



Maternal near-miss and death among women with postpartum haemorrhage: a secondary analysis of the Nigeria Near-miss and Maternal Death Survey

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Objective To investigate the burden and health service events surrounding severe maternal outcomes (SMO) related to life-threatening postpartum haemorrhage (PPH) in Nigerian public tertiary hospitals.

Design Secondary analysis of a nationwide cross-sectional study.

Setting Forty-two tertiary hospitals.

Population Women admitted for pregnancy, childbirth or puerperal complications.

Methods All cases of SMO [maternal near miss (MNM) or maternal death (MD)] due to PPH were prospectively identified using WHO criteria over a 1-year period.

Main outcome measures Incidence of SMO, health service events, case fatality rate (CFR) and mortality index (MI: % of death/SMO).

Results Postpartum haemorrhage occurred in 2087 (2.2%) of the 94 835 deliveries recorded during the study period. A total of 354 (0.3%) women had an SMO (103 MD; 251 MNM). It was the most frequent obstetric haemorrhagic complication across hospitals. PPH had the highest maternal mortality ratio (112/100 000 live births) and the recorded MI (29.1%) and CFR (4.9%) were second only to that of ruptured uterus. About 83% of women with SMO were admitted in a critical condition with

over 50% being referred. MD was more likely when PPH led to neurological (80.8%), renal (73.5%) or respiratory (58.7%) organ dysfunction. Although the timing of life-saving interventions was not statistically different between the cases of MD and MNM, close to one-quarter of women who died received critical intervention at least 4 hours after diagnosis of life-threatening PPH.

Conclusions Postpartum haemorrhage was a significant contributor to obstetric haemorrhage and SMO in Nigerian hospitals. Emergency obstetric services should be enhanced at the lower levels of healthcare delivery to reduce avoidable deaths from PPH.

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Keywords Maternal death, maternal near-miss, obstetric haemorrhage, postpartum haemorrhage, severe maternal outcome.

Tweetable abstract One hundred and three maternal deaths and 251 near-misses resulted from PPH in 42 Nigerian tertiary facilities in 1 year.

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Introduction

Postpartum haemorrhage (PPH) is the leading cause of maternal mortality in low-resource countries.¹ Although PPH is relatively more prevalent in low- and middle-income countries, its incidence in high-income countries has significantly increased in recent times.²

Postpartum haemorrhage is defined as excessive bleeding from the genital tract after the birth of the baby. Primary PPH refers to bleeding from the genital tract of 500 ml or more within 24 hours of birth. It is a more dramatic and commoner cause of adverse maternal outcome than secondary PPH, which occurs 24 hours after delivery.³ Apart from the immediate threat to maternal survival, PPH is associated with significant long-term complications as an estimated 12% of survivors develop severe anaemia postpartum. In addition, a woman who was a PPH near-miss has significant risk of dying in the following year from the effects of PPH.⁴ Health system factors and phase 3 delays due to deficiencies in the availability, accessibility, timeliness and appropriateness of emergency obstetric care are recognised factors that determine survival from this condition when it occurs.⁵

The importance of PPH as a cause of adverse maternal outcome globally has led to surgical, radiological and pharmacological breakthroughs and enriched guidelines in the management of this life-threatening condition.⁶ Health policies that ensure increased access to specialised care for woman at risk of PPH and those with PPH or PPH complications have been shown to improve the effectiveness of emergency obstetric care and foster better maternal outcome.⁷

It is well established that accurate and reliable data are central to policy formulation for improving the quality of obstetric care.⁸ The role of adequate surveillance, early diagnosis and timely institution of life-saving intervention in the management of PPH has also been well documented.^{8,9} Accurate and reliable information on PPH-associated severe maternal outcomes (SMO) and health service events surrounding PPH care in Nigeria is largely unavailable. Available data rely on statistical modelling and extrapolations from international health agencies and are therefore not adequate for objective assessment of the quality of emergency obstetric care. The aim of this secondary analysis was to investigate the burden of PPH, its associated SMO and surrounding health service events, based on uniform identification criteria and definitions of clinical conditions across Nigerian public tertiary hospitals.

