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Why Did Maternal Mortality Decline in Matlab?

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In 1991, an article on the Maternity Care Program in Matlab, Bangladesh, reported a substantial decline in direct obstetric deaths in the intervention area, but not in the control area. The decline was attributed primarily to the posting of midwives at the village level. In this article, data are presented from the same period and area on a variety of intermediate events. They indicate that the decline in deaths was probably due to the combined efforts of community midwives and the physicians at the Matlab maternity clinic. Their ability to refer patients to higher levels of care was important. The data further indicate that the decline in deaths depended upon the functioning of the government hospital in Chandpur, where cesarean sections and blood transfusions were available. Midwives might also have made a special contribution by providing early termination of pregnancy, which is legal in Bangladesh. (Studies in Family Planning 1996; 27,4:179-187)

Complications of pregnancy and childbirth are the leading cause of premature death among women in developing countries (World Bank, 1993). In the late 1980s, one out of every 33 women in Bangladesh was estimated to have died of such complications, compared with nearly one out of 10,000 women in northern Europe (Koenig et al., 1988; World Health Organization, 1991). In 1987, the international Safe Motherhood Initiative was launched to address this problem. Unfortunately, progress has been slow, partly because of a lack of consensus on how best to reduce maternal deaths.

Technical difficulties make testing the impact of programs on mortality difficult and expensive (Campbell et al., 1990); (Maine et al., 1992). Even the most efficient survey method, the sisterhood method, is not suitable for evaluating intervention programs, partly because of the sample size needed, and partly because of the time frame required. This method estimates the level of maternal mortality a decade before the survey (Graham et al., 1989). Because of these constraints, the intervention study done as part of ongoing research in Matlab, Bangladesh, is likely to be one of the few rigorous intervention studies with mortality as the outcome measure. Understandably, the

results carry tremendous weight among policymakers and program planners (World Bank, 1993:129).

In the Matlab study, maternal, mortality in the intervention area declined substantially (Fauveau et al., 1991). Deaths due to direct obstetric causes declined from 4.4 to 1.4 deaths per 1,000 live births in the three year period (1987-89) after the Maternity Care Program began. [1] No significant change was found in direct obstetric mortality in the control area (3.9 before the intervention, 3.8 after), or in adult female mortality from other causes in either area.

Although these results are impressive, their meaning is not clear. The study included a variety of components and, as the authors of the original report have pointed out, more research is needed to clarify their respective contributions to the mortality decline (Fauveau and Chakraborty, 1994). Unfortunately, the tendency has been, to attribute the decline in deaths to one particular component-the posting of nurse/midwives to rural centers (World Bank, 1993: 129). In this article, three new sets of data from the same study period and area are used to gain a better understanding of what caused the reduction of maternal mortality in Matlab.

The Study

The Matlab area of Bangladesh lies approximately 30 km (18.6 miles) to the southeast of the country's capital, Dhaka. In this rural area, where the dense population subsists by fishing and growing rice, much of the land is flooded for part of the year, and transportation by boat predominates. The community is conservative and Muslim. Women are generally confined to the family's compound and are rarely literate.

Since 1966, a demographic surveillance system (DSS) has been in place in an area that comprises about 80 villages. By 1991, the population in this area was roughly 196,000. Although the surveillance system was set up to facilitate research on cholera, it has also been used for research on population dynamics and various health issues. The research station is operated by the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The Matlab research area is divided into two parts-the Maternal and Child Health-Family Planning (MCH-FP) Project area and the comparison area (Figure 1 is missing). The Maternity Care Program focused on the MCH-FP area. This area has four subdivisions, called blocks A-D, each of which has a health subcenter. Two of the MCH-FP area blocks (C and D) comprised the intervention area; the other two blocks (A and B) served as the control area (Fauveau et al., 1991).

For the study, government-trained nurse/midwives were recruited and two were posted in each subcenter of the intervention area. Their duties included providing prenatal, home-delivery, and postpartum care to women in their area; identifying complications related to pregnancy, treating women with complications when possible and referring the others; organizing referral and accompanying the patient to the central clinic at Matlab; and working with community health workers who were meant to identify pregnant women and call the midwives when they were needed.

