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A case-control study of early neonatal deaths at the Port Moresby General Hospital to determine associated risk factors

APEAWUSU B. AMOA[1], CECIL A. KLUFIO[2] AND LUTTY AMOS[1]

Division of Obstetrics and Gynaecology, Port Moresby General Hospital, Papua New Guinea and Division of Obstetrics and Gynaecology, Faculty of Medicine, University of Papua New Guinea, Port Moresby

SUMMARY

From June 1998 to December 1999, mothers of 150 babies who died in the early neonatal period and 150 controls whose babies did not die were studied. In multiple logistic regression analysis the following variables were positively associated with early neonatal deaths: lack of antenatal attendance, thick meconium staining of the liquor, male sex, very low birthweight and delivery at gestational age less than 34 weeks. Maternal betelnut chewing was negatively associated with neonatal deaths. When babies with birthweight below 1000 g were excluded, the following variables were associated with early neonatal deaths: unmarried status, thick meconium staining of the liquor and gestational age below 34 weeks. The negative association with betelnut chewing persisted. The main causes of early neonatal deaths were respiratory distress syndrome, septicaemia, birth asphyxia, meconium aspiration syndrome and congenital abnormalities. Avoidable factors in these deaths were associated with the patient (53%), the labour ward (28%), the antenatal clinic (9%), the postnatal ward (8%) and the special care nursery (2%).

Introduction

The Port Moresby General Hospital (PMGH) delivers about 10,000 women in a year. The early neonatal death rate (ENNDR) is derived from the number of babies who die within the first week in hospital, and in PMGH the rate is 10-12/1000 live births. More than two-thirds of the early neonatal deaths are of low birthweight, ie less than 2500 g. The ENNDR in the low birthweight group is about 45/1000 live births and over 600/1000 in newborns weighing less than 1000 g (1).

Between 93% and 95% of women who deliver at the PMGH are antenatal attendants at the PMGH or at one of the urban clinics in the city. 4-5% are nonattendants and 1-2% are referred from the Central Province health centres. The early neonatal death rate among the nonattendants was 37/1000 live births compared with 8/1000 among the attendants (1).

Some sociodemographic and obstetric history characteristics that have been shown to be associated with preterm birth and hence neonatal death include low social class, maternal age at the extremes of reproductive life, ie less than 19 years and more than 35 years, and previous pregnancy wastage. Various studies have shown that attendance at antenatal clinic is an important factor in reducing the incidence of adverse neonatal outcome. The number of antenatal visits correlates positively with favourable perinatal outcome (2-4) and would be expected to cancel the effect of some of the risk characteristics. The aim of this study was to establish some of the risk factors associated with early neonatal death in our practice. Knowledge of such factors might

1 Division of Obstetrics and Gynaecology, Port Moresby General Hospital, Free Mail Bag, Boroko, NCD 111, Papua New Guinea

2 Division of Obstetrics and Gynaecology, Faculty of Medicine, University of Papua New Guinea, PO Box 5623, Boroko, NCD 111, Papua New Guinea
Present Address: University of Ghana Medical School, PO Box 4396, Accra, Ghana

indicate interventions to reduce the high rate of early neonatal deaths.

The primary objective of the study was to identify sociodemographic, obstetric and intrapartum factors associated with early neonatal death. The secondary objectives were to identify the causes of early neonatal deaths and avoidable factors in these deaths.

Patients and Methods

The study population consisted of all singleton babies delivered at the PMGH. The cases were babies who died within 7 days of birth in hospital. The first baby delivered after the case who was still alive after the first week was selected as a control. The controls were selected soon after a neonatal death.

Between June 1997 and December 1998 150 cases and 150 controls were enrolled. The subjects were enrolled sequentially, mothers were interviewed and their case records retrieved for study.

Definition of terms

1 *Early neonatal death* is death in a baby who is born alive and dies in hospital before it is 7 days old.

2 *Avoidable factor* is a characteristic, or an error of omission or commission, which, had it not been present or happened, might have prevented death. The presence of an avoidable factor, and the responsibility for it, were determined and classified at the monthly perinatal audit of the Division of Obstetrics and Gynaecology which is attended by the paediatric staff of the neonatal care unit.

