HEALTH POLICY AND PLANNING; **15**(1): 1–10

Prenatal screening in rural Bangladesh: from prediction to care

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The role of antenatal care is being increasingly questioned, particularly in resource poor environments. The low predictability of antenatal markers for adverse maternal outcomes has led some to reject antenatal care as an efficient strategy in the fight against maternal and perinatal mortality. Few studies, however, have assessed the predictability of adverse outcomes other than dystocia or perinatal death, and most studies have been hospital based. This population-based cohort study was undertaken to assess whether prenatal screening can identify women at risk of severe labour or delivery complications in a rural area in Bangladesh. Antenatal risk markers, signs and symptoms were assessed for their association with severe maternal complications including dystocia, malpresentation, haemorrhage, hypertensive diseases, twin delivery and death. The results of the study suggest that antenatal screening by trained midwives fails to adequately distinguish women who will need special care during labour and delivery from those who will not need such care. The large majority of the women with dystocia or haemorrhage had no warning signs during pregnancy. A single blood pressure measurement and the assessment of fundal height, on the other hand, may detect a substantial number of women with hypertensive diseases and twin pregnancies. In addition, women who had an antenatal visit were four times more likely to deliver with a midwife than women who had no antenatal visit. Antenatal care may not be an efficient strategy to identify those most in need for obstetric service delivery, but if promoted in concurrence with effective emergency obstetric care, and delivered in skilled hands, it may become an effective instrument to facilitate better use of emergency obstetric care services.

Introduction

Efforts to reduce maternal and perinatal mortality have often sought to identify population groups that are at higher risk for adverse pregnancy outcome. The primary rationale for antenatal care has been to screen a predominantly healthy population so that early signs of, or risk factors for, morbidity and mortality can be detected and intervened upon (Alexander and Keirse 1989; Rooney 1992). The assumption that prenatal screening can identify women at risk of an adverse outcome and that targeting scarce resources to such groups can effectively prevent maternal morbidity and mortality has led to the adoption of the risk approach in antenatal care as one of the key strategies in the safe motherhood initiative (Backett et al. 1984; Safe Motherhood Inter-Agency Group 1998).

Reviews examining the effectiveness of formal risk scoring in pregnancy have been inconclusive and opinions on its role are divided (Chng et al. 1980; Hall et al. 1980; Bruce and Winikoff 1990; Maine 1990; Walsh 1990; Lindmark and Chattingius 1991). Critics argue that adverse obstetric outcomes have a low predictability and that all women are at risk of an adverse outcome. The assumed low predictability of adverse maternal outcomes has led to a shift in the emphasis from universal antenatal care to universal access to emergency obstetric care. Yet a technical working group convened by the World Health Organisation adhered to the use of prenatal risk assessment (WHO 1994) and risk scoring is still widely in use.

Evaluations of the performance of risk scoring systems in developing countries have been limited. Most evaluations have focused on the predictability of selected maternal outcomes such as severe dystocia or postpartum haemorrhage and few assessments have been population based (Kasongo Project Team 1984; Tsu 1994; Dujardin et al. 1996). Assessments of risk scoring systems, which attempt to predict all potential serious obstetrical complications rather than selected outcomes, have rarely been done. Although such an approach may yield poorer results because the pooling of heterogeneous outcomes reduces the predictive power of specific risk markers, it may be more pertinent in settings where the actions following risk identification consist mainly of transfer to a health facility for special monitoring and delivery (Tsu 1994).

The present study was undertaken to assess whether a prenatal risk scoring system can identify women at risk of severe labour or delivery complications in a rural area in Bangladesh. In this population-based cohort study we explore the prenatal factors which are associated with adverse maternal outcomes and assess the capacity of a risk score to distinguish between those needing special care and those who can safely be advised to deliver at home.

Methods

Study area

The study was conducted in Matlab, a rural area 60 km from Dhaka, the capital of Bangladesh. The main sources of income are rice growing and fishing, the majority of the population is Muslim and literacy rates are low, particularly for women. It is not customary for women to walk far outside of their compounds and transfer to a health facility presents major constraints (Stark et al. 1994).

Health services

The data were drawn from part of the Matlab area called the Maternal and Child Health and Family Planning (MCH-FP) area. The MCH-FP area has received extensive health and family planning services since 1977 and covers a population of 104 323 (Registration of Demographic Events, 1994). Eighty community health workers who visit the women in their homes every two weeks provide the services. In 1987, a community-based Maternity Care Programme was introduced in part of the MCH-FP area (Fauveau et al. 1991). This programme consisted primarily of establishing a maternity clinic in Matlab town, posting four trained midwives in two health centres, covering half of the MCH-FP area, and providing a speedboat and an ambulance for emergency cases. In 1990 the programme was expanded to the entire MCH-FP area (Ronsmans et al. 1997a).

The midwives were encouraged to visit the women in their homes and perform as many antenatal visits, delivery services and postnatal visits as possible. They were trained and equipped to provide minimal obstetric care, they performed manual deliveries of the placenta in case of retention of the placenta and used oxytocics for intra- or post-partum haemorrhage. They were also expected to accompany the women to the Matlab maternity clinic when needed. Women needing a blood transfusion or a caesarean section were transferred to a hospital in Chandpur. The journey time between the Matlab clinic and the town of Chandpur was approximately 1 hour by ambulance.

