

A case-control study of meconium staining of amniotic fluid in labour at Port Moresby General Hospital to determine associated risk factors and perinatal outcome

CECIL A. KLUFIO^{1,2}, APEAWUSU B. AMOA², GRACE KARIWIGA³ AND ONENAMA RAGEAU²

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

SUMMARY

Aim: To identify sociodemographic and obstetric characteristics which could be used as markers for thick meconium staining of the amniotic fluid (MSAF) in labour. **Methods:** The design was an unmatched case-control study. The setting was the Port Moresby General Hospital labour ward. The eligibility criteria were: patients with a singleton pregnancy, cephalic presentation and baby alive at the time of admission in labour. Cases were parturients who had MSAF during labour. The cases were sequentially enrolled according to the time of delivery recorded in the labour ward register. A control was a patient who did not have MSAF and who was the first to deliver after a case. Data were collected using an interviewer-administered questionnaire and patients' hospital records. **Results:** Logistic regression analysis showed the following variables to have a positive significant association with MSAF: low social status, betelnut chewing, grand multiparity, past history of perinatal death and rupture of membranes to delivery interval. Preterm delivery was negatively associated with MSAF. Compared with the controls, the cases had a higher caesarean section rate; more of their babies were admitted to the Special Care Nursery (SCN); the mean stay of their babies in the SCN was longer; and the perinatal mortality was higher.

Introduction

Meconium staining of the amniotic fluid (MSAF) is associated with adverse outcomes, chiefly for the baby, but also for the mother. For the baby, the adverse outcomes include increased risks of intrapartum asphyxia and fetal distress, intrapartum fetal death, low Apgar scores, meconium aspiration syndrome and neonatal death. For the mother, there is an increased risk of caesarean section with its higher morbidity and mortality, and an increased risk of chorioamnionitis and puerperal sepsis.

(PMGH) thick MSAF occurs in 12% of all labours. Meconium aspiration syndrome (MAS) is the most common cause of neonatal morbidity and mortality among term, normally formed infants at the PMGH; and term fresh stillbirths are frequently associated with thick MSAF in labour. If preventable risk factors for MSAF could be identified, it might be possible to prevent it or reduce its incidence. If patients at risk could be identified early in labour, intensive surveillance and early intervention might improve the outcome.

Objectives of the Study

At the Port Moresby General Hospital

The primary objective of the study was to

¹ Professor of Obstetrics and Gynaecology, Faculty of Medicine, University of Papua New Guinea, PO Box 5623, Boroko, NCD 111, Papua New Guinea

² Consultant Obstetrician/Gynaecologist, Port Moresby General Hospital, Free Mail Bag, Boroko, NCD 111, Papua New Guinea

³ Registrar, now Consultant Obstetrician/Gynaecologist, Port Moresby General Hospital, Free Mail Bag, Boroko, NCD 111, Papua New Guinea

identify sociodemographic and obstetric characteristics and index intrapartum factors which might have an association with thick MSAF in labour. The secondary objective was to compare the perinatal outcome in the babies of mothers who had MSAF in labour with the outcome in a control group.

Patients and Methods

The study design was an unmatched case-control study.

Study population and enrolment

The site of the study was the PMGH labour ward (LW). The study population consisted of patients admitted in labour with a singleton pregnancy, cephalic presentation and with the baby alive at the time of admission, and who gave informed consent to participate in the study. A case was a patient who had thick MSAF at any time during the labour, and before delivery of the baby. A control was a patient who did not have MSAF and who according to the LW register was the first patient to deliver after the case. The subjects were enrolled sequentially.

Definition of terms

Thick meconium: the meconium was classified as thick if on clinical inspection it was grade 2 or 3 as defined by O'Driscoll and Meagher (1). The MSAF was graded as 2 if there was a reasonable amount of liquor with a heavy suspension of meconium. Grade 3 was when the meconium was undiluted and resembled spinach soup.

