Abortion-related near-miss morbidity and mortality in 43 health facilities with differences in readiness to provide abortion care in Uganda

Susan Atuhairwe ⚪, 1,2 Kristina Gemzell-Danielsson, 3 Josaphat Byamugisha, 1 Frank Kaharuza, 4 Nazarius Mbona Tumwesigye, 5 Claudia Hanson ⚪ 6, 7

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ABSTRACT

Introduction With a view to inform policy for improved postabortion care, we describe abortion-related near-miss and mortality by sociodemographic risk factors and management options by pregnancy trimester in Uganda.

Methods This secondary data analysis used an adapted WHO near-miss methodology to collect cross-sectional maternal near-miss and abortion complications data at 43 health facilities in Central and Eastern Uganda in 2016–2017. We computed abortion severe morbidity, near-miss and mortality ratios per 100 000 live births, and described the proportion of cases that worsened to an abortion near-miss or death, stratified by geographical region and trimester. We tested for association between independent variables and abortion near-miss, and obtained prevalence ratios for association between second trimester near-miss and independent demographic and management indicators. We assessed health facility readiness for postabortion care provision in Central and Eastern regions.

Results Of 3315 recorded severe abortion morbidity cases, 1507 were near-misses. Severe abortion morbidity, near-miss and mortality ratios were 2063, 938 and 23 per 100 000 live births, respectively. Abortion-related mortality ratios were 11 and 57 per 100 000 in Central and Eastern regions, respectively. Abortion near-miss cases were significantly associated with referral (p<0.001). Second trimester had greater abortion mortality than first trimester. Eastern region had greater abortion-related morbidity and mortality than Central region with facilities in the former characterised by inferior readiness to provide postabortion care.

Conclusions Uganda has a major abortion near-miss morbidity and mortality; with mortality higher in the second trimester. Life-saving commodities are lacking especially in Eastern region compromising facility readiness for postabortion care provision.

INTRODUCTION

Unsafe abortion is a major reproductive health challenge contributing to 7.9% global and 9.6% regional maternal deaths.1 2 Over 75% of all abortions in sub-Saharan Africa, Uganda inclusive, are unsafe due to restrictive abortion laws.3 4 Furthermore, low socioeconomic status, low literacy rates and low contraceptive uptake are associated with high unsafe abortion rates and severe abortion morbidity (SAM).5 6 Abortion-related deaths are largely preventable if patients receive timely appropriate care such as postabortion care (PAC).5 10 PAC is essential life-saving care to address the impact of abortion-related

Key questions

What is already known?

► The WHO near-miss indicator is proposed to assess the quality of maternal services and several studies provide evidence on the usefulness of the concept using the original and adapted WHO near-miss approaches.

► A systematic review of 70 studies from 28 countries published in 2018 estimates an abortion near-miss rate of 9%, and a mortality rate of 1.5% among abortion-related hospital admissions.

What are the new findings?

► This is the first study to provide detailed characterisation of abortion near-miss by pregnancy trimester.

► Using the adapted WHO near-miss criteria, we found a higher abortion-related mortality in the second trimester compared with first trimester. Referred women were more likely to develop abortion near-miss. Women who had a near-miss abortion event in the second trimester had a lesser prevalence of uterine evacuation or manual vacuum aspiration than spontaneous expulsion compared with women in the first trimester (crude prevalence ratio (cPR) 0.69, 95% CI 0.51 to 0.93).

► The Eastern region of Uganda had less readiness for Post Abortion Care, with higher abortion-related morbidity and mortality. Although both results come from independent cross-sectional data and precluding causal inference, our result points to the importance of providing adequate services for women with abortion complications.
complications which are primarily due to ‘unsafe’ abortions.

Assessing the incidence of severe abortion and abortion-related mortality is important to gauge the quality and effectiveness of PAC. To standardise the assessments of morbidity, WHO defined a near-miss as ‘a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy’.15 Abortion near-miss (ANM), a subset of maternal near-miss, may be the result of delays in accessing safe abortion care as well as delays in getting PAC when complications arise. While spontaneous and safe abortions are less likely to have near-miss complications (and deaths) than unsafe induced abortions, PAC addresses both.12 Quality PAC is dependent on appropriate equipment, commodities, laboratory tests, guidelines and trained staff; this averts further harm and improves patient survival.

ANM is both a success and a failure with respect to quality of care. A success because the woman has been saved in extremis by hospital teams, especially if she arrived in a very severe condition at the facility. A failure, because she became so severely ill.13 Still, ANM occurrence and mortality is a valuable indicator for health systems’ planning, case management strategies and evaluation of healthcare provided. Previous research proposed ANM incidences per 100 000 live births between 200 and 450 and abortion-related mortality ratio (AMR) about 85 per 100 000 live births in Africa.14-17

PAC was introduced in Uganda in the early 1990s as part of basic and comprehensive emergency obstetric care (EmOC) packages.18 19 PAC is offered by both midwives and doctors from primary level health facilities and hospitals.20 Paul et al published research on barriers that women in Uganda face in accessing PAC services which lead to more severe complications.21 Little is known, however, if incidence and mortality differ in relation to PAC services by country region and to which extent complication rates are driven by sociodemographic status, reproductive characteristics or management options by pregnancy trimester.17 Our study from 43 facilities in two distinct regions of Uganda22 aims to assess abortion-related morbidity and mortality by region, and therewith differences in the availability of PAC services—and by sociodemographic and reproductive characteristics including trimester in Uganda.

**METHODS**

**Study design, setting and participants**

We collected cross-sectional data on maternal near-miss as part of a cluster randomised two-arm trial to assess the impact of a 1-day competency-based training ‘Helping Mothers Survive: Bleeding after Birth’ on morbidity and mortality due to postpartum haemorrhage (PPH). The primary trial details are reported elsewhere.23 The study was conducted in 11, and 7 districts in Central and Eastern regions of Uganda, respectively, at 22 hospitals, and 21 high case load health centres; 9 were private not for profit (PNFP) and 34 public. In each district, taken as a cluster, we included all public hospitals and randomly sampled health centres and PNFP health facilities with more than 400 deliveries per year. Ministry of Health Uganda recommended the selected districts and all health facilities offer at least basic EmOC services. Data collection run from June 2016 to September 2017.

