THE MAGNITUDE AND ASSOCIATED FACTORS OF MECONIUM ASPIRATION SYNDROME AMONG NEONATES ADMITTED TO THE NICU OF TIBEBE GHION SPECIALIZED HOSPITAL NORTH WEST ETHIOPIA

Minwuyelet Amera Tizazu[1], Achenef Motbainor Begosaw[2], Yalemwork Anteneh Yimer[1]

ABSTRACT

BACKGROUND: Meconium aspiration syndrome is defined as respiratory distress in newborn infants born through meconium-stained amniotic fluid whose symptoms can't be explained otherwise. It is one of the common neonatal problems especially in developing countries leading to significant neonatal deaths. Understanding the burden of Meconium aspiration syndrome will help to give attention and decrease the risk factor.

OBJECTIVES: The aim of this study was to determine the proportion and associated factors of meconium aspiration syndrome in neonates admitted to neonatal intensive care unit, Tibebe Ghion Specialized Hospital Bahir Dar University, Ethiopia.

METHODS: Institutional based cross sectional study was conducted among neonates admitted to the NICU of TGSH from November 2023 to November 2024. Data were collected through chart reviewing by using systematic sampling technique. The data was collected using the Kobo tool box. After checking completeness and coding, data were exported to SPSS version 27 for analysis. Descriptive statistics like frequency and percentages were presented with texts and tables. bivariate analysis was made and all the variables with p-value less than 0.2 in bi-variable analysis were entered into the final multivariable logistic regression analysis. Statistically significant association was set at P-value less than 0.05 with 95% confidence interval.

RESULTS: In this study, the chart completeness was 96.9%. The study found that 8.5% (CI: 6.0-11.7) of neonates developed Meconium Aspiration Syndrome. Gestation age >40wk with AOR 5.179 (CI: 2.104-12.751), onset of labor with AOR 4.484 (CI: 1.259-15.962), and First minute APGAR<7 with AOR 7.463(CI: 2.783-20.016) were significantly associated with Meconium Aspiration Syndrome.

CONCLUSION AND RECOMMENDATIONS: The proportion of neonates that developed Meconium Aspiration Syndrome was high compared to data from previous studies. Enhanced Fetal Monitoring for Postdate and Post term Pregnancies: Close surveillance of pregnancies beyond 40 weeks detect fetal jeopardy early and Continuous fetal monitoring during labor are crucial to decrease the risk of MAS.

KEYWORDS: Meconium, Aspiration, Syndrome, Tibebe Ghion, north west Ethiopia

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1 Department of Pediatrics and Child Health, College of medicine and Health Sciences, Bahir Dar University, Ethiopia

2 School of Public Health, College of Medicine and Health Sciences, Bahir Dar University, Ethiopia

BACKGROUND

Meconium aspiration syndrome (MAS) is defined as respiratory distress in newborn infants born through meconium stained amniotic fluid (MSAF) whose symptoms cannot be otherwise explained[1]. Meconium is a thick, black-green, odorless material which is first recognized in the fetal intestine around 12 weeks of gestation and stored in the fetal colon throughout gestation[2].

Passage of meconium in the newborn infant is developmentally programmed. It normally occurs at 24 to 48 hours of birth. However, the fetus may pass meconium into amniotic fluid before birth due to different stressing events. This usually occurs after 37 weeks of gestation and it is not common in preterm[3].

When a neonate aspirates meconium during intrauterine gasping or during initial breaths at birth, MAS ensues[3]. Fetal hypoxic stress or vagal stimulation due to cord compression stimulates peristalsis in the colon. The evidence is mounting for a chronic in-utero insult that may be more important for meconium passage as opposed to an acute peripartum event[4]. Hypoxia also causes fetal gasping that results in meconium aspiration. Term and post term fetuses are more likely to pass meconium in response to such a stress than preterm[5]. Gastrointestinal maturation may be inadequate in preterm to be able to pass meconium; although, both the presence of meconium and active intestinal peristalsis have been reported as early as 8 weeks of gestational age[6].

