

Early Neonatal Mortality Profile in Dr. Soetomo General Hospital

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Abstract

Background: As part of the United Nations, Indonesia also aims to achieve Sustainable Development Goals (SDGs). Some of these targets are to lower the neonatal mortality rate (NMR) to 12/1000 live births and to eliminate all preventable under-five deaths. In 2019, Indonesia is on track to meeting the SDGs with an NMR of 12.4/1000 live births. Also in 2019, 50% of all under-five deaths occurred in the neonatal period and 80% of all neonatal deaths occurred during the early neonatal period (first 7 days of life). This study aims to present the profile of early neonatal mortality cases to better understand the causes and factors surrounding it.

Methods: This retrospective descriptive study used data from the medical record of Dr. Soetomo General Hospital from 2019 to 2020. This study used total sampling and got a total of 296 subjects.

Results: The main causes of early neonatal mortality are sepsis (27%), congenital anomaly (19%), hyaline membrane disease (19%), and perinatal asphyxia (15%). Most subjects were found male (57%), domicile in East Java outside Surabaya (49%), born < 28 weeks (29%) with low birth weight, singleton (87%), inpatient (77%), and born with c-section (57%). Most mothers were found aged 20-40 years old (85%), graduated high school (32%), and were on their first pregnancy (31%).

Conclusion: The findings in this study are similar to previous studies, except for the age of death. Further studies are needed to better understand the correlation between factors presented in this study and early neonatal mortality.

Keywords: neonatal mortality; cause of death; NICU; preventable death; neonatal mortality rate

1. Introduction

In 2019 worldwide, almost half of total infant or under-one mortality happened during the first month of life. This percentage was caused by a total of 2.4 million neonatal death in a year or around 7,000 neonatal deaths daily. Around 75% of these total neonatal death occurred during the first day of life (WHO, 2020). World statistics in 2019 showed that child mortality rate (CMR) was 38/1000, infant mortality rate (IMR) was 29/1000, and neonatal mortality rate (NMR) was 17/1000 (UNICEF, 2020a).

WHO states that in 2019, Indonesia has the 7th most total neonatal death worldwide (WHO, 2020). This rank was caused by a total of 60,000 neonatal deaths. Although having the 7th most total neonatal death worldwide, Indonesia (12.4/1000) had a much lower neonatal mortality rate compared to other South and South-East Asian Countries (average 25/1000) (UNICEF, 2020a).

In 2019, Indonesia had a child mortality rate of 23.9/1000, an infant mortality rate of 20.2/1000, and a neonatal mortality rate of 12.4/1000 (UNICEF, 2020a). According to statistics from Direktorat Kesehatan Keluarga Republik Indonesia, 69% of all child or under-five mortality in 2019 in Indonesia happened during the neonatal period. Around 80% of all neonatal mortality occurred during the first week of life or the early neonatal period (Kementerian Kesehatan Republik Indonesia, 2020).

Throughout 2019, the neonatal mortality rate in East Java was 5.2/1000 live births. A total of 3,000 neonatal death in a year made East Java the province with the second most neonatal death nationwide (Dinkes Jawa Timur, 2019; Kementerian Kesehatan Republik Indonesia, 2020). This total neonatal death takes around 79% of all infant mortality in East Java (Kementerian Kesehatan Republik Indonesia, 2020).

According to WHO (2020) and Kementerian Kesehatan Republik Indonesia (2020), the main causes of neonatal death are prematurity, birth complications such as neonatal asphyxia, and congenital abnormalities. Since most death causes in the neonatal period can be avoided by appropriate medical treatment in pregnancy, during, and after labor, the neonatal mortality rate is used to assess the quality of birth and newborn healthcare in a population (Kliegman *et al.*, 2020). The use of neonatal mortality rate as a metric can be seen in United Nations' Sustainable Development Goals (SDG). One of the targets of SDG is to eliminate under-five mortality from preventable causes. The UN also has a target that by 2030, the worldwide neonatal mortality rate will fall to 12/1000 live births and the under-five mortality rate to 25/1000 live births (UNICEF, 2020a).

As part of the United Nations, Indonesia also takes part in realizing the SDGs. According to UNICEF (2020b), Indonesia had already met the target for child mortality rate and in the tract for meeting the neonatal mortality rate target. Nevertheless, Indonesia still needs to maintain and keep on trying to lower these numbers, also eliminate child, infant, and neonatal deaths from preventable causes.

