Papers

Caesarean section in Malawi: prospective study of early maternal and perinatal mortality

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Abstract

Objective To examine potentially modifiable factors that may influence the high maternal and perinatal mortality associated with caesarean section in Malawi.
Design A prospective observational study of 8070 caesarean sections performed between January 1998 and June 2000 and associated complications.
Setting 23 district and two central hospitals in Malawi.
Participants 45 anaesthetists from hospitals that carried out caesarean sections.
Main outcome measures Associations between maternal or perinatal deaths in the first 72 hours and various quantifiable risk factors.
Results Questionnaires were returned for 5236 caesarean sections in district hospitals and 2834 in central hospitals; 7622 (94%) were emergencies, 5110 (63%) were because of obstructed labour. Preoperative haemorrhagic shock was present in 610 women (7.6%), anaemia in 503 (6.2%), and ruptured uterus in 333 (4.1%). Eighty five women died (1.05%), 68 of whom died postoperatively on the wards. Higher maternal mortality was associated with ruptured uterus (adjusted odds ratio 2.3, 95% confidence interval 1.3 to 4.0), little anaesthetic training (2.9, 1.6 to 5.1), general as opposed to spinal anaesthesia (6.6, 2.3 to 18.7), and blood loss requiring transfusion of ≥2 units (21.0, 11.7 to 37.7). Perinatal mortality up to 72 hours was 11.2% overall and was significantly associated with ruptured uterus and general rather than spinal anaesthesia.
Conclusion In sub-Saharan Africa high maternal and perinatal mortality at caesarean section is associated with major preoperative complications that are unusual in developed countries. Improved training in anaesthetics, wider use of spinal anaesthesia, and improved surveillance and resuscitation in postoperative wards might reduce mortality.

Introduction

Caesarean section is the most common major surgical procedure in sub-Saharan Africa,[1] although the caesarean section rate is only 9% in central hospitals and 1% in rural hospitals.[2 3] Most caesarean sections are performed as emergencies without preoperative preparation. Anaemia, hypovolaemia, and sepsis from obstructed labour and ruptured uterus are common. Despite its importance, there are few published data on caesarean section in Africa,[4] and published studies have been small[5] or retrospective.[6]

In 1982 maternal mortality in one district of Malawi was reported as 420/100 000 pregnancies,[7] and in 1992 in the whole of Malawi it was 620/100 000.[8] It has since risen to an estimated 1120 per 100 000[9] compared with 10 per 100 000 in developed countries. Caesarean section has a much higher mortality for mother and baby in Africa than in industrialised countries,[10] and improvements may be possible.

Proposals for change would have to take account of limited resources. The per capita health expenditure in Malawi is about 260-350 Kwacha (£1.80-2.40, $3-4, €2.6-3.5) a year, while around one in three pregnant women in urban areas are HIV positive.[9 11] There is a shortage of doctors, at one per 27 000 population in 1985-90.[12] Many countries, including Malawi, rely heavily on paramedical health workers. Anaesthetists are clinical officers who have trained in anaesthetics for 15 months after a three year foundation health course. Surgery may be carried out by doctors or clinical officers who have four years' general and surgical training.

We carried out a multicentre prospective study to identify potentially modifiable risk factors for maternal mortality during or after caesarean section in district and central hospitals in Malawi. We had four primary objectives: to examine whether mortality occurred mainly in the perioperative period or postoperatively on the wards, to explore differences between outcomes in district and central hospitals and the impact of level of training of surgeons and anaesthetists, to examine potentially modifiable risk factors, including blood loss and the use of transfusion, and to determine whether method of anaesthesia affected mortality.

Methods

We invited all anaesthetists from 27 of the 35 hospitals in Malawi that perform caesarean section to record prospectively the course and outcome of caesarean sections performed between January 1998 and June 2000. Two hospitals were central hospitals, generally serving the urban populations, and 25 were district hospitals, serving the rural population. In conformity with local practice caesarean section was defined as any operation to deliver the baby (live or dead) through the abdomen after 28 weeks' gestation, including surgery for ruptured uterus. Participating anaesthetists were

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Table 1 Numbers of caesarean sections in different categories and maternal and perinatal mortality