Methods

This is a secondary analysis of data from a nationwide cross-sectional study that was conducted by the Nigeria Near-miss and Maternal Death Surveillance Network. The

primary study investigated the burden and causes of severe maternal complications and the quality of emergency care in 42 publicly funded Nigerian tertiary hospitals.¹⁰ Briefly, this was a nationwide multicentre study in which women who died or suffered a maternal near-miss from pregnancy, childbirth or puerperal complications were identified based on uniform identification criteria. Women with maternal near-miss were identified using the WHO near-miss criteria while maternal death was defined according to the International Classification of Diseases tenth revision.^{11–13} Severe maternal outcome included women who experienced a maternal near-miss or death according to these definitions. Data were obtained through prospective surveillance of all women admitted for delivery or within 42 days of delivery or termination of pregnancy over a period of 1 year (between 1 June 2012 and 14 August 2013).

In this secondary analysis, data of women with life-threatening PPH leading to a SMO were examined to determine the burden and the health service events surrounding the management of related adverse maternal outcomes. We defined PPH as documented abnormal or excessive bleeding from the genital tract that occurred after the birth of the baby or within 42 days of giving birth. Primary PPH was defined as bleeding from the genital tract within 24 hours of birth, in excess of 500 ml following a vaginal birth, or 1000 ml following a caesarean section, or any blood loss that caused haemodynamic imbalance in a woman.³ The method for assessment of blood loss was not standardised across hospitals for the purpose of this study. Common practices across participating hospitals included both visual estimation of blood loss and objective assessment of volume of blood loss. For the purpose of this analysis, we defined 'definitive treatment/intervention' (i.e. the most crucial intervention required to end or reverse the underlying pathological process and avert death) for PPH as the use of a therapeutic uterotonic or hysterectomy depending on its cause and progression. We estimated the time interval (in minutes) between PPH diagnosis and initiation of this intervention, and until the attention by a senior health personnel.

Data analysis

We performed descriptive analysis and stratified the demographic characteristics according to the type of SMO. We calculated intrahospital maternal mortality ratio (MMR), maternal near-miss incidence ratio, SMO ratio, mortality index (MI) and the cause-specific case fatality rates (CFR) for PPH and other causes of obstetric haemorrhage. The time-related variables were expressed as median with interquartile range. We compared categorical variables using chi-squared test, Fisher's exact test and odds ratio as appropriate and compared normally and non-normally distributed continuous variables using *t*-test and the Mann–

Whitney test, respectively. The level of statistical significance was set at P -value < 0.05 . Statistical analyses were performed using EPI INFO 7.1.4 (CDC, Atlanta, GA, USA).

Results

A total of 94 835 deliveries occurred in the 42 participating hospitals during the study period; 97 634 births (including multiple births) were recorded, out of which there were 91 724 live births. In the entire study population, 2449 women met the criteria for SMO. Table 1 shows that PPH was diagnosed in 2087 (2.2%) of the deliveries and 354/2449 (14.5%) of the total SMO. Among women with SMO due to PPH, 251 (70.9%) survived and 103 (29.1%) died. PPH was the most frequently diagnosed obstetric haemorrhagic complication and it had the highest intrahospital MMR (112/100 000 live births). The condition also had relatively high MI (29.1%) and CFR (4.9%), second only to ruptured uterus, which had an MI of 33.2% and CFR of 12.2%. Supporting material (Table S1) summarises the sociodemographic characteristics of the women with SMO due to PPH. Most of the women were in the 20- to 35-year age group (74.9%), of low socio-economic class (64.7%) and resided more than 5 km from the hospital (61.3%). The majority (83.9%) were brought to the hospital in critical condition and during evening duty shift (56.5%).

Table S2 (see Supplementary material) shows the relationship between maternal demographic characteristics and fatality. The maternal death and MNM were comparable with respect to these characteristics except with age, where significantly more maternal deaths than MNM occurred in women aged 35 years and above ($P = 0.003$).

Table 2 shows that maternal death was most likely in women with PPH resulting in neurological (80.8%), renal

(73.5%) or respiratory (58.7%) dysfunction, and survival was better among women who had either cardiovascular or coagulation dysfunction.

