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ORIGINAL RESEARCH

Perioperative management of caesarean section-related haemorrhage in a maternal near-miss population: a retrospective study

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Background: Maternal near-miss (MNM) is a risk stratification for maternal morbidity. The purpose of this study was to describe the perioperative care given in the management of this particular population of women who have undergone a caesarean section (CS).

Methods: This was a retrospective, descriptive study at a single tertiary institute over a one-year period (1 January to 31 December 2018) at the Chris Hani Baragwanath Academic Hospital. The aim of this study was to describe the anaesthetic and surgical management of CS-related haemorrhage in an MNM population. The primary objectives were to determine the MNM rate from CS-related obstetric haemorrhage during the study period and to describe the intervention strategies employed in perioperative management for women with CS-related obstetric haemorrhage. The secondary objectives were to determine factors associated with massive transfusion and major estimated blood loss. The primary outcome was the MNM rate for CS deliveries.

Results: A total of 8 306 women had CS of whom 105 (1.26%) were classified as MNM due to bleeding during and after the procedure. The median age was 28, with a median parity of 2 (44%), and overall estimated median (IQR) blood loss volume of 1 800 (1 200–2 100) ml. The leading cause of haemorrhage was postpartum haemorrhage (87%). Eighteen (17%) of the women had relook surgery for postpartum CS sepsis. Age and parity of ≥ 3 had a univariate association with major estimated blood loss. The use of general anaesthesia and parity of ≥ 3 had an adjusted association with the institution of massive transfusion protocol (adjusted odds ratio [aOR] 5.28, 95% confidence interval [CI] 1.03–27.01 and aOR 3.88, 95% CI 1.47–10.25, respectively).

Conclusion: MNM from bleeding during or after a CS occurred in approximately 1 in 80 women who delivered by CS. These women required multiple interventions to arrest the haemorrhage and to achieve haemodynamic stability. Women with a higher parity and undergoing general anaesthesia were associated with severe bleeding. Approximately 1 in 4 women required an exploratory laparotomy and less than 7% required a hysterectomy.

Keywords: maternal near-miss, obstetric haemorrhage, postpartum haemorrhage, caesarean section

Background

The World Health Organization (WHO) considers any health condition attributed to or aggravated by pregnancy and childbirth which has negative effects on maternal wellbeing, as maternal morbidity.[1] Severe acute maternal morbidity is also referred to as a maternal near-miss (MNM) and has been defined by the WHO as any woman who nearly dies from either a complication of pregnancy or within 42 days of delivery or termination of the pregnancy.[1] The MNM classification was first described by Mantel et al.[2] who subdivided these criteria into an organ-based system classification (end organ dysfunction) and a management-based system classification (emergency hysterectomy and massive blood transfusion), and which has been widely used internationally.

Although caesarean section (CS) has been shown to reduce maternal and neonatal adverse outcomes, the increase in CS in high-income countries has not translated into improvements for maternal outcomes,[3] where very high rates of CS may lead to increases in mortality. Concomitantly, very low CS rates as seen in low- and middle-income countries due to the lack of access to CS may also substantially increase mortality. Maternal morbidity from perioperative haemorrhage is a cause for concern. Postpartum haemorrhage (PPH) after CS accounts for 9.3% and 45.7% of maternal deaths, in high- and low-income countries respectively.[4,5]

In our institution, the prevalence of MNM and its perioperative course and management, which depends on a multidisciplinary team, has not been well described. The aim of this study is to describe the anaesthetic and surgical management of CS-related haemorrhage in an MNM population.