Meconium aspiration syndrome, which occurs in 2 to 10% of infants born through meconium-stained amniotic fluid (MSAF), is the respiratory distress of the newborn due to the presence of meconium in the tracheobronchial airway. This causes airway obstruction, atelectasis, epithelial injury, surfactant inhibition, pneumothorax, pulmonary hypertension and respiratory failure[7]. The diagnosis of MAS is not well defined though term and post-term neonates with MSAF and respiratory distress soon after birth not otherwise explained have to be diagnosed MAS(8). Diagnosis of MAS is based on the presence of respiratory distress in an infant born through MSAF, with no alternate cause for respiratory distress. Chest radiograph and blood gas analysis should be performed if necessary. Because of diverse mechanisms causing this disease, radiographic findings are different. The classic radiographic findings in MAS are overexpansion of the lungs with widespread coarse, patchy infiltrates[9]. Ultrasonography can be used routinely to diagnose MAS in an accurate, reliable, convenient, and non-invasive manner[10]. In severe cases it can cause MAS requiring neonatal intensive care units(NICU) with respiratory, hemodynamic and metabolic support[6]. Meconium aspiration syndrome is one of the common causes of neonatal admission. It accounts for 10 % of all causes of respiratory failure in neonates with mortality of 20 % in the developing countries[11] .Despite the progress made in medicine, meconium aspiration syndrome is still one of the causes of newborn infants' mortality[12].

The burden of MAS is enormous, despite Variation depends on data sources, populations studied, and diagnostic criteria[13]. The burden is higher than in high income countries; especially Africa continues to face high MAS related morbidity and mortality, due to limited fetal monitoring and poor delivery care[15]. MAS is one of the common causes of neonatal admission and death in neonates. It mainly occurs in term and post term neonates. In developing countries like Ethiopia the burden is estimated to be high and we are admitting many newborns with MAS yearly[13]. However, there are only few studies so far in Ethiopia and the proportion is not well known in the study area.

Determining the burden of MAS is important to set goals on improving obstetric care to decrease MAS and to establish a better NICU set up for the management of MAS. Thus, this study aimed to assess the proportion of meconium aspiration syndrome and associated factors of neonates admitted to NICU at Tibebe Gion specialized hospital (TGSH) North West Ethiopia, from November 2023-November 2024G.C.

Methods and materials

Study setting

The study was conducted at Tibebe Gion Specialized Hospital, Bahir Dar,North West Ethiopia starting from November 2023 to November 2024. Bahir Dar, the capital of Amhara regional state is located Northern-west of Ethiopia, 565 Km far from Addis Ababa, capital city of Ethiopia.

Tibebe Ghion specialized hospital is a newly established Tertiary care Teaching hospital in Bahir Dar City founded in January, 2019GC. It is located about 10km south from the city center and it serves a total of around 5 million people. Currently, it provides 12 specialty programs and 3 sub-specialty programs.It has more than 450 bed capacity and gives for more than 94,000 clients (around 20,000 inpatient and 74,000 outpatient) services per year. Neonatal Intensive care unit (NICU) is one of the units in the pediatrics and child health department which has an average monthly admission rate of around 168 neonates and it has around 32 beds divided into term, preterm and kangaroo mother care (KMC). The service there is delivered by pediatricians, residents, interns and nurses.

Study design and period

Institution based cross-sectional study was conducted from November 2023 to November 2024 among neonates admitted at NICU ward TGSH, North West Ethiopia.

Source population and Study population

All neonates admitted to NICU at TGSH were considered as the source population and all term and post-term neonates admitted to NICU at TGSH during study period were considered as study population.

Eligibility Criteria

While all term and post term neonates admitted to NICU during study period included, Neonates with congenital heart disease, and Neonates suspected to have chromosomal abnormality (example: Down syndrome) were excluded from this study.