During the antenatal visits at the women's home, demographic, anthropometric and medical factors were recorded. At the first visit the women's parity and age were noted and women were asked to report their previous obstetric history. Height was measured using a tape against a wall or doorpost. The midwives examined the women for the presence of tibial oedema and assessed the conjunctivae and mucous membranes for the presence of anaemia and jaundice. Blood pressure was measured with a sphygmomanometer and the urine was tested for protein using a dipstick. Reported symptoms of fever or vaginal bleeding were noted. Women were submitted to an abdominal examination to determine the position of the foetus, the presence of twins and the measurement of fundal height.

All the women received iron-folic acid tablets. Women who screened positive for any of the medical factors were asked to go to the Matlab clinic, except in certain cases where treatment could be provided at home. These treatments included bed rest and restricted salt intake for tibial oedema, diazepam for a diastolic blood pressure exceeding 90 mmHg or a systolic blood pressure of more than 120 mmHg; bed rest for threatening abortion, and ampicillin for signs of infection or premature rupture of membranes. If the blood pressure did not respond to the proposed treatment, the woman was referred to the Matlab clinic for further treatment.

When midwives were called during or after labour and delivery they noted the timing of the visit and the nature of the complications. The midwives had been trained extensively in the recognition of complications and we relied on their clinical expertise for case definitions. For women referred to the Matlab clinic the complications were noted in the clinic register.

Assessment of the screening programme's performance

Definition of outcomes and sources of data

Since the antenatal screening was set up to identify women in need of special care around the time of labour and delivery, we defined outcomes which best reflected that need. We defined an adverse maternal outcome as either the death of a woman during the pregnancy or within 3 months of the delivery or the presence of a severe complication during or within 7 days of labour or delivery. Severe complications consisted of hypertensive diseases of pregnancy, intra- or post-partum bleeding, prolonged or obstructed labour (dystocia), malpresentation and twin pregnancy. Data on maternal deaths were obtained from the demographic surveillance system (DSS). Maternal deaths were the subject of special investigations into the causes of maternal death, obtained through interviews with the relatives of the deceased women (Ronsmans et al. 1998). Data on maternal morbidity were obtained from the records kept by the midwife and the register at the Matlab clinic.

Definition of cut-off points for antenatal markers and signs and symptoms

The cut-off points for antenatal markers were chosen based on cut-offs suggested in the literature, the percentage of women allocated to the risk group and the sensitivity and specificity of the markers for identifying adverse outcomes. Maternal age was divided into three groups (age <20, 20–34, >34 years) and first pregnancies were considered as high risk. Poor obstetric history was defined as one or more prior stillbirths, caesarean sections or dystocia. For height we chose the cut-off which classified 10% of the women as high risk (Dujardin et al. 1996). The uterus was considered large-for-date beyond the 85th percentile of fundal height for a given gestational age. Signs such as anaemia, jaundice, tibial oedema, fever, and proteinuria were categorized as dichotomous variables. Blood pressure was considered high if the diastolic pressure was 90 mmHg or more and if the systolic blood pressure exceeded 120 mmHg. Women who received more than one antenatal visit were considered as high risk when they fell into a high risk category during any of the visits.

Criteria for assessing the performance of the risk assessment

We used three criteria to assess the performance of the screening. These criteria are (1) the sensitivity of the screening in detecting those who will later develop an adverse outcome, (2) the proportion of the population identified as high risk, and (3) the predictive value of a positive test. Sensitivity was defined as the proportion of all future adverse outcomes that would be detected by the screening test. The prevalence of the risk factor gives an indication of the potential cost of screening to the health services. The predictive value of a positive test is the proportion of those screening positive that will later develop a complication and represents the burden of the screening activity to the individual woman. We sought to find a combination of antenatal markers yielding a high sensitivity at a relatively low cost to the services, yet with a high predictive power to the women.

Data analysis

There were two distinct analyses with regard to outcome: first we combined all the obstetric complications into one outcome and secondly we explored the associations for each complication separately. For the analysis of the pooled outcome, antenatal factors were examined for their association with the outcome using the odds ratio and its 95% confidence interval. All the risk markers were then incorporated into a logistic regression model and a backward stepwise selection was used to retain the factors for inclusion in the final risk score. To construct a risk score, weights of one were arbitrarily assigned to each risk marker. An alternative approach whereby each risk marker was attributed the precise relative risk estimate from the regression model yielded similar results and data are only shown for the arbitrary score.

A similar approach was used to explore the associations between the risk markers and each obstetric complication separately. The antenatal markers that were significantly associated with the outcome in the multivariate logistic regression were combined to seek the most optimal performance of the screening.

Results

Programme coverage and frequency of adverse outcomes

Of the 17 000 pregnancies noted by the DSS in the area covered by the maternity care programme between 1987 and 1993, 9594 (56.4%) had received one or more antenatal visits by the midwife. The majority (81.6%) of the women seen antenatally were seen only once, 14.6, 3 and 0.8% had two, three or more than three visits, respectively. The median gestational age at the first antenatal visit was 7 months; 74.3% of the first antenatal visits took place between the sixth and the eighth month of pregnancy.