Table S3 (see Supplementary material) summarises the critical interventions applied for PPH adverse maternal outcomes. Although only 45 (12.7%) women with PPH-related SMO were admitted into the intensive care unit (ICU), over a quarter of them had a massive blood transfusion, about one-fifth had an emergency laparotomy for conservative or radical surgery and 11% were transfused with blood products other than whole blood. There were no cases of uterine artery embolisation.

Table 3 highlights the time interval between PPH diagnosis and initiation of definitive intervention to avert a maternal death. Generally, the median time to initiating intervention was similar for women who survived and those who died. However, less than half of the women with SMO had intervention critical to survival initiated for them within 30 minutes of diagnosis of life-threatening PPH. It is also noteworthy that almost a quarter of the women who died received definitive intervention more than 4 hours after the diagnosis of a life-threatening PPH. This table also shows that less than half of the SMO were attended by senior personnel (i.e. senior registrar or consultant) within 30 minutes of diagnosis of life-threatening PPH although disproportionately more cases of maternal deaths compared with MNM were attended by senior personnel within this time interval.

Discussion

Main findings

Our analysis showed that PPH accounted for one-third of all admissions due to obstetric haemorrhage but for a substantial proportion (42%) of maternal deaths resulting

Table 1. Prevalence of obstetric haemorrhagic complications and near-miss indicators

Obstetric haemorrhagic complications	All complications	MNM ($n = 1451$)	Maternal death ($n = 998$)	MNM ratio (per 1000 live births)	MMR (per 100 000 live births)	SMO rate per 1000 live births	MNM:MD ratio	Mortality index (%)	Cause-specific CFR (%)
Placenta praevia	1655	83 (5.7)	12 (1.2)	0.90	13.08	1.04	6.92	12.63	0.7
Placental abruption	1324	174 (12.0)	36 (3.6)	1.90	39.25	2.29	4.83	17.14	2.7
Morbidly adherent placenta	117	19 (1.3)	2 (0.2)	0.21	2.18	0.23	9.50	9.52	1.7
Ruptured uterus	713	175 (12.1)	87 (8.7)	1.91	94.85	2.86	2.01	33.21	12.2
Postpartum haemorrhage	2087	251 (17.3)	103 (10.3)	2.74	112.29	3.86	2.44	29.10	4.9
Other obstetric haemorrhage	234	9 (0.6)	4 (0.4)	0.10	4.36	0.14	2.25	30.77	1.7

CFR: Case fatality rate; MD: Maternal death; MMR: Maternal mortality ratio; MNM: Maternal near-miss; SMO: Severe maternal outcome.

Table 2. Mortality index according to organ dysfunction associated with postpartum haemorrhage

Organ dysfunction (n = 354)	MNM (%)	Maternal death (%)	SMO (%)	Mortality index (%)
Cardiovascular dysfunction	202 (80.48)	89 (86.41)	291 (82.20)	30.6
Respiratory dysfunction	52 (20.72)	74 (71.84)	126 (35.59)	58.7
Renal dysfunction	9 (3.59)	25 (24.27)	34 (9.60)	73.5
Coagulation dysfunction	80 (31.87)	37 (35.92)	117 (33.05)	31.6
Uterine dysfunction	36 (14.34)	22 (21.36)	58 (16.38)	37.9
Hepatic dysfunction	2 (0.80)	1 (0.97)	3 (0.85)	33.3
Neurological dysfunction	5 (1.99)	21 (20.39)	26 (7.34)	80.8

MNM: Maternal near-miss; SMO: Severe maternal outcome

Table 3. Time interval from diagnosis to attention by senior personnel and definitive intervention to avert maternal death from PPH