**Data collection**

We used the WHO near-miss form to collect data of all maternal near-miss events, and deaths which took place in the selected health facilities.24 The data collection form was amended and included severe abortion complications, see online supplemental appendix I, as a screening question to ensure that these events were captured consistently. Details of categories for organ dysfunction, critical interventions, and other data collected are reported elsewhere.25

At each health facility, two of the midwives, selected as data collectors received a 1-day training on near-miss methodology and the data collection process. We collected data prospectively from several service points at the health facilities including (1) antenatal, labour and postnatal ward, (2) female and surgical ward, (3) laboratory and (4) theatre to ensure that all cases of near-miss and maternal deaths were included. A standard protocol was used to abstract information from the patient’s clinical case notes and registries for admission, birth, theatre, laboratory and discharge. From the paper forms, the data collectors entered data onto a tablet-based application (Lenovo A3500-F) and uploaded onto the cloud server biweekly using Open Data Kit Collect software application. Data on the total number of live births in the facilities were collected through monthly telephone calls and verified during supervision visits. The data collectors were supported through biweekly supervision visits and regular telephone calls to ensure complete and correct abstraction of data.

This paper uses only the data on maternal near-misses admitted as abortion-related complications. An abortion was defined as termination of a pregnancy less than 28 weeks gestation age. We extracted data for women coded as having abortion complications from those with severe maternal morbidity. Women with ectopic pregnancy or gestation age above 27 weeks were excluded, viability in Uganda begins at 28 weeks.23 Since PPH and abortion are both bleeding complications, we screened the PPH cases...
to identify the abortion cases that were miscoded as PPH using a gestation age less than 28 weeks. Cases that were coded as abortion cases but where the gestation age was missing were not excluded from the data set (see online supplemental appendix II).

We assessed for PAC provision health facility readiness at the 43 health facilities from February to April 2016 using an adapted Uganda health facility assessment tool. Components therein are very similar to the WHO service availability and readiness assessment tool, however, we did not collect information on whether the abortion was spontaneous or induced, and provision of family planning services as these were not captured in the primary study tool. Key items measured that influence access and availability to PAC services at all the health facilities included: (1) uterotonics like misoprostol and oxytocin; (2) manual vacuum aspiration (MVA) sets; (3) intravenous fluids; (4) parenteral antibiotics; (5) ability to provide PAC services 24 hours a day, 7 days a week (24/7); (6) referral capability (motorised transport for referral, health provider accompanying a referral); (7) communication means; and for health facilities offering comprehensive EmOC; (8) blood transfusion services and (9) surgical/laparotomy capability.

Service readiness components like equipment and commodities were verified by checking their presence on the wards, pharmacy, laboratory and the health facility stores. Health facilities’ ability to provide PAC services 24/7 was verified with checking duty schedules, ward and theatre registers for the previous 3 months. We inquired about the presence of motorised transport at the health facility, and whether the most recent referral to a higher facility had been accompanied by a health provider to check the referral capability.

Outcomes and explanatory variables
The main outcome, ANM, was defined using our adapted WHO near-miss criteria as a case of severe abortion complication with either organ dysfunction, severe sepsis, blood transfusion or laparotomy. Given the paucity of blood products in low to middle income countries, the threshold for massive blood transfusion was reduced to two units down from the five units recommended by WHO. Other outcomes were:

► SAM ratio (SAMR) as the number of all cases with severe abortion complications per 100,000 live births.
► ANMR as the number of abortion-related near-miss cases per 100,000 live births.
► AMR as the number of maternal deaths due to abortion per 100,000 live births.

Independent variables included background characteristics like gestation age based on weeks of amenorrhoea, patient’s age in completed years, number of pregnancies and timing of onset of complications. Reproductive and institutional factors like HIV status, referral status (referred into the facility), type of health facility and ownership. We also collected information on complications including infection, organ dysfunction and maternal death; as well as management options like types of uterine evacuation, uterotonics administered, and additional interventions, for example, blood transfusion, number of blood transfusion units administered and laparotomy, all abstracted from the patient’s clinical case notes.

Statistical analysis
Statistical analysis was performed using Stata V.14. We assessed for PAC provision health facility readiness indicator, for all health facilities and for central and eastern region. We also present the proportions of SAM that had ANM or abortion-related deaths by region and pregnancy trimester. The estimates were not weighted for region. We designated health facility as a primary sampling unit and assigned all health facilities the same weight using STATA command svyset (pw=wgt), psu(id3) singleunit (centred).

Background characteristics and categorical outcomes were presented with descriptive statistics. Continuous variables were summarised using means (SD) or medians (IQR) and categorical variables using proportions (CIs). Pearson’s $\chi^2$ was used to test the difference between severe abortion complications cases and those that progressed to be ANM across different sociodemographic, reproductive and institutional characteristics. We computed 95% CIs and statistical significance established at $p<0.05$. We excluded women with missing data for gestation age and unrecorded HIV status in the statistical test computation for background and reproductive characteristics comparison among near-miss cases to avoid misinterpretation of findings.

We then described the proportion of women with severe abortion complications or ANM that suffered complications such as infection, organ dysfunction, maternal death and the management options received including type of uterine evacuation, uterotonics administered, blood transfusion and when a laparotomy was performed. To examine the association between first and second trimester ANM and background characteristics, reproductive factors, institutional factors, types of complications and management options, we did multiple generalised linear models with binomial family and log link to obtain unadjusted prevalence ratios effect estimates.

Regarding health facility readiness for PAC, we computed the percentage of facilities that fulfilled each readiness indicator, for all health facilities and for central and eastern region. Performed Pearson $\chi^2$ or Fischer’s exact tests to compare PAC health facility readiness between the central and eastern region.

Role of the funding source
The funder had no role in study conceptualisation, data collection, analysis and manuscript writing. All authors had full access to the study data and the corresponding author had final responsibility for the decision to submit for publication.
RESULTS

We extracted data of 3315 (25.8%) SAM cases from the total of 12843 severe maternal complications collected over a period of 15 months from 43 health facilities. Forty five percent (n=1507) of the 3315 women with severe abortion-related complications fulfilled the criteria as ANM cases (see online supplemental appendix II). During the same period, there were a total of 160701 live births at the study sites with the Central and Eastern regions having 118674 and 42027 live births, respectively.