Social status was scored as a composite variable using the patient's years of schooling, partner's years of schooling, partner's occupation and employment status, and couple's area of residence.

An unbooked patient was a patient who did not attend for antenatal care in this pregnancy.

Last birth interval was the number of months between the last delivery and the start of this pregnancy. It was calculated by subtracting the gestational age from the number of months between the last birth and this birth.

Variables

The dependent variable was thick MSAF. The following independent variables were investigated.

a. Sociodemographic

Maternal age – mean, <18 years (yes, no), >35 years (yes, no); low social status (yes, no); betelnut chewing – mean nuts chewed/day, chewer (yes, no).

b. Past obstetric history

Parity – mean, nullipara (yes, no), para ≥ 5 (yes, no); past perinatal death (yes, no); last pregnancy interval – mean, <2 years (yes, no); outcome of penultimate delivery a perinatal death (yes, no); an antenatal condition in this pregnancy (yes, no).

c. Index pregnancy

Unbooked (yes, no); mean number of antenatal visits; lowest haemoglobin level during pregnancy – mean, <8 g/dl (yes, no); preeclampsia (yes, no); clinical malaria (yes, no); false labour (yes, no); syphilis (yes, no).

d. Index labour

Gestational age at delivery – mean, ≥ 42 weeks (yes, no), ≤ 37 weeks (yes, no); labour induced (yes, no); cervical dilatation at admission in labour – mean, <4 cm (yes, no); head engaged at admission in labour (yes, no); action line of partograph crossed (yes, no); labour augmented with syntocin (yes, no); caput succedaneum diagnosed in labour (yes, no); moulding diagnosed in labour (yes, no); liquor noted as offensive (yes, no); mean duration of first stage of labour; mean total duration of labour; admission to labour ward to delivery interval; membrane rupture to delivery interval; birthweight – mean, macrosomia (yes, no); sex of baby (male, female).

e. Perinatal outcome

Mode of delivery – spontaneous vertex (yes, no), caesarean (yes, no); Apgar score at 1 minute – mean, <7 (yes, no); Apgar score at 5 minutes – mean, <7 (yes, no); Special Care Nursery admission – mean number of days' admission, admitted (yes, no); perinatal death (yes, no).

Data sources and data recording

A pretested questionnaire was used to collect data on the sociodemographic and obstetric history variables. The questionnaire was administered by trained research assistants. Data on the index pregnancy, labour and neonatal outcome were collected from the subjects' antenatal and labour ward notes. After the data had been checked for any inaccuracies and inconsistencies, they were transferred to a computer-coded data-collecting form for computer analysis.

Data analysis

The Epi Info version 5 software was used for univariate analysis (2). Differences between the frequencies of categorical variables were tested with the Mantel-Haenszel chi squared test, Fisher exact test and odds ratios (ORs). The Kruskal-Wallis H test was used to test differences between the means of continuous variables. To test for confounding and interaction between covariates, variables which were found to be significant by univariate analysis were subjected to forward stepwise logistic regression analysis, using the SPSS PC+ package (Marketing Department, SPSS Incorporated, 444 North Michigan Avenue, Chicago, IL 60611, USA). Differences between the cases and controls were taken as significant if the two-sided p value was less than 0.05, or if the 95% confidence interval of the OR did not enclose 1.

Results

From August 1989 to March 1991, 313 cases and 313 controls were studied.

Univariate analysis results

Sociodemographic and drug characteristics (Tables 1 and 2)

The cases had a higher mean age than the controls (25.9 vs 24.7 years) but the proportions of those under 18 years and those over 35 years in the two groups were not significantly different. Significantly more of the cases had low social status than the controls (73.5% vs 50.5%). There was no difference in the percentage of smokers in the two groups. Significantly more of the cases were betelnut

chewers (78.6% vs 69.6%); the cases chewed significantly more betelnuts per day than the controls (3.1 vs 2.5 nuts). The p value for the chi squared test for linear trend for betelnut chewing was 0.0125. Only 6 of the 616 subjects admitted to drinking alcohol, 5 of the cases and 1 of the controls.

