Differences in Life-Saving Obstetric Hemorrhage Treatments for Women with Abortion Versus Nonabortion Etiologies in Tanzania

Lauren Smith, Michelle Skaer Therrien, Kim G. Harley, Selemani Mbuyita, Zacharia Mtema, Iddajovana Kinyonge, Robert Tillya, Godfrey Mbaruku, and Suellen Miller

Complications from unsafe abortion are among the major causes of preventable maternal morbidity and mortality, which may be compounded by delays and disparities in treatment. We conducted a secondary analysis of women with symptoms of hypovolemic shock secondary to severe obstetric hemorrhage in Tanzania. We compared receipt of three lifesaving interventions among women with abortions versus other maternal hemorrhage etiologies. Interventions included: non-pneumatic anti-shock garment (NASG) ($N = 393$), blood transfusion ($N = 249$), and referral to a higher-capacity facility ($N = 131$). After controlling for severity of disease and other confounders, women with abortion-related hemorrhage and shock had 78 percent decreased odds of receiving NASG ($p < 0.001$) and 77 percent decreased odds of receiving a blood transfusion ($p < 0.001$) compared to women with hemorrhage and shock from other etiologies. Our findings suggest that, in Tanzania, women with abortion-related hemorrhage received lower quality of care than women with other hemorrhage etiologies.

Preventable maternal morbidity and mortality from unsafe abortions remain significant issues of health and equity around the world. When performed according to medical guidelines, women with induced abortions rarely experience complications, but unsafe abortions contribute significantly to maternal mortality and morbidity globally (Sedgh et al. 2012). According to the World Health Organization (WHO), more than 300,000 women died during and following pregnancy and childbirth in 2015 (WHO 2016), and

Lauren Smith is an MPH graduate and Kim G. Harley is Associate Adjunct Professor, School of Public Health, University of California, 2121 Berkeley Way, Room 5302, Berkeley, CA 94720. Email: laurensmith@berkeley.edu. Michelle Skaer Therrien is Project Director, and Suellen Miller is Professor, Department of Obstetrics, Gynecology & Reproductive Sciences, Bixby Program, Safe Motherhood Programs, University of California, San Francisco. Selemani Mbuyita is Senior Research Scientist, Zacharia Mtema is Chief Research Scientist, Iddajovana Kinyonge is Research Scientist, Robert Tillya is Research Scientist, and Godfrey Mbaruku was Research Scientist and former Deputy Director, Ifakara Health Institute, Dar es Salaam, Tanzania.

approximately 8 percent of these deaths were attributable to unsafe abortion (Say et al. 2014). However, the proportion of deaths attributable to abortion varies by region and country, with estimates ranging from approximately 1 percent of maternal deaths in Eastern Asia to nearly 10 percent of maternal deaths in Latin America, the Caribbean, and sub-Saharan Africa (Say et al. 2014). In Tanzania, the Ministry of Health and Social Welfare estimates that approximately 16 percent of maternal deaths are the result of abortion complications (United Republic of Tanzania Ministry of Health and Social Welfare 2010). Although death is the most salient and recorded outcome, mortality estimates alone do not capture the true burden of disease and disability associated with unsafe abortion. One study found that for every case of maternal mortality, approximately 30 other women experienced acute or chronic morbidity (Prual et al. 2000). Morbidity associated with unsafe abortion includes secondary infertility, recurrent pregnancy loss, pelvic pain, ectopic pregnancy, and internal organ injury (Okonofua 2006; Haddad and Nour 2009).

The impact of unsafe abortion on maternal health is of particular concern in countries with restrictive abortion laws. A study conducted jointly by WHO and the Guttmacher Institute found no association between countrywide rates of abortion and the legal status of abortion in that country (Sedgh et al. 2016). However, according to WHO, almost all maternal deaths attributable to unsafe abortion occur in countries with restrictive abortion laws (WHO 2011). Thus, although rates of abortion do not differ in countries with restrictive versus liberal abortion laws, the impact on maternal health varies dramatically. This disparity in abortion-related mortality is one of the most striking examples of inequity in maternal health globally.

