, to compare with past performance and with other institutions, to help identify potential areas for improvement, to show whether allocated resources are being effectively utilised, and to make a case for more resources.

The mortality rate in a neonatal unit reflects quality of care but is also profoundly affected by the severity of illness of neonates offered for admission. These two factors are in turn determined by national resource allocation to health and education, by the effectiveness of obstetric services, and by individual patient factors including congenital anomalies, maternal health, financial and educational status.[1]

The Neonatal Intensive Care Unit (NICU) of the Korle-Bu Teaching Hospital (KBTH) in Ghana provides care for premature and critically ill term babies. It has a nominal capacity of 60 cots, warming platforms and incubators, though this number is often exceeded. The unit receives referrals from health facilities in the southern half of Ghana.

The aim of this study was to review the numbers of admissions and deaths at the NICU of the Korle Bu Teaching Hospital, from 2011 to 2015, for the purposes of documentation, analysis of associated factors, dissemination, and the provision of data to facilitate planning and improvement of neonatal outcomes.
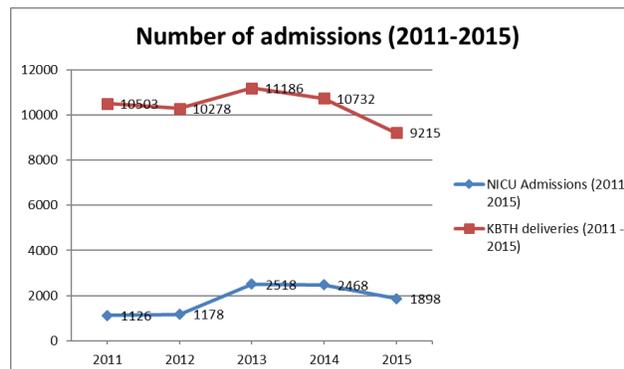
METHODS

All data in the NICU Admissions & Discharge (A&D) books from 2011 to 2015 were transferred into a spreadsheet (Microsoft Excel), checked carefully for transcription errors, and analysed with Microsoft Excel and SPSS version 14. The following data items were available from the admissions and discharge books – name, age, sex, reason for admission to NICU, labour ward weight, admission weight, date of birth, time of birth, date of admission, time of admission, labour ward, mother's ward, gestation at birth, mode of delivery, mother's parity, mother's age, discharge weight, date of discharge or death, time of discharge or death.

RESULTS

Number of admissions

Over the 5-year period, 9213 babies were admitted, a mean of 1843 per annum. Admissions peaked in 2013-2014 then dropped in 2015 - see Figure 1. The numbers of deliveries in KBTH were 2011 – 10503, 2012 – 10278, 2013 – 11186, 2014 – 10732, and 2015 – 9215; a total of 51,914 deliveries with mean of 10,383 per annum. There were 7035 inborn admissions, representing an admission rate of 13.6% for babies delivered in KBTH.

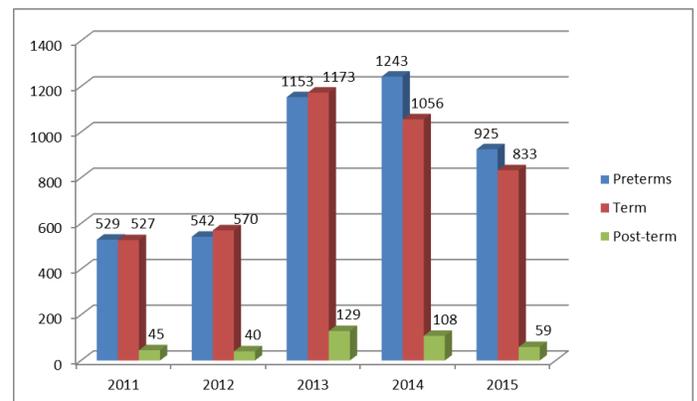**Figure 1** Number of deliveries in KBTH and NICU admissions from 2011 to 2015

Table 1 Admissions and mortality by sex

Sex	Number of admissions (% of total admissions) [95% CI]	Number of deaths (% of total deaths) [95% CI]	Sex-specific Percentage mortality (95% CI)
Male	4998 (54.2) [53.2-55.3]	963 (54.5) [52.2-56.8]	19.3 (18.2-20.4)
Female	4148 (45.0) [44.0-46.0]	793 (44.9) [42.5-47.1]	19.1 (17.9-20.3)
Indeterminate (Ambiguous)	5 (0.05) [0.0-0.1]	3 (0.2) [0.0-0.4]	60.0 (17.1-102.9)
Missing data	62	8 (0.5) [0.1-0.8]	12.9 (4.6-21.2)
Total	9213	1767	