With the statistics that have been presented, deaths during the early neonatal period take up a significantly big portion of total infant and under-five death. Therefore, reducing death during the first 7 days of life will directly lower the total neonatal, infant, and under-five mortalities.

In an attempt to lower death in the early neonatal period, it is necessary to understand why the mortality rate in this period is very high. According to Karlberg *et al.* (1962) and Kliegman *et al.* (2020), the high risk of the neonatal period, especially during the first day, is caused by physiological changes in all of the newborn's organs system to adapt to extrauterine life. Consequently, neonates are very susceptible to morbidities and causes of mortality. Previous research shows that neonatal mortality is affected by many factors, such as maternal factors, neonatal factors, intrapartum factors, and postpartum factors (Abdullah *et al.*, 2016; Al-Sheyab *et al.*, 2020; Djajakusli *et al.*, 2017)

This study aims to investigate the causes and leading factors of neonatal death during the early neonatal period in the NICU of Dr. Soetomo General Academic Teaching Hospital. Thus, the result of this study is expected to give more comprehensive knowledge about the causes and factors of neonatal death in the first week of life. It is hoped that this knowledge can provide a foundation for improvement in newborn management and

further research. Therefore, findings from this study can help lower neonatal, infant, and under-five mortality rates.

2. Materials and Methods

2.1. Study design and site

This study is a retrospective descriptive study that obtained data from the medical record of the NICU and the Intermediate Care Unit of Dr. Soetomo General Hospital from January 2019 to December 2020.

2.2. Sampling and study subject

To avoid bias, this study obtained data using total sampling, getting a total of 269 subjects. The subjects included in this study are neonates who died during the early neonatal period (under 7 days old) in the NICU or the Intermediate Care Unit of Dr. Soetomo General Hospital from January 2019 to December 2020. Any neonates with incomplete medical records are excluded from the study.

2.3. Data collection and analysis

Data were collected and analyzed using Microsoft Excel (ver. 16). Data were collected from August to September 2021. Aside from the cause of death, the variables collected were classified as neonatal profile, intrapartum profile, and maternal profile. Neonatal factors are gender, domicile, age of death, gestational age, birth weight, and congenital anomalies. Intrapartum factors consist of singleton/twin, type of birth, and birthplace. Maternal factors are maternal age and number of gestation(s). The final result was then presented in form of tables.

3. Result

3.1. Cause of death

From a total of 296 early neonatal death cases, most were caused by sepsis (27.4%), congenital anomaly (19.3%), and hyaline membrane disease (19.3%). Other causes of early neonatal mortality are presented in **Table 1**.

Table 1. Causes of early neonatal death

Cause of death	Total	Percentage
Sepsis	81	27.36%
Congenital anomaly	57	19.26%
Hyaline membrane disease	57	19.26%
Perinatal asphyxia	44	14.86%
Pneumonia	20	6.76%
Hemorrhage	12	4.05%
Multiorgan dysfunctional syndrome (MODS)	7	2.36%
Meconium aspiration syndrome (MAS)	5	1.69%

Peritonitis	4	1.35%
Hypoxic ischemic encephalopathy (HIE)	3	1.01%
Persistent pulmonary hypertension of the newborn (PPHN)	2	0.68%
Pneumothorax	2	0.68%
Kernicterus	1	0.34%
Atelectasis	1	0.34%

3.2. Neonatal profile

There are more males (57%) in this study compared to females (41.9%). Most subjects' family residences in East Java outside Surabaya (49%). There is a gradual incline in the number of deaths as the neonates' age progressed, yet a slight incline is found on day 1, day 2, and day 6. The neonatal demographic profile found in early neonatal mortality cases is described in **Table 2**.

Table 2. Neonatal demographic profile in early neonatal mortality cases

	Total	Percentage
Gender		
Male	169	57.09%
Female	124	41.89%
Unclear	3	1.01%
Family domicile		
Surabaya	139	46.96%
East Java (outside Surabaya)	145	48.99%
Java (outside East Java)	4	1.35%
Outside Java	8	2.70%
Age of death		
Under 24 hours	42	14.19%
1 day old	44	14.86%
2 days old	55	18.58%
3 days old	36	12.16%
4 days old	35	11.82%
5 days old	31	10.47%
6 days old	32	10.81%
7 days old	21	7.09%

Most subjects in this study were found born extremely preterm (29%) with a birth weight below 1500 grams. Congenital anomalies were found in 113 neonates (38.2%), with an anomaly of the cardiorespiratory system being the most common anomaly. Medical profiles found in early neonatal mortality cases are further elaborated in **Table 3**.