Abortion-related morbidity and mortality in countries with restrictive laws may be a combination of the unsafe conditions in which the abortions are conducted, delays in seeking and receiving care for complications, and the quality of care that is ultimately received. Few studies have investigated factors contributing to morbidity and mortality from unsafe abortions, and existing studies have focused on delays in care. Delays have widely been accepted as one of the principal causes of maternal morbidity and mortality (Thaddeus and Maine 1994). Specifically, the three-delays model identifies: (1) delays in seeking emergency obstetric care; (2) delays in reaching the desired health-care facility; and (3) delays in receiving appropriate care once at the health-care facility as the main determinants of preventable maternal mortality (Thaddeus and Maine 1994).

A study in Zambia evaluated access to transportation to health-care facilities, and found significant differences in transportation via ambulance by week of pregnancy, a proxy for abortion (Butrick et al. 2014). Specifically, women with obstetric hemorrhage that began before week 24 of pregnancy (the majority of which were assumed to be caused by complications of abortion) were much less likely to receive transportation via ambulance than women with obstetric hemorrhage after 24 weeks of pregnancy. The authors concluded that women with abortion-related hemorrhage received less access to medical transportation than women with other obstetric etiologies. Furthermore, the authors proposed that these differences in transportation options could lead to unequal delays in reaching a desired health-care facility (Butrick et al. 2014).

A study from one regional hospital in Tanzania found that all women who died secondary to abortion-related hemorrhage had received "major substandard care," defined as care that

led to a death that could have been avoided if delays in care had not existed (Sorensen et al. 2010). A study from Gabon found that women who died secondary to abortion-related hemorrhage had experienced significantly longer delays in receiving care than women who died from post-partum hemorrhage or eclampsia (Mayi-Tsonga et al. 2009). The difference in delays identified in these studies suggests a lack of access to facilities, fear or inability to seek care, and/or inequality in care received by women with abortion-related hemorrhage.

While previous studies have noted delays in accessing and receiving care, no other studies in resource-poor settings have evaluated differences in clinical treatment received. In this study, we compare differences in essential interventions and referral rates between women presenting with post-abortion hemorrhage versus women with other hemorrhage etiologies in Tanzania.

Abortion Care Context in Tanzania

In Tanzania, current law permits termination of pregnancy only if it is necessary to save a woman's life (Tanzania Government 1991). Despite the restrictions, the rate of abortion in Tanzania in 2013 was estimated to be 36 per 1,000 women aged 15–49 (Keogh et al. 2015), similar to the global average (Sedgh et al. 2016). Without legal options available to most women, unsafe abortions are prevalent throughout Tanzania. National-level estimates of unsafe abortions are not available for Tanzania specifically, but regional estimates for East Africa (including Tanzania) indicate that nearly all induced abortions are performed in unsafe conditions (Sedgh et al. 2012). Moreover, approximately one-third of all hospitalizations from obstetric complications in Tanzania are due to abortion (Price, Hawkins, and Ezekiel 2003). As a country with less access to safe abortion, Tanzania is an area of particular concern with regard to abortion-related morbidity and mortality.

Although current law prevents the acquisition of safe termination of pregnancy for most women, the Tanzanian government has demonstrated a desire to decrease morbidity and mortality associated with unsafe abortion. Since 2000, Tanzania has been adopting and expanding upon a post-abortion care (PAC) plan throughout the country (Woog and Pembe 2013). All health-care facilities are mandated to provide adequate treatment for abortion patients and are expected to be equipped with the knowledge and resources to treat abortion-related hemorrhage. Despite these good intentions, PAC training has not reached all facilities and the question still remains as to whether or not women with abortion-related hemorrhage are receiving adequate and appropriate care.