Methods

This was a single centre, observational study at the Chris Hani Baragwanath Academic Hospital (CHBAH) maternity theatre complex. CHBAH is a tertiary state hospital attached to the University of the Witwatersrand. It is situated in Soweto, a suburb of Johannesburg, and serves a majority African population with a lower- to middle-income socio-economical background. It houses approximately 3 700 beds, 300 of which are obstetric, with an average of 4 500 CSs performed per annum.[6]

This study has a retrospective, contextual and descriptive design. Approval to conduct the study was granted by the University of Witwatersrand Human Research Ethics Committee (M190516). Data were extracted from the medical records of

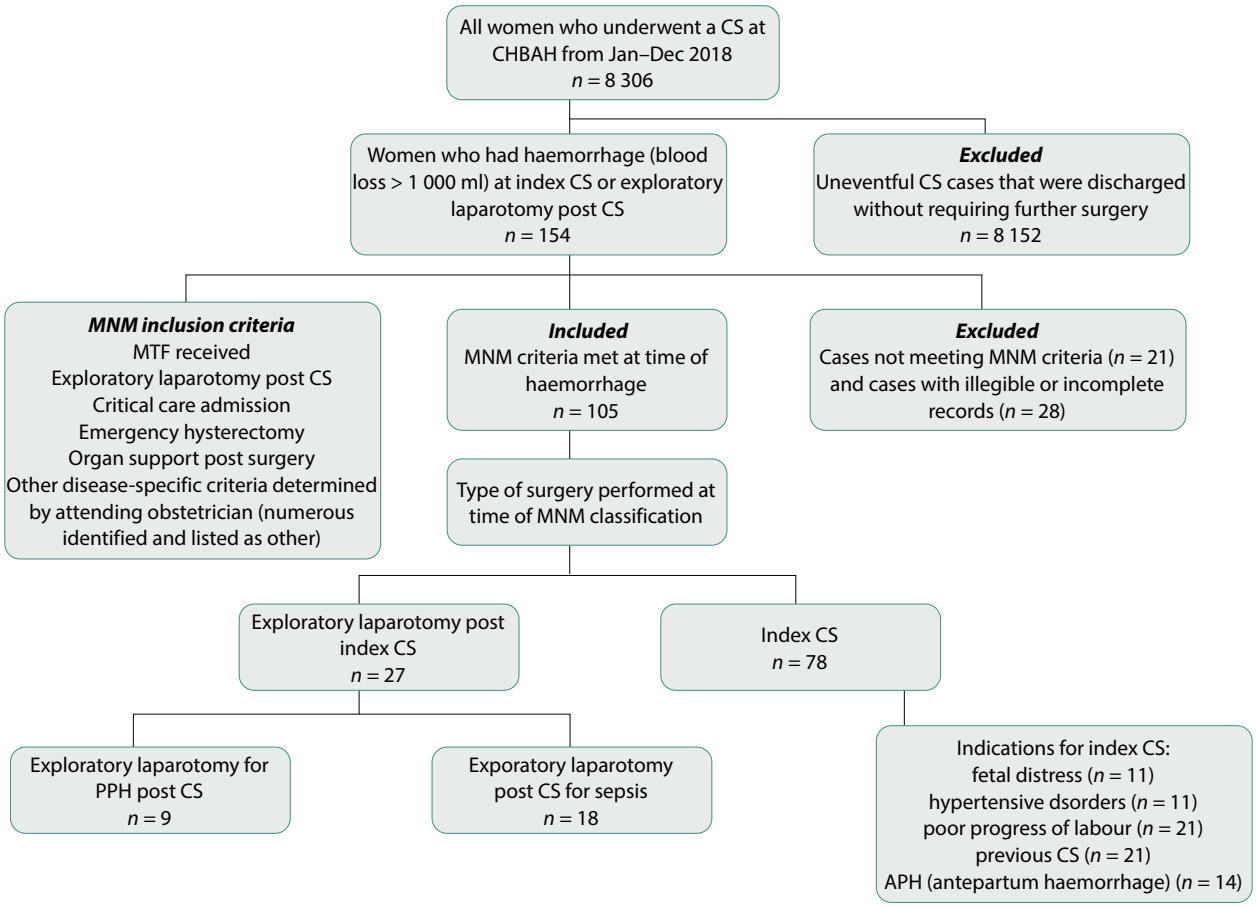

Figure 1: STROBE flow diagram of inclusion and exclusion criteria

Table I: Demographic and clinical characteristics with estimated blood loss

Variable		Proportions	Estimated blood loss in ml	*p*-value
		n (%)	median (IQR)	
Age in years	≤ 27	50 (48)	1 500 (1 200–2 000)	0.0045
	> 27	55 (52)	1 800 (1 300–2 250)	
Parity	1	20 (19)	1 450 (1 200–1 950)	0.0185
	2	47 (45)	1 600 (1 200–2 000)	
	3	24 (23)	2 125 (1 500–2 450)	
	4	13 (12)	1 800 (1 400–2 000)	
ASA status	1	40 (38)	1 550 (1 200–2 025)	0.8043
	2	48 (46)	1 800 (1 225–2 100)	
	3	17 (16)	1 800 (1 300–2 250)	
Main cause of haemorrhage	Antepartum	2 (2)	1 400 (1 000–1 800)	0.0002
	Intrapartum	5 (5)	1 200 (1 100–1 300)	
	Postpartum	86 (82)	2 000 (1 500–2 150)	
	Combination	12 (11)	2 400 (2 100–2 500)	
Primary indication for surgery	APH	14 (13)	2 250 (2 000–2 500)	< 0.001
	Hypertensive disorder	11 (11)	1 800 (1 200–2 000)	
	Fetal distress	11 (11)	1 300 (1 050–2 050)	
	Poor progress of labour	21 (20)	2 000 (1 600–2 250)	
	Previous CS	21 (20)	2 000 (1 600–2 100)	
	PPH post CS	9 (9)	1 250 (1 200–1 400)	
	Relook laparotomy for sepsis post CS	18 (17)	1 175 (1 080–1 300)	
Timing of surgery	Day	32 (31)	1 550 (1 150–2 200)	0.5529
	Night	73 (70)	1 800 (1 250–2 050)	
Type of surgery	CS	78 (74)	1 900 (1 400–2 200)	< 0.0001
	EL post CS	27 (26)	1 175 (1 100–1 300)	

MNM – maternal near-miss, APH – antepartum haemorrhage, PPH – postpartum haemorrhage, EL – exploratory laparotomy, CS – caesarean section