Table 3. Neonatal medical profile in early neonatal mortality cases

	Definition	Total	Percentage
Gestational age			
Extremely preterm	< 28 weeks	86	29.05%
Very preterm	28-31 weeks	58	19.59%
Moderately preterm	32-33 weeks	52	17.57%
Late preterm	34-36 weeks	40	13.51%
Early term	37-38 weeks	32	10.81%
Full term	39-40 weeks	22	7.43%
Late-term	41-42 weeks	4	1.35%
Post-term	> 42 weeks	2	0.68%
Birth weight			
Micro preemie	< 800 grams	54	18.24%
Extremely low birth weight	800-999 grams	47	15.88%
Very low birth weight	1000-1499 grams	81	27.36%
Low birth weight	1500-2499 grams	65	21.96%
Normal birth weight	2500-3999 grams	44	14.86%
High birth weight	4000-4999 grams	4	1.35%
No data		1	0.34%
Congenital anomaly		113	38.18%
Cardiorespiratory system		24	8.11%
Integumentary system		4	1.35%
Nervous system		17	5.47%
Anomaly of eye, ear, face, neck		7	2.36%
Digestive system		6	2.03%
Genital organs		11	3.72%
Musculoskeletal system		23	7.77%
Others		21	7.09%

All definitions are taken from Gomella *et al.* (2020)

3.3. Intrapartum profile

Most subjects were found born singleton (86.8%) with c-sections (57%). More subjects were found inpatient or were born in Dr. Soetomo General Hospital (77.36%), while others were born outside Dr. Soetomo General Hospital and were referred postpartum. More description of the intrapartum profile can be seen in **Table 4**.

Table 4. Intrapartum profile found in early neonatal mortality

	Total	Percentage
Singleton/twin		

Singleton	257	86.82%
Twin	34	11.49%
Triplet	5	1.69%
Type of birth		
Vaginal	127	42.91%
Cesarean	169	57.09%
Place of birth		
Dr. Soetomo General Hospital	229	77.36%
Other hospitals	54	18.24%
Midwife	5	1.69%
Public health center	3	1.01%
At home	3	1.01%
No data	2	0.68%

3.4. Maternal profile

Most mothers in this study were found around 20–40 years old, with only 5.4% being under 20 years old and 4.7% being above 40 years old. More mothers were found on their first pregnancy (30.7%). There are several incomplete data regarding the maternal profile since data was only obtained from the neonates' medical records.

Table 5. Maternal profile in early neonatal mortality

	Total	Percentage
Maternal age		
Under 20 years old	16	5.41%
20-25 years old	66	22.30%
26-30 years old	70	23.65%
31-35 years old	58	19.59%
36-40 years old	58	19.59%
Above 40 years old	14	4.73%
No data	14	4.73%
Number of gestation(s)		
1	91	30.74%
2	76	25.68%
3	72	24.32%
4	29	9.80%
5	19	6.42%
6	5	1.69%
7	2	0.68%
8	1	0.34%

No data	1	0.34%
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4. Discussion

4.1. Cause of death

In Indonesia in 2019, the main causes of neonatal death were low birth weight (35.3%), asphyxia (27%), congenital anomaly (12.5%), sepsis (3.5%), and tetanus (0.3%) (Kementerian Kesehatan Republik Indonesia, 2020). A prospective study states that from 2000-2017, the main causes of neonatal death in Indonesia are prematurity, birth asphyxia, sepsis, congenital anomaly, and acute respiratory infection (Soleman, 2020a). A study in Jember and Serang, Indonesia stated that the main cause of death is prematurity and asphyxia (Deviany *et al.*, 2022).

A study in South-East Asia Region found that the main cause of neonatal death is infection, prematurity, low birth weight, and asphyxia. It is also stated that Indonesia caused 6% of all neonatal mortality in the South-East Asia Region (Sharma, 2012). Another study in South-East Asia stated that the main cause of death in the region is prematurity, perinatal asphyxia, and congenital anomaly. Indonesia also has the highest NMR compared to other South-East Asian Countries (Soleman, 2020b).