	No of caesarean sections	No (%) of maternal deaths	No (%) of perinatal deaths
Hospital:			
District	5236	68 (1.3)	710 (13.6)
Urban	2834	17 (0.6)	197 (7.0)
Uterus:			
Ruptured	333	35 (11)	285 (86)
Not ruptured	7737	50 (0.65)	622 (8)
Surgeon:			
Medically qualified	2814	18 (0.64)	224 (8.0)
Clinical officer	5256	67 (1.3)	682 (13.0)
Anaesthetist:			
Trained	7367	68 (0.9)	823 (11.2)
Untrained	703	17 (2.4)	84 (12)
Anaesthesia:			
Spinal	3136	4 (0.13)	141 (4.5)
General	4934	79 (1.6)	760 (15.4)

asked to complete data forms reporting at least 20 consecutive caesarean sections that came under their management. Data recorded included indication for caesarean section, number of previous caesarean sections, preoperative complications such as anaemia or fever, status and training of anaesthetists and surgeons, estimated blood loss, overall need for blood transfusion, and type of anaesthetic. To avoid bias we did not restrict the study to better equipped hospitals. Reliable methods of measuring haemoglobin and functioning sphygmomanometers are not always available. The mother's status was usually assessed on clinical grounds only, as in many hospitals in sub-Saharan Africa. No constraints were placed on choice of technique for anaesthesia, which was determined by availability as well as anaesthetist's preference. Major outcomes were death during induction or maintenance of, or recovery from, anaesthesia and surgery, and up to 72 hours postoperatively on the ward. Birth outcome and the survival of the baby at 72 hours were also recorded. Cause of death was not recorded as we considered that this might be unreliable without postmortem facilities.

One of us (PMF) trained each participating anaesthetist to record operative and postoperative events and then checked the data sheets against hospital theatre records during routine district visits. Data sheets were collected for batches of 20 consecutive cases to minimise selective reporting. If details of a case did not tally with those in the operating theatre log or had not been recorded contemporaneously, the batch was rejected and the anaesthetist given further training. When records were repeatedly unreliable the source was not included in the study.

The data were entered into EpiInfo (version 6) and analysed with Stata 7 (StataCorp, College Station, TX). Uncorrected odds ratios for maternal and perinatal death were calculated with logistic regression and adjusted for prespecified potential confounding. Prespecified potential confounding factors were rural setting, previous caesarean section, haemorrhage, other medical complication, and level of training of surgeon and anaesthetist. Other potential confounding factors for particular risk factors were tested for each of the reported outcomes, including tests for interactions. None were found to be confounding factors for major outcomes, and the final model was the same for all adjusted analyses. We also analysed the data using anaesthetists as the primary sampling unit but as this made no significant difference to outcome it is not reported here.

Results

We accepted reports for 8070 operations; 2834 (35%) were performed in two central hospitals and 5236 in 23 district hospitals. No valid data forms were forthcoming from two hospitals. A further 440 records from eight anaesthetists were rejected as they were potentially inaccurate in representing clinical events. Ten batches (200 cases) were rejected because they contained data subsequently transcribed from other sources, rather than being a contemporary record. There were discrepancies between the form and other verifiable sources of data such as between timing recorded on the form and that in the theatre log in nine batches (180 cases). In three batches (60 cases) events were reported that seemed unlikely or inconsistent.

In total 7622 operations (94%) were emergencies. The indication was related to obstructed labour in 5110 (63%) operations, with a similar proportion in central and district hospitals. Fetal distress (885, 11%), antepartum haemorrhage (384, 5%), and pre-eclampsia (268, 3%) were less common indications. The most common serious preoperative complications were haemorrhagic shock (610, 8%) and ruptured uterus (333, 4%) (5% of cases in district hospitals and 4% of cases in central hospitals). Preoperative anaemia was also common.

Data were accepted from 45 anaesthetists, all of whom were paramedics. In 703 caesarean sections (9%), anaesthesia was provided by individuals who had

Table 2 Risk factors for maternal death and perinatal death, unadjusted and adjusted for possible confounding factors*

	Maternal death			Perinatal death†		
	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P value	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P value
District *v* central hospitals	2.1 (1.2 to 3.7)	1.1 (0.6 to 2.2)	0.8	2.1 (1.8 to 2.5)	1.4 (1.1 to 1.8)	0.007
Ruptured uterus *v* other presentations	18.1 (11.5 to 28.3)	2.3 (1.3 to 4.0)	0.006	68.0 (49 to 93)	31.4 (22 to 45)	<0.001
Clinical officer surgeons *v* medically qualified surgeons	1.8 (1.0 to 3.1)	1.4 (0.7 to 2.9)	0.4	1.7 (1.4 to 2.0)	1.1 (0.8 to 1.3)	0.6
Untrained *v* trained anaesthetists	2.7 (1.6 to 4.6)	2.9 (1.6 to 5.1)	<0.001	1.1 (0.8 to 1.4)	1.0 (1.5 to 2.1)	0.96
General *v* spinal anaesthesia	13.1 (4.7 to 35)	6.6 (2.3 to 18.7)	<0.001	3.9 (3.2 to 4.7)	1.8 (1.5 to 2.3)	<0.001

*Rural setting, previous caesarean section, haemorrhage, other preoperative medical complication, and level of training of surgeon and anaesthetist.
†Includes stillbirth and death up to 72 hours after delivery.