3 *High antenatal attendance* is defined as at least three antenatal visits. This would give some time to determine risk status of the pregnancy, obtain laboratory results and take action when required.

Variables

The dependent variable was early neonatal death.

The following independent variables were investigated:

1 Sociodemographic characteristics

Maternal age: mean age; age less than 19 years or more than 35 years

Region of origin: Southern, Highland, Islands or Momase

Education of subjects: mean number of years of formal education; some or no education

Residential area: settlement, urban or village

Husband's occupation: unemployed, unskilled, skilled or professional – a skilled worker included occupations like laboratory technician and auto mechanic whilst unskilled workers included labourers

Betelnut chewing: yes,no; mean number of betel nuts chewed per day

Smoking: yes,no; mean number of cigarettes smoked per day

2 Past obstetric history

Previous stillbirth, neonatal death or low birthweight; last delivery interval – mean; more or less than 2 years.

The determination of whether or not a woman had a low birthweight infant or any problem in the past was confirmed from information in the child health record book (CHRB). If a patient indicated at the booking visit that she had had a low birthweight infant in any previous pregnancy she was asked to bring the CHRB for the next visit so that the relevant information could be confirmed.

3 Present obstetric characteristics

Antenatal care: Attendance; maternal weight at first visit

Parity

Antenatal complications in the index pregnancy: clinical malaria; urinary tract

infection; a febrile illness; systolic blood pressure; premature rupture of membranes; preeclampsia; haemoglobin; intrauterine growth restriction.

4 Labour

Gestational age at delivery; high station (with the level of the head 3/5 or higher); labour augmentation; crossing of action line of partograph; thick meconium staining of the amniotic fluid; birthweight; birth before arrival (BBA) to labour ward (yes, no); sex of infant; labour ward admission mean symphysio-fundal height (SFH).

Data collection and recording

A pretested questionnaire was used to collect data on sociodemographic features, past obstetric history and antenatal characteristics. Information on intrapartum events was collected from the labour ward register and the patients' hospital records. The completed questionnaire was checked before the patient was discharged from hospital. Inconsistencies and inaccuracies were corrected by the researchers.

The data were analyzed using the Epi Info version 6. Mantel-Haenszel chi squared tests, Kruskal-Wallis H tests and odds ratios were calculated as appropriate. Multiple logistic regression analysis was used to investigate variables which were found on univariate and stratified analysis to have an association with early neonatal death. Differences with p values <0.05 and odds ratios whose 95% confidence intervals did not include 1 were taken as significant.

Results

Univariate analysis

Sociodemographic characteristics (Table 1)

There was no difference between the two groups in age, the proportion of women in the extremes of reproductive age, region of origin, residential status, husband's occupation, number of school years and smoking. However, significantly more cases were not married (8.7% vs 0.7%) and more controls chewed betelnut (76% vs 59%).

Obstetric history (Table 2)

Parity did not make any difference to the outcome. More of the cases had a history of past stillbirth (9.5% vs 5.0%) and the proportions of mothers with a history of past neonatal death and low birthweight were higher among the cases (11.9% vs 5.0% and 13.5% vs 5.9%, respectively). None of these differences reached statistical significance. When past history of stillbirth, neonatal death and low birthweight were combined into one variable – *bad obstetric history* – there was still no statistically significant difference between the two groups. The mean last delivery interval was not different in the two groups (43.8 months vs 40.2 months).

Significantly more of the cases did not attend antenatal care (26% vs 2%). Moreover, the proportion of cases who were considered to have had adequate antenatal care was lower than in the controls (59% vs 76%). Mothers who delivered prematurely could not be expected to avail themselves of sufficient antenatal care so the analysis was performed excluding babies delivered before 34 weeks. After the adjustment, there was no difference between the two groups as far as antenatal attendance was concerned. Antenatal weight and weight gain during pregnancy was similar in the two groups. More of the cases were short (15.5% vs 7.5%), although this was not statistically significant.