Below admission weight of 2500g, over the 5-year period, there were 4531 admissions with annual mean of 906, representing 49.2% of the total. For admissions below 1500g, there were 1727, with annual mean of 365, representing 18.8% of the total. Below 500g, there were 42 admissions with an annual mean of 8 and representing 0.5% of the total. More males than females were admitted; there was no significant difference in their mortality rates. (p-value: 0.81)

Admissions by Gestational Age

Over the five-year period, preterm babies accounted for 48% of admissions, term admissions 45%, post-term babies 4% and missing gestation 3%. There were 3383 preterm babies delivered in KBTH during the period, representing 6.5% of total deliveries, compared to 26,375 term babies, representing 50.8%. The breakdown of admissions by gestational age for the individual years is shown in Figure 2.

Figure 2 Number of admissions by gestation from 2011-2015

Admission weights

Admission weights ranged from 300g to 6700g with median of 2400g. The baby who weighed 6700g had massive hydrocephalus. Babies with admission weight below 600g represented 1% of all admissions.

Age of neonates when admitted

Majority (91%) of the neonates were admitted on the day of delivery, and a further 6% by the end of the next day. Further details are shown in Table 2.

Mortalities

Table 3 shows that out of 9,213 neonates admitted over the five-year period, 1,767 died before discharge, an overall mortality rate of 19.2%. There were statistically significant differences in mortality rate among neonates born <26 weeks, 26 – 27 weeks, 28 – 31 weeks and >32weeks; the earlier the gestation the higher the mortality rate. Neonates less than 26 weeks gestation had the

highest gestation-specific mortality rate of 80.2%. Beyond 32 weeks gestation, mortality rates were not significantly different as shown in Figure 3.

Table 2 Age of neonates when admitted

Age in days	Number of babies (%)
0 (day of delivery)	8366 (90.8)
1	557 (6.0)
2	137 (1.5)
3	36 (0.4)
4	21 (0.2)
5	7 (0.1)
6	4 (0.0)
7	6 (0.1)
8 – 14	4 (0.0)
Not stated	75 (0.8)
Total	9213 (100)

Table 3 Admissions and mortalities by gestation

Gestation		Number admitted	Number of deaths	Gestational age-specific mortality/100 with 95% CI
Group	Weeks			
Extreme preterm	<26	237	190	80.2 [75.1-85.2]
	26 - 27	302	208	68.9 [63.7-74.1]
Very preterm	28 - 31	1326	441	33.2 [30.6-35.7]
Moderate preterm	32 - 33	1027	138	13.4 [11.4-15.6]
Late preterm	34 - 36	1500	158	10.5 [9.0-12.1]
Early term	37 - 38	1359	181	13.3 [11.5-15.1]
Full term	39 - 40	1535	191	12.6 [10.9-14.2]
Late term	41 - 42	873	101	11.6 [9.4-13.7]
Post term	> 42	371	50	13.5 [10.0-17.0]
Incomplete data	Not stated	939		
Total		9213	1767	19.2 [18.4-20.0]

Table 4 shows that neonates born before 37 weeks had about twice the mortality rate of those born after 37 weeks, with no significant difference between term and post-term gestations.
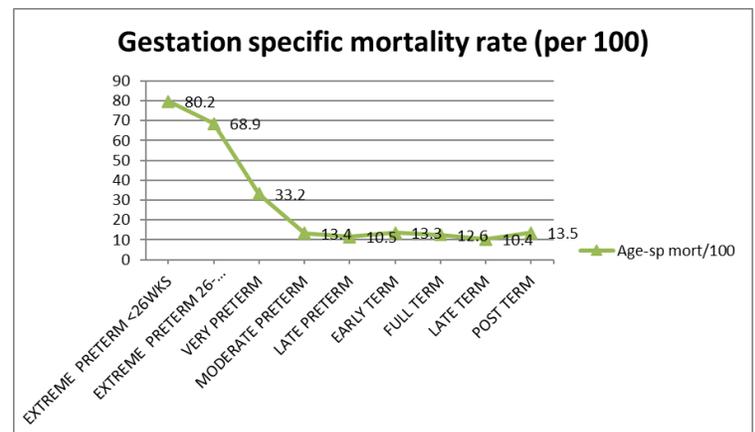
Number of admissions and deaths by admission weight

Table 5 and Figure 4 show that mortality rate was generally lower for babies with higher admission weights. There were significant differences among babies with admission weights <750g, 750 – 999g, 1000 – 1499g and 1500 – 2499g. There was no difference in mortality rate between the 1500 – 2499g and over-2500g groups. 10% of babies with admission weight less than 750g survived to discharge.