Table 3 Types of anaesthesia as risk factors for early maternal and perinatal mortality after caesarean section, unadjusted and adjusted for possible confounding factors*

	Maternal death			Perinatal death		
	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P value	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P value
General *v* spinal anaesthesia:						
All patients	13.1 (4.7 to 35)	6.6 (2.3 to 18.7)	<0.001	3.9 (3.2 to 4.7)	1.8 (1.5 to 2.3)	<0.001
Restricted†	5.4 (1.9 to 15.4)	4.4 (1.5 to 12.8)	0.006	2.1 (1.7 to 2.6)	1.7 (1.4 to 2.1)	<0.001
Inhalation general *v* spinal anaesthesia, restricted‡	5.1 (1.8 to 14.8)	4.2 (1.5 to 12.4)	0.008	2.0 (1.7 to 2.5)	1.7 (1.4 to 2.1)	<0.001
Halothane (n=3124) *v* ether (n=1629)	1.2 (0.7 to 2.1)	0.75 (0.4 to 1.4)	0.4	1.3 (1.1 to 1.5)	0.93 (0.7 to 1.2)	0.5
Ketamine *v* other methods of anaesthesia	11.9 (6.8 to 20.9)	2.9 (1.5 to 5.2)	<0.001	13.6 (9.6 to 19.0)	6.2 (4.1 to 9.3)	<0.001

*Rural setting, previous caesarean section, haemorrhage, other preoperative medical complication, level of training of surgeon and anaesthetist.
†Restricted to the 7460 without preoperative haemorrhage.
‡Restricted to the 7408 without preoperative haemorrhage not given ketamine.

received on the job training but had no formal training in anaesthetics. Surgeons were paramedics in 5256 operations (65%), intern doctors in 1739 (22%), registrars in 324 (4%), general doctors in 495 (6%), and specialists in 256 (3%).

Eighty five women died, giving a mortality of 1.05%. Fifteen deaths occurred on the operating table, two in recovery, and 68 on the wards. Of those who died on the wards, 58 women (68% of all deaths, 85% of ward deaths) died in district hospitals between the first and third postoperative days. Table 1 shows the numbers of maternal and perinatal deaths by hospital type, training of surgeon and anaesthetist, ruptured uterus, and method of anaesthesia. Table 2 shows the unadjusted and adjusted odds ratios, stratified by prespecified confounding factors.

Table 3 gives the association of method of anaesthesia with early maternal and perinatal mortality after caesarean section. Preoperative haemorrhage and hypotension are contraindications to spinal anaesthesia, and ketamine is used in only severely ill women. To reduce possible bias we also calculate the comparisons restricted to women without these major risk factors. The adjusted odds ratio for maternal death with general compared with spinal anaesthesia fell from 6.6 to 4.4 when we used this restricted analysis.

Ruptured uterus was present in 333 women, 35 of whom died (41% of deaths); 245 of these women (74%) had had no previous caesarean section (70% of all women and 80% of those who died had had no previous caesarean section, table 4). Other complications believed to contribute to mortality were intraoperative hypotension (64, 75% of deaths), operative haemorrhage (45, 53%), ventilation difficulty (12, 14%), regurgitation of stomach contents (11, 13%), pre-eclampsia (7, 8%), and difficult intubation (1, 1%). In 65 (77%) cases in which the mother died, the baby also died. The overall three day survival rate for all babies was 88.8%.

Anaesthetists estimated how much blood was needed and recorded how much was given. The numbers of deaths at each level of deficit are given in table 5. There was a strong association between increasing blood deficit and mortality (χ^2 for trend up to 3 units: 1041, $P<0.0001$). In 45 (53%) of those who died and in 128 (1.6%) of those who survived the blood deficit was ≥ 2 units. The odds ratio for death in those with more than two units' deficit was 68 (43 to 108). After adjustment for pre-existing medical complications, excluding haemorrhage and the pre-specified potential confounding factors, the odds ratio was 22.1 (10.8 to 45.2). The unadjusted odds ratio for maternal death among women who needed ≥ 2 units, whether or not it was available, was 55.1 (32 to 93) (adjusted 21.0, 11.7 to 37.70). Participating centres estimated blood loss more accurately in the last 5198 consecutive cases. In these, the median estimated intraoperative blood loss was 800 ml (interquartile range 350-1200) in those who died and 300 ml (250-450) in those who survived ($P<0.0001$).