The midwife was present around the time of labour and/or delivery in 3909 (40.7%) women who received antenatal care compared to only 748 (11.1%) of the women not receiving antenatal care (relative risk = 3.73, p = 0.000). About one-quarter (26.5%) of the women who received antenatal care experienced a labour or delivery complication, including the 21 women who died as a consequence of pregnancy. The majority (78.3%) of these women had only one complication. The types of complications included eclampsia (n = 31), other hypertensive diseases (n = 250), dystocia (n = 351), malpresentation (n = 142), intra- or post-partum haemorrhage (n = 439), and twin pregnancy (n = 73). The maternal mortality ratio and perinatal mortality rate were 5.4 and 76.5 per 1000 pregnancies, respectively. Thirteen percent of the women were transferred to a health facility, and 4% were admitted to a higher level hospital with facilities for caesarean sections.

The large majority of the cases of eclampsia and dystocia were admitted to a health facility (90 and 82%, respectively) (Figure 1). Admission rates were lowest for cases of intra- or post-partum bleeding (23% of all cases). The perinatal mortality rate was significantly higher in women who experienced a complicated labour or delivery than in those not experiencing obstetric problems (164.7 compared to 45.3 per 1000 pregnancies, p = 0.000). Perinatal mortality rates were highest for malpresentation (422 per 1000), eclampsia (323 per 1000) and twin pregnancy (274 per 1000). Maternal mortality was highest for eclampsia (9.7%), other hypertensive diseases (2.4%) and twin pregnancy (1.1%).

Antenatal screening and need for special care around the time of labour and delivery

To explore the capacity of antenatal screening in distinguishing between those needing special care and those not needing such care, we analyzed the association of antenatal markers with a pooled outcome combining all the above complications (Table 1). The most common antenatal marker was primiparity (33%). The most common sign or symptom was tibial oedema (19%). Antenatal bleeding or a diagnosis of twins were rare events (0.7 and 1.0%, respectively).

The associations between antenatal markers and adverse maternal outcome were in the expected direction (Table 1). In the multivariate analysis, an adverse maternal outcome was significantly associated with primiparity, poor obstetric history, and signs and symptoms such as jaundice, vaginal bleeding, high diastolic blood pressure, proteinuria, tibial oedema, a diagnosis of twins and large-for-date uterus. Vaginal bleeding, though uncommon, was associated with a six-fold increase in the odds of an obstetric complication.

The above factors were used to compute a scoring system for adverse maternal outcome. The sensitivity, prevalence and predictive value of single risk markers and signs and symptoms are shown in Table 2. Risk markers alone perform poorly. A poor obstetric history, for example, was reported by 9% of the women, yet only a very small fraction of women with adverse outcomes report such a history (sensitivity of 12%). Forty-one percent of the women with adverse outcome (sensitivity) were primiparae, but the cost of transferring all primiparae (33% of all pregnant women) to a health facility may be too high. The relatively small group of women (22%) who have two or more risk markers account for only 38% of all adverse outcomes. Increasing the sensitivity to 75% by considering anyone with one or more risk markers as high-risk

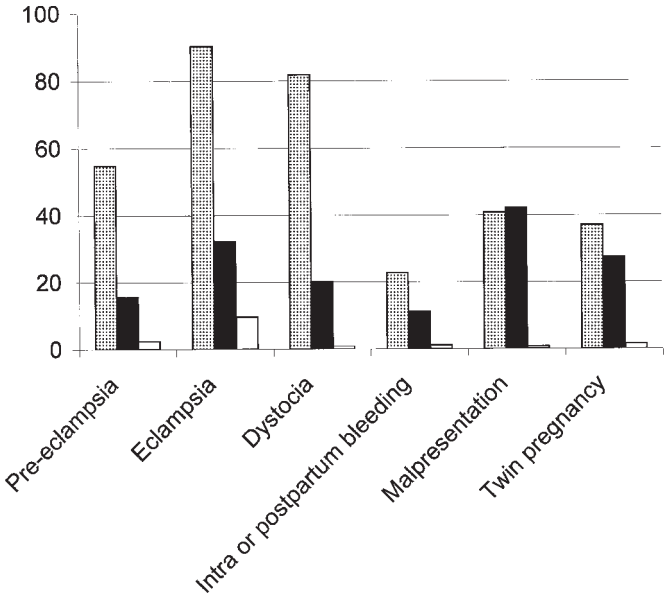

Figure 1. Proportions of each obstetric complication that are associated with admission to a health facility and perinatal or maternal death (Matlab 1987–93). Stippled bars, percent admitted to health facility; filled bars, percent perinatal death; open bars, percent maternal death

results in an unacceptably large proportion of women to receive special care (60%).

Signs and symptoms during pregnancy also have a low sensitivity for obstetric complications when considered on their own (Table 2). Two-thirds (67%) of all women reporting a vaginal bleeding later developed a complication, but they represented less than 2% of all women with complications. Similarly, many of the women diagnosed with twin pregnancy developed problems during labour or delivery (63%), but very few (2%) women with labour or delivery problems had been diagnosed with twins. An attempt to increase the sensitivity by considering women with any of the signs or symptoms as high risk results in a large proportion of women to be referred for special care (Figure 2). Approximately one-third of the women (34%) screen positive for one or more of the listed signs and symptoms, yet as much as half (50%) of the adverse outcomes still occur in those without any warning signs or symptoms.

Results for combinations of risk markers and for a score incorporating risk markers as well as signs and symptoms are shown in Figures 2 and 3, respectively. Combining risk markers with signs and symptoms does not improve the performance of the score (Figure 3).