Table 4 Admissions and mortalities classified by preterm, term and post-term.

Gestation	Number admitted	Number of mortalities	Gestation-specific mortality/100 (95% C.I.)
Preterm	4399	1137	25.8 [24.5-27.1]
Term	4165	508	12.2 [11.2-13.2]
Post-term	371	50	13.5 [10.0-17.0]
Incomplete data	278	72	
Total	9213	1767	19.2 [18.4-20.0]

Figure 3 Gestation specific mortality rate (per 100)

Table 5   Number of admissions and deaths by admission weight

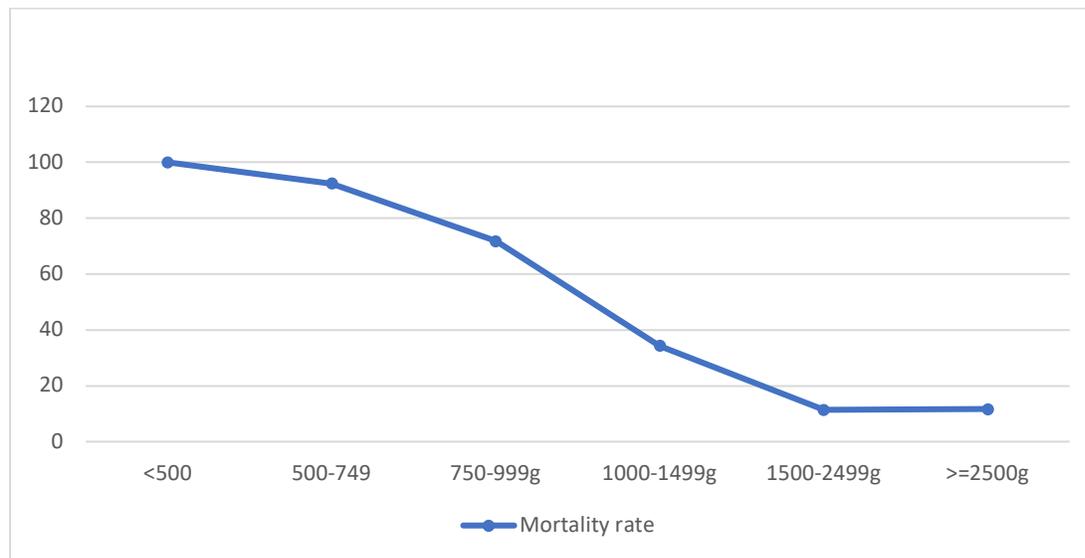| Admission weight	Number (%) of admissions	Number (%) of deaths	Admission weight-specific mortality rate (%) (95% CI)	Odds ratio (95% C.I)	p-value
<750g	237 2.6%	213 (12.0%)	90.0 (86.0-93.7)	0.01 (0.01-0.02)`	<0.0001
750-999g	323 3.5%	234 (13.2%)	72.4 (67.6-77.3)	0.05 (0.04-0.06)	<0.0001
1000-1499g	1167 12.7%	403 (22.8%)	34.5 (31.8-37.3)	0.25 (0.21-0.29)	<0.0001
1500-2499g	2804 30.4%	318 (18.0%)	11.3 (10.2-12.5)	1.02 (0.88-1.18)	0.8342
2500g and above	4469 48.5%	514 (29.1%)	11.5 (10.6-12.5)	Ref	
Missing data	213 2.3%	85 (4.8%)	40.0 (33.3-46.5)		
Total	9213 100%	1767 (100%)			