The adjusted odds ratios show that perinatal mortality was higher in the presence of ruptured uterus and lower with spinal anaesthesia compared with inhalational anaesthesia and with all other types of anaesthesia (see table 3).

Discussion

From this observational study of caesarean section in Malawi we have identified potentially modifiable risk factors for early maternal and perinatal mortality. As caesarean section is the most common surgical procedure in Africa, combinations of small advances may have a considerable effect. Observational studies of this kind are subject to several potential biases, which the study design and analysis can minimise but never entirely remove, but the size of most associations seen suggests that our findings are robust.

Maternal mortality

The observed maternal death rate of 1.05%, though high by the standards of developed countries, is lower than the official overall maternal mortality for much of sub-Saharan Africa.[9] The figures are not directly comparable as we recorded deaths occurring only during surgery and the subsequent 72 hours (further follow up would not have been accurate), whereas maternal death is defined as that occurring throughout pregnancy and up to six weeks postpartum. Among the many women who experience obstructed labour,

Table 4 Previous caesarean section and death from ruptured uterus

	Total	Ruptured uterus		Deaths from all causes
		No (%)	Deaths	
Previous caesarean	2442	88 (3.6)	7 (8)	17 (0.7)
No previous caesarean	5628	245 (4.4)	28 (11)	68 (1.2)
All	8070	333 (4.1)	35 (11)	85 (1.1)

Table 5 Association between maternal mortality and deficit between units of blood required and units of blood available and given

Estimated deficit	No of mothers	No (%) of deaths
0	7391	25 (0.3)
1	504	15 (3)
2	147	25 (17)
3	27	19 (70)
4	1	1 (100)

however, those who make it to the operating theatre are the lucky ones. Many obstacles stand between women and obstetric intervention.

During the period studied about 18 000 caesarean sections would have been conducted in Malawi; 8070 caesarean sections therefore represents about 45% of the total. Both preoperative morbidity and maternal and perinatal mortality were high. Obstructed labour—with its serious consequences of ruptured uterus and maternal haemorrhage, sepsis, and anaemia—was the principal indication for caesarean section and was significantly associated with both maternal and perinatal mortality. Much of this may be explained by preoperative haemorrhage; the adjusted odds ratio for maternal death was much lower among women who did not bleed excessively (unstratified odds ratio 18.1; 6.4 when stratified only by preoperative haemorrhage). Women who had previously experienced caesarean section had a marginally smaller blood loss and a lower death rate from ruptured uterus. Reduced bleeding when uterine rupture occurs at the site of a previous caesarean scar may contribute to a reduced death rate in these circumstances.

Other risk factors

Other, potentially modifiable, factors in maternal death were level of training of the anaesthetist, blood loss, and type of anaesthetic. Non-medically qualified clinical officers, who are likely to remain the backbone of medical services in much of Africa, performed most operations and gave all anaesthetics. Not all those giving anaesthetics were formally trained to do so, which may have had a large impact on early maternal mortality.

Greater blood loss was strongly associated with mortality. This association may not be causal in all cases as blood loss may reflect other intraoperative problems. Fluid replacement alone, however, may improve outcome, is relatively cheap and safe,[4 13] and does not carry the same risks as blood transfusion, particularly in areas of high HIV incidence. Considering the largely haemodynamic nature of the complications, as estimated by the anaesthetists, their own role would seem to be important in all stages of management, though the skills needed are more in basic resuscitation and follow up on the ward than in advanced knowledge of techniques in anaesthesia.

While we cannot exclude some residual confounding, our results show that spinal anaesthesia may be safer than general anaesthesia for caesarean section among women without depletion of blood volume. It is a cheap and simple option that requires minimal monitoring. There was little difference in maternal safety between inhalational anaesthetics used for general anaesthesia. Ether, the cheaper of the two available options, might therefore be a more logical choice than halothane in less wealthy countries. The group given ketamine cannot easily be compared with those given other types of anaesthetic as ketamine is reserved for severely ill women.

Few studies have examined caesarean section in sub-Saharan Africa. A prospective review of operative obstetric mortality among 9833 operations carried out in Zimbabwe, 1992-4, identified 22 deaths within 24 hours after surgery, probably mostly caesarean section.[14] All but one of the deaths were associated with the use of general anaesthesia. The author acknowledged that, had the period of observation been longer, the death rate would have been higher. Our observation, that most deaths (80%) occurred in the wards postoperatively, would support this.