Antenatal screening for specific obstetric complications

The antenatal factors associated with specific adverse obstetric outcomes are shown in Table 3. As expected, eclampsia and other hypertensive diseases around the time of labour or delivery are associated with primiparity, antenatal hypertension, proteinuria, tibial oedema and a large-for-date uterus. Dystocia is associated with primiparity, short stature, poor obstetric history, vaginal bleeding, a large-for-date uterus and an antenatal diagnosis of twins. Haemorrhage during or after labour is associated with very few antenatal markers, except for vaginal bleeding during pregnancy which increases the risk of intra-and post-partum bleeding four-fold. Twin delivery is associated with a poor obstetric history, an antenatal diagnosis of twins and a large-for-date uterus.

Table 1. Association between antenatal markers and labour or delivery complications[a] in 3909 pregnancies (Matlab 1987–93)

Antenatal markers	Prevalence (%)	Odds ratio (95% CI)	Adjusted odds ratio[b] (95% CI)
Risk markers			
Primiparity	32.6	1.67 (1.44–1.93)**	1.80 (1.53–2.11)**
Maternal age<20 years	11.3	1.28 (1.03–1.59)*	–
≥34 years	9.0	1.31 (1.03–1.67)*	1.25 (0.96–1.63)
Poor obstetric history	9.1	1.46 (1.16–1.85)**	1.60 (1.25–2.05)**
Height ≤144 cm	10.8	1.14 (0.91–1.43)	–
Signs and symptoms			
Moderate and severe anaemia	3.7	1.70 (1.21–2.40)**	–
Jaundice	1.5	2.77 (1.65–4.63)**	2.16 (1.24–3.75)**
Fever	3.9	2.02 (1.45–2.81)**	1.43 (0.99–2.05)
Vaginal bleeding	0.7	5.70 (2.55–12.73)**	5.75 (2.51–13.17)**
Diastolic BP ≥90 mmHg	9.1	3.21 (2.57- 4.01)**	1.72 (1.21–2.44)**
Systolic BP ≥120 mmHg	10.4	2.82 (2.29–3.48)**	1.38 (0.99–1.92)
Proteinuria	1.0	3.65 (1.96–6.79)**	1.99 (1.01–3.92)*
Tibial oedema	19.5	2.45 (2.08–2.90)**	1.73 (1.45–2.08)**
Diagnosis of twins	1.0	4.91 (2.53–9.53)**	3.72 (1.84–7.53)**
Fundal height ≥85th percentile	15.3	2.31 (1.93–2.77)**	1.92 (1.58–2.33)**

[a] Labour or delivery complications include problems during labour or within 7 days of delivery such as eclampsia and other hypertensive diseases, dystocia, intra- or post-partum bleeding, malpresentation or twin delivery.
[b] Adjusted for all other factors, results only shown for associations significant at $p < 0.10$.
* $p < 0.05$; ** $p < 0.01$.

Table 2. Sensitivity, prevalence and predictive value of antenatal markers for identification of labour and delivery complications[a]

	Sensitivity[b]	Prevalence[c]	Predictive value[d]
Risk markers			
Primiparity	41.1	32.6	33.1
Poor obstetric history	11.6	9.1	33.4
Primiparity or poor obstetric history	51.6	40.5	33.4
Multiparity and poor obstetric history	10.4	7.9	34.5
Signs and symptoms			
Jaundice	2.8	1.5	49.1
Vaginal bleeding	1.7	0.7	66.7
Diastolic BP ≥90 mmHg	17.3	9.1	50.1
Proteinuria	2.2	1.0	56.1
Tibial oedema	31.0	19.5	41.6
Diagnosis of twins	2.3	1.0	63.2
Fundal height ≥85th percentile	24.2	15.3	41.5

[a] Labour and delivery complications include problems during labour or within 7 days of delivery such as eclampsia and other hypertensive diseases, dystocia, intra- or post-partum bleeding, malpresentation or twin delivery.
[b] Sensitivity = the proportion of women with an adverse outcome who screen positive for the antenatal marker.
[c] Prevalence = the proportion of all women who screen positive for the antenatal marker.
[d] Predictive value = the proportion of those who screen positive for the antenatal marker who develop an adverse outcome.

The performance of the risk scoring system is better for specific adverse maternal outcomes than for a combination of adverse outcomes, particularly for pre-eclampsia/eclampsia and twin delivery (Table 4). A high diastolic blood pressure, for example, was found in nearly half (47%) of the cases of pre-eclampsia/eclampsia, whilst only classifying 9% of all pregnant women at risk. The sensitivity of the antenatal screening for pre-eclampsia/eclampsia can be increased to 72% when the score includes women with a high diastolic blood pressure or with tibial oedema, but at an increased cost (prevalence) of 24%. A prenatal diagnosis of twin pregnancy or of a large-for-date uterus can recognize 68% of all cases of twin delivery, at a cost of only 16%. Dystocia and intra- or post-partum haemorrhage, on the other hand, cannot be adequately predicted.