Past obstetric history (Table 3)

Before this delivery, both groups had 26.8% of nulliparae (para 0). On the other hand, the proportion of para ≥ 5 was much higher among the cases than among the controls (13.1% vs 4.2%). After excluding the nulliparae, significantly more of the cases (10.0%) had a past history of a perinatal death than the controls (3.5%). However, the proportion of subjects whose penultimate pregnancy had ended in a perinatal death was not different in the two groups (5.7% vs 4.4%). The mean last pregnancy interval was not significantly different in the two groups (33.6 vs 31.1 months). The interval was less than 24 months in 31.0% of the cases and in 33.5% of the controls; again, the difference was not significant.

Antenatal conditions (Table 4)

Taken together and individually, the antenatal conditions examined were not significantly different in the two groups. The lowest haemoglobin level among those who had antenatal care was not different in the two groups. The antenatal conditions included anaemia (haemoglobin less than 10.0 g/dl), preeclampsia, urinary tract infection, malaria, chest infection, false labour, syphilis, diabetes and bleeding in early pregnancy. Preeclampsia was more frequent in the controls (3.8% vs 7.7%) but the OR enclosed one. The numbers with clinical malaria and syphilis were too small for any useful analysis.

Intrapartum factors (Tables 5-7)

Of the intrapartum factors examined, the following were found to have a significant association with MSAF: offensive smell of the liquor (9.6% vs 0.0%); abnormal fetal heart rate (3.8% vs 0.3%); longer time interval between rupture of membranes and delivery (5.2 vs 4.5 hours). Interestingly, there was no practical difference between the groups in mean gestational age (39.5 vs 39.0 weeks); and

TABLE 1

SOCIODEMOGRAPHIC CHARACTERISTICS AND MSAF

Panel A		Categorical Variables			
	Cases	Controls	OR (95% CI)	M-H p value	
Age under 18 years	3.2% (10/313)	3.8% (12/313)	0.83 (0.33-2.09)	0.6645	
Age over 35 years	8.3% (26/313)	5.4% (17/313)	1.58 (0.80-3.13)	0.1553	
Low social status score	73.5% (230/313)	50.5% (158/313)	2.72 (1.91-3.87)	0.0001	
Cigarette smoker	8.9% (28/313)	5.4% (17/313)	1.71 (0.88-3.36)	0.0890	
Betelnut chewer	78.6% (246/313)	69.6% (218/313)	1.60 (1.09-2.34)	0.0107	
Alcohol drinker	1.6% (5/313)	0.3% (1/313)	5.06 (0.58-115.23)	0.2165*	

Panel B		Continuous Variables		
	Cases mean (sd)	Controls mean (sd)	K-W H p value	
Age	25.9 (5.82)	24.7 (5.39)	0.0107	
Number of cigarettes/day	0.6 (2.69)	0.6 (2.91)	0.1035	
Number of betelnuts/day	3.1 (3.07)	2.5 (2.89)	0.0049	

MSAF = meconium staining of amniotic fluid

OR = odds ratio; CI = confidence interval

M-H = Mantel-Haenszel chi squared test

*2-tailed Fisher exact test p value

K-W H = Kruskal-Wallis H test

TABLE 2

NUMBER OF BETELNUTS CHEWED PER DAY AND MSAF

Number of nuts/day	0	1-3	4-6	≥7
Number of cases in chewing categories (n=313)	67	145	68	33
Number of controls in chewing categories (n=313)	95	141	49	28
Odds ratio	1.00	1.46	1.97	1.67