The facility SAMR, ANMR and AMR were 2063, 938 and 23 per 100 000 live births, respectively (see table 1). The Eastern region had an SAMR of 3641 and ANMR of 1785 per 100 000 live births; while the Central region had an SAMR of 1504 and ANMR of 638 per 100 000 live births. Thirty-seven women died from abortion complications with an AMR of 11 vs 57 per 100 000 live births in Central and Eastern region, respectively. Of the documented 1459 and 1044 first and second trimester severe abortion complications, 589 (40.4%) and 499 (47.8%), respectively, developed into an ANM and 5 (0.3%) and 21 (2.0%), respectively, died.

In the Central region, out of 625 and 543 first and second trimester women with SAM, 284 (45.4%) and 212 (39.0%), respectively, developed into ANM and 1 (0.2%) and 6 (1.1%), respectively, died. While the Eastern region, had 36.6% and 57.3% of the SAM in the first and second trimester respectively develop ANM, and death occurred in 0.5% and 3.0% in the first and second trimester, respectively. The mean age of participants was 26 years (SD 7), and the median number of pregnancies was three (IQR 2–5) (see table 2). Patients referred into the health facilities were more likely to progress to develop an ANM (p<0.001). Regarding complications seen and management options in table 3, only 243 women (16%) with ANM had an infection and 76% presented with organ dysfunction. Surgical uterine evacuation using MVA or curettage (D&C) was performed in 58% of ANM cases, 41% had a spontaneous expulsion while only 1% got medical evacuation. Oxytocin was the most commonly administered uterotonics in 58% of the cases, followed by misoprostol in 40%.

Only 42% of all ANM cases received a blood transfusion, and 47% of patients who received blood transfusion had their haemoglobin (Hb) checked at discharge. The median Hb at discharge was 72g/L (IQR 58–90). Majority (58%) of the near-miss cases only got one unit of blood, 40% got 2–4 units of blood and 2% received five or more units.

Laparotomy was performed in 27 patients; nine and 11 of whom were in the first and second trimester, respectively, with gestation age not specified in seven patients (table 3). The indications for laparotomy included: uterine perforation in 10, 8 had pelvic abscess, 3 got subtotal hysterectomy, 1 patient with missed abortion and disseminated intravascular coagulopathy had a hysterectomy, 2 patients with induced abortion had vesicovaginal fistula and 1 of them in addition had a rectovaginal fistula. Majority (52%) of these laparotomies were performed between 3 and 12 hours from admission. The prevalence of ANM complications developing after having been admitted at least 12 hours was 37% (cPR 1.37, 95% CI 1.07 to 1.76) higher in women with second trimester ANM compared with women with first trimester ANM (table 4). We also observed an association between second trimester ANM and the methods used for uterine evacuation. Women with second trimester ANM had a 31% (cPR 0.69, 95% CI 0.51 to 0.93) lesser prevalence of uterine evacuation or MVA as opposed to a spontaneous expulsion compared with women with first trimester ANM.

All 43 health facilities could offer PAC services 24/7. Majority of the health facilities had intravenous fluids (93%), parenteral antibiotics (86%) and oxytocin (86%) while misoprostol (42%) was grossly lacking with MVA sets in only 70% of them. Approximately 74% of the health facilities had motorised transport for referral; and only 42% had a health provider accompanying the referral. A comparison of the central and eastern regions for PAC readiness revealed that the central region had significantly more MVA sets (p=0.003), motorised transport for referral (p=0.004) and health provider accompaniment of referrals (p=0.034). Availability of uterotonic, intravenous fluids, parenteral antibiotics, communication means, blood transfusion services and surgical/laparotomy capability did not significantly differ by region (table 5).

DISCUSSION

Main findings

This study reveals the high burden of abortion-related morbidity and mortality in Uganda which agrees with evidence from similar settings with highly restrictive abortion laws. Close to 1.8% of women with SAM died particularly those in the second trimester. The Eastern region of the country had less PAC readiness, only 40% of health facilities had MVA kits compared with 86% in the Central region (p=0.003) but also had worse abortion-related near-miss and mortality outcomes.

A WHO multicountry survey of 23 countries cites Uganda second to Afghanistan in reporting abortion-related severe maternal outcomes. Uganda has one of the highest fertility rates in the sub-Saharan region hence more pregnancy-related complications. We report a high ANMR of 938 per 100 000 live births, which can be attributed to the fact that we modified the near-miss definition to also include those with at least two instead of at least five blood transfusions. Despite the huge morbidity burden shown in this study, our AMR (23 per 100 000 live births) is lower compared with other countries like Zambia (52 per 100 000 live births), and Nigeria (85 per 100 000 live births).

PAC is globally accepted as life-saving care to women with abortion complications. In Uganda, PAC is recognised as a core signal function from health centre II level, and trained health providers including midwives...
Table 1 Abortion-related severe morbidity, near-miss and mortality indicators by pregnancy trimester and by region in Uganda