women who underwent a CS during the period 1 January to 31 December 2018 and who met the criteria for MNM and intra- or postoperative haemorrhage with an estimated blood loss (EBL) > 1 000 ml. At the CHBAH, a modified WHO MNM criteria was used, reflecting only the intervention classification suitable to limited resource settings: hysterectomy; exploratory laparotomy; ventilation; intensive care unit (ICU) admission; dialysis; and massive transfusion (MTF). MTF is defined as transfusion of ≥ 4 units of packed red cells (PRC). Major EBL is defined as ≥ 2 000 ml which is consistent with the Royal College of Obstetricians and Gynaecologists (RCOG) guidelines.[7]

The primary objectives of this study were to determine the MNM rate from CS-related obstetric haemorrhage during the study period and to describe the intervention strategies employed in the perioperative management of women with CS-related obstetric haemorrhage. The primary outcome was the MNM rate for CS deliveries. The secondary objectives were to determine the factors associated with MTF and major EBL. Two subpopulation groups were delineated based on the timing of haemorrhage and MNM classification: women who were identified as MNM at the time of CS delivery; and those who were identified as MNM at the time of an exploratory laparotomy after CS.

Statistical analysis

Descriptive statistics were used to analyse numerical data. Demographic data were presented as median and interquartile range (IQR) because data were not normally distributed, and categories were reported as proportions and percentages. Parametric data were compared using the Mann–Whitney and Wilcoxon test and the Kruskal Wallis test which are used to compare three and more datasets. Associations were determined by using univariate regression analysis between MTF and clinically relevant variables and major EBL and clinically relevant variables. The results of the univariate regression analysis with a *p*-value of ≤ 0.1 were included in the multivariable regression analysis. Statistical significance was set at $p < 0.05$. Results were analysed using SAS© version 9.4 (SAS Inc. Cary, NC, USA).