In 2019 worldwide, the main causes of neonatal mortality are prematurity, birth-related complications such as asphyxia, infection (sepsis, pneumonia, tetanus), and congenital anomaly (World Health Organization, 2022). A report focusing on death during the first 24 hours stated that the main cause of newborn mortality is prematurity, severe infection, and birth-related complications (Save the Children, 2013).

In comparing this study to other studies mentioned above, keep in mind that the studies stated above is describing causes of neonatal death, not specific to early neonatal death. However, the causes of death are quite comparable with this study's findings. This might be caused by the fact that around 80% of all neonatal mortality occurred during the early neonatal period (Kementerian Kesehatan Republik Indonesia, 2020).

4.2. Neonatal demographic profile

Gender is not a risk factor for neonatal mortality, however, previous studies state that males are more susceptible to death compared to females. This study found that 57% of all neonates in this study are male. In Indonesia, the percentage of male neonatal death is 51.7% (Titaley *et al.*, 2008). In East Java, the percentage of male neonatal death is 58.8% (Dinkes Jawa Timur, 2019). A higher percentage of males in neonatal mortality is also found in a study in Jember and Serang, Indonesia, with a total of 60.6% male neonates (Deviany *et al.*, 2022). A higher percentage of males compared to females might be caused by preconception (hormonal level and sex-determining genes), biological, and intrapartum factors (Pongou, 2013).

Family domicile will determine the prenatal healthcare service, socio-economical condition, and time to be referred to Dr. Soetomo General Hospital. This study found that most subjects have family residence in East Java outside Surabaya. A study in Zambia and Malawi states that better geographical access leads to a higher rate of facilitated delivery, yet there isn't a correlation between home-hospital distance to mortality rate (Lohela *et al.*, 2012). Other studies in France and Vietnam also state that there isn't any correlation between the distance from home to the hospital with fetal and maternal mortality (Målqvist *et al.*, 2010; Pilkington *et al.*, 2014).

In discussing the subjects' family domicile, consider that Dr. Soetomo General Hospital is a type A healthcare facility in Indonesia. This means that patients with complicated medical conditions that can't be treated in the lower healthcare facility will be referred to this hospital. Another consideration while discussing the family domicile is that all neonates in this study died during the early neonatal period or the first 7 days, thus not giving much time for referral.

The highest risk for mortality is in the first 24 hours of life. This risk decreases as age progresses (Kliegman *et al.*, 2020; Save the Children, 2013; WHO, 2020). Other studies also found the highest number of deaths on the first day of life (Auger *et al.*, 2015; Gizaw *et al.*, 2014; Welaga *et al.*, 2013). This study found that only 14% of all subjects died in the first 24 hours, with the highest number being on the 2nd day of life (18.5%). Further research is needed to conclude why the finding in this study is different from what other studies have stated.

4.3. Neonatal medical profile

A study in Uganda states that for every 1,000 grams increase in birth weight, the risk of mortality decreases by 0.016. This Uganda study also states that the mortality rate is highest for babies born with birth weights between 500-999 grams (336/1000 live births) (Mubiri *et al.*, 2020). In Indonesia, a study found that the risk for neonatal mortality is 9.89 times higher for babies with low birth weight (Suparmi *et al.*, 2016). Other studies also state that babies born under 2,500 grams have a higher risk of neonatal mortality (Eshete *et al.*, 2019; Rahma Pratiwi *et al.*, 2020; Vilanova *et al.*, 2019).

Almost 50% of all death in neonates with low birth weight occurred during the first 24 hours of life (Olack *et al.*, 2021). This study found that 60% of all neonates that died during the first 24 hours have a birth weight under 1,500 grams. In this study, only 15% of all subjects are born with a birth weight above 2,500 grams (normal birth weight). This data is consistent with the gestational age in **Table 3**.

Around 90% of all major congenital anomaly is found in low and middle-income countries, including Indonesia, causing serious health problem (WHO, 2022). From 1980 to 2001, Indonesia had a congenital anomaly rate of 59.3/1000 live births, making Indonesia the 4th highest in South-East Asia (Christianson *et al.*, 2006). This study found that the most common anomaly is of the cardiorespiratory and musculoskeletal systems. Other studies also found cardiorespiratory anomaly as the most common congenital anomaly (Ajao and Adeoye, 2019; de Galan-Roosen *et al.*, 1998; Roncancio *et al.*, 2018). However, musculoskeletal anomalies are not mentioned as one of the most common congenital anomalies. This might be caused by the different classifications used in other studies.