The midwives were "supported by two other components of the programme-namely, development of a referral chain, including a boatman and helper to accompany patients night or day to the central clinic, and installation of a maternity clinic at Matlab, where trained paramedics and female physicians were always available for intensive surveillance, treatment, or further referral to a district hospital. Patients requiring cesarean section and blood transfusion were further referred by ambulance to the district hospital" (Fauveau et al., 1991: 1,184).

Data and Methods

The study evaluation by Fauveau and his colleagues relied on mortality data. In addition, however, a wealth of data on treatment of complications existed from the study period. These data were gathered by the authors of this article during 1993. The data sets used in the following analyses are: the DSS; the midwives' cards; the Matlab maternity clinic record book; and the records at the government's district hospital in Chandpur.

The Demographic Surveillance System (DSS)

Every two weeks, 80 community health workers (CHWs) visit every household in the research area to record vital events (births and deaths) and migration. Every month, a health assistant accompanies the CHW to each house where a birth or death was reported and gathers detailed information.

Starting in the mid-1980s, special interviews (verbal autopsies) were conducted with the family and friends of women of reproductive age who had died. The most likely cause of death was assigned by an experienced physician, based on the information available.

The Midwives' Cards

A 10"x12" card was filled out by the midwife for each pregnancy attended-in the antenatal period, during delivery, and/or postpartum. During the period 1987-89, 2,364 cards were filled out. These had already been entered in a computerized data base when the current research began in 1993. In addition to the existing data base, all cards for which major complications were coded as being present were retrieved and reviewed . [2] Cards were also retrieved for women known from the DSS to have died. In all, 288 cards were examined. Of these, 239 were retained in the analysis. The cards excluded had been miscoded; on close inspection, no evidence was found that these women had experienced obstetric complications.

The design of the midwives' cards was far from ideal for the purposes of this study. Most of the space was devoted to details of prenatal care and fetal outcome. No direct questions about treatment of complications were asked, and only small spaces were available in which such information could be volunteered. The midwives often wrote details about the case (complications, referral, treatment) in the margins and on the back of the card. These were abstracted and added to the existing data base.

The Matlab Maternity Clinic Register

Beginning in March 1987, female physicians at the clinic provided round-the-clock treatment for obstetric complications. They referred women who required surgery (for example, cesarean sections) to urban hospitals, usually the government hospital in Chandpur. At the clinic, a single register was kept in which were noted: the woman's name; her DSS identification number; her village of residence; her diagnosis on admission to the clinic; details of her treatment; if and where she was referred; and (in most cases) outcome. This information was entered into a computerized data base. During 1987-89, 300 admissions were recorded. Eleven women were admitted more than once.

The Chandpur District Hospital Records

The hospital records are kept for five years, then destroyed. Because this research was conducted in 1993, no records were available from the period before the Maternity Care Program began. The hospital records were searched for information about women coming from any part of the Matlab research area, especially those noted in the maternity clinic register as having been referred to Chandpur District Hospital. The

hospital's general admission register and patient admission sheets were searched for the period 1987-89. When a woman from the Matlab area was identified, an effort was made to locate the treatment notes. Of the 62 women referred from the Matlab maternity clinic to this hospital, records were located for 56 women (90 percent). Treatment notes were located for 44 of the women (71 percent). An additional 98 maternity cases from the Matlab area (MCH-FP and comparison) were identified that had not been referred from the Matlab clinic. (All statistical tests were performed using Epi Info, Version 6.02.)

Treatment by Midwives and the Maternity Clinic

In order to determine which interventions contributed to the decline in maternal deaths, an examination of changes in the number of deaths due to specific complications, as well as of interventions that might avert such deaths, is instructive. In this section, treatment of complications that was provided by the midwives and the Matlab clinic is examined, because these were new services and were intended for women in the intervention area. Treatment provided by the government hospital, which was not new and which is intended to serve the whole district, is examined in a later section.

