Factors associated with neonatal mortality in a tertiary hospital in Phnom Penh, Cambodia

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ABSTRACT

This study aimed to identify hospital neonatal mortality rate (NMR) and the causes of neonatal deaths, and to understand risk factors associated with neonatal mortality in a national tertiary hospital in Cambodia. The study included all newborn infants, aged 0–28 days old, hospitalized in the Pediatrics department of Khmer-Soviet Friendship Hospital between January 2016 and December 2017. In total, 925 infants were included in the study. The mean gestational age was 35.9 weeks (range, 24–42 weeks). Preterm infants and low birth weight accounted for 47.5% and 56.7%, respectively. With respect to payment methods, the government (53.5%) and non-governmental organizations (NGO) (13.7%) paid the fees as the families were not in a financial position to do so. The hospital NMR at the Pediatrics department was 9.3%. Respiratory distress syndrome (37.2%) was the main cause of deaths followed by hypoxic-ischemic encephalopathy (31.4%) and neonatal infection (21.0%). Factors associated with neonatal mortality were Apgar score at 5th minute <7 (adjusted odds ratio (AOR) = 3.57), payment by the government or NGO (AOR = 11.32), admission due to respiratory distress (AOR = 11.94), and hypothermia on admission (AOR = 9.41). The hospital NMR in the Pediatrics department was 9.3% (95% confidence interval 7.50–11.35) at Khmer-Soviet Friendship Hospital; prematurity and respiratory distress syndrome were the major causes of neonatal mortality. Introducing continuous positive airway pressure machine for respiratory distress syndrome and creating neonatal resuscitation guidelines and preventing hypothermia in delivery rooms are required to reduce the high NMR.

Keywords: Cambodia, neonatal infection, neonatal mortality, prematurity, respiratory distress syndrome

Abbreviations:
ANC: antenatal care
AOR: adjusted odds ratio
CPAP: continuous positive airway pressure
INC: Immediate Newborn Care
KSF Hospital: Khmer-Soviet Friendship Hospital
LBW: low birth weight
NGO: non-governmental organizations
NMR: neonatal mortality rate
RDS: respiratory distress syndrome

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INTRODUCTION

The first 28 days is the most vulnerable time for newborn infants to survive due to potential complications after birth or a weak immune system. In 2017, the neonatal mortality rate (NMR) was 18 deaths per 1,000 live births globally and neonatal deaths accounted for 47% of all deaths in children under five years old. Neonatal death is a global burden, especially in developing countries. In 2014, the Cambodia Demographic and Health Survey showed that the NMR in Cambodia was 18 deaths per 1,000 live births, which represented 63% of under-five mortality rate. The Cambodian government set a target NMR of 14 deaths per 1,000 live births by 2020 in the Health Strategic Plan 2016–2020. The NMR has been gradually decreasing to 14.9 deaths per 1,000 live births in 2017, but has not yet reached the national target.

Khmer-Soviet Friendship (KSF) Hospital is one of the central hospitals in Phnom Penh, Cambodia, and has 600 beds and 26 departments. Most patients are low- or middle-income families from all over the country. KSF Hospital provides health services to patients at very low fees, namely 3–5 USD for consultation with medication at the Outpatient department and five USD for one-day hospitalization with medication. Low-income families who have “IDPoor,” which is an identification card of poor household, are eligible for free healthcare service at public health facilities, including KSF Hospital, with the government support. Non-governmental organizations (NGO) also provide financial support for poor families who live near the organizations. Furthermore, when patients cannot afford treatment and do not have the IDPoor or qualify for NGO support, the treatment fees can be waived based on the hospital’s decision. The Pediatrics department has 20 beds, including 11 beds for neonates, but there is no neonatal intensive care unit. At the end of 2017, the medical equipment for neonatal care included one incubator, two cots, two phototherapy devices, eight oxygen cylinders, six infant radiant warmers, two portable suctioning machines, one weighing machine, two sets of infant laryngoscopes and two pulse oximeters. Unfortunately, the department had no ultrasound, neonatal cardio-respiratory monitor, continuous positive airway pressure (CPAP) machine or neonatal mechanical ventilator. Although newborns in serious conditions need to be referred to a hospital that has a higher level of neonatal intensive care unit, this is sometimes impossible as the family refuses due to the financial burden.