Discussion

Antenatal screening by trained midwives during a single antenatal visit at the women's home in Matlab fails to

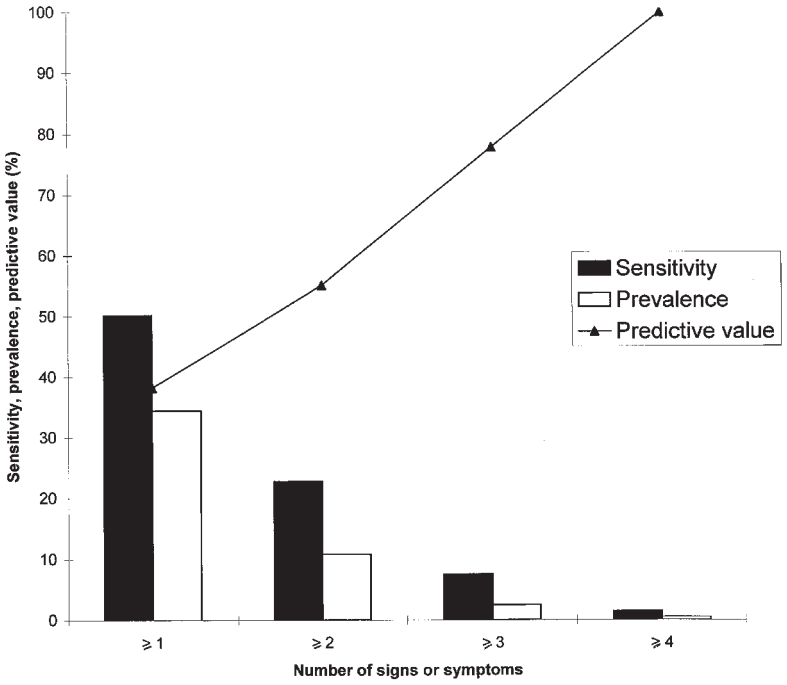

Figure 2. Prevalence, sensitivity and predictive value of antenatal signs and symptoms for the identification of severe obstetric complications around the time of labour and delivery

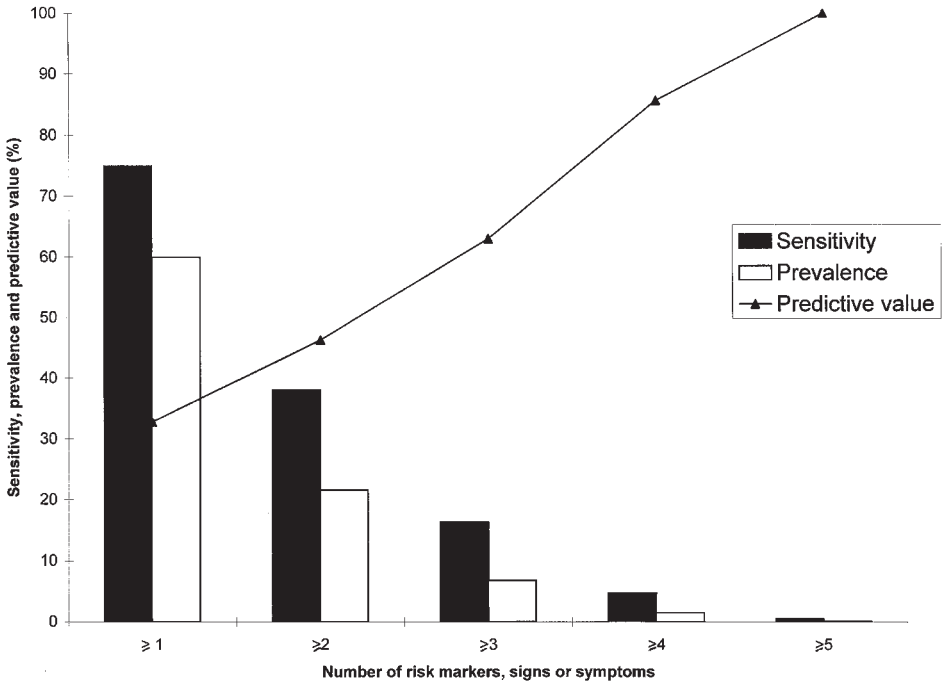

Figure 3. Prevalence, sensitivity and predictive value of antenatal risk markers, signs and symptoms for the identification of severe obstetric complications around the time of labour and delivery

distinguish women who will need special care during labour and delivery from those who will not. Antenatal risk factors are either too insensitive to predict the adverse maternal outcome or too common to be efficient as a screening strategy.

Screening for specific conditions such as dystocia or haemorrhage, the major causes of maternal death in Matlab, is greatly inefficient. The large majority of women with dystocia or haemorrhage in Matlab had no warning signs during pregnancy. Screening for blood pressure and twin pregnancies, however, may be worthwhile. A single high blood pressure reading combined with tibial oedema identified nearly three-quarters of all women diagnosed with pre-eclampsia/eclampsia during labour and delivery, and was present in only one-quarter of the women. Similarly, the measurement of fundal height allowed the midwives to identify a large proportion of women with twin pregnancies.

The failure of antenatal markers such as age, primiparity, prior obstetric history and short stature to adequately distinguish women who will later develop a dystocia from those who will not is well known (Kasongo Project Team 1984; Hermann and Duale 1990; Tsu 1994; Dujardin et al. 1996). Our findings were consistent with those of other studies, although the sensitivity of the risk markers is somewhat lower than that reported for the African populations to which most published reports refer (Everett 1975; Tsu 1994). Rural Bangladeshi women are small and there is little variation in height between them. The difference between the fifth and the tenth percentile in height – a differentiation which has been deemed important (Dujardin 1996; WHO 1994) – is only 3 cm, and lowering the cut-off did not substantially alter the screening performance (data not shown). The relatively high prevalence of primiparity (32.6%) in Matlab may have contributed to the poor efficiency of primiparity as a screening tool. The low sensitivity of the reported obstetric history may partly be explained by misreporting (Ronsmans et al. 1997b) and by poor access to emergency obstetric care prior to the introduction of the Safe Motherhood programme (only five women reported a previous caesarean section).