As Table 1 shows, the number of direct obstetric deaths in the intervention area declined from 20 deaths in the three years before the Maternity Care Program was implemented to six deaths in the three years after the program began. In the control area, 20 direct obstetric deaths occurred in the three years before the program and 20 during the three years after it began.

Table 1 Direct obstetric deaths occurring in the intervention and control areas during the preintervention (1984-86) and postintervention (1987-89) periods, by cause, and the difference between periods, Matlab, Bangladesh.

	Intervention area			**Control area**		
Cause of death	**1984-86**	**1987-89**	**Difference**	**1984-86**	**1987-89**	**Difference**
Spontaneous abortion	3	1	-2	1	0	-1
Induced abortion	6	0	-6	4	4	0
Antepartum hemorrage	0	1	1	0	2	2

Preeclampsia/eclampsia	5	1	-4	3	1	-2
Prolonged/ obstructed labor	3	0	-3	1	2	1
Postpartum hemorrage	2	1	-1	6	7	1
Postpartum sepsis	0	1	1	0	3	3
Other direct	1	1	0	5	1	-4
Total	20	6	-14	20	20	0

Of the 14 deaths that apparently did not occur in the intervention area during the later period, 13 were in three diagnostic categories: induced abortion (-6); eclampsia and pre-eclampsia (-4); and prolonged/obstructed labor (-3). Smaller changes occurred in other categories: spontaneous abortion (-2 deaths); postpartum hemorrhage and other postpartum complications (-1 death each); antepartum hemorrhage, other antepartum complications, postpartum sepsis (+1 death each). In the control area, only minor variations occurred (±1 or 2 deaths) in most diagnostic categories between the pre- and post-intervention periods. Larger changes occurred in the categories of postpartum sepsis (+3) and other direct causes (-4).

The question considered here is: Were the midwives and the clinic providing sufficient treatment to sufficient numbers of women to account for the observed decline in deaths due to induced abortion, eclampsia/ pre-eclampsia, and prolonged/obstructed labor?

Induced Abortion

Deaths due to induced abortion can be averted in a number of ways: A decline in unwanted pregnancies can occur; a decline in the proportion of unwanted pregnancies that end in induced abortion may take place; induced abortions can become safer; and complications of induced abortion can be treated more successfully.

During the study period, fertility was declining in both the intervention and control areas. (The total fertility rate declined by .5 from the pre- to post-intervention period in both areas.) However, no change was found in the number of deaths attributed to induced abortion in the control area. Therefore, a change in demand for induced abortion or in the overall availability of safe abortion services in the study area seems unlikely.

Using midwives to increase access to safe abortion services was not a stated objective of the program, nor was it discussed in the study protocols for midwives (Fauveau et al., 1991; Fauveau and Chakraborty, 1988). However, early abortion (called menstrual regulation) is legal in Bangladesh, and midwives receive training in menstrual regulation while in government service (Dixon-Mueller, 1988). No information was found on the midwives' cards regarding provision of abortion services.

Some deaths from unsafe abortions performed by other practitioners may have been averted through the midwives' treatment of complications-for example, infection and bleeding. Among the 239 midwives' cards studied, 18 recorded postpartum infection (see Table 2). This condition was coded if the midwife checked the space for fever on the postpartum section of the card, or noted fever or infection in her remarks. The fever could have been caused by postpartum sepsis, septic abortion, or by some other infection. [3] The midwives gave antibiotics to or referred for further treatment fewer than half of the infected women, lending support to the idea that a large proportion of these infections were not obstetric complications. Women with postpartum sepsis and septic abortion probably would have been either treated or referred.

Postpartum bleeding was noted on 167 (70 percent) of the 239 cards. Some of these women may have been bleeding after an abortion. In the original coding system, this variable was set up as a binomial variable, so no indication is given concerning the extent of bleeding. Of the women with bleeding, the midwives administered Methergin or Syntocinon to 40 percent.[4] Only three women were referred for further treatment.