There has been no report on hospital NMRs in Cambodia to date. The aims of this study were to identify the hospital NMR and causes of neonatal deaths and to understand risk factors associated with neonatal mortality in KSF Hospital. The results of this study can be used to develop the neonatal section and to improve the management of neonatal diseases.

METHODS

Study design and participants

This retrospective cohort study was carried out in the Pediatrics department of KSF Hospital in Phnom Penh, Cambodia. The study included all newborn infants who were 0–28 days old and hospitalized in the Pediatrics department between January 2016 and December 2017. However, newborn infants who were admitted but transferred to other hospitals before completion of their treatment or who were discharged against doctor’s medical advice were excluded.
Data collection

Data were collected from patient records, including neonatal characteristics (age at admission, gestational age at birth, sex, birth weight, causes of admission, and Apgar score), obstetrical and maternal data (residence of mother, mode of delivery, level of delivery facilities and payment methods), and neonatal outcomes (duration of hospitalization, mode of discharge and causes of deaths). The causes of neonatal admission and death were decided by pediatric specialists (Dr. Ponloeu Leak and Dr. Pisey Noy) with reviewing medical records. The payment methods were categorized into four groups: (1) out-of-pocket (full payment by patients), (2) out-of-pocket + hospital (partial payment by patients as per the hospital’s decision), (3) government (free of charge due to IDPoor or the hospital decision), and (4) NGO (free of charge due to the support of NGO).

Definition of medical terms

‘Prematurity’ of newborn infant was defined by a gestational age less than 37 weeks. Sub-categories of preterm birth were based on gestational weeks as follows; ‘extremely preterm’ (<28 weeks), ‘very preterm’ (28–31 weeks), and ‘moderate to late preterm’ (32–36 weeks).7 The low birth weight (LBW) was defined as less than 2,500 g.8 ‘Respiratory distress’ was used for patients who had clinical signs, such as tachypnea, nasal flaring, chest retraction, and grunting.2 Diagnosis of ‘respiratory distress syndrome (RDS)’ was made based on chest radiographic findings and clinical signs of respiratory distress. Based on the National Clinical Practice Guidelines, ‘neonatal infection’ was diagnosed in the following cases: (1) when patients had either of three infectious risk factors from their mothers, namely a prolonged period from membrane rupture to delivery (>18 hours), maternal fever during delivery (≥38.5°C), and foul-smelling or purulent amniotic fluid; (2) when patients showed either of clinical signs that could not be explained by other causes, namely fever, hypothermia, pallor, jaundice, refusal to feed, vomiting, abdominal distension, hypotonia altered consciousness, convulsions, and coma; (3) when patients had either of the following biological criteria: white blood cells >30,000/mm³, white blood cells <6,000/mm³, and C-reactive proteins >10mg/L.9 Bacterial cultures were unavailable in the hospital. ‘Hypoxic-ischemic encephalopathy’ was clinically diagnosed based on perinatal asphyxia with neurologic signs, namely decreasing muscle tone and reflexes, absence of crying, hypersensitive, subnormal level of consciousness, coma with or without convulsions, and difficulty with respiration.10 Neuroimaging techniques, such as magnetic resonance imaging (MRI), and the pH analysis of arterial umbilical cord blood were unavailable to confirm the diagnosis in the hospital. ‘Meconium aspiration syndrome’ was defined as respiratory distress occurring after birth from a meconium stained milieu with compatible radiological findings which could not be otherwise explained.11 Hypothermia was defined as body temperature below 36.5°C.12

Statistical analysis

Kaplan-Meier curve was made to estimate survival time. A logistic regression model was used to determine 95% confidence intervals and odds ratio. A p-value <0.05 was deemed to be statistically significant. Data were analyzed by Statistical Package for the Social Sciences version 25.0 (IBM SPSS Inc., New York, USA).