MSAF = meconium staining of amniotic fluid

Chi squared for linear trend = 6.23; p = 0.0125

TABLE 3
PAST OBSTETRIC HISTORY CHARACTERISTICS AND MSAF

Panel A	Categorical Variables	Cases	Controls	OR (95% CI)	M-H p value
	Nullipara before index delivery	26.8% (84/313)	26.8% (84/313)	1.00 (0.69-1.45)	1.0000
	Grand multipara (para >4) before index delivery	13.1% (41/313)	4.2% (13/313)	3.48 (1.75-7.04)	0.0001
	History of past perinatal death (nulliparae excluded)	10.0% (23/229)	3.5% (8/229)	3.08 (1.27-7.74)	0.0053
	Last pregnancy interval <2 years (nulliparae excluded)	31.0% (71/229)	33.5% (76/227)	0.89 (0.59-1.35)	0.5721
	Penultimate pregnancy a perinatal death (nulliparae excluded)	5.7% (13/229)	4.4% (10/229)	1.32 (0.53-3.32)	0.5214

Panel B Continuous Variables

	Cases mean (sd)	Controls mean (sd)	K-W H p value
Parity	2.1 (1.97)	1.6 (1.51)	0.0176
Last pregnancy interval, months	33.6 (19.33)	31.1 (16.73)	0.4655

MSAF = meconium staining of amniotic fluid
 OR = odds ratio; CI = confidence interval
 M-H = Mantel-Haenszel chi squared test
 K-W H = Kruskal-Wallis H test

TABLE 4
ANTENATAL FACTORS AND MSAF

Panel A	Categorical Variables	Cases	Controls	OR (95% CI)	M-H p value
	Unbooked status (no antenatal care)	7.0% (22/313)	4.2% (13/313)	1.74 (0.82-3.77)	0.1177
	Preeclampsia in index pregnancy	3.8% (12/313)	7.7% (24/313)	0.48 (0.22-1.02)	0.0395
	Clinical malaria during pregnancy	1.0% (3/313)	1.6% (5/313)	0.60 (0.11-2.88)	0.4770
	Lowest haemoglobin level during pregnancy <8 g/dl (excluding unbooked)	10.5% (26/247)	10.3% (28/273)	1.03 (0.56-1.88)	0.9198
	Syphilis during pregnancy	1.0% (3/313)	1.3% (4/313)	0.75 (0.11-4.46)	0.7041
	An antenatal condition	52.1% (163/313)	55.0% (172/313)	0.89 (0.64-1.24)	0.4711
Panel B	Continuous Variables	Cases mean (sd)	Controls mean (sd)	K-W H p value	
	Number of antenatal visits	5.5 (2.84)	5.8 (2.63)	0.2424	

MSAF = meconium staining of amniotic fluid
 OR = odds ratio; CI = confidence interval
 M-H = Mantel-Haenszel chi squared test
 K-W H = Kruskal-Wallis H test

TABLE 5
INTRAPARTUM FACTORS AND MSAF - PART I

Panel A	Categorical Variables	Cases	Controls	OR (95% CI)	M-H p value
	Labour induced	2.6% (8/313)	3.2% (10/313)	0.79 (0.28-2.23)	0.6327
	Cervical dilatation <4 cm at admission in labour	31.0% (97/313)	31.9% (100/313)	0.96 (0.67-1.36)	0.7964
	Head engaged at admission in labour	40.3% (126/313)	39.0% (122/313)	1.05 (0.75-1.48)	0.2888
	Labour augmented with syntocin	16.6% (52/313)	13.7% (43/313)	1.25 (0.79-1.99)	0.3164
Panel B	Continuous Variables	Cases mean (sd)	Controls mean (sd)	K-W H p value	
	Admission cervix dilated, cm	5.3 (2.94)	5.1 (2.88)	0.4510	

MSAF = meconium staining of amniotic fluid
 OR = odds ratio; CI = confidence interval
 M-H = Mantel-Haenszel chi squared test
 K-W H = Kruskal-Wallis H test