| Region and trimester distribution | Severe abortion morbidity | Abortion near-miss | Abortion-related deaths | Live births | Severe abortion morbidity ratio | Abortion near-miss ratio | Abortion-related mortality ratio |
|----------------------------------|---------------------------|-------------------|------------------------|-------------|-------------------------------|-------------------------|-------------------------------|
|                                  | SAM | ANM | N | n/ % of reported SAM, 95% CI | N | per 100,000 live births | N | per 100,000 live births | N | per 100,000 live births |
| All women                        | 3315 | 1507 | 37 | 1.1, 0.1 to 2.1 | 160,701 | 2063 | 938 | 23 |
| Timing of abortion               |     |     |     |     |     |     |     |     |     |
| First trimester                  | 1459 | 589 | 45.5, 31.1 to 59.8 | 37 | 1.1, 0.1 to 2.1 | 160,701 | 2063 | 938 | 23 |
| Second trimester                 | 1044 | 499 | 40.4, 22.5 to 61.2 | 5  | 0.3, 0.1 to 1.3 | 160,701 | 2063 | 938 | 23 |
| Trimester not indicated          | 812  | 419 | 47.8, 36.4 to 59.4 | 21 | 2.0, 0.8 to 5.0 | 160,701 | 2063 | 938 | 23 |
| Central region                   | 1785 | 757 | 42.4, 31.3 to 54.3 | 13 | 0.7, 0.4 to 1.4 | 118,674 | 1504 | 638 | 11 |
| First trimester                  | 625  | 284 | 45.4, 39.6 to 51.2 | 1  | 0.2* | 118,674 | 1504 | 638 | 11 |
| Second trimester                 | 543  | 212 | 39.0, 32.4 to 45.6 | 6  | 1.1, 0 to 9.4 | 118,674 | 1504 | 638 | 11 |
| Trimester not indicated          | 617  | 261 | 45.4, 39.6 to 51.2 | 1  | 0.2* | 118,674 | 1504 | 638 | 11 |
| Eastern region                   | 1530 | 750 | 38.9, 33.0 to 44.8 | 6  | 1.0, 0 to 9.0 | 42,027 | 3641 | 1785 | 57 |
| First trimester                  | 834  | 305 | 49.0, 23.2 to 75.3 | 24 | 1.6, 0.4 to 5.6 | 42,027 | 3641 | 1785 | 57 |
| Second trimester                 | 501  | 287 | 36.6, 31.2 to 42.0 | 4  | 0.5, 0 to 7.4 | 42,027 | 3641 | 1785 | 57 |
| Trimester not indicated          | 195  | 158 | 45.4, 39.6 to 51.2 | 1  | 0.2* | 42,027 | 3641 | 1785 | 57 |

Estimates are not weighted for regions.

*Insufficient observations for CI computation.

AMR, abortion-related mortality ratio; ANM, abortion near-miss; ANMR, Abortion near-miss ratio; SAM, severe abortion morbidity; SAMR, severe abortion morbidity ratio.
can manage bleeding complications by performing MVA especially for first trimester abortions. This deliberate effort by the Uganda Ministry of Health to task share in patient management probably contributes to the reduced mortality from abortion complications.19

Our study shows that ANM morbidity and mortality is greater in the Eastern region compared with the

### Table 2  Sociodemographic, reproductive and institutional characteristics of severe abortion morbidity and abortion near-miss in Uganda

| Characteristics                  | Severe abortion complications n* | Abortion near-miss cases n† | Abortion near-miss row %‡ (95% CI) | χ   | P value § |
|----------------------------------|----------------------------------|-----------------------------|-----------------------------------|------|-----------|
| **Age group (years)**            |                                 |                             |                                   |      |           |
| <18                              | 180                              | 94                          | 52 (37 to 67)                     | 8.74 | 0.22      |
| 18–24                           | 1335                             | 572                         | 43 (29 to 58)                     |      |           |
| 25–29                           | 729                              | 334                         | 46 (33 to 59)                     |      |           |
| 30–34                           | 542                              | 260                         | 48 (36 to 60)                     |      |           |
| 35 +                            | 529                              | 247                         | 47 (29 to 65)                     |      |           |
| **Number of pregnancies**        |                                 |                             |                                   |      |           |
| 1                                | 752                              | 313                         | 42 (28 to 56)                     | 9.75 | 0.22      |
| 2                                | 589                              | 263                         | 45 (30 to 60)                     |      |           |
| 3                                | 482                              | 216                         | 45 (32 to 59)                     |      |           |
| 4                                | 369                              | 167                         | 45 (32 to 59)                     |      |           |
| 5 or more                       | 1123                             | 548                         | 49 (33 to 65)                     |      |           |
| **Gestation age**                |                                 |                             |                                   |      |           |
| First trimester                 | 1459                             | 589                         | 40 (23 to 61)                     | 13.66| 0.33¶     |
| Second trimester                | 1044                             | 499                         | 48 (36 to 59)                     |      |           |
| Trimester not indicated         | 812                              | 419                         | 52 (36 to 67)                     |      |           |
| **HIV status**                  |                                 |                             |                                   |      |           |
| Negative                        | 2388                             | 942                         | 39 (26 to 55)                     | 10.18| 0.12**    |
| Positive                        | 148                              | 78                          | 53 (37 to 68)                     |      |           |
| Not recorded                    | 779                              | 487                         | 63 (44 to 78)                     |      |           |
| **Timing of complications**     |                                 |                             |                                   |      |           |
| At arrival or within 12 hours   | 3253                             | 1468                        | 45 (31 to 60)                     | 7.75 | 0.07      |
| Developed after 12 hours        | 62                               | 39                          | 63 (46 to 77)                     |      |           |
| **Referral status**             |                                 |                             |                                   |      |           |
| Not referred                    | 2880                             | 1173                        | 41 (28 to 55)                     | 198.11| <0.001    |
| Referred††                      | 435                              | 334                         | 77 (64 to 86)                     |      |           |
| **Type of health facility**     |                                 |                             |                                   |      |           |
| Health Centre                   | 1204                             | 628                         | 52 (34 to 70)                     | 34.22| 0.42      |
| Hospital                        | 2111                             | 879                         | 42 (25 to 61)                     |      |           |
| **Ownership of health facility**|                                 |                             |                                   |      |           |
| Public                          | 2675                             | 1265                        | 47 (31 to 64)                     | 18.7 | 0.60      |
| Private                         | 640                              | 242                         | 38 (25 to 53)                     |      |           |

*Number of women with severe abortion complications in each row category, the denominator includes abortion near-miss cases as well.
†Number of abortion near-miss cases in each row category.
‡Proportion of women with abortion near-miss out of the total with severe abortion complications in each row category.
§Using the Pearson χ² to test difference in the proportion of all severe abortion complications that are near-miss across different sociodemographic, reproductive and institutional characteristics.
¶Excludes patients where the trimester was not indicated.
**Excludes patients that did not have a recorded HIV status.
††Patients referred into the health facility for management of abortion complications.
central region of the country. The Eastern region is characterised by a slightly younger age of sexual debut and higher unmet need for family planning which translates to increased unintended pregnancies.22 31 32 Previous evidence shows that the Eastern region has a huge burden of unintended pregnancies, 8% of them end in abortions and complications occur in 58% of the women.22 Family planning or postabortion contraception is a key intervention to reduce unintended pregnancies and repeat unsafe abortions respectively, ultimately decreasing ANM and mortality. In addition, access to safe abortion within the confines of the law mitigates the negative effects of unsafe abortion.