Ethical considerations

Written informed consent was waived due to the retrospective study. This study was approved by the National Ethic Committee for Health Research, Ministry of Health (issue number: 219NECHR).
RESULTS

A total 925 newborn babies met the criteria of the study. The percentage of males was 51.7% and 87.4% of patients were hospitalized in the first 24 hours after birth (Table 1). The mean gestational age was 35.9 weeks (range, 24–42 weeks) and preterm infants accounted for 47.5%. The mean of birth weight was 2,480 g (range, 800–5,200 g) and 56.7% of patients were classified as LBW. Neonates who were born by Caesarean section accounted for 29.0% of the patients. The level of delivery facility was national hospital in 910 cases (98.5%), all of whom were born at KSF Hospital. There were 909 cases transferred after delivery, including 900 cases

| Characteristic                          | Male (N=478) | Female (N=447) | Total (N=925) |
|----------------------------------------|--------------|----------------|---------------|
| Age at admission                       |              |                |               |
| 0–24 hours                             | 409 (85.5%)  | 399 (89.3%)    | 808 (87.4%)   |
| 1–7 days                               | 50 (10.5%)   | 41 (9.2%)      | 91 (9.8%)     |
| 8–28 days                              | 19 (4.0%)    | 7 (1.5%)       | 26 (2.8%)     |
| Gestational age (weeks)                |              |                |               |
| < 28                                   | 5 (1.1%)     | 7 (1.5%)       | 12 (1.3%)     |
| 28–31                                  | 74 (15.5%)   | 58 (13.0%)     | 132 (14.3%)   |
| 32–36                                  | 135 (28.2%)  | 160 (35.8%)    | 295 (31.9%)   |
| ≥ 37                                   | 264 (55.2%)  | 222 (49.7%)    | 486 (52.5%)   |
| Birth weight (g)                       |              |                |               |
| <1,000                                 | 3 (0.6%)     | 3 (0.7%)       | 6 (0.7%)      |
| 1,000–<1,500                           | 29 (6.1%)    | 28 (6.3%)      | 57 (6.2%)     |
| 1,500–<2,500                           | 210 (43.9%)  | 251 (56.1%)    | 461 (49.8%)   |
| ≥2,500                                 | 236 (49.4%)  | 165 (36.9%)    | 401 (43.3%)   |
| Mode of delivery                       |              |                |               |
| Vaginal delivery                       | 343 (71.8%)  | 314 (70.2%)    | 657 (71.0%)   |
| Caesarean section                      | 135 (28.2%)  | 133 (29.8%)    | 268 (29.0%)   |
| Level of facilities of delivery        |              |                |               |
| National hospital                      | 466 (97.5%)  | 444 (99.3%)    | 910 (98.5%)   |
| Othersa                                | 12 (2.5%)    | 3 (0.7%)       | 15 (1.5%)     |
| Apgar score at 5th minute              |              |                |               |
| < 7                                    | 261 (54.6%)  | 239 (53.5%)    | 500 (54.1%)   |
| ≥ 7                                    | 217 (45.4%)  | 208 (46.5%)    | 425 (45.9%)   |
| Duration of hospitalization            |              |                |               |
| 0–24 hours                             | 16 (3.4%)    | 12 (2.7%)      | 28 (3.0%)     |
| 1–7 days                               | 320 (66.9%)  | 313 (70.0%)    | 633 (68.4%)   |
| ≥ 8 days                               | 142 (29.7%)  | 122 (27.3%)    | 264 (28.6%)   |
| Payment methods                        |              |                |               |
| Out-of-pocket                          | 47 (9.8%)    | 50 (11.2%)     | 97 (10.5%)    |
| Out-of-pocket + hospital               | 104 (21.8%)  | 102 (22.8%)    | 206 (22.3%)   |
| Government                             | 251 (52.5%)  | 244 (54.6%)    | 495 (53.5%)   |
| NGO                                    | 76 (15.9%)   | 51 (11.4%)     | 127 (13.7%)   |
| Residence of mothers                   |              |                |               |
| Phnom Penh                             | 240 (50.2%)  | 243 (54.3%)    | 483 (52.2%)   |
| Provinces                              | 238 (49.8%)  | 204 (45.7%)    | 442 (47.8%)   |