Figure 4 Mortality rate by admission weight

Table 6 Admissions and deaths for admission weights <750g

Admission weight (g)	Number (%) of admissions	Number of deaths	Admission weight -specific mortality rate (%) (95% CI)	Odds ratio (95% C.I)	p-value
300-349	6	6	100 (100-100)	0.02 (0.00-0.28)	0.0045
350-399	6	6	100	0.02 (0.00-0.28)	0.0045
400-449	27	27	100	0.02 (0.00-0.28)	0.0045
450-499	3	3	100	0.02 (0.00-0.28)	0.0045
500-549	55	51/53 (*2 missing data)	96.2 (91.1-100)	0.01 (0.00-0.03)	<0.0001
550-599	7	6	85.7 (60.0-100)	0.03 (0.00-0.28)	0.0017
600-649	41	36/38 (*3 missing data)	94.7 (87.6-100)	0.01 (0.00-0.05)	<0.0001
650-699	15	13	86.7 (69.5-100)	0.03 (0.01-0.14)	<0.0001
700-749	77	65/72 (*5 missing data)	90.3 (83.4-97.1)	0.02 (0.01-0.05)	<0.0001
Sub-Total	237 (10 with missing outcome data)	213			
≥750	8763	1469	16.8 (16.0-17.5)	Ref	
Missing data	213	85			
Total	9213	1767	19.2		

Table 6 shows that there were no survivors among the 42 babies with admission weights less than 500g. Of 195 babies with admission weights between 500 and 749g, the estimated mortality rate was between 73% and 92% (as the outcome for 9 babies is unknown). The mortality rate for the VLBW group (500 - 1499g) was 53% (1018/1912). There was a statistically significant difference (95% C.I.) in mortality rate between the 700-749g admission weight group and those <500g. The mortality rate for the >749g group was significantly lower than the <750g group, with odds ratios and p-values as shown in Table 6.

Table 7 Mortality by place of delivery

Place of delivery	Number of admissions	Number of deaths (% of total deaths) [95% C.I]	Place-specific Percentage mortality [95% C.I]	p-value
Inborn	7035 (76.4%)	1112 (63%) [61-65]	15.8 [15.0-16.7]	<0.05
Outborn	2112 (22.9%)	638 (36%) [34-38]	30.2 [28.3-32.2]	
No entry	66 (0.7%)	17 (1%)		
Total	9213	1767		

Compared to babies born in KBTH, those born outside KBTH were significantly more likely to die, 15.8% and 30% mortality rates respectively (Table 7).

Table 8 Admissions and Mortalities by day of week

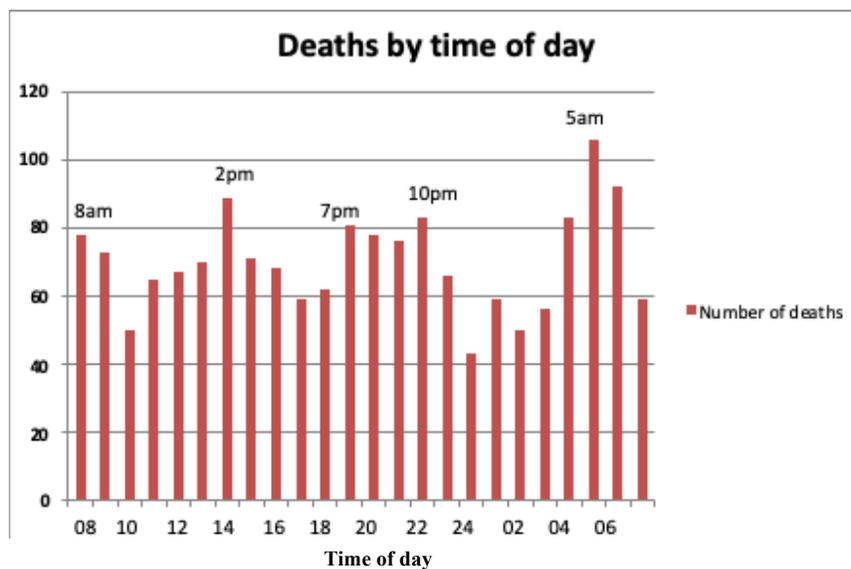| Day of week	Number of admissions	Percentage of all admissions (95% CI)	Number of deaths	Percentage of all deaths (95% CI)
Sunday	1165	12.6 (11.9 – 13.3)	281	15.9 (14.2–17.6)
Monday	1195	13.0 (12.3 – 13.7)	227	12.8 (11.3–14.4)
Tuesday	1419	15.4 (14.7 - 16.1)	260	14.7 (13.0 –16.3)
Wednesday	1394	15.1(14.4 – 15.8)	264	15.0 (13.3 – 16.6)
Thursday	1304	14.2 (13.5 – 14.9)	250	14.1 (12.5 – 15.8)
Friday	1355	14.7 (14.0 – 15.4)	234	13.2 (11.6 – 14.8)
Saturday	1338	14.5 (13.8 – 15.2)	242	13.7 (12.1 – 15.3)
Missing data	43	0.5	9	
Total	9213	100%	1767	100%