Sampling technique and sample size determination

The sample size was calculated using a single population proportion formula assuming; 50% was taken as proportion of MAS with marginal error (d) of 5% and confidence interval of 95%.

$n=Z^2*P(1-P)d^2$, $n=1.96*1.96*0.5(1-0.5)/0.05*0.05=384$

(Where n= sample size, p= prevalence, d= margin of error). By adding 10% non –response (chart incompleteness) rate total sample size was 423.

A systematic sampling technique was used to select 423 charts from neonatal ICU registration books. The first chart was selected randomly and the subsequent chart was selected based on K^{th} value which was 3.

Variables

The dependent variable was Meconium aspiration syndrome (Yes/No). The independent variables included under categories of; socio-demographics of the mother (age, residency), maternal, fetal and obstetrics related (mode of delivery, gestational age, antenatal care, sex of neonates, perinatal complications like, hypertension, diabetes, hemorrhage, onset of labor, duration of labor, rupture of membrane, APGAR score, birth weight), co-morbidities (sepsis, perinatal asphyxia, neonatal hyper bilirubinemia).

Operational definition and definition of terms

Neonate: an infant whose age is from birth up to 28 days of age

Meconium: a thick, black-green, odorless material which is first recognized in the fetal intestine around 12 weeks of gestation and stores in the fetal colon throughout gestation.

Meconium aspiration syndrome: is a clinical diagnosis of neonates with meconium stained amniotic fluid evidenced by meconium stained finger nail, umbilical stump and inter-nipple to chest circumference ratio ≥ 27% and respiratory distress not explained by other diseases entity4.

Term neonate: a baby born at 37-41+6 weeks.

Post term neonate: a baby born after 42 weeks.

Postdate neonate: baby born between 40-42 weeks.
Preterm neonate: neonates born before 37 completed weeks.
APGAR: a score out of 10 given to new born during 1st and 5th minute based on five parameters (appearance, heart rate, respiratory rate, grimace and reflex) each having two scores(2).
Good APGAR: greater or equal to Seven(7)(2).
Low APGAR: less than Seven (7)(2).

Data collection tools and procedures
Data were collected from the patients' medical records by using an English structured questionnaire (check list). Data were collected by five trained residents who are working at TGSH NICU ward. The questionnaire was prepared reviewing the previous literature[2,5,13,14,16,22]and incorporating the medical chart and registration book components.

Data quality control
Data collectors and supervisors were trained for one day on the objective of the study, content of questionnaire, and data collection procedure or on how to extract the data from the medical charts and registration books. The data extraction checklist was pre-tested at Felegehiwot hospital to make sure that all components of the chart and registration book variables were included; and some corrections were made accordingly. During the data collection period the collected data were checked daily for completeness by the principal investigator and supervisor.

Data processing and analysis
The collected data using the kobo collect tool (the prepared checklist was incorporated into the online kobo collect tool) were exported to SPSS version 27 for analysis. Descriptive summary was presented using frequencies, proportions, means, figures and tables. The association between independent variables and MAS was made using a binary logistic regression model. First bivariable analysis was made and all the variables with p-value less than 0.2 in bi-variable analysis were entered into the final multivariable logistic regression analysis. Statistical significance was determined using adjusted odds ratio (AOR), with 95% confidence intervals and P-value less than 0.05 in the final model.

Ethical clearance
Ethical clearance was obtained from Bahir Dar University College of Medicine and Health science institutional review board (3029/2024). Then, a permission letter was written to have access to charts and help from the record and data center about the selected patients. Names of study participants were not mentioned in the questionnaire or other places so that confidentiality was assured.