The incidence of obstetric complications observed in this study is higher than that reported in other settings. One-quarter of the women were diagnosed with an obstetric complication. Although this study was community based, pregnancy outcomes were available for only 41% of the women with antenatal care. Since women seen by the midwife at the time of delivery were presumably more likely to have been women with pregnancy complications, we may have over-estimated the true magnitude of the complications and hence the predictive power of the screening (UNICEF, WHO and UNFPA 1997; Tsu 1994). Nevertheless, sensitivity and specificity are independent of the incidence of the target condition and therefore not affected by an overestimation of the outcome.

The incidence of haemorrhage (11%) and hypertensive diseases of pregnancy (6%) falls within the ranges reported elsewhere, but the incidence of dystocia (9%) is higher than the incidence of cephalo-pelvic disproportion noted in other settings (WHO 1990; Uzan et al. 1991; Italian study 1993; CLASP 1994; Tsu 1994; Dujardin et al. 1996). Dystocia in this study included all cases of prolonged labour, while in most other studies dystocia was defined as cephalopelvic disproportion excluding all dynamic dystocia cases.

Table 3. Association between selected antenatal markers and specific obstetric complications around the time of labour and delivery (3909 pregnancies)

Obstetric complication	Antenatal markers	Adjusted odds ratio (95% C.I.)[a]
Eclampsia and other hypertensive diseases	**Risk markers**	
	Primiparity	2.49 (1.86–3.33)**
	Signs and symptoms	
	Moderate and severe anaemia	1.63 (0.92–2.89)
	Diastolic BP ≥90 mmHg	3.86 (2.36–6.30)**
	Systolic BP ≥120 mmHg	2.48 (1.53–4.03)**
	Proteinuria	5.68 (2.39–13.51)**
	Tibial oedema	4.50 (3.34–6.06)**
	Fundal height ≥85th percentile	2.05 (1.48–2.84)**
Dystocia (including malpresentation)	**Risk markers**	
	Primiparity	2.47 (1.99–3.07)**
	Maternal age ≥34 years	1.37 (0.97–1.95)
	Poor obstetric history	2.09 (1.54–2.85)**
	Height ≤144 cm	1.41 (1.06–1.89)*
	Signs and symptoms	
	Vaginal bleeding	4.43 (1.94–10.11)**
	Diagnosis of twins	4.25 (2.11–8.55)**
	Fundal height ≥85th percentile	1.87 (2.11–8.55)*
Intra- or post-partum bleeding	**Risk markers**	
	Maternal age ≥34 years	1.59 (1.18–2.16)**
	Signs and symptoms	
	Vaginal bleeding	4.53 (2.05–10.00)**
	Tibial oedema	1.34 (1.06–1.70)*
Twin pregnancy	**Risk markers**	
	Poor obstetric history	2.11 (1.07–4.13)**
	Signs and symptoms	
	Tibial oedema	1.95 (1.15–3.31)**
	Diagnosis of twins	49.13 (22.39–107.82)**
	Fundal height ≥85th percentile	7.11 (4.20–12.05)**

[a] Adjusted for all other factors, results only shown for associations significant at $p < 0.10$; * $p < 0.05$; ** $p < 0.01$.

We did not include infection as an obstetric complication in this study nor did we assess the potential role of antenatal infections as predictors of adverse maternal outcomes for a variety of reasons. Puerperal sepsis was an uncommon cause of death in women during the study period (Ronsmans et al. 1998) and puerperal infection was rarely reported by the midwives or recorded at the Matlab clinic (data not shown). When the outreach programme was designed it was not deemed feasible to set up a mechanism for detecting maternal infections during pregnancy in the woman's home, and data on the prevalence of such infections were not available. Recent research has shown that reproductive tract infections (RTI) are uncommon among married women in Matlab while over-diagnoses on clinical grounds are common (Hawkes et al. 1997). Antenatal screening for syphilis, on the other hand, has been suggested as a cost-effective strategy for improving perinatal outcomes (Khan et al. 1998).

The identification of antenatal signs and symptoms may contribute to the prevention of maternal ill health provided effective antenatal interventions are available. Such interventions could have weakened the association between the antenatal factor and the outcome (Lilford and Chard 1983; Alexander and Keirse 1989). However, the potential for treating problems occurring during pregnancy in an outreach programme such as the Matlab programme is limited. The most effective strategies would have involved referral but compliance with antenatal referral was low. It is therefore unlikely that the 'treatment paradox' affected the results of this study to a great extent.

Signs and symptoms such as vaginal bleeding, jaundice, hypertension or twin pregnancy require further observation and referral to a hospital either at the time of diagnosis or at the start of labour. Yet, compliance with antenatal referral is often low, even in settings where the environment is said to enhance compliance (Dujardin et al. 1995). In Matlab, women who were visited by the midwife during pregnancy were four times more likely to call the midwife around the time of labour and delivery than women who were not visited. These findings suggest that establishing a relationship with the midwife during pregnancy may promote the utilization of midwives during labour, and possibly facilitate entry into a hospital when needed. Ensuring an interaction between the community and the medical system may therefore be the primary purpose of an outreach antenatal care programme.