TABLE 6
INTRAPARTUM FACTORS AND MSAF - PART II

Panel A	Categorical Variables	Cases	Controls	OR (95% CI)	M-H p value
	Caput succedaneum in labour	4.5% (14/313)	1.9% (6/313)	2.40 (0.84-7.15)	0.0693
	Moulding diagnosed in labour	5.0% (11/218)	2.2% (5/232)	2.41 (0.75-8.19)	0.0983
	Preeclampsia in labour	12.1% (38/313)	10.2% (32/313)	1.21 (0.72-2.06)	0.4471
	Offensive smell of liquor in labour	9.6% (30/313)	0.0% (0/313)	undefined	0.0000
	Abnormal fetal heart rate (<120 or >160/min) in labour	3.8% (12/313)	0.3% (1/313)	12.4 (1.68-257.70)	0.0021
	Sex of baby: male	54.3% (170/313)	53.7% (168/313)	1.03 (0.74-1.43)	0.8727

MSAF = meconium staining of amniotic fluid
 OR = odds ratio; CI = confidence interval
 M-H = Mantel-Haenszel chi squared test

TABLE 7
INTRAPARTUM FACTORS AND MSAF - PART III

Panel A		Categorical Variables		Cases	Controls	OR (95% CI)	M-H p value
	Postterm (gestational age at delivery ≥42 weeks)			7.8% (22/282)	6.9% (20/291)	1.15 (0.59-2.25)	0.6701
	Preterm (gestational age at delivery ≤37 weeks)			5.7% (16/282)	13.1% (38/291)	0.40 (0.21-0.77)	0.0025
	Macrosomia (birthweight ≥4000 g)			9.3% (29/313)	9.3% (29/313)	1.00 (0.56-1.78)	1.0000
Panel B		Continuous Variables		Cases mean (sd)	Controls mean (sd)	K-W H p value	
	Total duration of labour, hours			11.3 (7.45)	11.5 (7.04)	0.7982	
	Duration of first stage of labour, hours			11.1 (7.35)	11.4 (7.05)	0.6220	
	Admission to delivery, hours			5.5 (5.83)	5.7 (5.77)	0.3756	
	Membrane rupture to delivery, hours			5.2 (5.85)	4.5 (8.00)	0.0183	
	Delivery at gestational age, weeks			39.5 (1.88)	39.0 (2.14)	0.0202	
	Birthweight, g			3141.5 (495.0)	3139.1 (491.27)	0.7942	

MSAF = meconium staining of amniotic fluid
 OR = odds ratio; CI = confidence interval
 M-H = Mantel-Haenszel chi squared test
 K-W H = Kruskal-Wallis H test

the frequency of postterm delivery was not different in the two groups. As was to be expected, preterm delivery had a negative association with thick MSAF (5.7% vs 13.1%). There was no difference in the mean birthweight or in the frequency of macrosomia.

Perinatal outcome (Table 8)

The mode of delivery was significantly different in the two groups. Spontaneous vaginal delivery occurred in less of the cases than the controls (93.0% vs 99.4%). Emergency caesarean section was performed in 7 (2.2%) of the cases and in none of the controls. The mean Apgar scores at 1 minute and 5 minutes were lower for the babies of cases (8.3 vs 8.9 and 8.9 vs 9.0, respectively); but when examined as categorical variables, the frequency of low Apgar score (<7) was not different between the groups. Significantly more of the babies of the cases than of the controls were admitted to the Special Care Nursery (SCN) (13.4% vs 3.8%); the mean number of days spent in the SCN by those admitted was significantly larger in the cases than in the controls (5.8 vs 2.1 days). Seven perinatal deaths occurred in the babies of the cases and one in the controls.

Logistic regression analysis

When the variables which were significantly associated with meconium staining by univariate analysis were examined by forward stepwise logistic regression analysis, each of the following were found to have an independent and significant association with MSAF (Table 9): low social status, betelnut chewing, grand multiparity, past history of perinatal death and rupture of membranes (ROM) to delivery interval. The association with preterm delivery remained negative.