Results
Study participant characteristics (Neonatal factors)
In this study, the chart completeness rate was 96.9%. Seven (1.7%) had post-term pregnancies, which delivered after 42 weeks, and 37 (9.0%) had postdate pregnancies, which delivered between 41 and 42 weeks, the remaining 366 (89.3) had term pregnancy. A total of 102 (24.9%) neonates were less than or equal to 72 hours old at admission, whereas 308 (75.1%) were older than 72 hours.
There were 197 (48.0%) female neonates and 213 (52.0%) male neonates. Of the 402 neonates, 322 (80.1%) weighed between 2500 and 3999 grams at birth, 5 (1.2%) weighed 4000 grams and above, and 75 (18.7%) weighed less than 2500 grams. In the first minute, 360 neonates (89.6%) had an APGAR score of 7 or higher, whereas 42 neonates (10.4%) had a score of less than 7.
Spontaneous vaginal delivery (SVD) was the most common mode of delivery, occurring in 327 (79.8%) cases. Cesarean section (C/S) was performed in 78 (19.0%) cases, while 5 (1.2%) were instrumental assisted deliveries.
Among the 78 cesarean deliveries, 28 (35.9%) were due to maternal indications, while 50 (64.1%) were performed due to fetal reasons, specifically non-reassuring fetal heart rate (NRFHR).

Among the 28 cases where cesarean section was indicated for maternal reasons, 7 (25.0%) were due to eclampsia, 10 (35.7%) were due to poor maternal effort, 7 (25.0%) were due to placenta Previa, and 4 (14.3%) were attributed to other unspecified reasons (see Table 1).

Table 1: Study participant characteristics (term and post term neonates) admitted to NICU at Tibebe Gion specialized hospital (TGSH) North West Ethiopia, 2025.

Variables	Category	Frequency(n)	Percentage (%)
Gestational age (in weeks)	Term (37-40)	366	89.3
	Postdate (41-42)	37	9.0
	Post-term (>42)	7	1.7
Age of neonate during admission	≤72 hours	102	24.9
	>72 hours	308	75.1
Sex of neonate	Male	213	52.0
	Female	197	48.0
Birth weight (n=402)	<2500gm	75	18.7
	2500-3999gm	322	80.1
	≥4000gm	5	1.2
First Minute APGAR(n=402)	<7 score	42	10.4
	≥7 score	360	89.6
Fifth minute APGAR(n=402)	<7 score	125	30.1
	≥7 score	277	68.9
Mode of delivery	SVD	327	79.8
	C/S	78	19.0
	Instrumental assisted	5	1.2
If 'C/S' indication(n=78)	Maternal	28	35.9
	Fetal (NRFHR)	50	64.1
Maternal indication for C/S (n=28)	Eclampsia	7	25
	Poor effort	10	35.7
	Placenta Previa	7	25.0
	Others	4	14.3

Other comorbid conditions

Perinatal complications were reported in 26 (6.3%) mothers, among the 26 mothers who experienced perinatal complications, 5 (19.2%) had antepartum hemorrhage (APH), 4 (15.4%) had premature rupture of membranes (PROM), 13 (50.0%) developed preeclampsia or eclampsia, and 4 (15.4%) had diabetes mellitus (DM).

Among the neonates, 309 (75.4%) were diagnosed with sepsis, 38 (9.3%) had perinatal asphyxia (PNA), 55 (13.4%) had neonatal hyperbilirubinemia (NHB), and 60 (14.6%) were classified under surgical cases. Additionally, 16 (3.9%) had other diagnoses (see Table 2).

Table 2: Other comorbid conditions among term and post term neonates admitted to NICU at Tibebe Gion specialized hospital (TGSH) North West Ethiopia, 2025.