Conclusion

High quality antenatal care cannot be a substitute for adequate emergency obstetric care (EOC) and ensuring access to

Table 4. Sensitivity, prevalence and predictive value of antenatal markers for the identification of specific obstetric complications around the time of labour and delivery

Obstetric complication	Antenatal markers	Sensitivity[a]	Prevalence[b]	Predictive value[c]
Eclampsia and other hypertensive diseases	**Single markers**			
	Primiparity	53.4	32.6	11.0
	Diastolic BP ≥90 mmHg	47.3	9.1	34.9
	Systolic BP ≥120 mmHg	47.7	10.4	30.9
	Proteinuria	8.0	1.0	51.2
	Tibial oedema	61.8	19.5	21.2
	Fundal height ≥85th percentile	33.6	15.3	14.7
	Combination of markers			
	Diastolic BP ≥90 or proteinuria	48.1	9.6	33.6
	Diastolic BP ≥90 or tibial oedema	72.1	24.4	19.8
	Diastolic BP ≥90 and (proteinuria or tibial oedema)	37.4	4.3	58.3
Dystocia (including malpresentation)	**Single markers**			
	Primiparity	47.5	32.6	16.7
	Poor obstetric history	14.1	9.1	17.7
	Height ≤144 cm	15.0	10.8	15.8
	Antenatal bleeding	2.0	0.7	33.3
	Diagnosis of twins	2.9	1.0	34.2
	Fundal height ≥85th percentile	23.9	15.3	17.9
	Combination of markers			
	Poor obstetric history or height ≤144 cm	26.8	18.6	16.5
	Primiparity and height ≤144 cm	11.6	3.9	23.5
	Primiparity and height ≤144 cm or poor obstetric history	21.9	12.8	19.6
	Vaginal bleeding or diagnosis of twins or fundal height ≥85th percentile	26.6	16.4	18.6
Intra- or post-partum haemorrhage	**Single markers**			
	Age ≥34 years	13.2	9.0	16.5
	Vaginal bleeding	2.3	0.7	37.0
	Tibial oedema	24.1	19.5	13.9
	Combination of markers			
	Any of the above	33.7	26.8	14.1
Twin pregnancy	**Single markers**			
	Diagnosis of twins	47.4	1.0	47.4
	Fundal height ≥85th percentile	61.6	15.3	7.5
	Combination of markers			
	Diagnosis of twins or fundal height ≥85th percentile	68.5	15.8	8.1

[a] Sensitivity = the proportion of women with an adverse outcome who screen positive for the antenatal marker.
[b] Prevalence = the proportion of all women who screen positive for the antenatal marker.
[c] Predictive value = the proportion of those who screen positive for the antenatal marker who develop an adverse outcome.

effective obstetric care for *all* women remains the key priority for the prevention of adverse maternal outcome in poor countries. Yet even one visit late in pregnancy may confer benefits to the mother and her baby, not only because women with serious conditions such as hypertensive diseases in pregnancy can be diagnosed and kept under observation, but also because a dialogue can be initiated which may facilitate the use of skilled care when the need arises. Antenatal care may not be an efficient strategy to identify those most in need for obstetric service delivery, but if promoted in concurrence with effective EOC, and delivered in skilled hands, it may become an effective instrument for better use of EOC services.

References

Alexander S, Keirse MJNC. 1989. Formal risk scoring during pregnancy. In: Chalmers I, Enkin M, Keirse MJNC (eds). *Effective Care in Pregnancy and Childbirth*. Oxford: Oxford University Press, pp. 345–65.

Backett EM, Davies AM, Petros-Barvazian A. 1984. The Risk Approach in Health Care, with Special Reference to Maternal and Child Health, including Family Planning. *WHO Public Health Papers, Number 76*. Geneva: World Health Organization.

Bruce J, Winikoff B. 1990. Executive Summary: Findings from the seminar on 'Reassessment of the Concept of Reproductive Risk in Maternity Care and Family Planning Services'. New York: The Population Council.

Chng PK, Hall MH, MacGillivray I. 1980. An audit of antenatal care: the value of the first antenatal visit. *British Medical Journal* **281**: 1184–6.

CLASP. 1994. A randomised trial of low-dose aspirin for the prevention and treatment of preeclampsia among 9364 women. *The Lancet* **343**: 619–29.

Dujardin B, Van Cutsem R, Lambrechts T. 1996. The value of maternal height as a risk factor for dystocia: a meta-analysis. *Tropical Medicine and International Health* **1**(4): 510–21.

Dujardin B, Clarysse G, Criel B, De Brouwere V, Wangata N. 1995. The strategy of risk approach: evaluation of the referral compliance. *Social Science and Medicine* **40**(4): 529–35.

Everett VJ. 1975. The relationship between maternal height and cephalo-pelvic disproportion in Dar es Salaam. *East African Medical Journal* **52**: 251–6.

Fauveau V, Stewart K, Khan SA, Chakraborty J. 1991. Effect on mortality of community-based maternity-care programme in rural Bangladesh. *The Lancet* **338**: 1183–6.

Hall MH, Chng PK, MacGillivray I. 1980. Is routine antenatal care worth while? *The Lancet* **ii**: 78–80.