Antenatal complications (Table 3)

The following antenatal conditions were significantly associated with neonatal death: malaria (17.3% vs 6.7%); premature rupture of the membranes (10% vs 0%); and intrauterine growth restriction (IUGR) (6.7% vs 0%). Fever was analyzed as a separate variable. It included all patients who had a fever at some stage of the pregnancy and could have been expected to include malaria and UTI. There was no significant difference between the two

Labour and delivery characteristics (Table 4)

Labour characteristics that were significantly associated with early neonatal death were: gestational age less than 29 weeks (20.9% vs 0%), gestational age between 29 and

TABLE 1

SOCIODEMOGRAPHIC CHARACTERISTIC

	Cases	Controls	p value	OR (95% CI)
Mean age (sd)	25.1 (5.92)	25.4 (5.67)	0.57	-
Age >35 years	10/150 (6.7%)	9/149 (6.0%)	0.825	1.11 (0.40-3.08)
Age <19 years	25/150 (16.7%)	18/149 (12.1%)	0.259	1.46 (0.72-2.99)
Southern Region origin	91/149 (61.1%)	104/150 (69.3%)	0.157	0.71 (0.43-1.17)
No education	32/150 (21.3%)	24/150 (16%)	0.226	1.44 (0.76-2.70)
Mean school years (sd)	6.11 (4.01)	6.17 (3.95)	0.86	-
Settlement vs City	49/110 (44.5%)	47/118 (39.8%)	0.472	1.21 (0.69-2.14)
Settlement vs Others	49/150 (32.7%)	47/150 (31.3%)	0.775	1.07 (0.64-1.79)
Married	137/150 (91.3%)	149/150 (99.3%)	0.001	0.07 (0.00-0.53)
Husband's occupation unskilled*	47/100 (47%)	56/121 (46.3%)	0.92	1.03 (0.58-1.81)
Betelnut chewing	89/150 (59.3%)	114/150 (76%)	0.002	0.46 (0.27-0.78)
Mean number of betelnut among chewers (sd)	2.36 (2.74)	2.09 (1.9)	0.85	-
Smoking	13/146 (8.9%)	14/150 (9.3%)	0.869	0.94 (0.40-2.2)
Mean number of cigarettes smoked by smokers (sd)	0.60 (2.5)	0.58 (2.6)	0.95	-

p value = Mantel-Haenszel χ^2 test for categorical and Kruskal-Wallis H test for continuous variables
OR(95% CI) = odds ratio with 95% confidence interval
*unemployed excluded

34 weeks (29.5% vs 2.8%), thick meconium staining of amniotic fluid (9.6% vs 0.8%), extremely low birthweight (between 500 and 999 g) (14.2% vs 0%), very low birthweight (between 1000 and 1499 g) (20.9% vs 0%) and birthweight between 1500 g and 2499 g (29.1% vs 12.9%). There were significantly more female infants in the control group. The mean gestational age, mean birthweight and the mean labour ward symphysio-fundal height were significantly lower in the cases than the controls.

Labour ward complications (Table 5)

Labour ward complications occurred in 76% of the cases compared with 11% of controls. There were significantly more preterm labours among the cases and the following complications were found among the cases only: prolonged latent phase with rupture of membranes (ROM) >12 hours, preeclamptic toxaemia (PET), breech presentation, abruptio placentae, placenta praevia and premature rupture of the membranes.

Causes of early neonatal death (Table 6)

Table 6 shows the principal causes of early neonatal death diagnosed clinically. 148 of the 150 early neonatal deaths had a cause of death assigned. The cause of death was associated with the following conditions: respiratory distress syndrome (27%), infection alone (17%), infection associated with other causes (9%), congenital abnormality (17%), birth asphyxia (12%) and meconium aspiration syndrome (11%).