Furthermore, in 2017 the Tanzanian Ministry of Health, Community Development, Gender, Elderly and Children released new standard treatment guidelines (United Republic of Tanzania Ministry of Health, Community Development, Gender, Elderly and Children 2017). In general, the new guidelines review basic identification, management, and referral steps for different causes of obstetric hemorrhage including incomplete abortion, complete abortion, septic abortion, molar pregnancy, ectopic pregnancy, placenta previa, placental abruption, and postpartum hemorrhage. Of note, abortion is specifically defined as the "spontaneous loss of a fetus before it is viable" and does not acknowledge the possibility of an induced abortion. Unfortunately, the management instructions and referral instructions for all obstetric complications are quite minimal or, in some cases, absent. For example, for incomplete

abortion the referral instructions suggest that providers "Refer patient to hospital level with an escort of a nurse if bleeding continues," but details no specific guidelines or specific quantity of blood, shock symptoms, or time period when one should consider referral. Other sections say "Apply ABCD principles of resuscitation" broadly without giving specifics, and yet others refer to checking hemoglobin levels for possible transfusion without giving suggested transfusion cutoffs. While this provides some framework for care, it is minimal and does not detail clear, usable guidelines for health-care providers to implement.

This present study uses data from a larger health intervention in Tanzania called Empower II (Mbaruku et al. 2018). The purpose of our study was to compare rates of three recommended management strategies for obstetric hemorrhage and hypovolemic shock—(1) management with the non-pneumatic anti-shock garment (NASG), (2) blood transfusion, and (3) referral to higher-level facilities—among women with post-abortion hemorrhage versus other hemorrhage etiologies. Given that attitudes toward and familiarity with abortion treatment may vary throughout Tanzania, we are also interested in examining whether this relationship varied by region.

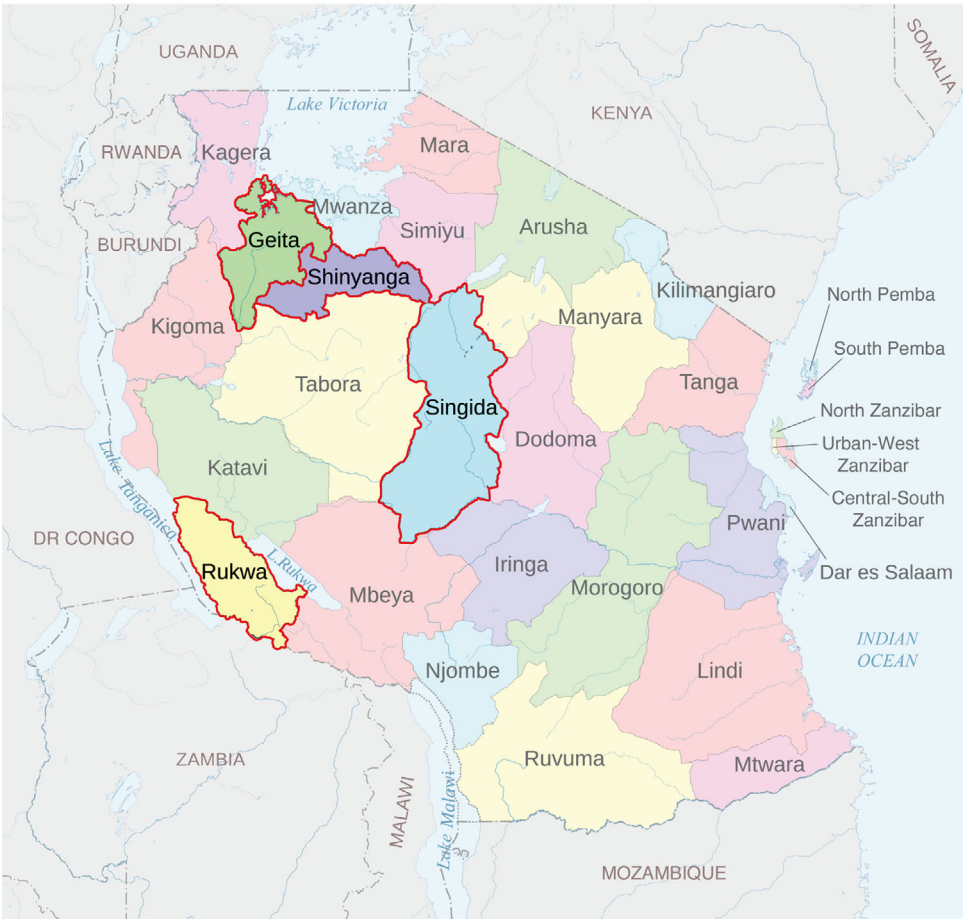
Numerous studies have demonstrated that NASG is effective at reducing mortality for women with any etiology of obstetric hemorrhage, and should be applied equally across different etiologies (Miller et al. 2010; El Ayadi et al. 2013; Manandhar et al. 2015; Miller and Belizán 2015). For blood transfusion, although a number of different protocols for obstetric hemorrhage and hypovolemic shock exist (Royal College of Obstetricians and Gynecologists 2009; Gulmezoglu, Souza, and Mathai 2012), the guidelines are very similar regardless of hemorrhage etiology (Martel et al. 2002; Jadon and Bagai 2014). Finally, the Tanzanian health system recognizes that the majority of its health facilities are not equipped to manage obstetric hemorrhage, and therefore the protocol indicated in their guidelines is generally to refer to a facility that is equipped for Comprehensive Emergency Obstetric Care, which includes capacity for transfusion across hemorrhage etiologies. In the context of the Empower II maternal health intervention and the international evidence (described below), all patients with a similar severity of obstetric hemorrhage and hypovolemic shock should have received NASG, blood transfusion, and referral to higher-level facilities (if blood transfusions cannot be performed), at similar rates.