4.4. Intrapartum profile

In 1998 America, the percentage of singleton birth is 92%, twin birth 2%, and triplets were 0.06% (Hedriana *et al.*, 1998). By 2021, the rate in America is 96.9% for singletons, 2.96% for twins, and 0.13% for triplets (Kalikkot Thekkeveedu *et al.*, 2021). In Korea from 2009 to 2015, there was a 34.5% increase in twin birth and a 154.3% increase in triplet birth (Ko *et al.*, 2018). In 2007 Indonesia, the prevalence of twin birth was 14/1000 live births. The rate is probably higher in 2019-2020 when this study was conducted.

Previous studies stated that the mortality risk in twin and triplets have decreased in the past decade. The mortality risk difference between singleton and twin is not significant, yet the mortality risk in triplets is significantly higher compared to singleton (Kalikkot Thekkeveedu *et al.*, 2021; Ko *et al.*, 2018). Other studies also state that the mortality risk is lower in twins compared to a singleton for babies born 29-38 weeks (Cheung *et al.*, 2000; Hedriana *et al.*, 1998; Vasak *et al.*, 2017).

This study found twin is 11.5% and triplet is 1.7%. This finding is higher compared to what other demographic studies have stated. The higher percentage found in this study can be a reflection that the mortality risk is higher for twins and triplets as stated before. However, further research is needed to evaluate the relationship between multiple births and neonatal mortality in Dr. Soetomo General Hospital.

The ideal rate of c-sections in a country is between 5-10%. Above 15%, c-sections no longer help lower maternal and neonatal mortality (Volpe, 2011; Ye *et al.*, 2016). Between 2000-2012, there is an increase in c-

section delivery (Ye *et al.*, 2016). This increase is mostly caused by maternal request, not by medical indication (Signore and Klebanoff, 2008). This study found a very high rate of cesarean section, 57.1%. However, it needs to be considered that the subjects in this study are those with a congenital anomaly or other complications that might be an indication of a c-section. Further study is needed to explain the correlation between c-sections and neonatal mortality in Dr. Soetomo Hospital.

The highest risk for neonatal mortality is found in babies that were born outside a healthcare facility without the help of a medical professional (Chaka *et al.*, 2020; Das *et al.*, 2021). Although 22.6% of the subjects in this study are outpatients, almost 99% of all subjects in this study were born with the help of a medical professional. This rate is higher than the average in Indonesia, where only 90.9% of all deliveries are attended by a medical professional (Kementerian Kesehatan Republik Indonesia, 2020).

4.5. Maternal profile

Higher risk is found in mothers pregnant under 20 years old or above 35 years old, both for the mother and the baby (Carolan, 2013; Finlay *et al.*, 2011; Kim *et al.*, 2021; Laopaiboon *et al.*, 2014; Neal *et al.*, 2018; Wu *et al.*, 2021). The Indonesian Demographic Data states that the highest fertility rate is found in women aged 25-29 (122.88/1000 women), followed by age 20-24 years old (120.42/1000 women), and age 30-34 years old (96.04/1000 women). The finding in this study is mostly women aged 20-40 years old, with most being 26-30 years old. This study also found that there are more than 40% of mothers aged 35 years old or more.

The risk for neonatal mortality according to birth order forms a 'J' curve, with the highest risk at the first and the last birth (Mishra *et al.*, 2018). The highest risk is found in babies of mothers with a history of neonatal death (Rahman *et al.*, 1996). This study found most subjects' mothers were on their first (30.7%), second (25.7%), and third (24.3%) pregnancy. This finding is consistent with the Indonesian fertility rate, which is 2.27 children per woman (Knoema, 2020).

5. Conclusion

This study found the main cause of death is sepsis, congenital anomaly, and hyaline membrane disease. Most subjects were male, residents in East Java outside Surabaya, and died on the 2nd day of life. More subjects were found born extremely preterm, with low birth weight, with a c-section, and singleton at Dr. Soetomo General Hospital. The most common anomaly was of the cardiorespiratory and musculoskeletal systems. The subjects' mothers were mostly 20-40 years old and on their first gestation.

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