Our health facility assessment in the two regions reveals that the Eastern region has less readiness to manage abortion complications such as fewer MVA kits—yet these are

| Characteristics | Complication/management option n* | Proportion (%) of complication among severe abortion complications † (95% CI) N=3315 | Proportion (%) of complication among abortion near-miss‡ (95% CI) N=1507 |
|-----------------|----------------------------------|-------------------------------------------------|---------------------------------|
| **Complications** |                                  |                                                 |                                 |
| Maternal deaths  | 37                               | 1 (0 to 3)                                      | N/A                             |
| Infection       | 243                              | 7 (4 to 12)                                     | 16 (10 to 24)                   |
| Organ dysfunction| 1138                             | 34 (23 to 48)                                   | 76 (65 to 84)                   |
| **Management options** |                          |                                                 |                                 |
| Types of uterine evacuation | |                                                 |                                 |
| Spontaneous expulsion | 1086                          | 35 (24 to 47)                                   | 41 (27 to 56)                   |
| Evacuation/MVA  | 2038                             | 65 (53 to 75)                                   | 58 (43 to 72)                   |
| Medical         | 17                               | 1 (0 to 1)                                      | 1 (0 to 3)                      |
| **Uterotonics administered** | |                                                 |                                 |
| Misoprostol     | 950                              | 33 (23 to 46)                                   | 40 (27 to 54)                   |
| Oxytocin        | 1826                             | 64 (52 to 75)                                   | 58 (44 to 71)                   |
| Other uterotonics | 69                             | 2 (1 to 11)                                     | 2 (1 to 7)                      |
| **Additional interventions** |                          |                                                 |                                 |
| Blood transfusion |                                  |                                                 |                                 |
| Yes             | 636                              | -§                                               | 42 (24 to 62)                   |
| Blood units received (n=636) | |                                                 |                                 |
| 1               | 367¶†                           | -§                                               | 58 (45 to 69)**                 |
| 2               | 188                              | -§                                               | 30 (23 to 37)**                 |
| 3–4             | 64                               | -§                                               | 10 (5 to 18)**                  |
| 5 or more       | 10                               | -§                                               | 2 (1 to 3)**                    |
| Units unknown   | 7                                | -§                                               | 1 (0 to 3)**                    |
| Laparotomy(n=27) |                                  |                                                 |                                 |
| Done <3 hours from admission | 9                        | -§                                               | 33 (12 to 64)                   |
| Done 3–12 hours from admission | 14                       | -§                                               | 52 (21 to 81)                   |
| Performed after 12 hours of admission | 4                    | -§                                               | 15 (5 to 36)                    |

Pearson $\chi^2$ was the statistical test used however we do not present the $\chi^2$ or p value.

*Number of all women with each row characteristic.
†Proportion of severe abortion complications with row characteristic out of the total number of severe abortion complications, severe abortion complications also include the near-miss cases.
‡Proportion of abortion near-miss cases with row characteristic out of the total number of abortion near-miss cases.
§All patients who received additional interventions (blood transfusion and laparotomy) were near-miss cases.
¶Women who received only one unit of blood transfusion but had other near-miss criteria.
**Proportion of women who received each number of blood transfusions out of 636.
MVA, manual vacuum aspiration.
critical in removing uterine contents to control bleeding following an abortion. In the event of referral, facilities in the Eastern region are less likely to have motorised transport or a trained health provider accompany the referred woman to a higher health facility. Kanamura et al report a profound lack of abortion services and MVA

| Characteristic | Abortion near-miss | Prevalence ratio* | P value† |
|---------------|-------------------|------------------|---------|
|               | Column % (95% CI) | (95% CI)         |         |
| First trimester‡ N=589 | 27 (0.2) | 0.99 (0.98 to 1.00) | 0.17 |
| Second trimester§ N=499 | 26 (0.2) | 0.99 (0.97 to 1.01) | 0.48 |
| Background indicators Mean age (SE) | | | |
| Median no of pregnancies (IQR) | 3 (2–6) | 3 (2–5) | 1.00 (0.81 to 1.23) | 0.91 |
| HIV status¶ | | | |
| Negative | 69 (56 to 79) | 0.94 (0.81 to 1.08) | 0.27 |
| Positive | 4 (3 to 8) | 1.10 (0.83 to 1.45) | 0.52 |
| Timing of complications | | | |
| At arrival or within 12 hours | 98 (96 to 99) | Ref |
| Developed after 12 hours | 2 (1 to 4) | 1.37 (1.07 to 1.76) | 0.01 |
| Referral status | | | |
| Not referred | 82 (73 to 88) | Ref |
| Referred | 18 (12 to 27) | 1.11 (0.87 to 1.42) | 0.40 |
| Type of health facility | | | |
| Hospital | 44 (24 to 66) | Ref |
| Health centre | 56 (34 to 76) | 0.85 (0.61 to 1.18) | 0.32 |
| Ownership of health facility | | | |
| Public | 85 (69 to 94) | Ref |
| Private | 15 (6 to 31) | 0.92 (0.74 to 1.14) | 0.44 |
| Complications and outcome | | | |
| Infection | 15 (8 to 24) | 1.08 (0.86 to 1.37) | 0.49 |
| Organ dysfunction | 80 (68 to 88) | 0.96 (0.80 to 1.16) | 0.66 |
| Management options | | | |
| Types of uterine evacuation | | | |
| Spontaneous expulsion | 37 (20 to 59) | Ref |
| Evacuation/MVA | 62 (41 to 80) | 0.69 (0.51 to 0.93) | 0.02 |
| Medical | 0 (0 to 2) | 1.49 (0.96 to 2.30) | 0.07 |
| Uterotonics administered | | | |
| Misoprostol | 40 (27 to 55) | Ref |
| Oxytocin | 57 (43 to 70) | 0.94 (0.78 to 1.15) | 0.55 |
| Other uterotonics | 3 (1 to 10) | 0.86 (0.53 to 1.39) | 0.53 |
| Laparotomy(n=27) | | | |
| Done <3 hours from admission | 25 (3 to 76) | Ref |
| Done 3–12 hours from admission | 50 (9 to 91) | 0.90 (0.25 to 3.23) | 0.85 |
| Performed after 12 hours of admission | 25 (3 to 76) | 0.75 (0.12 to 4.85) | 0.73 |