In the Matlab maternity clinic, a variety of diagnoses might have been given to women with complications of induced abortion. The most straightforward, of course, was "induced abortion" or "possible induced abortion." As shown in the table, of the 300 admissions to the clinic during 1987-89, five women were admitted for induced abortion, and three women for possible induced abortion. Of these eight women, antibiotics were given to six, and dilatation and curettage (D&C) was performed on one. Three women were referred to hospitals in Dhaka or Chandpur, and three others refused referral.

At the maternity clinic, 13 women were admitted for postpartum infection. Some of these may have been postabortion rather than postpartum infections. All 13 women received antibiotics, two were given blood, and only one was referred to the hospital. Eleven women were admitted for postpartum hemorrhage. In eight cases, the women received antibiotics, two were given blood, one had a D&C, and four were referred.

Table 2 Diagnoses and treatment of women who presented with complications that may have been due to induced abortion, by service provider, Matlab, Bangladesh, 1987-89

	Service provider	
Diagnosis / treatment	**Midwives**	**Clinic**
Postpartum infection	18	13
Antibiotics	5	13
Blood	0	2
Referred	3	1
Postpartum bleeding	167	11
Antibiotics	49	8
Methergin	54	3
Syntocinon	14	1
Blood	0	2
Dilation and curettage	0	1
Referred	3	4
Induced abortion or possible induced abortion	-	8
Antibiotics	-	6
Dilation and curettage	-	1
Referred	-	3
Refused referral	-	3
(N)	(239)	(300)

- =Not available

Eclampsia and Pre-eclampsia

As was noted in Table 1, in the intervention area, four fewer deaths occurred from pre-eclampsia/eclampsia during the postintervention period than during the preintervention period. The records show that during the postintervention period, the midwives dealt with 49 women with pre-eclampsia, of whom six developed eclampsia (see Table 3). The midwives administered sedatives to 20 of these women, two of whom had eclampsia. Twenty women were referred to the maternity clinic for further treatment (including five of the six women with eclampsia).

During the same period, 54 women were admitted to the Matlab clinic with the primary diagnosis of pre-eclampsia or eclampsia. Sedatives were administered to 32 of these women, antihypertensive drugs to nine, and one woman had an instrumental delivery (that is, assisted by vacuum extraction or forceps). Fourteen women were referred for further treatment.

Prolonged and Obstructed Labor

Three fewer deaths due to prolonged or obstructed labor occurred in the intervention area during the post-intervention period than during the pre-intervention period. The midwives attended 77 women with prolonged labor (of whom half were noted as having malpresentation). The midwives gave antibiotics to about one-fifth of these women (see Table 4). This treatment could have reduced the likelihood of subsequent infection. About one-fifth of the women received Methergin or Syntocinon. More than half of the women with prolonged labor seen by the midwives were referred to a facility for further treatment.

Table 3: Diagnoses and treatment of pre-eclampsia and eclampsia, by service provider, Matlab, Bangladesh, 1987-89

	Service Provider	
Diagnosis / treatment	**Midwives**	**Clinic**
Pre-eclampsia and eclampsia	49	54
Sedatives	20	32

Antihypertensives	0	9
Instrumental delivery	0	1
Referred	20	14
(N)	(239)	(300)

Table 4: Diagnoses and treatment of prolonged labor, by service provider, Matlab, Bangladesh, 1987-89

	Service Provider	
Diagnosis / treatment	**Midwives**	**Clinic**
Prolonged labor	77	116
Antibiotics	17	68
Methergin	9	55
Syntocinon	5	46
Episiotomy	0	22
Instrumental delivery	0	16
Referred	40	32
(N)	(239)	(300)

Of the 300 admissions to the Matlab clinic, 116 were for prolonged or obstructed labor. Of these women, six in 10 were given antibiotics, and nearly nine in 10 were treated with Methergin or Syntocinon. Twenty-two women were given episiotomies, and 16 had instrumental deliveries. Thirty-two women (28 percent) were referred to a hospital for additional treatment.