Variables	Category	Frequency(n)	Percentage (%)
Perinatal complications	Yes	26	6.3
	No	384	93.7
If 'yes' which complication (n=26)	APH	5	19.2
	PROM	4	15.4
	Pre/eclampsia	13	50.0
	DM	4	15.4
Was MSAF detected	Yes	37	9.0
	No	373	91.0
If 'yes' grade of Meconium (n=37)	Grade 1	7	18.9
	Grade 2	11	29.7
	Grade 3	19	51.4
Was there a diagnosis of MAS	Yes	35	8.5
	No	375	91.5
Other diagnosis	Sepsis	309	75.4
	PNA	38	9.3
	NHB	55	13.4
	Surgical cases	60	14.6
	Others	16	3.9

Maternal factors

Among mothers, 50 (12.2%) were younger than 25 years old, while the majority, 252 (61.5%), were between 25 and 34 years old. Additionally, 108 (26.3%) of the mothers were older than 34 years. A total of 199 (48.5%) mothers resided in rural areas, whereas 211 (51.5%) lived in urban areas.

Among the participants, 174 (42.4%) were primiparous, meaning they were experiencing childbirth for the first time. In contrast, 236 (57.6%) were multiparous, having given birth multiple times. Most of the mothers, 397 (96.8%), received antenatal care during pregnancy, whereas 13 (3.2%) did not receive any antenatal care.

Spontaneous labor occurred in 392 (95.6%) of the mothers, while labor induction was required for 18 (4.4%) of them. A total of 210 (51.2%) of the mothers experienced labor lasting less than 12 hours, whereas 200 (48.8%) had labor lasting 12 hours or longer

Among the mothers, 8 (2.0%) experienced rupture of membranes before the onset of labor, while the majority, 402 (98.0%), did not. A total of 208 (50.7%) mothers gave birth in a government hospital, while 194 (47.3%) delivered at a health center. Additionally, 8 (2.0%) mothers gave birth at home (see Table 3).

Table 3: Maternal factors among term and post-term neonates admitted in NICU, at Tibebe Gion specialized hospital (TGSH) North West Ethiopia, 2025.

Variables	Category	Frequency(n)	Percentage (%)
Age of the mother	<25	50	12.2
	25-34	252	61.5
	>34	108	26.3
Place of residency	Rural	199	48.5
	Urban	211	51.5
Parity	Primipara	174	42.4
	Multipara	236	57.6
Antenatal care	Yes	397	96.8
	No	13	3.2
Onset of labor	Spontaneous	392	95.6
	Induction	18	4.4
Duration of labor (in hours)	<12 hours	210	51.2
	≥12 hours	200	48.8
Rupture of membrane before onset of labor	Yes	8	2.0
	No	402	98.0
Place of delivery	Gov't hospital	208	50.7
	Health center	194	47.3
	Home	8	2.0

Proportion of Meconium aspiration syndrome

The proportion of Meconium aspiration syndrome (MAS) was 8.5% (CI: 6.0-11.7). Meconium-Stained Amniotic Fluid (MSAF) was detected in 37 (9.0%) of the cases, while 373 (91.0%) had clear amniotic fluid. Among the 37 cases with MSAF, 7 (18.9%) were classified as Grade 1, 11 (29.7%) as Grade 2, and 19 (51.4%) as Grade 3. Meconium aspiration syndrome was diagnosed in 35 (8.5%) neonates.

Meconium aspiration syndrome and its associated factors

The result of this study shows that gestational age, onset of labor, and first minute APGAR were significantly associated with meconium aspiration syndrome.

Newborns born post-date (>40 weeks) had five times higher odds of developing MAS compared to those born at term (37-40 weeks) (AOR: 5.179, 95% CI: 2.104-12.751)

Neonates born after labor induction had more than four times higher odds of MAS compared to those with spontaneous onset of labor (AOR: 4.484, 95% CI: 1.259-15.962).

Neonates with an APGAR score of less than 7 at the first minute had more than Seven times higher odds of MAS compared to those with a score of 7 or more (AOR: 7.463, 95% CI: 2.783-20.016). (see Table 4).

Table 4: Bivariable and multivariable logistic regression of Meconium aspiration syndrome (MAS) and its associated factors, among term and post-term neonates admitted in NICU, at Tibebe Gion specialized hospital (TGSH) North West Ethiopia, 2025.