Improving safety of caesarean section in Africa

In the United Kingdom the overall death rate associated with caesarean section fell from 40/10 000 in 1952-4 to 4/10 000 in the 1980s.[15] Despite the possibly 25-fold higher overall mortality for caesarean section in Malawi than in the United Kingdom, the lives of almost 90% of women with ruptured uterus were nevertheless saved, while the severity of preoperative haemorrhage, sepsis, and anaemia would be unheard of in developed countries.

We have indicated some achievable actions that might have a considerable impact on maternal and perinatal mortality in a low resource setting. Better fluid resuscitation and training in spinal anaesthesia are two, although a randomised study would be needed to ascertain whether greater use of spinal anaesthesia could save lives. Possibly our most striking finding is

What is already known on this topic

Maternal mortality is a major problem in the developing world and is highest in sub-Saharan Africa

Emergency caesarean section is the most common surgical procedure in sub-Saharan Africa

In most cases caesarean section saves the life of the mother, even though hypovolaemia, anaemia, and sepsis from obstructed labour and ruptured uterus are often present

What this study adds

In Malawi maternal mortality associated with caesarean section was 1.05%, and 80% of deaths occurred postoperatively on the wards; perinatal mortality was 11.2% up to 72 hours

Ruptured uterus, blood loss (but not transfusion deficit), general as opposed to spinal anaesthesia, and limited training of the person giving the anaesthetic were all factors associated with maternal death

Perinatal mortality was associated with ruptured uterus and general rather than spinal anaesthesia

Improving training in anaesthesia and postoperative surveillance might reduce mortality

the predominance of deaths on the ward, and the postoperative ward may be the most important place to concentrate efforts. More training of anaesthetic clinical officers in Africa to improve their basic resuscitation skills and extend their role into the postoperative period might have an important impact on mortality associated with caesarean section.

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Ethical approval: The study was conducted according to the ethical guidelines laid down for observational studies of routine medical practice by the Government of Malawi and the University of Malawi College of Medicine Research Committee.

1 Fenton PM. The epidemiology of district surgery in Malawi. *East Cent Afr J Surg* 1997;3:33-41.

2 Nordberg E. Incidence and estimated need of caesarean section, inguinal hernia repair and operation for strangulated hernia in rural Africa. *BMJ* 1984;289:92-3.

3 Cisse CT, Faye EO, de Bernis L, Dujardin B, Diadhiou F. Cesarean sections in Senegal: coverage of needs and quality of services. *Sante* 1998;8:369-77.

4 Fenton PM, Blood transfusion for caesarean section in Malawi. A study of requirements, amount given and effect on mortality. *Anaesthesia* 1999;54:1055-8.

5 Zishirir C, Shodu LK, Tshimanga M, Nyirongo L. Post-natal maternal morbidity patterns in mothers delivering in Gweru City (Midlands province). *Cent Afr J Med* 1999;45:234-9.

6 National Committee of the Confidential Enquiries into Maternal Deaths. A review of maternal deaths in South Africa during 1998. *S Afr Med J* 2000;90:367-73.

7 Chiphangwi J, Zamaere TP, Graham WT. Maternal mortality in the Thyolo district of Malawi. *East African Med J* 1992;69:675-9.

8 National Statistical Office (Malawi) and ORC Macro. *Malawi Demographic Health Survey, 1992*. Zomba: National Statistical Office, 1993.

9 National Statistical Office (Malawi) and ORC Macro. *Malawi Demographic and Health Survey 2000*. Zomba: National Statistical Office of Malawi, 2001.

10 Hussein J, Goodburn EA, Damisoni H, Lema V, Graham W. Monitoring obstetric services: putting the "UN guidelines" into practice in Malawi: 3 years on. *Int J Gynaecol Obstet* 2001;75:63-73.

11 Taha ET, Dallabetta GA, Hoover DR Chiphangwi JD, Mtimavalye LA, Liomba GA, et al. Trends of HIV-1 and sexually transmitted diseases among pregnant and postpartum women in urban Malawi. *AIDS* 1998;12:197-203.

12 *Better health in Africa: lessons and experiences learned*. Washington, DC: World Bank, 1994. (Table A-11, statistical appendices.)

13 Hardy JF, Fenton PM, Effectiveness of blood transfusion in Malawi. *Anaesthesia* 2000;55:613-4.

14 McKenzie AG. Operative obstetric mortality at Harare Central Hospital 1992-4: an anaesthetic view. *Int J Obstetric Anesthesia* 1998;7:237-41.

15 Morris S, Harmer M, Reynolds F. The impact of regional anaesthesia on maternal mortality. In: Reynolds F, ed. *Regional analgesia in obstetrics*. London: Springer, 2000:347-56.

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