TABLE 2

PAST AND PRESENT OBSTETRIC HISTORY CHARACTERISTICS

	Cases	Controls	p value	OR (95% CI)
History of past stillbirth	8/84 (9.5%)	5/101 (5.0%)	0.227	2.02 (0.56-7.54)
History of past NND	10/84 (11.9%)	5/101 (5.0%)	0.085	2.59 (0.75-9.26)
History of past LBW	10/74 (13.5%)	6/101 (5.9%)	0.086	0.40 (0.12-1.3)
Bad obstetric history: combination of stillbirth, NND or LBW	22/149 (14.8%)	15/150 (10%)	0.22	0.65 (0.03-1.38)
Last delivery interval more than 2 years	55/81 (67.9%)	71/99 (71.7%)	0.579	0.83 (0.42-1.67)
Para O	65/146 (44.5%)	49/140 (35%)	0.10	1.49 (0.90-2.4)
Para ≥5	5/146 (3.4%)	10/140 (7.1%)	0.31	0.56 (0.16-1.89)
Unbooked	39/150 (26%)	3/150 (2%)	0.00000	17.3 (4.92-73.07)
Low antenatal attendance	44/108 (40.7%)	36/148 (24.3%)	0.005	2.14 (1.21-3.79)
Low antenatal attendance excluding mothers who delivered before 34 weeks	19/78 (24.4%)	35/147 (23.8%)	0.93	1.03 (0.52-2.05)
Mean antenatal attendance excluding mothers who delivered before 34 weeks	6.3 (3.3)	6.1 (3.1)	0.55	-
Low maternal weight at first visit <50 kg	88/104 (84.6%)	130/142 (91.5%)	0.091	0.51 (0.21-1.21)
Mean weight gain per week (kg)	0.49 (0.358)	0.59 (0.876)	0.987	-
Height <150 cm	22/142 (15.5%)	11/146 (7.5%)	0.034	2.25 (0.98-5.22)

p value = Mantel-Haenzsel χ^2 test for categorical variables and Kruskal-Wallis H test for continuous variables
OR (95% CI) = odds ratio with 95% confidence interval
NND = neonatal death
LBW = low birthweight

Multivariate analysis

Multiple logistic regression analysis (Table 7)

When the variables which were significantly associated with early neonatal death by univariate analysis were examined by logistic regression analysis, the following were still found to be significantly associated with neonatal death: no or poor antenatal care, thick meconium staining of the liquor, male sex, very low birthweight and gestational age at delivery less than 34 weeks. The negative association with betelnut chewing persisted.

Multiple logistic regression analysis excluding birthweights less than 1000 grams (Table 7)

When the extremely low birthweight neonates were excluded, the following variables were significantly associated with neonatal deaths: unmarried status, thick meconium staining of the amniotic fluid diagnosed in labour and gestational age at delivery less than 34 weeks. Betelnut chewing was again negatively associated.

Avoidable factors

88 avoidable deaths (59% of the total) were identified. Patient factors were associated with

TABLE 3

ANTENATAL COMPLICATIONS

	Cases	Controls	p value	OR (95% CI)
Malaria	26/150 (17.3%)	10/150 (6.7%)	0.004	2.96 (1.29-6.91)
UTI	10/150 (6.7%)	15/150 (10%)	0.30	0.65 (0.26-1.61)
Fever	31/150 (20.7%)	21/150 (14%)	0.12	1.61 (0.84-3.11)
High systolic BP	24/143 (16.8%)	20/148 (13.5%)	0.44	1.29 (0.64-2.60)
PROM	15/150 (10%)	0/150	0.00007	-
PET	17/150 (11.3%)	16/150 (10.7%)	0.84	1.08 (0.49-2.36)
Mean systolic BP (sd)	124.06 (21.98)	123.38 (13.7)	0.053	-
Mean Hb	10.23 (2.7)	10.45 (1.4)	0.62	-
Anaemia Hb<8 g/100ml	14/98 (14.3%)	9/132 (6.8%)	0.0625	2.28 (0.87-6.07)
IUGR	10/150 (6.7%)	0/150	0.0013	-
VDRL positive	8/101 (7.9%)	4/126 (3.2%)	0.11	0.38 (0.09-1.47)

p value = Mantel-Haenszel χ^2 test for discrete variables and Kruskal-Wallis H test for continuous variables
OR = odds ratio
CI = confidence interval
UTI = urinary tract infection
BP = blood pressure
PROM = premature rupture of membranes
PET = preeclamptic toxaemia
Hb = haemoglobin
IUGR = intrauterine growth restriction
VDRL = Venereal Disease Research Laboratories