Referrals

Of the 2,364 midwives' cards from the study period, referral was noted on 102 of the cards (4 percent). On 84, referral was noted on the labor and delivery section of the

card; on 18 it was noted on the postpartum section. The institution to which the woman was referred was coded only for labor and delivery referrals. Seventy of these 84 referrals (83 percent) were to the Matlab clinic, while the rest were to other facilities or providers. Assuming that all of the former group followed the midwives' recommendations, reached Matlab and were admitted, at most 88 women came to Matlab by way of the midwives (the 70 women explicitly referred there during labor and delivery, plus all 18 postpartum referrals).

Of the 300 admissions to the Matlab maternity clinic during the study period, 194 (65 percent) were from the intervention area and 99 (33 percent) were from the control area. As noted above, a maximum of 88 women were referred by the midwives. Thus, at least 106 women came to the Matlab clinic from the intervention area without being referred by a midwife.

Table 5: Admissions to the maternity clinic, by the area of residence, and proportion of admissions that were live births, Matlab, Bangladesh, 1987-89

Area of residence	**Admissions to Matlab clinic Percent (N)**	**Live births**	**Admissions as a proportion of live births**
Intervention area	65(194)	4,424	.044
Referred by midwives	29(88)	--	--
Not referred by midwives	35(106)	--	--
Control area	33(99)	5,206	.019
Other	2(7)	--	--
Total	100(300)	--	--

- = Not Applicable

Note: Intervention versus control area: relative risk = 2.31; Taylor series 95 percent confidence limits : 1.82;2.93

Using live births as a proxy for number of pregnancies, the proportion of pregnant women admitted to the Matlab clinic was .044 from the intervention area, as compared with .019 from the control area (see Table 5). Women from the intervention area were therefore 2.3 times more likely to be treated at the Matlab clinic than were their counterparts from the control area. The difference was statistically significant.

Referrals to Chandpur Hospital

Of the 300 admissions to the Matlab maternity clinic during the study period, 86 (29 percent) were referred for further care. Of these, nearly three-quarters (62) were referred to the government's district hospital in Chandpur.

For the years 1987-89, records at Chandpur Hospital were found for 154 women from the Matlab area. Of these, 56 had been referred from the Matlab maternity clinic, according to the clinic records. Of the women referred from the clinic, 34 were from the intervention area, 18 were from the control area, and four were from areas of Matlab not included in the maternity study. An additional 98 women from the Matlab area (including 15 from the intervention area and 49 from the control area) were admitted to the hospital in Chandpur without having been referred from the clinic. Table 6 show the movement of women with complications.

Table 6: Percentage distribution of admissions to Chandpur District Hospital maternity ward of women from the Matlab area, by area of residence, according to referral status, Bangladesh , 1987-89

Area of residence	**Referred from clinic** **Percent (N)**	**Not referred from clinic** **Percent (N)**	**Total admissions**	**Live births**	**Admissions as a proportion of live births**
Intervention area (N)	69(34)[a]	31(15)	100(49)	4,424	.011[b]
Control area (N)	27(18)	73(49)	100(67)	5,206	.013
Other Matlab (N)	11(4)	89(34)	100(38)	-	-
Total (N)	36(56)	64(98)	100(154)	-	-

- = Not Applicable

[a]Intervention versus control area : relative risk = 2.58; Taylor series 95 percent confidence limits: 1.67;4.00.

[b]Intervention versus control area : relative risk = .86; Taylor series 95 percent confidence limits: 0.60;1.24.

Among admissions to Chandpur from the intervention area, 69 percent had been referred from Matlab, as compared with 27 percent of admissions from the control area. This difference was statistically significant. However, using live births as a proxy, the proportion of pregnant women admitted to the Chandpur Hospital was .011 from the intervention area and .013 from the control area. This difference was not statistically significant.

Case Fatality Rates in Chandpur District Hospital

In the past, the level of maternal mortality in a hospital has been gauged by using the "hospital maternal mortality rate"-that is, maternal deaths in the hospital during the study period, divided by live births (or deliveries) in the hospital during the same period. This is not an appropriate measure, because it is greatly influenced by the proportion of deliveries in the hospital comprised of normal births. The case fatality or CFR (deaths among people with the condition of interest) is a more appropriate measure (Maine et al., 1992). Here the term is used to indicate maternal deaths among women admitted to the hospital with direct obstetric complications. Although it would be ideal to calculate CFRs for each major complication, the numbers are too small to yield meaningful results.