Time to definitive intervention (minutes)	SMO n = 307 (%)	MD n = 87 (%)	MNM n = 220 (%)	Odds ratio, 95% CI	P-value (MNM vs MD)
≤30	134 (43.65)	41 (47.1)	93 (42.3)	1.22, 0.73–2.00	0.440
31–60	59 (19.22)	13 (14.9)	46 (20.9)	0.66, 0.34–1.30	0.232
61–120	38 (12.38)	9 (10.3)	29 (13.2)	0.75, 0.34–1.68	0.496
121–180	11 (3.58)	2 (2.3)	9 (4.1)	0.55, 0.12–2.61	0.447
181–240	14 (4.56)	2 (2.3)	12 (5.5)	0.41, 0.09–1.86	0.232
>240	51 (16.61)	20 (23.0)	31 (14.1)	1.82, 0.97–3.41	0.059
Time to attention by senior personnel (minutes)	n = 302 (%)	n = 92 (%)	n = 210 (%)	Odds ratio, 95% CI	P-value (MNM vs MD)
≤30	147 (48.7)	57 (62.0)	90 (42.9)	2.17, 1.31–3.59	0.002
31–60	47 (15.6)	12 (13.0)	35 (16.7)	0.75, 0.37–1.53	0.424
61–120	30 (9.9)	5 (5.4)	25 (11.9)	0.42, 0.16–1.15	0.084
121–180	17 (5.6)	3 (3.3)	14 (6.7)	0.47, 0.13–1.68	0.237
181–240	6 (2.0)	1 (1.1)	5 (2.4)	0.45, 0.05–3.91	0.458
>240	55 (18.2)	14 (15.2)	41 (19.5)	0.73, 0.38–1.44	0.372

CI: Confidence interval; MD: Maternal death; MNM: Maternal near-miss; SMO: Severe maternal outcome

from these complications. No clear differences were observed in the demographic and reproductive characteristics of women who survived or died from life-threatening PPH. Maternal survival was threatened when PPH led to neurological, renal or respiratory organ dysfunction. Only a small percentage of women with life-threatening PPH were admitted to ICU even though about a quarter of them had transfusion of five or more blood units and approximately one-fifth had an emergency laparotomy for conservative or radical surgery to stop further blood loss.

Strengths and limitations

This was the largest prospective survey in many centres across Nigeria that collected information on PPH-related SMO in a standardised manner. This investigation reports the largest cohort of maternal deaths from PPH in any hospital-based study and provides insight into phase 3 delays that affect maternal survival.

The main limitation relates to the study setting and the potential referral bias that is inherent in hospital studies of obstetric complications. Given that this study was conducted in publicly funded tertiary hospitals, our findings may not be generalisable to primary and secondary level hospitals and private hospitals. Likewise, the prevalence obtained for PPH may not be a true representation of the burden of PPH in the general obstetric population. Our analysis was limited by the lack of data on specific causes of PPH, because determination of PPH causes was not standard practice in many of the participating hospitals, because of widespread refusal of autopsy for cultural and religious reasons.

Interpretation

The PPH prevalence of 2.2% observed in our study is almost double the prevalence reported for a study in Brazil, which used the same WHO criteria and standard definitions for outcome measures.² Our PPH prevalence is much

lower than the 10.5% estimated for the African region, and the reported global prevalence of 5–12%.^{4,14} A similarly large multicentre study in the USA, however, obtained a lower prevalence of 0.3%.¹⁵ This is not surprising as high-income countries have been able to reduce the prevalence and mortality from PPH and other obstetric complications to an extent that conditions like pulmonary embolism, suicide and road traffic accidents now top the list of causes of maternal mortality in many of these countries. PPH still remains, however, the leading cause of maternal mortality in most of the low- and middle-income countries.¹⁶

Postpartum haemorrhage was observed to be the most frequently diagnosed obstetric haemorrhage complication; this is in consonance with findings from a study in India where it was found that PPH raised obstetric haemorrhage morbidity by 50 times.¹⁷ It also agrees with findings from a secondary analysis of a WHO multi-country survey,¹ where it was observed that PPH, apart from being the most frequent obstetric haemorrhage complication, was the leading cause of severe adverse maternal outcomes.

The observed intrahospital MMR for PPH in this study is much higher than the 36.5/100 000 live births found in a similar study in Brazil,² and also higher than the 71/100 000 live births observed in Bangalore, India.¹⁷ Our observed MMR is very high, when compared with that of a high-income country such as the UK, where MMR due to PPH was as low as 1/100 000 live births.¹⁸ PPH reportedly accounts for up to 30% of maternal deaths in Africa and Asia.¹⁹ The WHO reported that in the low-resource countries, MMR from PPH is as high as 1000 per 100 000 live births and as high as 25% of maternal deaths are due to PPH.²⁰ Although the MI obtained in our study is much higher than the global 6.6% (0.0–40.7%) reported in a recent systematic review, this value (29.1%) lies within the range of high MIs observed from low- and middle-income countries.²¹

Although PPH occurred more frequently, as a cause of obstetric haemorrhage, ruptured uterus had a higher case fatality rate; this may not be unlikely as over 60% of deliveries that occur in Nigeria are attended by unskilled personnel.²² This finding is also supported by the fact that most of the women with PPH arrived at the tertiary hospitals in critical condition. Late recognition of the severity of the complication and delayed referral may have led to their late presentation to the referral centres.