53% of these followed by factors in the labour ward (28%), antenatal clinic (9%), postnatal ward (8%) and special care nursery (2%). Some of the patient-related factors were nonattendance at the antenatal clinic and not reporting promptly to the labour ward with problems such as reduced fetal movements and prolonged or premature rupture of membranes. The labour ward factors included inadequate monitoring of high-risk patients, failure to institute appropriate treatment at the appropriate time and failure to involve the paediatrician early. The antenatal clinic factors included failure to identify high-risk patients, failure to institute appropriate care, inconsistent fundal height measurements and inadequate counselling. The postnatal ward factors included failure to identify and adequately monitor high-risk neonates. The special care nursery factors included failure to diagnose and initiate early treatment for significant neonatal conditions.

Discussion

The neonatal death rate in Papua New Guinea is about 23-38/1000 live births, similar to the rate in the USA in the 1960s. The current neonatal death rate in the USA and other industrialized countries is less than 8/1000 live births (5). The early neonatal death rate at the PMGH is about 10-12/1000 live births, more than two-thirds of which are of low birthweight (1). Neonatal mortality is highest during the first 24 hours of life and it accounts for about 65% of deaths under 1 year. Although the neonatal period defines the first 4 weeks of life after birth, both fetal and neonatal life form a continuum during which human growth and development are affected by genetic, intrauterine, extrauterine and environmental factors. Social, economic and cultural factors also affect the continuum (5).

Low socioeconomic class, with the

TABLE 4

LABOUR AND DELIVERY CHARACTERISTICS

	Cases	Controls	p value	OR (95% CI)
Level of the head 3/5 and above on admission to labour ward	67/111 (60.4%)	83/137 (60.6%)	0.971	0.99 (0.57-1.72)
Labour augmented	26/129 (20.2%)	20/149 (13.4%)	0.133	1.63 (0.82-3.25)
Action line crossed	82/94 (87.2%)	129/144 (89.6%)	0.577	0.75 (0.33-1.93)
Presence of fetal heart abnormality	4/123 (3.3%)	3/138 (2.2%)	0.601	0.67 (0.12-3.62)
Thick MSAF in labour	11/114 (9.6%)	1/120 (0.8%)	0.002	12.71 (1.66-267.7)
Extremely low birthweight (500-1000 g)	21/148 (14.2%)	0/147	0.000002	undefined
Very low birthweight (1000-1499 g)	31/148 (20.9%)	0/147	0.000000	undefined
Low birthweight (1500-2499 g)	43/148 (29.1%)	19/147 (12.9%)	<0.0006	2.76 (1.46-5.23)
Mean birthweight (sd)	2048 (950.7)	3089 (491.5)	0.000000	-
Gestational age at delivery <29 weeks	31/148 (20.9%)	0/144	0.000000	undefined
Gestational age 29 to 34 weeks	36/122 (29.5%)	4/145 (2.8%)	0.000000	4.76 (4.75-51.23)
BBA	8/150 (5.3%)	2/150 (1.3%)	0.0527	4.20 (0.80-29.53)
Female sex	62/148 (41.9%)	85/150 (56.7%)	0.0129	0.56 (0.34-0.91)
Mean gestational age at delivery	34.4 (5.2)	38.7 (2.1)	0.000000	-
Mean SFH (cm)	33.04 (6.95)	36.86 (2.86)	0.000000	-

p value = Mantel-Haenszel χ^2 test for categorical variables and Kruskal-Wallis H test for continuous variables
OR (95% CI) = odds ratio with 95% confidence interval
MSAF = meconium-stained amniotic fluid
BBA = birth before arrival
SFH = symphysio-fundal height

associated high incidence of maternal undernutrition, anaemia and illness, has been shown to be associated with adverse neonatal outcome. Coupled with these are inadequate prenatal care, drug addiction, obstetric complications, maternal history of reproductive inefficiency (relative infertility, abortions, stillbirths, premature or low birthweight infants), single parent families, teenage pregnancies, close spacing of pregnancies and grand-multiparity (4-14).