Table 7 shows the case fatality rates in the hospital among women from the entire Matlab area (including areas outside the intervention and control areas). Case fatality was not significantly different among women from the Matlab area who were referred by the maternity clinic compared with women who were not referred from the clinic. Excluding women from areas of Matlab that were not included in this study (that is, restricting the analysis to women from the intervention and control areas) does not materially alter the findings (not shown).

Table 7: Number of women admitted to Chandpur District Hospital, by referral status; total admissions, deaths, and case fatality rate, for all areas of Matlab, Bangladesh, 1987-89

Admissions /case fatality rate	Referred from Matlab clinic	Not referred from Matlab clinic
Admitted and died	3	3
Total admissions	56	98
Case fatality rate	.054	.031

Note: Referred from Matlab clinic versus not referred from Matlab clinic: relative risk = 1.75; Taylor series 95percent confidence limits: 0.37; 8.38

Table 8 shows the case fatality rates in the hospital among women from the study area. Case fatality was not significantly different among women from the intervention and control areas.

Discussion

The data presented above allow a consideration of which interventions could explain the decline in direct obstetric deaths in the intervention area of Matlab. They show that while the midwives provided first aid and treatment, they relied heavily on their ability to refer. Four in ten women with pre-eclampsia/eclampsia and five in ten women with prolonged labor were referred by the midwives. The midwives were also able to facilitate transport by boat. Together, these two interventions may account for the women from the intervention area's being more than twice as likely to be brought to the clinic in Matlab as were women from the control area, even though, of the two areas, the intervention area is the farther from the clinic.

Of course, the prerequisite to midwife referrals was the creation of a facility to which women could be referred. The Matlab maternity clinic did not exist prior to 1987. Though the clinic was established to treat women in the intervention area referred by the midwives, other women arriving with complications were not turned away. Referrals from midwives represented fewer than one-third of the 300 admissions to the clinic. More than a third of admissions came from the intervention area without explicit referrals. The remaining third of the women came to the Matlab clinic from the control

area, where no midwives were posted. This pattern of self-referral strongly suggests that if quality emergency obstetric services are available, substantial numbers of people will use them, even in the absence of community interventions encouraging use.

Table 8: Number of women admitted to Chandpur District Hospital, by referral status; total admissions, deaths, and case fatality rate, intervention and control areas of Matlab, Bangladesh, 1987-89

Admissions /case fatality rate	**Intervention area**	**Control area**
Admitted and died	1	2
Total admissions	49	67
Case fatality rate	.020	.030

Note: Intervention versus control area: relative risk = .68; Taylor series 95 percent confidence limits: 0.06; 7.33

The data suggest that the Matlab clinic provided an important amount of first aid and treatment of obstetric complications, but that clinic staff also relied heavily on their ability to refer and transport patients to the district hospital in Chandpur. For complications of possible induced abortion, antibiotics were given, but only two D&C procedures were performed. One-third of the women with possible induced abortion were referred for further treatment. For pre-eclampsia/eclampsia, Matlab clinic staff were able to administer life-saving sedative and antihypertensive drugs, but one-fourth of the cases were still referred. The situation was similar for women with prolonged and obstructed labor of which more than one-fourth were referred to higher level facilities.

Thus, while treatment by the midwives and the Matlab clinic staff might explain some of the deaths averted, an important role seems to have been to identify the serious cases (that is, those that might have resulted in death), and to channel them to Chandpur for cesarean section, blood transfusion, and D&C. The medical staff at the Matlab clinic were apparently aware of the limits of their facilities, and do not appear to have been hesitant about referring serious cases.