a Provincial hospital in one case, referral hospitals in six cases, health center in one case, private clinics in three cases, home in two cases, and on the way to hospital in two cases.

NGO: non-governmental organization.
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from the Maternity department of KSF Hospital and nine cases from other facilities or home. Sixteen cases visited outpatient department from their home and were hospitalized at 4–27 days old. The mean of Apgar score was 5.7 at 1st minute and 6.5 at 5th minute. The proportion of cases whose Apgar score was <7 at the 1st and 5th minute was 65.9% and 54.1%, respectively. Only 10.5% cases paid by their families; the government and NGO paid in 53.5% and 13.7% of cases, respectively. The mean duration of hospitalization was 5.9 days (range, 0–52 days), and 68.4% of patients stayed in the hospital for 1–7 days. In terms of the mother’s residence, 47.8% of cases came from provinces, mostly from provinces close to Phnom Penh, such as Kandal, Prey Veng, Kampong Cham, Kampong Chhnang and Svay Rieng Provinces. However, some patients came from Ratanakiri, Bantheay Meanchey and Palin Provinces which are 351–636 km from Phnom Penh. There were no statistically differences in all characteristics between male and female patients.

The major causes of admission were complications by prematurity, which accounted for 47.5% of patients (Table 2). Of 439 preterm babies, 404 cases had complications such as hypothermia, respiratory distress, perinatal asphyxia, and neonatal infection. Among non-preterm babies, the major admission cause was perinatal asphyxia in 173 cases, including 47 cases with respiratory distress, two cases with altered consciousness and two cases with meconium aspiration syndrome. The second cause among non-preterm babies was neonatal infection in 156 cases (16.8%). There were 207 preterm babies and 27 full-term babies who were admitted due to hypothermia; however, 76.5% of all newborns (708 cases) had hypothermia on admission regardless of causes of admission.

In 2016–2017, 86 neonates died and the hospital NMR in the Pediatrics department was 9.3% (95% confidence interval 7.50–11.35). The NMR in all deliveries at KSF Hospital was 1.4%.

Table 2 Causes of neonatal admission

| Diagnosis                  | Male (N=478) | Female (N=447) | Total (N=925) |
|----------------------------|--------------|----------------|---------------|
|                            | n           | %             | n            | %             | n     | %     |
| < 37 weeks of gestational age |             |               |               |               |       |       |
| Prematurity                | 214         | 44.7          | 225          | 50.4          | 439   | 47.5  |
| Without complication       | 13          | 2.7           | 22           | 4.9           | 35    | 3.8   |
| Hypothermia                | 88          | 18.4          | 119          | 26.6          | 207   | 22.4  |
| Respiratory distress       | 56          | 11.7          | 39           | 8.7           | 95    | 10.3  |
| Perinatal asphyxia         | 44          | 9.2           | 39           | 8.8           | 83    | 8.9   |
| Infection                  | 13          | 2.7           | 6            | 1.4           | 19    | 2.1   |
| ≥ 37 weeks of gestational age |             |               |               |               |       |       |
| Perinatal asphyxia         | 102         | 21.3          | 71           | 15.8          | 173   | 18.7  |
| Without severe signs       | 68          | 14.2          | 54           | 12.1          | 122   | 13.2  |
| Respiratory distress       | 32          | 6.7           | 15           | 3.3           | 47    | 5.1   |
| Altered consciousness      | 1           | 0.2           | 1            | 0.2           | 2     | 0.2   |
| MAS                        | 1           | 0.2           | 1            | 0.2           | 2     | 0.2   |
| Neonatal infection \ a      | 83          | 17.4          | 73           | 16.3          | 156   | 16.8  |
| Low birth weight           | 28          | 5.9           | 48           | 10.7          | 76    | 8.2   |
| Hypothermia \ a            | 18          | 3.8           | 9            | 2.0           | 27    | 2.9   |
| Macrosomia                 | 11          | 2.2           | 10           | 2.2           | 21    | 2.3   |
| Neonatal RDS \ a           | 8           | 1.7           | 6            | 1.3           | 14    | 1.5   |
| Neonatal jaundice \ a      | 7           | 1.5           | 3            | 0.8           | 10    | 1.1   |
| Other                      | 7           | 1.5           | 2            | 0.5           | 9     | 1.0   |