This study found no significant relationship between socioeconomic class and early neonatal death (ENND). This could be a chance finding and a larger sample size may be required to show the influence of this composite variable. Although there was no direct relationship between socioeconomic status and early neonatal death, patients who were unmarried were more likely to have ENNDs. This association remained even after controlling for low birthweight, past stillbirth, poor antenatal attendance, and other significant

TABLE 5

LABOUR COMPLICATIONS

Variables	Cases	Controls	M-H p	OR (95% CI)
No complications	33/139 (23.7%)	133/149 (89.3%)	0.00000	0.27 (0.17-0.42)
Preterm labour	49/139 (35.3%)	2/149 (1.3%)	0.00000	26.26 (6.10-159.2)
Prolonged latent phase with ROM >12 hours	8/139 (5.8%)	No cases	-	-
PET	8/139 (5.8%)	No cases	-	-
Breech presentation	5/139 (3.6%)	No cases	-	-
Abruptio placentae	4/139 (2.9%)	No cases	-	-
Placenta praevia	2/139 (1.4%)	No cases	-	-
PROM	4/139 (2.9%)	No cases	-	-
Prolonged first stage	2/139 (1.4%)	7/149 (4.7%)	0.12	0.31 (0.04-1.64)
Other complications	24/139 (17.3%)	7/149 (4.7%)	0.0021	3.68 (1.45-9.71)

M-H p = Mantel-Haenszel χ^2 test p value
OR = odds ratio
Cl = confidence interval
ROM = rupture of membranes
PET = preecclamptic toxaemia
PROM = premature rupture of membranes (rupture of membranes before 37 completed weeks gestation)

variables. This was in consonance with other studies (7, 14-16).

There was no significant association between the extremes of reproductive age and early neonatal death. However, other studies have shown that women at the extremes of reproductive life, adolescents and women over 35 years, have increased risk for an adverse neonatal outcome. Teenage pregnancy with the associated low social status, unemployment, not being married and poor antenatal care are associated with increased adverse outcome. On the other hand, preeclampsia and other hypertensive diseases and diabetes mellitus, low birthweight and prematurity are more common in the older women (8,16-18)

Lifestyle habits studied were betelnut chewing and smoking. More than 90% of the population studied were nonsmokers and of those who smoked, the average number of cigarettes smoked per day was less than one. However, moderate smoking (up to 15 cigarettes per day) has been associated with adverse neonatal outcome (17,19,20).

Surprisingly, betelnut chewing was shown to be negatively associated with early neonatal death. A previous study at the PMGH found an association between betelnut chewing and meconium staining of the liquor and this would have been expected to have some adverse effect on neonatal deaths (21). It is difficult to explain the possible reasons for this favourable association. Whilst we are not aware of any study of the physiological effects of betelnut chewing during pregnancy it would be tempting to speculate that catecholamines released with betelnut chewing could act like tocolytic agents with potential beneficial effects of suppressing uterine activity. This effect needs to be studied further.

There was no significant difference in the last delivery interval. This finding is surprising, because shorter intervals between births have been reported to be associated with adverse neonatal outcome.

The study revealed that some antenatal care was better than no care at all. At the PMGH, about 4-5% of women were nonattendants; however, the early neonatal death rate in this

TABLE 6

CAUSES OF EARLY NEONATAL DEATH

Cause	Number*	%
RDS without infection BWT 1000-1499 g	23	15.5
RDS with infection BWT 1000-1499 g	2	1.4
RDS without infection BWT 1500-2499 g	10	6.8
RDS with infection BWT 1500-2499 g	5	3.4
Septicaemia	20	13.5
Birth asphyxia	18	12.2
Meconium aspiration syndrome	17	11.5
Major congenital anomaly	15	10.1
Congenital heart disease	6	4.1
Birthweight 500-999 g without infection	10	6.8
Birthweight 500-999 g with infection	4	2.7
Intraventricular haemorrhage	3	2.0
Chorioamnionitis following ROM	3	2.0
Congenital syphilis	3	2.0
Pneumonia	2	1.4
Diaphragmatic hernia	2	1.4
Kernicterus/jaundice	2	1.4
Neural tube defect	1	0.7
Chromosomal defect	1	0.7
Inhalation of milk	1	0.7