*These are unadjusted prevalence ratio estimates for generalised linear models with binomial family and loglink.
†P value of the prevalence ratio when the null hypothesis of no difference between ANM in first and second trimester for the characteristic is true as extracted from the generalised model.
‡Proportion of near-miss cases in the first trimester with row characteristic.
§Proportion of near-miss cases in the second trimester with row characteristic.
¶HIV status missing for 32% (487/1507) of the near-miss cases.
MVA, manual vacuum aspiration.
sets in 40 health facilities, ranging from Health Centre IIIs to hospitals, from three districts in the same region.\textsuperscript{33} Inability to obtain EmOC at nearby health facilities due to lack of supplies and commodities, non-accompaniment to the next referral site using non-motorised means on bad terrain road infrastructure increases complication rates or death due to delay in accessing appropriate critical care.\textsuperscript{33–35}

SAM cases were 42\% in first trimester and 31\% in the second trimester; 2\% of the women with SAM died in second trimester and 0.3\% in the first trimester. The former could reflect the higher frequencies of pregnancies ending in the first trimester than in the second trimester; while the latter agrees with previous studies which show that mortality from abortion complications like bleeding and infection increases with gestation age.\textsuperscript{36–38} The Uganda national reproductive guidelines recommend use of surgical techniques, under general anaesthesia or heavy sedation by doctors for second trimester evacuations. It is worth noting that second trimester near-miss cases were less likely to have uterine evacuation compared with spontaneous expulsion. One possible explanation could be that second trimester abortions tend to be spontaneous hence the complete expulsion. However, it might as well reflect a gap in accessing surgical services overall for abortion cases. Only 85\% of comprehensive EmOC facilities had surgical/laparotomy capability, this may delay patients to receive appropriate surgical care further increasing the severity of the complications with some ending as maternal deaths.

ANM is increased among referrals, who can be identified as high risk cases that require close monitoring. Unlike other studies where majority of maternal near-misses develop either before or at admission,\textsuperscript{39} ANM mainly occurred after 12 hours of admission showing that the cascade of near-miss and mortality can be disrupted if the quality of care is improved and the health facility/providers respond promptly to women who are already in their care.

Despite blood transfusion being a core component of the near-miss classification particularly in a condition such as abortion where massive haemorrhage occurs, over 39\% of transfused patients were discharged with an Hb less than 70 g/L denoting severe anaemia according to WHO recommendations.\textsuperscript{40} With only 64\% of the comprehensive EmOC facilities able to offer blood transfusion services, this study and others in similar settings demonstrate the scarcity of blood products in low and middle income countries.\textsuperscript{14, 26, 41, 42} We did not perform a comparative analysis using the WHO near-miss definition of massive transfusion of 5 blood units due to the small number of 17 cases that got a massive transfusion. We had done some more analysis on the cut-off in another paper published from this database.\textsuperscript{27}

**Strengths and limitations**

A strength of the study is a large data set of over 12800 women from the primary trial with severe maternal morbidity and mortality from 43 health facilities in 18 districts of the country, from which eligible records of those with 3315 severe abortion complications were extracted, enhancing the generalisability of the results. We used the WHO maternal near-miss tool. We modified the data collection tool to include severe abortion complications,\textsuperscript{45} and amended the definition to include all those who received at least two units of blood transfusion.\textsuperscript{26, 41, 42} We acknowledge that some researchers cite discrepancies in reporting using modified WHO near-miss tool, however, with a clear reporting of the

| Table 5 Health facility readiness for postabortion care (PAC) in 43 health facilities in central and eastern Uganda |
|--------------------|-------------------------------|-----------------------------|------------------|---|
| Indicator                        | All health facilities n(%) N=43 | Region n(%) Central N=28 | Eastern N=15 | P value* |
| Uterotonics                  |                               |                             |                |   |
| Misoprostol                  | 18 (41.9)                      | 9 (32.1)                    | 9 (60.0)       | 0.075 |
| Oxytocin                     | 37 (86.1)                      | 23 (82.1)                   | 14 (93.3)      | 0.304 |
| Manual vacuum aspirators     | 30 (69.8)                      | 24 (85.7)                   | 6 (40.0)       | 0.003 |
| Intravenous fluids           | 40 (93.0)                      | 25 (89.3)                   | 15 (100)       | 0.541 |
| Parenteral antibiotics       | 37 (86.1)                      | 25 (89.3)                   | 12 (80.0)      | 0.647 |
| Provision of PAC services 24/7 | 43 (100)                      | 28 (100)                    | 15 (100)       | – |
| Motorised transport for referral | 32 (74.4)                      | 25 (89.3)                   | 7 (46.7)       | 0.004 |
| Health provider accompanying referral | 18 (41.9)                      | 15 (53.6)                   | 3 (20.0)       | 0.034 |
| Communication means          | 17 (39.5)                      | 13 (46.4)                   | 4 (26.7)       | 0.207 |
| Blood transfusion services†  | 25 (64.1)                      | 19 (67.9)                   | 6 (54.6)       | 0.297 |
| Surgical/laparotomy capability† | 33 (84.6)                      | 25 (89.3)                   | 8 (72.7)       | 0.323 |

The indicators were measured for all 43 health facilities unless otherwise stated.

\(\chi^2\) or Fischer’s exact test done to compare PAC health facility readiness between the central and eastern regions.

†Only assessed for 39 health facilities that offer comprehensive emergency obstetric care services.

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of key supplies and commodities, for example, MVA kits, parenteral antibiotics and uterotonic like misoprostol which impede access to appropriate care. Policy-makers should strengthen primary prevention strategies like family planning and harm reduction strategies to reduce the burden of unintended pregnancy and resulting abortion complications. Life-saving drugs and supplies should be available in the health system and referral pathways strengthened to ensure patients access emergency appropriate care early. Finally, abortion maternal death and ANM audit should be implemented and arising recommendations instituted to curtail the vicious cycle of abortion morbidity and mortality.