Results

A total of 105 (1.26%) out of 8 306 women were classified as MNM due to bleeding during and after CS during the study

Table II: Comparison between estimated blood loss and management strategies

Variable		Proportions	Estimated blood loss in ml	*p*-value
		n (%)	median (IQR)	
Anaesthesia technique	Spinal	23 (23)	1 400 (1 100–1 800)	0.0007
	GA	48 (47)	1 400 (1 175–2 000)	
	Conversion	31 (30)	2 000 (1 500–2 300)	
Blood product administration	PLT only	1 (1)	1 500 (1 500–1 500)	< 0.001
	PRC only	37 (41)	1 500 (1 150–1 800)	
	PRC + FFP	16 (18)	1 500 (1 200–2 050)	
	PRC + PLT	5 (6)	1 300 (1 200–2 000)	
	PRC + FFP + PLT	29 (32)	2 200 (2 000–2 300)	
	PRC + FFP + PLT + cryoprecipitate	3 (3)	2 600 (2 500–2 700)	
IV fluids	Crystalloids only	66 (65)	1 600 (1 200–2 100)	0.1329
	Crystalloids and colloids	36 (35)	2 000 (1 350–2 100)	
Tranexamic acid use	Yes	68 (65)	2 000 (1 300–2 225)	0.0003
	No	37 (35)	1 300 (1 150–1 800)	
Uterotonic drugs	Oxytocin	53 (52)	1 800 (1 200–2 000)	0.1657
	Oxytocin + ergometrine	50 (49)	1 800 (1 400–2 200)	
Surgical intervention	B-Lynch procedure	14 (14)	2 000 (1 800–2 100)	< 0.0001
	Balloon tamponade	18 (17)	2 200 (1 900–2 300)	
	Hysterectomy	7 (6.73)	2 200 (1 200–2 500)	
	Other	37 (36)	1 300 (1 150–2 000)	
	Not documented	28 (27)	1 400 (1 100–1 650)	
Outcome	ICU	9 (9)	2 200 (1 500–2 500)	0.1158
	High care	96 (91)	1 650 (1 200–2 000)	
MNM criteria	Ventilated	4 (4)	1 100 (1 000–1 250)	< 0.001
	Massive transfusion	20 (19)	2 000 (1 400–2 275)	
	Relook laparotomy	18 (17)	1 175 (1 100–1 300)	
	Combination	33 (31)	2 100 (2 000–2 500)	
	Other	30 (29)	1 550 (1 200–1 800)	

GA – general anaesthesia, APH – antepartum haemorrhage, PPH – postpartum haemorrhage, EL – exploratory laparotomy, CS – caesarean section, EL – exploratory laparotomy, PRC – packed red cells, PLT – platelets, FFP – fresh frozen plasma, ICU – intensive care unit

Table III: Comparison between categories of blood loss and perioperative factors

Variable		Estimated blood loss 1 000–2 000 ml (*n* = 77), *n* (%)	Estimated blood loss ≥ 2000 ml (*n* = 28), *n* (%)	*p*-value
Age years, median (IQR)		27 (23–31)	30 (27–33)	0.0129
Parity	1	17 (22)	3 (11)	< 0.001
	2	38 (40)	9 (32)	
	3	11 (14)	13 (46)	
	4	10 (13)	3 (11)	
ASA classification	1	30 (39)	10 (36)	0.0414
	2	35 (46)	13 (46)	
	3	12 (16)	5 (18)	
Indication for surgery	CS – hypertensive disorder	10 (13)	1 (4)	< 0.0001
	CS – fetal distress	8 (10)	3 (11)	
	CS – poor labour progress	13 (17)	8 (29)	
	APH	4 (5)	10 (36)	
	EL for PPH	9 (12)	-	
	EL for sepsis	18 (23)	-	
	CS for previous CS	15 (20)	6 (21)	
MNM criteria	Ventilated	4 (5)	-	< 0.001
	Massive transfusion	13 (17)	7 (25)	
	Relook laparotomy	18 (23)	-	
	Combination	14 (19)	19 (68)	
	Other	28 (36)	2 (7)	
Main cause of haemorrhage	Antepartum	2 (3)	-	< 0.0001
	Postpartum	67 (87)	19 (68)	
	Intrapartum	5 (7)	-	
	Combination	3 (4)	9 (32)	
Anaesthesia technique	Spinal anaesthesia	22 (29)	1 (4)	0.0003
	General anaesthesia	37 (48)	11 (44)	
	Conversion	18 (23)	13 (52)	
Uterotonic agents	Oxytocin	42 (56)	11 (39)	0.0573
	Oxytocin + ergometrine	33 (44)	17 (61)	
Tranexamic acid use	Yes	43 (56)	25 (89)	0.0008
	No	34 (44)	3 (1)	
Blood products	PRC only	35 (56)	2 (7)	< 0.0001
	PLT only	1 (2)	-	
	PRC + FFP	12 (19)	4 (14)	
	PRC + FFP + PLT	11 (18)	18 (64)	
	PRC + PLT	4 (6)	1 (4)	
	PRC + FFP + PLT + cryoprecipitate	-	3 (11)	
Surgical intervention	B-Lynch procedure	10 (13)	4 (15)	< 0.0001
	Balloon tamponade	6 (8)	12 (44)	
	Hysterectomy	2 (3)	5 (19)	
	None documented	32 (42)	5 (19)	
	Other	27 (35)	1 (4)	