There was a significantly low number of admissions on Sundays and Mondays (95% C.I. as shown in Table 8). The highest number of deaths (281) and percentage mortality (15.9%) of the week was recorded on Sundays. The lowest number of deaths (227) and percentage mortality (12.8%) was on Mondays, and was significantly lower than on Sundays (p=0.0086)

How long after admission do babies die?
Forty-nine percent of those who died did so within 48 hours of admission; and 66% within 72 hours. By the end of the seventh day, 83% of the deaths had occurred. Of the 869 babies who died within 48 hours, 59.6% were preterm, 31.9% were term, 4.1% were post-term and 4.4% were of unspecified gestation (Table 9).

Table 9 Duration of survival of babies who die on admission

Time from admission to death	Number of deaths	Percentage mortality (95% CI)
Within 24hrs	432	24.4 (22.4-26.4)
24-<48hrs	437	24.7 (22.7-26.7)
48-<72hrs	298	16.9 (15.1-18.6)
3 days	125	7.1 (5.9-8.3)
4 days	71	4.0 (3.1-4.9)
5 days	55	3.1 (2.3-3.9)
6 days	47	2.7 (1.9-3.4)
7 days	36	2.0 (1.4-2.7)
8 days	35	2.0 (1.3-2.6)
9 days	24	1.4 (0.8-1.9)
10 days	21	1.2 (0.6-1.7)
11 days	19	1.1 (0.6-1.6)
12 days	13	0.7 (0.3-1.1)
13days	8	0.5 (0.1-0.8)
14days	3	0.2 (0.0-0.4)
15 days	12	0.7 (0.3-1.1)
>15 days	101	5.7 (4.6-6.8)
Missing data	30	1.7
Total	1767	100

Figure 5 Number of deaths by time of day

Due to inadequate monitoring for apnoea, the recorded time of death may have been later than the actual event. There were significantly more deaths during the night shift than during the day shifts (p <0.05), with a peak period from 5 am to 6 am, and trough at midnight.

Missing data
Some data were missing due to incomplete entries and torn pages in the A & D book. The percentages of missing data ranged from 0.2 – 6.0% with median of 1.4 % (Table 10).

Table 10 Number of missing entries by category

Category	Number of entries missing	Percentage of total entries (9213)
Year of delivery	22	0.2
Gestational age	268	2.9
Maternal age	557	6.0
Admission weight	213	2.3
Age at admission	75	0.8
Mode of delivery	55	0.6
Outcomes	512	5.6
Admissions by day of week	43	0.5
Deaths by birth weight	179	1.9
Source of referral	66	0.7

Limitations
Gestations recorded in the A&D books were determined by dates (last menstrual period or early antenatal ultrasound) and therefore subject to the errors inherent in that. Babies admitted to the NICU with suspected self-limiting diagnoses and who were discharged before 24 hours were not entered into the A&D book. The numbers reported here are therefore an underestimate of the unit's workload.

The NICU admits all babies born in KBTH who need immediate medical care. These are babies who are preterm, low birth weight, clinically ill, dysmorphic or those considered to be at significant risk of infection, jaundice or hypoglycaemia. The unit also admits out-born babies who have not yet been home, have not received any vaccines and are less than 24 hours old. KBTH NICU generally does not admit babies, whether inborn or out-born, who do not fit these criteria. Such babies are admitted to a separate Babies Unit in the children's department.

Admission weights have been quoted rather than birth weight because there were significant differences between weights recorded in the labour ward and in the NICU, even when babies were admitted within minutes of birth. 96.8% of babies were admitted within a day of birth, so the admission weight in these cases would not be significantly different from weight immediately after birth.

Since our data are from only one tertiary institution, they probably do not reflect what pertains in the rest of the country. For example, it is not known what proportion of preterm infants receives any medical care in the rest of the country.

DISCUSSION
The number of admissions to the NICU was directly related to the number of deliveries conducted in the Obstetrics Department of the Korle-Bu Teaching Hospital, which was the source of the majority (76%) of NICU admissions.