Discussion

Meconium staining of the amniotic fluid (MSAF) in labour occurs in 8-19% of deliveries; in about 46% of the affected cases the staining is moderate to thick (3-6). Meconium aspiration syndrome (MAS) occurs in 1-3% of all cases of MSAF (7). If meconium is found below the vocal cords, the incidence of MAS is 10-30% (4,5,8). MSAF with thick meconium increases the risk for

adverse neonatal outcome, independent of fetal heart rate abnormalities or maternal diseases (9). But the passage of thick meconium early in labour, accompanied by fetal heart rate (FHR) abnormalities, carries the worst prognosis (10). The reported perinatal mortality and neonatal morbidity in meconium passage with FHR abnormalities are 3-22% and 7-50% respectively (11,12). The presence of thick MSAF is evidence that there is very little or no liquor to dilute the meconium passed. The oligohydramnios may be a sign of a failing placenta, a placenta without any functional reserve for the stress of labour, i.e. it may signify chronic fetal distress. Compression of the cord by the contracting uterus against the body of the baby is a danger in these cases. Meconium passage may be considered a manifestation of normal maturation and increased myelination and responsiveness of the fetal gastrointestinal tract (7,13). Meconium passage may also be provoked by hypoxic insults (13,14). The hypoxic insult may be caused by cord compression or the stress of uterine contractions superimposed on chronic fetal distress. The association of thick MSAF and adverse perinatal outcome may be due to the meconium itself or to the cause of the hypoxic insult. Meconium damages through the following mechanisms:

- a. Meconium produces vasoactive substances which cause fetal hypoperfusion and damage placental and fetal vessels (15,16).
- b. Meconium aspiration may occur in utero or at delivery and lead to the meconium aspiration syndrome (MAS).
 - i. The aspirated meconium is an irritant and causes chemical pneumonitis.
 - ii. It is a good culture medium for bacteria and promotes lung infection.
 - iii. It lines the alveoli and hinders gas transfer.
 - iv. It destroys surfactant, causing alveolar instability, collapse and atelectasis (17,18).
 - v. In the small bronchioles, it may cause a

TABLE 8
PERINATAL OUTCOME AND MSAF

Panel A		Categorical Variables		OR (95% CI)	M-H p value
	Cases	Controls			
Emergency caesarean delivery	2.2% (7/313)	0.0% (0/313)		undefined	0.0078
Spontaneous vaginal delivery	93.0% (291/313)	99.4% (311/313)		0.09 (0.01-0.38)	<0.0005
Apgar score at 1 minute <7	4.5% (14/313)	1.9% (6/313)		2.40 (0.84-7.15)	0.0693
Apgar score at 5 minutes <7	1.7% (5/301)	0.3% (1/303)		5.12 (0.58-116.47)	0.0985
Baby admitted to Special Care Nursery (SCN)	13.4% (42/313)	3.8% (12/313)		3.89 (1.92-8.03)	0.0000
This delivery a perinatal death	2.2% (7/313)	0.3% (1/313)		7.14 (0.87-157.92)	0.0329
Panel B		Continuous Variables		K-W H p value	
	Cases mean (sd)	Controls mean (sd)			
Apgar score at 1 minute	8.3 (1.45)	8.9 (0.55)		0.0000	
Apgar score at 5 minutes	8.9 (0.61)	9.0 (0.26)		0.0000	
Days spent in SCN*	5.8 (3.28)	2.1 (1.31)		0.0000	

MSAF = meconium staining of amniotic fluid

OR = odds ratio; CI = confidence interval

M-H = Mantel-Haenszel chi squared test

K-W H = Kruskal-Wallis H test

*Days spent in Special Care Nursery by babies admitted

TABLE 9

LOGISTIC REGRESSION ANALYSIS OF COVARIATES WHICH WERE SIGNIFICANT ON UNIVARIATE ANALYSIS

Variable	-2 log LR	df	Significance of log LR
Low social status	32.137	1	0.0000
Betelnut chewer	6.494	1	0.0108
Grand multiparity	11.230	1	0.0008
Past perinatal death	4.435	1	0.0352
Preterm delivery	7.761	2	0.0206
ROM to delivery interval, hours	46.812	28	0.0143

LR = likelihood ratio
 df = degrees of freedom
 ROM = rupture of membranes

ball-valve obstruction after birth, allowing air to get into the alveoli during inspiration but preventing the air from being expired; the trapped air causes emphysema which may produce air leaks, pneumothorax and pneumomediastinum.