As is shown on the map (Figure 1 is missing), the intervention area lies considerably farther from Chandpur than does the control area. Thus, if the program had no effect, utilization of the Chandpur Hospital would be expected to be lower among women from the intervention area. In fact, no significant difference was found. Condition on arrival also might be expected to have been worse (and, consequently, case fatality rates to have been higher) among women from the intervention area, because they had to travel farther. Again, no significant difference was found. "No difference" thus represents a positive finding. Because the majority of women from the intervention area seen at Chandpur Hospital were referred from the Matlab clinic, these findings can at least partly be attributed to the program. Thus, midwives' and clinic staff's referral of women to the hospital at Chandpur, coupled with project transport, may have contributed to the decline in maternal deaths in two ways: It may have increased the number of women with complications from the intervention area who reached the hospital, and it may also have reduced the time it took them to get there.

While the government hospital at Chandpur was not part of the project, the chain of referral and transport that brought women from the intervention area depended upon the existence of a functioning hospital. The obstetric case fatality rate of below four percent at Chandpur Hospital is in the range of CFRs reported in other developing countries. Hospital studies in West Africa have shown rates of 1.9 to 8.0 percent (PMM Network, 1995). A survey of hospitals in India found mean district case fatality rates to range from 0.7 to 6.9 percent (Nirupam and Yuster, 1995). A reasonable standard for case fatality rate has been proposed as around 1 percent, provided patients arrive in time (Maine et al., 1992). While there may be room for improvement, the Chandpur Hospital seems to have been delivering services of reasonable quality during the period. The decline in maternal mortality is highly unlikely to have taken place in the absence of such a referral endpoint.

Limitations of the Data

The research context in Matlab is unique. Its surveillance system is more intensive and of longer duration than that for any other population in a developing country. Although data on the provision and use of various kinds of medical services have been emphasized here, these all lie within the context of the demographic surveillance system. Nevertheless, underreporting may still be a problem, especially in the midwives' records. The midwives may have treated women for complications, or told women to go to the clinic in Matlab, but not noted the treatment or referral on their cards. Even had such omissions occurred, they would not alter the modest conclusions presented here. Because the records at the Matlab clinic were in one register, they were not likely to have been lost. The quality of the record-keeping seemed fairly high. Some

records may have been lost in the Chandpur Hospital. (Only 10 percent of records of women referred from the Matlab clinic could not be found.) But unless the records of women from the intervention area were much more likely to be lost than those of women from the control area, the findings would not be changed.

Whether the diagnoses of the midwives, clinic staff, and hospital staff are either correct or comparable is not known. The most reliable diagnoses are likely to be those of the cause of death assigned in the demographic surveillance system, because they were made systematically and by one person only.

A key gap in the data is information on induced abortion. The decline in abortion deaths in the intervention area was the largest for any single cause of obstetric death. Providing induced abortions was not listed as one of the interventions in the study, but the government training for midwives includes early abortion. Although the Matlab midwives cannot be shown to have been directly responsible for the decline in abortion deaths, this finding serves as a reminder that safe abortion services are an important component of programs aiming to reduce maternal deaths in developing countries.

Conclusion

The new data presented here give a fuller picture of what happened in Matlab than has been available previously. Certainly, they underscore the importance of considering the full range of interventions, rather than attributing the reduction in deaths to a single component, for example, the posting of midwives to rural subcenters. The data indicate that the posting of midwives resulted in greater utilization of the Matlab clinic by women from the intervention area. They also show that considerable treatment of obstetric complications was provided by the midwives and the Matlab clinic. That the decline in deaths in the intervention area was at least partly due to treatment received from the midwives and the Matlab clinic (which was open around the clock and staffed by physicians) seems plausible. With a functioning chain of referral and proper transport, patients from the intervention area were able to get to the Matlab clinic and to Chandpur Hospital in greater numbers, and probably in better condition, than they might otherwise have done. Without the services at these two facilities, the decline in maternal mortality in Matlab is unlikely to have been achieved.

These new data from the Matlab Maternity Care strongly suggest that intervention at the community level alone is unlikely to result in a substantial reduction in maternal mortality. The contribution of community-level intervention to reducing maternal mortality depends upon the functioning of higher levels of the health system.