Mortality by sex
We found no significant difference in mortality rates between males and females, similar to reports by Jehan from urban Pakistan.[1] In contrast, using a large database in the United States, Zhao found that the odds of neonatal mortality and other perinatal outcomes were higher among male twins than their female co-twins in mixed-sex pairs. There was however no sex difference in foetal mortality.[2]

The overall mortality rate in our study was 19.2%; Jehan reported a mean neonatal mortality rate of 47.3% whilst Zhao reported a neonatal mortality rate of about 2%. Though the study methodologies and populations are different, these figures suggest that perhaps when mortality rates are very high, sex differences may be obscured.

The finding that preterm babies represented almost half (48%) of all admissions is partly accounted for by hospital policy which directs that all preterm babies delivered in KBTH should be admitted to NICU. The vast majority of babies were admitted within a day of birth. This is due to the hospital policy of admitting all preterms and also not admitting to the NICU, babies who become ill after discharge. A further possible explanation is that most causes of admission are present at birth.

Comparison of worldwide mortality rates
Comparison of mortality rates among different facilities and over different periods of time is fraught with problems including reliability of data, and different ranges of parameters such as gestation and birth weight. It has been suggested that birth weights less than 500g be excluded from analysis to achieve some level of uniformity across publications.[3,4] A further difficulty in comparisons is uncertainty about how ill the admitted infants were. Not surprisingly, reported mortality rates for admissions involving all gestations vary widely from 3.1% to 29%.[5] From South Africa, Pepler reported a mortality rate of 3.1% in neonates from 23 to 42 weeks gestation, born in 2007-2008 and managed in private NICUs.[6]

Shakaran reported a mortality rate of 4% in neonates of all gestations born in Canada in 1996-1997.[7] From Australia, Feng reported 8.3% for 2001 – 2006.[8] In England, Mankelow reported 8.1% for 2008 – 2010.[9] Costa reported 5.7% from Portugal in 2004 – 2008.[10] For neonates with "severe perinatal morbidity" above 28 weeks gestation, Musooka in Uganda, reported a mortality rate of 26 - 29% in 2013.[11]

In 2009, Shim reported data for 2,584 very low birth weight infants admitted to NICUs in 76 hospitals in S Korea.[12] For babies with birth weight less than 750 g, mortality rate was 45%; 750 – 999g 20%; 1000g – 1499g 6.5% compared to 89%, 72% and 34% respectively in our NICU. For the 500g – 1499 group, our estimated mortality rate was 53%; in S Korea the rates were 15% for 2007, 33% in 1996, and 68% in the early 1960s.[12]

Atiah in a study at the NICU of another hospital in Accra reported a mortality rate of 85.5% for babies with birth weights below 1.5kg.[13] The equivalent rate for our unit was 49%. From North Western Ethiopia, Woldehanna et al, in a study involving 304 neonates admitted to a paediatric ward from 1994 to 1999, reported an overall mortality rate of 41%; in the VLBW group, the mortality rate was 80%.[14]

In a study of 135 babies with birth weights 600g to 2500g and gestation 26 to 38 weeks at the NICU of Kenyatta National Hospital, an overall mortality rate of 46% was reported.[15] In Cairo, of 113 babies with birth weight between 700 and1500g, mortality rate was 35%.[16] In our study, 699 out of the 1566 babies born between 700 and 1500g died, giving a mortality rate of 44.6%

Why higher mortality rates?
These differences in outcome are attributable to various factors including the severity of illness of patients, the absolute level of resources devoted to obstetric and neonatal care, as well as efficient organisation of national and local resources.[11,16,17] Within countries, facilities that offer higher-level neonatal intensive care services and treat larger numbers of patients are reported to have better mortality outcomes.[4]

As far as it is possible to compare, the KBTH NICU has similar mortality rates to other low-resource NICUs, presumably because the challenges and constraints are the same. Compared to higher income countries, there are many possible reasons why the KBTH NICU mortality rates are higher. The KBTH NICU currently does not provide mechanical ventilation though it admits VLBW and other seriously ill infants; an anomaly that reflects the mismatch, in low resource areas, between what is needed and what can be provided. The KBTH NICU

therefore fits into neither level 2 nor 3A of the draft version of the American Academy of Pediatrics report on NICU levels of care.[3] A suggested level for such units could be "level 2 plus".