Meconium damage of the fetus therefore starts in utero and continues after birth. Because meconium aspiration may occur in utero, combined obstetric and paediatric toileting which has been prescribed as prevention for MAS (19,20) may not always succeed (4,21). This toileting consists of nasopharyngeal and oropharyngeal suctioning when the head is on the perineum followed by intubation and tracheal suctioning before the first breath.

At the Port Moresby General Hospital (PMGH) the incidence of MSAF is 20% for all grades of meconium staining, of which 47% are grade 1, 40% grade 2 and 13% grade 3. Meconium aspiration syndrome (MAS) is the single most common cause of neonatal morbidity and mortality among term, normally formed infants at the PMGH; and term fresh stillbirths are frequently associated with thick MSAF in labour. We therefore look on MSAF

with a lot of concern. A paediatrician attends any delivery which is complicated by thick MSAF. As soon as the head is born and before delivery of the shoulders, the oropharynx and nasopharynx are suctioned using a wide-bore catheter, such as a DeLee's suction catheter. The delivery is completed quickly and the baby handed over to the paediatrician for endotracheal intubation and suctioning if indicated. In spite of this, about 100 babies are admitted with MAS to the Special Care Nursery annually and about 10% of those admitted die. Identification of patients at risk of thick MSAF would allow intensive fetal surveillance and early intervention, which might lead to a reduction in the high neonatal morbidity and mortality. Some of the conditions which have been associated with MSAF are: intrauterine growth retardation and oligohydramnios (22), postdatism (23), ethnicity, maternal age, parity, cigarette smoking, cocaine use, hypertensive disease, anaemia, pyrexial illness, prolongation of the active phase, prolonged rupture of the membranes, chorioamnionitis, abruptio placentae and macrosomia. In this study, of the variables found to be associated with MSAF, only low social status, grand multiparity and betelnut chewing may be useful as markers for MSAF. Although the

ROM to delivery interval was significantly different in the two groups, the difference (42 minutes) has no practical importance. The association with betelnut chewing is interesting. Two previous studies in this hospital which investigated the effects of betelnut chewing and pregnancy outcome did not find any association between betelnut chewing and MSAF (24,25). The research designs of the two studies were, however, different from ours. With respect to MSAF as an outcome variable, both were prospective; and therefore possibly required larger numbers to show a difference. In one of the studies, meconium staining was not examined as a dependent variable in its own right but as one manifestation of fetal distress (25). Finally, in our study, postterm pregnancy and preeclampsia were not found to be associated with MSAF.