**Interpretation**

ANM and mortality evidence can be captured using the adapted WHO maternal near-miss criteria particularly in low-income settings. Women with second trimester abortion complications need urgent attention to avert severe abortion-related complications and deaths. Provision of essential drugs and supplies is crucial to averting abortion-related near-miss and deaths. We cannot infer causality as the prospective near-miss and the health facility data come from two different cross-sectional surveys. Still, our analysis indicates that the differences observed between the two settings underscore the importance of quality PAC services to address abortion-related mortality. Appropriately defined studies may further investigate into these associations.

**CONCLUSION**

We report an overall high ANMR and AMR, particularly in the Eastern region of the country; and a greater proportion of abortion-related deaths in second trimester. However, mortality is lower compared with studies done in similar settings. ANM is more likely among referrals. The second trimester near-miss is more likely to occur after 12 hours of admission, and less likely to have surgical uterine evacuation. Only three-quarters of health facilities in Uganda that provide comprehensive EmOC have functional blood transfusion services. This coupled with the moderate number of transfused patients at discharge still having severe anaemia shows that use of the adapted WHO near-miss criteria in low-income settings may be more applicable than the strict criteria. There’s a lack of key supplies and commodities, for example, MVA kits, parenteral antibiotics and uterotonic like misoprostol which impede access to appropriate care. Policy-makers should strengthen primary prevention strategies like family planning and harm reduction strategies to reduce the burden of unintended pregnancy and resulting abortion complications. Life-saving drugs and supplies should be available in the health system and referral pathways strengthened to ensure patients access emergency appropriate care early. Finally, abortion maternal death and ANM audit should be implemented and arising recommendations instituted to curtail the vicious cycle of abortion morbidity and mortality.

**Author affiliations**

1Department of Obstetrics and Gynaecology, Makerere University CHS, Kampala, Uganda
2Reproductive Endocrinology and Infertility, Mulago Specialised Women and Neonatal Hospital, Kampala, Uganda
3Obstetrics and Gynecology, Women’s and Children’s Health, Stockholm, Sweden
4Association of Obstetricians and Gynaecologists of Uganda, Kampala, Uganda
5Epidemiology & Biostatistics, School of Public Health, Makerere University, Kampala, Uganda
6Public Health Sciences, Karolinska Institute, Stockholm, Sweden
7Dept of Disease Control, London School of Hygiene and Tropical Medicine Faculty of Infectious and Tropical Diseases, London, UK

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**Contributors**

SA conceptualised the study, performed data compilation, data analysis, manuscript writing, and was lead author with substantive support from KG-D and ChI. FK and JB assisted with study conception and NMT provided statistical input. All coauthors reviewed the draft manuscript versions and approved the final manuscript.

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**Competing interests**

None declared.

**Patient and public involvement statement**

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

**Patient consent for publication**

Not required.

**Ethics approval**

Ethical clearance was obtained from Makerere University School of Medicine Research and Ethics Committee (Rec Ref 2017–016) and Uganda National Council for Science and Technology (HS153ES). District Medical Officers, who head the district health management team, gave informed consent at district level and health facility in-charges gave informed consent at health facility level. We did not seek informed consent from individual patients since we abstracted data which were routinely documented. We received ethics approval for this procedure.

**Provenance and peer review**

Not commissioned; externally peer reviewed.

**Data availability statement**

Data are available on request.
of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

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Author note: Uganda has abortion severe morbidity, near-miss, and mortality ratios of 2063, 938 and 23 per 100 000 live births, respectively.

ORCID iDs
Susan Atuhairwe http://orcid.org/0000-0001-7904-5655
Claudia Hanson http://orcid.org/0000-0001-8066-7873