To compound the problem of illness severity is the issue of volume. Ciaran et al defined a high-volume unit as one that treats more than 100 VLBW infants annually.[4] The KBTH NICU would therefore be rated as a very high-volume unit as it admits a mean of 365 VLBW infants annually. Closely linked to the high volumes is the problem of insufficient staff, in particular, general and neonatal nurses, administrative and clerical staff, and medical engineers. A further issue is the inability of many families to afford basic neonatal care, let alone intensive care.[18]

The problem of determining whether differences in mortality between NICUs are primarily due to differences in illness severity or quality of care may be addressed in future studies by the use of Illness severity scores such as the Clinical Risk Index for Babies (CRIB II).[19][20,21][22]

Our data are comparable to those from other LMICs but much worse than outcomes in higher income countries. Recent studies from Pakistan and other low-resource settings indicate that substandard care, inadequate training, low staff competence and a lack of resources, including equipment and medication, are all factors that contribute to neonatal deaths.[1]These deficits are likely due to poorer organisation of the countries in general, resulting in lower productivity and GDP, compounded by misallocation of resources.

To substantially improve perinatal and neonatal outcomes, there is the need for both wider health-care coverage and better quality of health care including clinical audits.[1] Neogi reported from India that high patient volume (>2,000 deliveries/year), inborn status, availability of referral system and inter-facility transfers, and adequate nursing care staff in neonatal units also demonstrated protective effect in averting neonatal deaths.[23] This confirms that complex interventions are necessary to improve outcomes, not just an increase in the allocation of particular resources.[24]

How long after admission do babies die?
The fact that 66% of deaths occurred within 72 hours of admission is probably a reflection of the severity of illnesses babies come in with, and perhaps the lack of high-level intensive care facilities such as intermittent positive pressure ventilation. These findings are similar to reports from Bhopal, India where 75% of deaths occurred in the first week; and from Ogun State, Nigeria where 39% of deaths occurred in the first 24 hours.[26,27]

Times of day when deaths occur.
The higher nocturnal mortality rate coincides with, and may be causally related to, the lower number of nurses and doctors at night [28]. Typically, the ratio of all grades of nurses providing bedside care ranges from 10:1 for the 8am to 2pm shift, to 18:1 for the 8pm to 8am shift. Other potential contributory factors may include reduced ambient lighting, reduced alertness of staff and lack of parental presence.[29]

Mortality rate was significantly higher among outborn babies. The possible reasons include suboptimal antenatal and perinatal care e.g. antenatal steroids, and poor transport conditions resulting in more severe illness. In a study involving 894 infants born at 23 to 32 weeks' gestation, outborn babies were found to have a higher frequency of severe intraventricular haemorrhage associated with lower uptake of antenatal steroids.[30] It has been postulated that when considering referral to higher level facilities, the babies referred are those considered by the referrer to be most likely to survive.

Therefore, babies with worse prognosis, and considered less likely to benefit from referral, are not referred.[3] If this selection bias occurs in our area, it suggests that there may be an even larger difference in outcomes between higher level and lower level facilities. The significantly low number of admissions on Sundays and Mondays is not accounted for by transfers from other hospitals and may therefore be due to fewer local births on those days.

In the absence of increased resources there may be a need to ration care – in order to optimise outcomes for those with better prognosis. There were 195 infants (2.1% of all admissions) with admission weight between 500 and 749g; and 42 infants (0.5% of admissions) below 500g. Based on current survival rates, an option may be to offer only comfort care to neonates with birth weights below 500g.[31, 32] For neonates with admission weights between 500g and 750g, whose overall mortality rate is 90%, a possible approach could be to offer resuscitation at birth if they are vigorous and without severe congenital malformations; but if subsequently they require resuscitation, to consider limiting its intensity and duration. However, considering the basic level of care currently provided, efforts should also be directed towards improving the range and quality of services in the unit.

Missing data
Although there is no established threshold for determining what percentage of missing data is acceptable, between 5 and 10% has been quoted in the literature.[25] Using this criterion, the missing data percentage of between 0.5 and 6.0% in this study, falls within acceptable limits.

CONCLUSION
We report a relatively high NICU mortality rate of 19.2%, compared to the worldwide range of 3.1% to 29%. This wide range of outcomes may be attributed to differences in the severity of illness of patients and to the organisation of resources devoted to obstetric and neonatal care. To substantially improve perinatal and neonatal outcomes, there is a need for wider coverage and better quality of health care; and to consider rationing of care. Complex interventions are necessary to improve outcomes, not just an increase in the allocation of particular resources.

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