\ a Excluding cases related to prematurity and perinatal asphyxia

MAS: meconium aspiration syndrome

RDS: respiratory distress syndrome.
because there were 5,987 deliveries in 2016–2017 and 84 of the 86 dead patients were born at the hospital. Twenty-six neonates (30.2%) died within the first day of hospitalization and 58 neonates (67.4%) died within 2–7 days of hospitalization. The mortality significantly decreased after the newborns survived the first seven days of hospitalization (Fig. 1). The mortality rate in extremely preterm infants, very preterm, moderate to late preterm, and term was 100.0%, 25.8%, 6.1%, and 4.6%, respectively. In terms of birth weights, the mortality rate was 100.0% in six cases in weight <1,000 g and decreased to 47.4% in weight <1,500 g, 7.4% in weight <2,500 g and 5.2% in weight ≥2500 g. RDS was the main cause of deaths accounting for 37.2% followed by hypoxic-ischemic encephalopathy (31.4%) and neonatal infection (21.0%) (Table 3). Seven cases died due to congenital anomalies with the major anomaly being heart disease. The

Table 3 Causes of deaths in preterm and full-term infants

| Diagnosis                        | Gestational age | Total (N=86) |
|----------------------------------|-----------------|--------------|
|                                  | < 37 weeks (N=64) | ≥ 37 weeks (N=22) | n | % | n | % |
| Respiratory distress syndrome    | 32 50.0         | 0 0.0        | 32 | 37.2 |
| Hypoxic-ischemic encephalopathy  | 13 20.2         | 14 63.7      | 27 | 31.4 |
| Neonatal infection               | 16 25.0         | 2 9.0        | 18 | 21.0 |
| Neonatal sepsis                  | 10 15.6         | 1 4.5        | 11 | 12.8 |
| Necrotizing enterocolitis        | 5 7.8           | 0 0.0        | 5 5.9 |
| Pneumonia                        | 1 1.6           | 1 4.5        | 2 2.3 |
| Meconium aspiration syndrome     | 0 0.0           | 2 9.0        | 2 2.3 |
| Congenital anomalies             | 3 4.8           | 4 18.3       | 7 8.1 |
| Heart disease                    | 0 0.0           | 4 18.3       | 4 4.5 |
| Hydrocephalus                    | 1 1.6           | 0 0.0        | 1 1.2 |
| Achondrodisplasia                | 1 1.6           | 0 0.0        | 1 1.2 |
| Multiple congenital anomaly      | 1 1.6           | 0 0.0        | 1 1.2 |

Fig. 1 Kaplan-Meier survival estimate of neonates hospitalized at Khmer-Soviet Friendship Hospital in 2016–2017.
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percentage of death cases caused by RDS and neonatal infections in preterm infants were 50.0% (32/64) and 25.0% (16/64).