REFERENCES

1 Say L, Chou D, Gemmill A, et al. Global causes of maternal death: a who systematic analysis. Lancet Glob Health 2014;2:e323–33.
2 Dragonian M, Sheldon WR, Qureshi Z, et al. Overview of abortion cases with severe maternal outcomes in the who multicountry survey on maternal and newborn health: a descriptive analysis. BJOG 2014;121 Suppl 1:25–31.
3 Sedgh G, Bearak J, Singh S, et al. Abortion incidence between 1990 and 2014: global, regional, and subregional levels and trends. Lancet 2016;388:258–67.
4 Sully EA, Atuyambe L, Bukunya J, et al. Estimating abortion incidence among adolescents and differences in postabortion care by age: a cross-sectional study of postabortion care patients in Uganda. Contraception 2018;98:510–6.
5 Ganatra B, Gerds C, Rosser C, et al. Global, regional, and subregional classification of abortions by safety, 2010–14: estimates from a Bayesian hierarchical model. Lancet 2017;390:2372–81.
6 Akinlusi FM, Rabiu KA, Adegunmi AA, et al. Complicated unsafe abortion in a Nigerian teaching hospital: pattern of morbidity and mortality. J Obstet Gynaecol 2018;38:961–6.
7 Bankole A, Kayembe P, Chae S, et al. The severity and management of complications among Postabortion patients treated in Kinshasa health facilities. Int Perspect Sex Reprod Health 2018;44:1–9.
8 Borges ALV, Olá-Olórún F, Fujimori E, et al. Contraceptive use following spontaneous and induced abortion and its association with family planning services in primary health care: results from a Brazilian longitudinal study. Reprod Health 2015;12:94.
9 Combs Thorsen V, Sundby J, Malata A. Piecing together the maternal death puzzle through narratives: the three delays model revisited. PLoS One 2012;7:e25090.
10 Calvert C, Owalobi OO, Yeung F, et al. The magnitude and severity of abortion-related morbidity in settings with limited access to abortion services: a systematic review and meta-regression. BMJ Glob Health 2018;3:e000692.
11 Say L, Souza JP, Pattinson RC, et al. Maternal near miss—towards a standard tool for monitoring quality of maternal health care. Best Pract Res Clin Obstet Gynaecol 2009;23:287–96.
12 Campbell OMR, Aquino EML, Vwalika B, et al. Signal functions for measuring the ability of health facilities to provide abortion services: an illustrative analysis using a health facility census in Zambia. BMC Pregnancy Childbirth 2016;16:105.
13 Lewis G. Beyond the numbers: rethinking the definition of post abortion care services for women and girls in eastern and southern Africa: a systematic review. Contraception 2019:87:77–88.
14 Population QBD, Fertility C, QBD 2017 Population and Fertility Collaborators. Population and fertility by age and sex for 195 countries and territories, 1950-2017: a systematic analysis for the global burden of disease study 2017. Lancet 2018;392:1995–2051.
15 Aantjes CJ, Gilmoor A, Syurina EV, et al. The status of provision of post abortion care services for women and girls in eastern and southern Africa: a systematic review. Contraception 2018;98:77–88.
16 Aantjes CJ, Gilmoor A, Syurina EV, et al. Persisting demand and supply gap for maternal and newborn care in eastern and southern Africa: a mixed-method cross-sectional study. Reprod Health 2017;14:136.
17 Ministry of Health U. In: National policy guidelines for sexual and reproductive health services. 4th edn. Kampala: Reproductive Health Division, Community Health Department, 2011.
18 Klingberg-Allvin M, Cleve A, Atuhairwe S, et al. Comparison of treatment of incomplete abortion with misoprostol by physicians and midwives at district level in Uganda: a randomized controlled equivalence trial. Lancet 2015;385:2392–8.
19 Paul M, Gemzell-Danielsson K, Kiggundu C, et al. Barriers and facilitators in the provision of post-abortion care at district level in central Uganda – a qualitative study focusing on task sharing between physicians and midwives. BMC Health Serv Res 2014;14:28.
20 Prada E, Atuyambe LM, Blades NM, et al. Incidence of induced abortion in Uganda, 2013: new estimates since 2003. PLoS One 2016;11:e0165812.
21 Hansen C, Pembre AB, Alwy F, et al. Evaluating the effect of the helping mothers survive bleeding after birth (HMS BAB) training in Uganda and Tanzania: study protocol for a randomised controlled trial. Trials 2017;18:307.
22 WHO. Evaluating the quality of care for severe pregnancy complications. WHO Document Production Services, Geneva, Switzerland: The WHO near-miss approach for maternal health, 2011.
23 Sara World Health organization service availability and readiness assessment. version 2.2. December 2014. Available: http://www.who.int/healthinfo/syringes/sara_reference_manual_en.pdf [Accessed 30 Aug 2020].
24 Neissen E, Mduma E, Broers J, et al. Applicability of the WHO maternal near miss criteria in a low-resource setting. PLoS One 2013;8:e61248.
25 Pembre AB, Hirose A, Alwy Al-Beity F, et al. Rethinking the definition of maternal near-miss in low-income countries using data from 104 health facilities in Tanzania and Uganda. Int J Gynaecol Obstet 2019;147:389–96.
26 Aantjes CJ, Gilmoor A, Syurina EV, et al. The status of provision of post abortion care services for women and girls in eastern and southern Africa: a systematic review. Contraception 2018;98:77–88.
27 Population QBD, Fertility C, QBD 2017 Population and Fertility Collaborators. Population and fertility by age and sex for 195 countries and territories, 1950-2017: a systematic analysis for the global burden of disease study 2017. Lancet 2018;392:1995–2051.
28 Faúndes A. Strategies for the prevention of unsafe abortion. Int J Gynaecol Obstet 2012;119 Suppl 1:586–71.
29 Uganda Bureau of Statistics (UBOS) and ICF. Uganda demographic and health survey 2016: key indicators report. Kampala, Uganda: UBOS, and Rockville, Maryland, USA UBOS and ICF; 2017.
30 Ministry of Health (MoH), United Nations Children’s Fund (UNICEF), World Health Organization (WHO), The United Nations Entity for Gender Equality and the Empowerment of Women (UN WOMEN), United Nations Population Fund (UNFPA) and The Joint United Nations Programme on HIV/AIDS (UNAIDS). Adolescent health risk behaviors in Uganda: a national cross-sectional survey. Uganda, 2016.
31 Kanaruna RM, Kiwarukena SN, Ekirapa-Kiracho E, et al. Persistent demand and supply gap for maternal and newborn care in eastern Uganda: a mixed-method cross-sectional study. Reprod Health 2017;14:136.
32 Wilenska P, Kallander K, Persson S, et al. Using the three delays model to understand why newborn babies die in eastern Uganda. Trop Med Int Health 2010;15:964–72.
33 Melese T, Habte D, Tsima BM, et al. Management of post abortion complications in Botswana -The need for a standardized approach. PLoS One 2018;13:e0192438.
34 Zsuda AK, Izugbara C, Lavendowski BA, et al. Unsafe abortion in Kenya: a cross-sectional study of abortion complication severity and associated factors. BMC Pregnancy Childbirth 2015;15:34.
35 Pestvenedze E, Lomia N, Berzdul N, et al. Effects of gestational age and the mode of surgical abortion on postabortion hemorrhage and fever: evidence from population-based reproductive health survey in Georgia. BMC Womens Health 2017;17:136.
36 Madziyre MG, Polis CB, Riley T, et al. Severity and management of postabortion complications among women in Zimbabwe, 2016: a cross-sectional study. BMJ Open 2018;8:e019658.
37 Nakimuili A, Nakubulu S, Kakeire O, et al. Maternal near misses from two referral hospitals in Uganda: a prospective cohort study on incidence, determinants and prognostic factors. BMC Pregnancy Childbirth 2016;16:24.
38 WHO. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva: Vitamin and Mineral Nutrition Information System, 2011. https://www.who.int/vmnis/indicators/haemoglobin.pdf
van den Akker T, van Rhenen J, Mwagomba B, et al. Reduction of severe acute maternal morbidity and maternal mortality in Thyolo district, Malawi: the impact of obstetric audit. *PLoS One* 2011;6:e20776.

Owolabi OO, Biddlecorn A, Whitehead HS. Health systems’ capacity to provide post-abortion care: a multicountry analysis using signal functions. *Lancet Glob Health* 2019;7:e110–8.

Tura AK, Stekelenburg J, Scherjon SA, et al. Adaptation of the WHO maternal near miss tool for use in sub-Saharan Africa: an international Delphi study. *BMC Pregnancy Childbirth* 2017;17:445.

Tura AK, Trang TL, van den Akker T, et al. Applicability of the WHO maternal near miss tool in sub-Saharan Africa: a systematic review. *BMC Pregnancy Childbirth* 2019;19:79.