*total number of early neonatal deaths with known causes = 148
RDS = respiratory distress syndrome
BWT = birthweight
ROM = rupture of membranes

population was 4 times more than the booked population (37/1000 vs 8/1000 live births) and contributed 12% to the early neonatal deaths (1). The negative impact on neonatal deaths remained after multiple logistic regression analysis. This finding is comparable with studies elsewhere which have shown that whilst antenatal care reduces adverse neonatal outcome in all socioeconomic classes, greatest impact is seen in the socially disadvantaged group (2-4,6). It would seem reasonable therefore to identify the 'at risk' patient and offer appropriate monitoring, counselling and hospitalization where indicated, in order to improve perinatal outcome (17,22). While antenatal care has a positive effect on neonatal deaths it is important to appreciate that women who have premature deliveries are in no position to avail themselves of the benefits of antenatal care. The answer to this is to educate women to attend clinics early so that any high-risk factors may be diagnosed and treated to avoid some of these deaths that are related to prematurity.

Antenatal complications which had adverse effects on neonatal outcome were clinical malaria, premature rupture of membranes and intrauterine growth restriction (IUGR) whilst labour and delivery complications associated with early neonatal death were thick meconium staining of the liquor and prematurity. All

TABLE 7

MULTIPLE REGRESSION ANALYSIS OF VARIABLES SIGNIFICANT IN UNIVARIATE ANALYSIS

Variable	Log likelihood	-2 log LR	df	Significance of log LR
All cases				
Low antenatal attendance	-123.126	10.138	2	0.0063
Betelnut chewing	-123.476	10.837	1	0.0044
Thick MSAF	-123.751	10.388	2	0.0034
Male sex	-123.491	10.868	1	0.0044
Very low birthweight	-140.003	43.891	2	0.0000
Delivery at gestational age <34 weeks	-127.068	18.021	2	0.0001
Excluding birthweights 490-999 g				
Unmarried	-112.399	4.287	1	0.0384
Betelnut chewing	-116.225	11.939	1	0.0026
Thick MSAF	-115.007	9.501	2	0.0086
Delivery at gestational age <34 weeks	-145.775	71.038	2	0.0000

LR = likelihood ratio
df = degrees of freedom
MSAF = meconium-stained amniotic fluid

these problems are well known for their adverse effects on pregnancy outcome. Malaria attacks in the pregnant woman, especially the primigravida, may be recurrent and severe, sometimes leading to placental insufficiency and intrauterine growth restriction, prematurity and fetal death. It is also a major cause of anaemia in holoendemic regions. Preterm premature rupture of membranes (PPROM) has been shown to account for one quarter of all cases of premature rupture of membranes and was responsible for about 30% of all premature deliveries (23). Intrauterine growth restriction, or small for gestational age (SGA), from whatever cause, is detrimental to pregnancy and its outcome. The perinatal mortality rate for SGA pregnancies in most centres in the USA is 1.5-2 times that of the appropriately grown infant because of the increased risk of meconium aspiration syndrome, polycythaemia, hypoglycaemia and temperature instability (24). In an earlier study at this hospital, meconium staining of amniotic fluid was significantly associated with early neonatal death, in consonance with other studies (21). In multiple logistic regression analysis malaria was not associated with neonatal death. There could well have been confounding with variables like low birthweight. Malaria could have initiated the preterm labour but eventually it was not malaria which killed the newborn: it was low birthweight. It is surprising also that Venereal Disease Research Laboratories (VDRL) positivity was not associated with neonatal death even though the proportion of VDRL-positive women among the cases was higher than among the controls (7.9% vs 3.2%). Even though we vigorously look for VDRL positives and offer them treatment as early as possible, syphilis accounted for 9.5% of all stillbirths at the PMGH and would reasonably have been expected to significantly contribute to neonatal deaths as well (25).