Variables category	Meconium Aspiration Syndrome (MAS)		COR (95% CI)	AOR (95%CI)
	Yes	No		
Gestational age				
Term (37-40)	21	345	1	1
Post-date/term (>40)	14	30	7.667(3.541-16.597)	5.179(2.104-12.751) **
Onset of labor				
Induction	7	11	8.273(2.975-23.002)	4.484(1.259-15.962) *
Spontaneous	28	364	1	
First minute APGAR				
<7 score	14	28	8.072(3.706-17.579)	7.463(2.783-20.016) **
≥7 score	21	339	1	1
Fifth minute APGAR				
<7 score	19	106	2.924 (1.449-5.924)	1.415(0.571-3.507)
≥7 score	16	261	1	1
Mode of delivery				
C/S and Instrumental	12	71	2.234(1.061-4.702)	1.741(0.707- 4.284)
SVD	23	304	1	

Note: *p-value<0.05, **p-value<0.01

DISCUSSION

In this study we found that the proportion of meconium aspiration syndrome was 8.5% among term and post term neonates in TGSH. The current finding is lower than a study done in southern Ethiopia at Nigist Elleni Mohammed memorial hospital 30.6%[21]. The possible explanation for the difference might be due to the difference in high-risk mothers and quality of care.

However, our findings were higher than those from Nigeria (0.57%)[19], South Africa (4%)[18], Italy (2%)[15], Pakistan (4.9%)[23], and Australia (2%)[14]. This difference might be due to the variations in the quality of care, study population or eligibility criteria. For example, the study in Nigeria included all neonates including preterm who were at very low risk for MAS.

Post term pregnancies are associated with an increased odds of MAS (AOR 5.179, 95% CI: 2.104-12.751). This finding is consistent with the studies done at Nepal[13], and in Nigeria[19]. The likelihood of meconium-stained amniotic fluid (MSAF) rises with gestational age, leading to a higher incidence of MAS in post term infants[14].

Neonates born after labor induction had more than Four times higher odds of MAS compared to those with spontaneous labor (AOR: 4.484, 95% CI: 1.259-15.962). This suggests that labor induction is a significant risk factor for MAS. This finding is consistent with other findings; in North West Ethiopia[6], Southern Ethiopia[4], and South Gonder[2].

In contrast to a study done in Australia; induction of labor was associated with a reduced risk of MAS compared with women who were not induced, <40 weeks of gestation[14]. The possible explanation for this may be the set up for follow-up after starting induction and the gestational age cut off for induction indication which is usually greater than 42 weeks.

A low first-minute APGAR score (<7) is a significant

risk factor for MAS (AOR 7.463, 95% CI: 2.783-20.016). This finding is in line with studies done in South Africa, Johannesburg (18) and Nepal[13] in neonates with poor Apgar score (<7) were more likely to have higher odds for MAS.

This study has several limitations that should be considered when interpreting the results. First, it relied on secondary data sources; second, it was conducted at a tertiary care center. Additionally, as a tertiary care center, the hospital is more likely to admit mothers with comorbidities, which may increase the risk of meconium aspiration syndrome (MAS).

Conclusion and Recommendation

Conclusion

The study found that the proportion of neonates developed Meconium Aspiration Syndrome (MAS), was high compared with other studies post term gestation and low first-minute APGAR scores and labor induction are significant risk factors for MAS. Close follow-up of pregnancies beyond 40 weeks, continuous fetal monitoring during labor, and increased awareness of postdate and post-term pregnancies are essential to help prevent meconium aspiration syndrome (MAS).

Contribution of Authors

All authors contribute throughout the whole research steps.

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Conflict of interest

The authors declared that there is no conflict of interest.

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Corresponding Author: Yalemwork Anteneh
Email: yalexanteneh@gmail.com
MA: minwuyelet62@gmail.com
AM: motbianor2@gmail.com

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