IQR – interquartile range, MNM – maternal near-miss, APH – antepartum haemorrhage, PPH – postpartum haemorrhage, EL – exploratory laparotomy, CS – caesarean section, EL – exploratory laparotomy, PRC – packed red cells, PLT – platelets, FFP – fresh frozen plasma

period at the CHBAH (see Figure 1). The median (IQR) EBL was 1 800 (1 200–2 100) ml. The median (IQR) age was 28 (24–32) years, and majority of the patients (46%) were classified as American Society of Anaesthesiology (ASA) II. In most women (82%), PPH was recorded as the main cause of haemorrhage (Table I). Univariate regression analysis demonstrated that the severity of bleeding was associated with age, parity, primary indication for surgery and whether the CS was the index procedure (Table I).

The association between management strategies and EBL are shown in Table II. An increased median (IQR) EBL was found in patients who had a conversion from spinal anaesthesia (SA) to general anaesthesia (GA) ($p = 0.007$), who received a combination of blood products including PRC, FFP, PLT and cryoprecipitate ($p < 0.001$), tranexamic acid (TXA) ($p < 0.001$) and who had surgical interventions such as balloon tamponade or hysterectomy ($p < 0.001$) (Table II).

The majority of women with increased median (IQR) EBL experienced a combination of MNM criteria including ventilation, MTF and relook laparotomy ($p < 0.001$). The intervention rate was 17% for uterine balloon tamponade, 14% for haemostatic suture (B-Lynch) and 6% for hysterectomy.

Univariate associations with major EBL are shown in Table III. Women with major EBL (≥ 2 000 ml) had a median age of 30 and a higher parity, and were undergoing an index CS at the time of MNM classification. They also had a significantly higher number of multiple interventions such as GA, MTF, TXA, surgical interventions (particularly balloon tamponade) and ICU admission. The main cause of haemorrhage was PPH in both EBL groups.

The independent associations with major EBL and MTFs are shown in Table IV and Table V, respectively. There were no independent associations for major EBL (Table IV), and GA and parity of ≥ 3 were independently associated with MTF (Table V)

Discussion

The key findings of this study were that a total of 1.26% of all CSs were classified as MNM due to bleeding during and after the CS with intervention rates of 17% for uterine balloon tamponade, 14% for haemostatic suture (B-Lynch) and 6% for hysterectomy. The African Surgical Outcomes Study (ASOS) described a maternal mortality rate of 0.5% in 3 684 women, with severe intraoperative and postoperative bleeding for 3.8% of the women.[8] In contrast to this multi-country multicentre study, the current study was conducted at a tertiary facility where women often have 24-hour access to specialist and multidisciplinary care, which is not the case in the majority of hospitals in low- and middle-income countries.

Parity of ≥ 3 and GA were independently associated with MTF. This finding is predictable as the nature of severe bleeding perioperatively often requires that women be managed under GA as the circumstances demand comprehensive interventions aimed at maintaining systemic and haemodynamic stability. A previous study found that although GA was associated with a higher blood loss than SA, the need for blood transfusion was not necessarily greater.[9] Similarly, our data showed that women who received GA, especially those who were converted from SA to GA, had significantly higher intraoperative EBL than those who only received SA.