For any given duration of gestation the lower the birthweight the higher the neonatal mortality, and for any given weight the shorter the gestation the higher the neonatal mortality. The highest risk of neonatal mortality occurs in infants who weigh less than 1000 g at birth and whose gestation is less than 30 weeks; as birthweight increases from 500 to 3000 g, a logarithmic decrease in neonatal mortality occurs (5,23,26). At the PMGH, the survival

rate among birthweight groups ranges from 7% for neonates weighing less than 1000 g to 92% for the group weighing 1500-2499 g (27). In our study, 14.2% of the cases had birthweight less than 1000 g compared with none of the controls. Gestational age had a similar impact on early neonatal deaths and is thought to be a better predictor before 29 weeks, but birthweight seems to be a better predictor after that gestational age (24,28,29).

When past history of stillbirths, early neonatal deaths and low birthweight were studied individually and then combined into one variable – *bad obstetric history* – there was no difference between the two groups. However, other studies have shown that bad obstetric history has an adverse impact on neonatal outcome. History of previous pregnancy wastage could be a proxy for inherent biological problems such as chromosomal abnormalities, diabetes, maternal infections and other unexplained causes. Some of these risk factors, like IUGR, may recur in subsequent pregnancies so antenatal care is essential to assess these risk factors in order for the pregnancy to be closely monitored (5,17,30,31).

Interestingly, female infants had a better survival rate than male infants. This is in agreement with other studies which have shown that despite male babies being generally heavier than female babies, their risk of dying in the neonatal period was double that of female babies (5,23).

The common causes of early neonatal death were respiratory distress syndrome in the low birthweight group (27%) followed by congenital abnormalities (17%), septicaemia (14%), birth asphyxia (12%) and meconium aspiration syndrome (11%). These causes were based on clinical diagnosis alone; the findings are consistent with a previous study done at the PMGH neonatal unit (27).

Avoidable factors

At the PMGH, monthly perinatal audits are conducted by a combined obstetric and neonatal staff. The staff decides, to the best of their knowledge, the cause of death and assigns avoidable factors when present. The exercise is not designed to apportion blame but to draw attention to areas where more effort could be made to enhance other efforts to reduce morbidity and mortality, perinatal or maternal. Deaths in infants weighing less than 1000 g and those with lethal congenital abnormalities are classified as unavoidable. 59% of the neonatal deaths were avoidable. Patient-related factors were associated with more than 50% of the avoidable deaths. Lack of understanding, failure to seek prompt medical advice, failure to promptly attend hospital after rupture of membranes and failure to report reduced fetal movements were some of the problems that were detected. At the PMGH antenatal clinics prenatal education is conducted every morning before the clinics actually start. Wideranging problems in pregnancy are discussed including nutrition, malaria, fetal movements and their implications for fetal well-being, premature rupture of the membranes and family planning. The effort to educate our women is reinforced at each visit. In the circumstance, if a patient fails to seek advice in the presence of any such problem, at least part of the blame for failure to act can reasonably be laid at her door. However, improvement of education and social status of women in the community and improved counselling at the antenatal clinics must continue so as to avoid some of these perinatal deaths.

Labour ward factors accounted for 28% of the total avoidable factors. The shortage of midwives in the labour ward has been a long-standing problem which is unlikely to improve in the near future. Nonetheless, adherence to labour ward management protocol for high-risk patients, inservice training of midwives and residents to recognize and appropriately manage high-risk patients and the availability of the labour ward operating theatres after 10 pm will all make an impact on reducing neonatal deaths. Though we have determined the primary responsibility for avoidable factors, there is no certainty that if action had been taken to deal with a particular avoidable factor a more favourable outcome would have ensued.

In conclusion, this study has identified certain risk indicators, risk factors and avoidable factors which should be used to

educate health care providers, the community at large and administrators to improve early neonatal death rates. Adherence to these factors would also help to reduce the stillbirth rate.

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