Hawkes S, de Francisco A, Chakraborty J, Gausia K, Williams L, Mabey D. 1997. Using the results of the Matlab RTI/STI study to develop suitable STI control programmes in Bangladesh. Paper presented at the Sixth Annual Scientific Conference on 'Reproductive tract infections and sexually transmitted infections'. ICDDR,B special publication No 57. Dhaka: ICDDR,B.

Hermann CB, Duale S. 1990. Improving the maternity services in the Karawa Health Zone of Zaire. Maternal Nutrition and Health Care Program. Report No 2. Washington DC: International Centre for Research on Women.

Italian study of aspirin in pregnancy. 1993. Low-dose aspirin in prevention and treatment of intrauterine growth retardation and pregnancy-induced hypertension. *The Lancet* **341**: 396–400.

Kasongo Project Team. 1984. Antenatal screening for fetopelvic dystocias: a cost-effectiveness approach to the choice of simple indicators for use by auxiliary personnel. *Journal of Tropical Medicine and Hygiene* **87**(4): 173–83.

Khan M, Hawkes S, Ali D. 1998. The economic evaluation of MCH/FP clinic-based syphilis screening in rural Bangladesh. Paper presented at the Seventh Annual Scientific Conference. Dhaka: ICDDR,B.

Lilford RJ, Chard T. 1983. Problems and pitfalls of risk assessment in antenatal care. *British Journal of Obstetrics and Gynaecology* **90**: 507–10.

Lindmark G, Chattingius S. 1991. The scientific basis of antenatal care, Report from a state-of-the-art conference. *Acta Obstetrics Gynecology of Scandanavia* **70**(2): 105–9.

Maine D. 1991. Safe Motherhood Programs: Options and Issues. Centre for Population and Family Health, School of Public Health, Faculty of Medicine, Colombia University, New York.

Registration of demographic events, 1990. 1994. Scientific Report No 73. Dhaka: ICDDR,B.

Ronsmans C, Vanneste A, Chakraborty J, Van Ginneken J. 1997a. Maternal Mortality decline in Matlab, Bangladesh, a cautionary tale. *The Lancet* **350**: 1810–4.

Ronsmans C, Achadi E, Cohen S, Zazri A. 1997b. Women's recall of obstetric complications in South Kalimantan, Indonesia. *Studies in Family Planning* **28**: 203–14.

Ronsmans C, Vanneste A, Chakraborty J, Van Ginneken J. 1998. A comparison of three verbal autopsy methods to ascertain levels and causes of maternal deaths in Matlab, Bangladesh. *International Journal of Epidemiology* **27**: 660–6.

Rooney C. 1992. Antenatal care and maternal health: How effective is it? A review of the evidence. WHO/MSM/92.4. Geneva: World Health Organization.

Safe Motherhood Inter-Agency Group. 1998. Report on the Safe Motherhood Technical Consultation, 18–23 October 1997, Colombo, Sri Lanka. New York: Family Care International.

Stark N, Akhter R, Aziz KMA, Chakraborty J. 1994.Therapy management and reproduction in Matlab. In: Fauveau V (ed). Matlab: Women, Children and Health. ICDDR,B special publication No. 35, p 343. Dhaka: ICDDR,B.

Tsu VD. 1994. Antenatal screening: its use in assessing obstetric risk factors in Zimbabwe. *Journal of Epidemiology and Community Health* **48**: 297–305.

UNICEF, WHO, UNFPA. 1997. Guidelines for monitoring the availability and use of obstetric services. New York: UNICEF.

Uzan S, Beaufil M, Breart G, Bazin B, Capitant C, Paris J. 1991. Prevention of foetal growth retardation with low-dose aspirin: findings of the EPREDA trial. *The Lancet* **337**: 1427–31.

Walsh JA. 1990. Maternal and perinatal health. In: Jamison DT, Mosley WH (eds). *Disease control priorities*. Washington DC: World Bank.

World Health Organization. 1990. The prevention and management of post partum haemorrhage. Report of a Technical Working Group, WHO/MCH/90.7. Geneva: WHO.

World Health Organization. 1994. Report of a Technical Working Group. WHO/FRH/96.8. Geneva: WHO.

Acknowledgements

This research was supported by the British Department for International Development (DFID), the Belgian Administration for Development Cooperation (BADC) and the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The Ford Foundation funded the Maternity Care Programme during the period this study refers to (1987–93). The ICDDR,B is supported by countries and agencies which share its concern for the health problems of developing countries. Current donors include: the aid agencies of the Governments of Australia, Bangladesh, Belgium, Canada, China, Germany, Japan, the Netherlands, Norway, Saudi Arabia, Sri Lanka, Sweden, Switzerland, Thailand, the United Kingdom and the United States; international organizations including the Arab Gulf Fund, Asian Development Bank, European Union, United Nations Children's Fund (UNICEF), the United Nations Development Programme (UNDP), the United Nations Population Fund (UNFPA) and the World Health Organization (WHO); private foundations including Aga Khan Foundation, Child Health Foundation (CHF), Ford Foundation, Population Council, Rockefeller Foundation and the Sasakawa Foundation; and private organizations including American Express Bank, Bayer A.G., CARE, Family Health International, Helen Keller International, the Johns Hopkins University, Macro International, New England Medical Centre, Procter Gamble, RAND Corporation, SANDOZ, Swiss Red Cross, the University of Alabama at Birmingham, the University of Iowa, Wander A.G. and others.

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