Authors' Note

Data on the level of maternal mortality from the comparison area of Matlab are available. This area was not included in the Maternity Care study, but is covered by ICDDR,B's demographic surveillance system. During the study period, the maternal mortality ratio for the comparison area declined substantially, although it remained higher than in the intervention area (Fauveau and Chakraborty, 1994: 123). The reasons for this decline are not known. What is clear (from research studies and from history) is that maternal mortality does not decline by itself (Loudon, 1992). Large decreases in maternal mortality ratios generally accompany improvements in access to emergency obstetric care (Maine, 1991). Unfortunately, information available from the comparison area is insufficient for an exploration of what these improvements might have been.

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Notes

[1] A direct obstetric death is defined as one attributable to complications of pregnancy and occurring during pregnancy, delivery, or within 42 days postpartum; this includes complications of induced abortion.

[2] The complications selected included: profuse bleeding; malpresentation of the baby; membranes ruptured > 12 hours; severe cervical/perineal tear; pre-eclampsia; assisted delivery; placenta retained > 30 minutes; referral to hospital or clinic; and maternal death.

[3] Because this variable was not specific to obstetric complications, it was not used as a criterion for selecting (via the existing data base) cards that were then located and studied. Of the 2,364 midwives' cards in the original data base, 85 cards noted fever during the postnatal period.

[4] Methergin and Syntocinon both cause contraction of the uterus, which can reduce bleeding. Syntocinon is more powerful, and can also be used to induce labor. Midwives were authorized to administer Methergin by injection and Syntocinon by nasal preparation.

References

1. Campbell, Oona M.R. and Wendy J. Graham. 1990. *Measuring Maternal Mortality and Morbidity: Levels and Trends.* London: Maternal and Child Health Epidemiology Unit, London School of Hygiene and Tropical Medicine.

2. Dixon-Mueller, Ruth. 1988. 'Innovations in reproductive health care: Menstrual regulation policies and programs in Bangladesh.' *Studies in Family Planning* 19,3:129-140.

3. Fauveau, Vincent and J. Chakraborty. 1988. 'Maternity Care in Matlab: Present Status and Possible Interventions." *Special Publication* No. 26. Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.

4. 1994. 'Women's health and maternity care in Matlab.' In *Matlab: Women, Children and Health.* Ed. Vincent Fauveau. Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh.P.134.

5. Fauveau, Vincent, Kate Stewart, S.A. Khan, and J. Chakraborty. 1991. 'Effect on mortality of community-based maternity-care programme in rural Bangladesh." *The Lancet* 338, 8,776: 1,183 - 1,186.

6. Graham, Wendy J., William Brass, and R. Snow. 1989. "Estimating maternal mortality: The sisterhood method.' *Studies in Family Planning* 20,3: 125-135.

7. Koenig, Michael A., Vincent Fauveau, A.I. Chowdhury, J. Chakraborty, and M.A. Khan. 1988. "Maternal mortality in Matlab, Bangladesh: 1976-85." *Studies in Family Planning* 19,2:69-80.

8. Loudon, Irvine. 1992. *Death in Childbirth: An International Study of maternal Care and Maternal Mortality 1800-1950.* Oxford: Clarendon Press.

9. Maine, Deborah. 1991. *Safe Motherhood Programs: Options and Issues.* New York: Columbia University Center for Population and Family Health.

10. Maine, Deborah, James McCarthy, and Victoria M. Ward. 1992. *Guidelines for Monitoring Progress in the Reduction of Maternal Mortality.* New York: United Nations Children's Fund.

11. Nirupam, Siddharth and E. Alexandra Yuster. 1995 "Emergency obstetric care: Measuring availability and monitoring progress.' In*ternational Journal of Gynecology and Obstetrics* 50, Supplement 2: 79-88.

12. PMM Network. 1995. 'Situation analyses of emergency obstetric care facilities: Examples from eleven sites in West Africa.' *Social Science and Medicine* 40,5: 657-667.

13. World Bank. 1993. *World Development Report 1993: Investing in Health:* Oxford, New York: World Bank.

14. World Health Organization. 1991. *Essential Elements of Obstetric Care at First Referral Level.* Geneva: World Health Organization.