It is surprising that maternal demographic factors like socio-economic class, parity and residence more than 5 km from referral centres were not significant risk factors for maternal death in this study. This is in contrast to an earlier report where a directly proportional relationship was found between these factors and maternal death due to PPH in sub-Saharan Africa.²³ Maternal age more than 35 years was the only factor that was found to be

associated with maternal death. This observation is similar to the findings from a large multicentre US national survey where maternal age above 35 years was a significant risk factor for PPH adverse maternal outcome.¹⁵

The poor maternal survival rates observed when PPH was complicated by neurological, renal and respiratory dysfunction could be partly due to the fact that only about one-eighth of the women with SMO received ICU care. Although it is unclear how the criteria for ICU admission at the various hospitals impact on their care of women with PPH, the proportion of women who received critical interventions such as emergency laparotomy suggests that ICU care could have improved outcomes. In contrast to PPH outcomes when neurological, renal or respiratory dysfunction are present, better survival rates (lower MI) were recorded among women who had coagulation or cardiovascular dysfunction, a clear indication of the increased ability to tackle PPH through resuscitation with blood and blood products. In a study in India, organ failure and ICU admission were observed to be higher among women referred from lower cadre hospitals to tertiary centres.¹⁷ This might be due to women being brought into the hospital in a moribund state where organ failure might have set in due to inadequate resuscitation.

The observation that less than half of the women with SMO received life-saving treatment critical to survival within 30 minutes of PPH diagnosis, together with a similar finding regarding attention by senior medical personnel, suggests that initiation of definitive life-saving interventions depended on the presence of senior medical personnel. Availability of specialist care during obstetric emergencies has been shown to be associated with better maternal outcome and increased effectiveness of emergency services.^{7,24} Therefore, improving outcomes of PPH emergencies in the current context may require additional training of junior medical personnel to trigger the PPH bundle of care to avert severe maternal morbidity or death at the earliest sign of deterioration of a woman's clinical condition.

Conclusions

Postpartum haemorrhage is associated with significant adverse maternal outcome in Nigeria, and phase 3 delay is still a major player in the pathway to maternal death. Timely intervention with life-saving treatment and attention by senior medical personnel was critical to survival after PPH. Initiation of adequate resuscitation before referral to tertiary hospitals may improve the survival of women with organ dysfunction. Protocols for lower level hospitals regarding the use of volume expanders during resuscitation and referral may help to achieve this. The impact of ICU care on maternal outcomes for PPH with organ failure needs further investigation. Increased availability of senior obstetric

personnel during emergencies and training of junior personnel for immediate response to life-threatening PPH could potentially improve maternal outcome from PPH.

Disclosure of interest

The authors declared no conflict of interest. Completed conflict of interest forms are available to view online as supporting information.

Contribution to authorship

OTO conceived the idea of this secondary analysis. AAA wrote the concept note. OTO analysed the data. JOS, AAA and JOI (in order of authors) prepared the first draft of the manuscript, and BF, OA, COA, ASA, KH, OAD, OOA and OTO (in order of authors) reviewed and revised the draft manuscript for intellectual content. All authors approved the final manuscript for publication.

Details of ethics approval

Ethical approval for the primary study was obtained from the WHO Research Ethics Review Committee (WHO ERC) on 10 May 2011 (protocol ID: A65745, version 4). Approval was also obtained from the ethics review boards of the 42 hospitals that participated in the study. No additional ethics approval was obtained for this secondary analysis.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Demographic characteristics of women with severe maternal outcome due to postpartum haemorrhage.

Table S2. Association between maternal characteristics and fatality.

Table S3. Critical interventions for postpartum haemorrhage adverse maternal outcomes ■

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