REFERENCES

- 1 **O'Driscoll K, Meagher D.** Active Management of Labour. London: WB Saunders, 1980:92.
- 2 **Dean AG, Dean JA, Burton AH, Dicker RC.** Epi Info, version 5: a Word Processing, Database, and Statistics Program for Epidemiology on Microcomputers. Stone Mountain, Georgia: USD Incorporated, 1990.
- 3 **Benny PS, Malani S, Hoby MA, Hutton JD.** Meconium aspiration – role of obstetric factors and suction. *Aust NZ J Obstet Gynaecol* 1987;27:36-39.
- 4 **Davis RO, Philips JB, Harris BA Jr, Wilson ER, Huddleston JF.** Fatal meconium aspiration syndrome occurring despite airway management considered appropriate. *Am J Obstet Gynecol* 1985;151:731-736.
- 5 **Holtzman RB, Banzhaf WC, Silver RK, Hageman JR.** Perinatal management of meconium staining of the amniotic fluid. *Clin Perinatol* 1989;16:825-838.
- 6 **Cialone PR, Sherer DM, Ryan RM, Sinkin RA, Abramowicz JS.** Amnioinfusion during labor complicated by particulate meconium-stained amniotic fluid decreases neonatal morbidity. *Am J Obstet Gynecol* 1994;170:842-849.
- 7 **Katz VL, Bowes WA Jr.** Meconium aspiration syndrome: reflections on a murky subject. *Am J Obstet Gynecol* 1992;166:171-183.
- 8 **Falciglia HS.** Failure to prevent meconium aspiration syndrome. *Obstet Gynecol* 1988;71:349-353.
- 9 **Berkus MD, Langer O, Samueloff A, Xenakis EMJ, Field NT, Ridgway LE.** Meconium-stained amniotic fluid: increased risk of adverse neonatal outcome. *Obstet Gynecol* 1994;84:115-120.
- 10 **Enkin M, Keirse MJNC, Chalmers I.** A Guide to Effective Care in Pregnancy and Childbirth. Oxford: Oxford University Press, 1989:190.
- 11 **Miller FC, Sacks DA, Yeh SY, Paul RH, Schifrin BS, Martin CB Jr, Hon EH.** Significance of meconium during labor. *Am J Obstet Gynecol* 1975;122:573-580.
- 12 **Yeomans ER, Gilstrap LC, Leveno KJ, Burris JS.** Meconium in the amniotic fluid and fetal acid-base status. *Obstet Gynecol* 1989;73:175-178.
- 13 **Wenstrom KD, Parsons MT.** The prevention of meconium aspiration in labor using amnioinfusion. *Obstet Gynecol* 1989;73:647-651.
- 14 **Bacsik RD.** Meconium aspiration syndrome. *Pediatr Clin North Am* 1977;24:463-479.
- 15 **Altshuler G.** Placenta within the medicolegal imperative. *Arch Pathol Lab Med* 1991;115:688-695.
- 16 **Altshuler G, Hyde S.** Meconium-induced vasoconstriction: a potential cause of cerebral and other fetal hypoperfusion and of poor pregnancy outcome. *J Child Neurol* 1989;4:137-142.
- 17 **Clark DA, Nieman GF, Thompson JE, Paskanik AM, Rokhar JE, Bredenberg CE.** Surfactant displacement by meconium free fatty acids: an alternative explanation for atelectasis in meconium aspiration syndrome. *J Pediatr* 1987;110:765-770.
- 18 **Moses D, Holm BA, Spitale P, Liu MY, Enhorning G.** Inhibition of pulmonary surfactant function by meconium. *Am J Obstet Gynecol* 1991;164:477-481.
- 19 **Carson BS, Losey RW, Bowes WA Jr, Simmons MA.** Combined obstetric and pediatric approach to prevent meconium aspiration syndrome. *Am J Obstet Gynecol* 1976;126:712-715.
- 20 **Gregory GA, Gooding CA, Phibbs RH, Tooley WH.** Meconium aspiration in infants – a prospective study. *J Pediatr* 1974;85:848-852.
- 21 **Manning FA, Schreiber J, Turkel SB.** Fatal meconium aspiration 'in utero': a case report. *Am J Obstet Gynecol* 1978;132:111-113.
- 22 **Gabbe SG.** Intrauterine growth retardation. In: Gabbe SG, Niebyl JR, Simpson JL, eds. *Obstetrics: Normal and Problem Pregnancies*, 2nd edition. New York: Churchill Livingstone, 1991:923-944.
- 23 **Freeman RK, Lagrew DC Jr.** Prolonged pregnancy. In: Gabbe SG, Niebyl JR, Simpson JL, eds. *Obstetrics: Normal and Problem Pregnancies*, 2nd edition. New York: Churchill Livingstone, 1991:945-956.
- 24 **Taufa T.** Betel-nut chewing and pregnancy. *PNG Med J* 1988;31:229-233.
- 25 **de Costa C, Griew AR.** Effects of betel chewing on pregnancy outcome. *Aust NZ J Obstet Gynaecol* 1982;22:22-24.