Bivariate logistic regression analysis on neonatal mortality showed that babies of preterm delivery, LBW, age at admission <24 hours old, Apgar score at 5th minute <7, mother’s residence in provinces, payment by the government or NGO, admission due to respiratory distress or infection, and hypothermia on admission had significantly higher mortality than the others (Table 4). To identify risk factors of neonatal mortality in the hospital, multiple logistic regression analysis was performed and adjusted for all factors. The results showed that Apgar score at 5th minute <7 (adjusted odds ratio (AOR) = 3.57), payment by the government or NGO (AOR = 11.32), admission due to respiratory distress syndrome (AOR = 11.94), and hypothermia on admission (AOR = 9.41) were significantly associated with neonatal mortality (Table 4).

Table 4  Bivariate and multivariate logistic regression for predictors of neonatal mortality among newborn babies hospitalized in pediatrics department

| Variable                      | Death     | Survival  | Crude OR (95% CI) | Adjusted OR (95% CI) |
|-------------------------------|-----------|-----------|-------------------|---------------------|
|                               | n (%)     | n (%)     |                   |                     |
| Sex                           |           |           |                   |                     |
| Female                        | 33 (38.4) | 414 (49.3)| 1                 | 1                   |
| Male                          | 53 (61.6) | 425 (50.6)| 1.56 (0.99–2.46) | 1.44 (0.83–2.51)    |
| Gestational age               |           |           |                   |                     |
| Term                          | 22 (25.6) | 464 (55.2)| 1                 | 1                   |
| Preterm                       | 64 (74.4) | 375 (44.8)| 6.67 (1.61–27.49)**| 1.95 (0.65–5.91)    |
| Birth weight (g)              |           |           |                   |                     |
| ≥ 2,500                       | 19 (22.1) | 382 (45.5)| 1                 | 1                   |
| < 2,500                       | 67 (77.9) | 457 (54.5)| 2.94 (1.74–4.99)**| 1.61 (0.49–5.31)    |
| Age at admission              |           |           |                   |                     |
| ≥ 24 hours                    | 2 (2.3)   | 115 (13.7)| 1                 | 1                   |
| < 24 hours                    | 84 (97.7) | 724 (86.3)| 6.67 (1.61–27.49)**| 1.20 (0.23–6.21)    |
| Apgar at 5th minute           |           |           |                   |                     |
| ≥ 7                           | 16 (18.6) | 409 (48.7)| 1                 | 1                   |
| < 7                           | 70 (81.4) | 430 (51.3)| 4.16 (2.37–7.28)**| 3.57 (1.84–6.96)**  |
| Residence of mothers          |           |           |                   |                     |
| Phnom Penh                    | 36 (41.9) | 447 (53.3)| 1                 | 1                   |
| Provinces                     | 50 (58.1) | 392 (46.7)| 1.58 (1.01–2.48)* | 1.26 (0.73–2.18)    |
| Methods of Payment            |           |           |                   |                     |
| Out-of-pocket                  | 6 (7.0)   | 297 (35.4)| 1                 | 1                   |
| Government/NGO                | 80 (93.0) | 542 (64.6)| 7.30 (3.15–16.95)**| 11.32 (4.58–28.00)**|
| Admission due to respiratory  |           |           |                   |                     |
| distress                      |           |           |                   |                     |
| No                            | 32 (37.2) | 737 (87.8)| 1                 | 1                   |
| Yes                           | 54 (62.8) | 102 (12.2)| 12.19 (7.51–19.78)**| 11.94 (6.71–21.27)**|
| Admission due to infection    |           |           |                   |                     |
| No                            | 84 (97.7) | 665 (79.3)| 1                 | 1                   |
| Yes                           | 2 (2.3)   | 174 (20.7)| 0.09 (0.02–0.37)**| 1.22 (0.25–6.01)    |
| Hypothermia on admission      |           |           |                   |                     |
| No                            | 1 (1.2)   | 216 (25.7)| 1                 | 1                   |
| Yes                           | 85 (98.8) | 623 (74.3)| 29.47 (4.09–212.92)**| 9.41 (1.25–71.08)    |

* Out-of-pocket includes patients who paid all by out-of-pocket and patients who paid by out-of-pocket with some supports by the hospital.