The increased need for transfusion has been shown to be almost certainly related to the underlying disease process (APH, preeclampsia and placenta praevia/accreta), that often preclude the use of neuraxial anaesthesia techniques.[10] Equally, premorbid disease such as pregnancy-induced hypertension which is a well-described risk factor for APH, especially abruptio placentae,[11] may be accompanied by thrombocytopaenia or altered consciousness/seizures. These scenarios would also preclude the use of neuraxial anaesthetic techniques.[12]

Table IV: Factors associated with major estimated blood loss

Parameter		uOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Age		1.12 (1.03–1.22)	0.006	1.09 (0.99–1.20)	0.073
Parity	1 and 2	1 (base)		1 (base)	
	3 and more	2.71 (1.19–6.15)	0.018	1.54 (0.58–4.08)	0.387
ASA classification	1	1 (base)			
	2	1.97 (0.82–4.77)	0.131		
	3	2.33 (0.71–7.67)	0.163		

ASA – American Society of Anaesthesiology, uOR – unadjusted odds ratio, aOR – adjusted odds ratio

Table V: Factors associated with massive transfusion

Parameter		uOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Parity	1 and 2	1 (base)		1 (base)	
	3 and more	3.35 (1.35–8.30)	0.009	3.88 (1.47–10.25)	0.006
ASA classification	1	1 (base)			
	2	1.575 (0.59–4.15)	0.359		
	3	2.8 (0.76–10.26)	0.120		
Anesthetic technique	Regional	1 (base)		1 (base)	
	General	4.65 (0.96–22.32)	0.055	5.28 (1.03–27.01)	0.045
Timing of surgery	Day	1 (base)			
	Night	1.16 (0.452–2.95)	0.762		

ASA – American Society of Anaesthesiology, uOR – unadjusted odds ratio, aOR – adjusted odds ratio

Overall, 47% of patients were classified as ASA II, implying the presence of systemic disease without target organ damage.[13] The ASA classification, which is observer dependent, has often been criticised due to its failure as a good predictor of postoperative mortality.[14] This study population had a median age of 28 years and median parity of 2. Notably, the APH group included older and more multiparous women, which corroborates the observation of a higher incidence of morbidity with advancing age and parity. Comparable sociodemographic data have been reported for women in Brazil and France.[15]

Only 19% of the women received an MTF. A recent report from the United Kingdom, in which MTF was defined as a transfusion of more than 10 units of packed red blood cells (PRBC), described a lower transfusion rate of 8.5 per 10 000 deliveries (0.085%), with half of all MTF related to CS.[16] Our institute has a limited number of blood banks and shortages of blood, MTF is thus classified as 4 units of blood or more. Despite major EBL, these women survived the MNM event and less than a tenth required a hysterectomy to arrest haemorrhage. Surgical interventions are employed when pharmacological management alone fails. Hysterectomy is seen as a last resort intervention for protracted bleeding.[17]

A strength of this study is that it described the outcomes for women with MNM from bleeding during and after CS in an African hospital which serves a very large population in South Africa, and it outlined both the anaesthetic and surgical management of major EBL and MNM during and after CS, using perioperative data. The results describe which intraoperative interventions were implemented. Process mapping may be a better indicator of the access and quality of care available.

Study limitations

It is a retrospective study and is therefore limited by the quality and completeness of hospital records. Maternal deaths were not included in the study. The population MNM rate, including non-CS patients, was not determined and should be a subject of future studies.

Conclusion

MNM from bleeding during or after CS occurred in approximately one in 80 women who delivered by CS. A higher parity was associated with severe bleeding and management requiring GA. Multiple interventions were required to arrest haemorrhage and achieve haemodynamic stability. Exploratory laparotomy was required in approximately 1 in 4 patients, while hysterectomy to arrest haemorrhage was required in less than 7% of the patients. This highlights the importance of the anaesthetist's role in the fluid resuscitation and medical management of a bleeding patient during a CS.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

Approval to conduct the study was granted by the University of the Witwatersrand Human Research Ethics Committee (Certificate number M190516).

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