* P < 0.05; ** P < 0.01; *** P < 0.001
NGO: non-governmental organization
OR: odds ratio
CI: confidence interval
DISCUSSION

First, this study showed that the hospital NMR in the Pediatrics department of KSF Hospital in 2016–2017 was 9.3%, which was lower than those reported in other developing countries; 15.7% at the sub-urban hospital in Cameroon, and 10.0–22.9% at the referral hospitals in Cameroon, Iraq and Southern Ethiopia. This is probably because some of the severely ill newborns at KSF Hospital were transferred to other hospitals with more appropriate neonatal intensive care units. In this study, the proportion of admission due to prematurity was 47.5% and the mortality of preterm babies accounted for 74.4% (64/86) of all neonatal deaths. The association between high mortality rate and prematurity was consistent with the results of previous studies that were conducted in other developing countries. These findings suggest that prematurity is the most challenging problem for neonatology in developing countries. Therefore, prevention of preterm delivery and management of preterm infants should be priority of maternal and neonatal development program in order to reduce the NMR in developing countries including Cambodia.

Second, the major cause of deaths was RDS, which represented 37.2% of all causes. In KSF Hospital, two doses of intravenous dexamethasone with a 24-hour interval (12 mg per dose) are administered to pregnant patients who are less than 34 weeks of gestation 48 hours prior to delivery to prevent RDS. The treatment for RDS was only oxygen through a nasal cannula because surfactant therapy, CPAP machine, or neonatal mechanical ventilator were unavailable. Surfactant administration is a standard care for preterm infants with RDS globally, but very expansive. The safety and efficacy of CPAP in developing countries were reported as the introduction of CPAP greatly decreased the hospital mortality of preterm infants. CPAP machine may be a feasible solution to control RDS in preterm babies in KSF Hospital.

In this study, neonatal infection was the third cause of deaths. Most death cases by infections were diagnosed with neonatal sepsis, and all 11 infants who died due to neonatal sepsis were born with LBW (1,000–1,900 g). LBW has been reported as a risk factor of neonatal sepsis. Due to the limited number of healthcare workers, family members have to look after their babies who are hospitalized in KSF Hospital such as bottle or gavage feeding, oral administration, changing diapers, and bathing. However, it seemed that the family members did not sufficiently follow the instructions of doctors and nurses, and this may have caused more neonatal deaths. Family integrated care in neonatal intensive care unit was reported to lead better neonatal outcomes compared to the standard care by medical staff. These results suggest that care by family members might not be appropriate for babies in KSF Hospital and could lead to catastrophic outcomes as no educational training programs were provided to family members. Therefore, the neonatal infection control guidelines and programs of training for medical professionals and family members should be developed, especially with respect to hygiene.

Thirdly, factors associated with neonatal mortality were Apgar score at 5th minute <7, payment by the government or NGO, admission due to respiratory distress, and hypothermia on admission. Previous studies reported that a low Apgar score at 5th minute had a strong association with neonatal death, although the Apgar score can be affected by many factors including gestational age. Hypothermia has been reported as one of risk factors of neonatal mortality and as common complication in developing countries. The percentage of newborns with a Apgar score at 5th minute <7 and hypothermia on admission were higher in this study than those of previous studies in developing countries. These results suggest that newborn care and neonatal resuscitation in delivery rooms by midwives and doctors in the Maternity department may be inappropriate. Another reason may be that, due to the limited number of healthcare professionals, pediatric teams could not attend all deliveries that needed neonatal resuscitation in delivery rooms.

Newborns with poor families had higher mortality compared to those who could afford
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treatment. The odds ratio for the government/NGO payment might be overestimated, because babies with poor families had to stay at KSF Hospital even if they needed to be transferred to higher level hospitals. According to the Cambodia Demographic and Health Survey in 2014, low income status was associated with many factors of pregnant women, such as coverage of antenatal care (ANC), skilled birth attendance (SBA), institute delivery rate, lower level of education, malnutrition and a lower percentage of women taking iron supplements during pregnancy.\(^4\) Public health facilities in Cambodia provide free iron and folic acid for pregnant women. In this study, most mothers had SBA and institutional deliveries and were assumed to have had more ANC visits than the general pregnant population in Cambodia. However, poorer mothers might have less ANC visits than those in a more financially secure position. Previous studies in low- and middle-income countries concluded that ANC visits and poor income status were significantly associated with neonatal deaths.\(^33-35\) Moreover, it has been reported that multiple-micronutrients supplement containing iron and folic acid during pregnancy reduced neonatal mortality and significantly decreased preterm deliveries and LBW.\(^36-38\) These results suggest that financial support for poor pregnant women should be increased, such as incentives for ANC visits, free transportation services to visit health facilities, and free food service for patients and family members during hospitalization for childbirth.\(^39\)

To reduce infant mortality, the Ministry of Health established ‘Five-Year Action Plan For New-born Care, 2016–2020’ in 2015.\(^40\) In the plan, early essential newborn care was introduced as a comprehensive intervention delivered to mothers and newborns. Early essential newborn care consists of Intrapartum and Immediate Newborn Care (INC) and Expanded INC. INC includes (1) immediate and throughout drying, immediate skin-to-skin contact, appropriate timed cord crumping, and early exclusive breastfeeding, and (2) using bag and mask ventilation for newborns who are not breathing despite throughout drying. Expanded INC includes (1) preventing unnecessary inductions and Caesarean sections, antibiotics for premature pre-labor rupture of membranes, antenatal steroids and the Kangaroo Mother’s Care approach, and (2) identification of babies at high risk (birth asphyxia, neonatal sepsis, and complications of delivery) and management of sepsis and other common problems. In 2012, INC coaching sessions for referral hospital staff began and all participants were coached until they completed at least 90.0% of all clinical tasks correctly. Implementation of INC by all health professionals is needed to improve the NMR in Cambodia.\(^41\)

This study has some limitations. There was no maternal information such as age, number of ANC visits, education level, number of parity, and disease complications during pregnancy. These factors are also important because it was reported that the maternal factors were significantly associated with neonatal mortality.\(^34,42,43\) Second, diagnosis of hypoxic-ischemic encephalopathy, neonatal sepsis, and congenital heart diseases were diagnosed with only clinical symptoms, although the diagnosis should be made using neuroimaging technique, pH analysis, blood cultures, and heart ultrasound. The causes of admission or deaths in this study might not be correct, but this is due to the limited medical equipment in KSF Hospital. Third, 16 newborn infants were discharged against medical advice and they might have died at their home. Another 16 newborns were transferred to other hospitals for further treatment, and their outcomes were unavailable. Consequently, the neonatal mortality rate in this study might be underestimated. Therefore, further studies will be needed to investigate more clearly about risk factors associated with neonatal mortality.

In conclusion, the hospital NMR at the Pediatrics department was 9.3% and prematurity was the major cause of admission to KSF Hospital. RDS was the main cause of deaths followed by hypoxic-ischemic encephalopathy and neonatal infection. Apgar score at 5th minute <7, payment by the government or NGO, admission due to respiratory distress and hypothermia on admission
were associated with neonatal mortality. This study suggests that prevention of preterm delivery, using CPAP machine for RDS, and creating guidelines and providing training programs of neonatal resuscitation and prevention of neonatal hypothermia in delivery rooms may be suitable solutions in this setting.

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CONFLICT OF INTEREST

The authors have nothing to disclose.

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