METHODS

Data were collected as part of an evaluation of the Empower II maternal health improvement program implemented by Ifakara Health Institute (IHI) throughout 246 rural health dispensaries, 28 rural health centers, and 6 referral facilities in 4 regions across 8 districts (Figure 1) of Tanzania. The program was introduced to all public health facilities in the 8 districts as well as private referral facilities that received patients regularly from the public system.

All public facilities at any level and any large private facility that provided Comprehensive Emergency Obstetric Care (CEmOC) were eligible and included. Empower II focused on accelerating scale-up for Maternal, Newborn and Child Health (MNCH) interventions, and included three components: (1) the implementation of a new system to improve referrals and communication between providers at Basic Emergency Obstetric Care (BEmOC) level

FIGURE 1 Map of study regions within Tanzania



facilities and providers at CEmOC referral facilities through the use of a mobile telephone system; (2) the introduction of NASG as a first-aid measure for obstetric hemorrhage/hypovolemic shock in resource-limited facilities; and (3) e-data capture on real time using a mobile phone platform. BEmOC refers to facilities that are capable of dispensing parenteral antibiotics, parenteral oxytocic drugs, parenteral sedatives for eclampsia, manually removing placenta, and manually removing retained products (Maine, Bailey, and Lobis 2009). CEmOC describes facilities that have all of the above capabilities and are also able to perform surgeries and administer anesthesia and blood transfusions (Maine, Bailey, and Lobis 2009). As part of the Empower II project, the Blue Fuzion NASG, a neoprene and Velcro compression garment that wraps around the lower body to reduce blood loss and reverse shock, was introduced for treatment of all cases of obstetric hemorrhage, regardless of etiology, within participating health-care facilities (Mbaruku et al. 2018). For the training provided within the context of this project, protocols were given for obstetric hemorrhage due to any etiology, with an explicit note that this included abortion (without specification of spontaneous or induced). Education was provided to participating facilities regarding the principles of

resuscitation and the treatment of shock; for example, use of isotonic fluids was recommended prior to blood transfusion. Of note, provider bias was not an original goal of the intervention. A baseline record review was completed before the intervention to compile a rudimentary snapshot of rates of obstetric hemorrhage at each facility, but data were not available related to underlying etiologies of obstetric hemorrhage. Ethical approval for the Empower II program was obtained from Ifakara Health Institute Ethics Committee and the National Medical Research Institute Committee in Tanzania.

Because the program was introduced across a large number of facilities, it was gradually rolled out over a number of months. The program began in November 2014 with trainings on use of NASG and the new referral system in CEmOC facilities. By April 1, 2015 the program and data collection were ongoing at all 280 participating facilities. Data collection continued through July 31, 2016. Pre-program data collection was collected for some baseline data, but only data collected after program implementation was used in this secondary data analysis. The first four months of intervention data were excluded from this analysis because not all facilities had begun the intervention and the electronic data collection had not begun in all sites. The same training staff was deployed to all regions to lead the trainings, consisting of two teams from Ifakara Health Institute who visited all 280 facilities four times over the course of the intervention to conduct supervision and ensure consistent implementation.

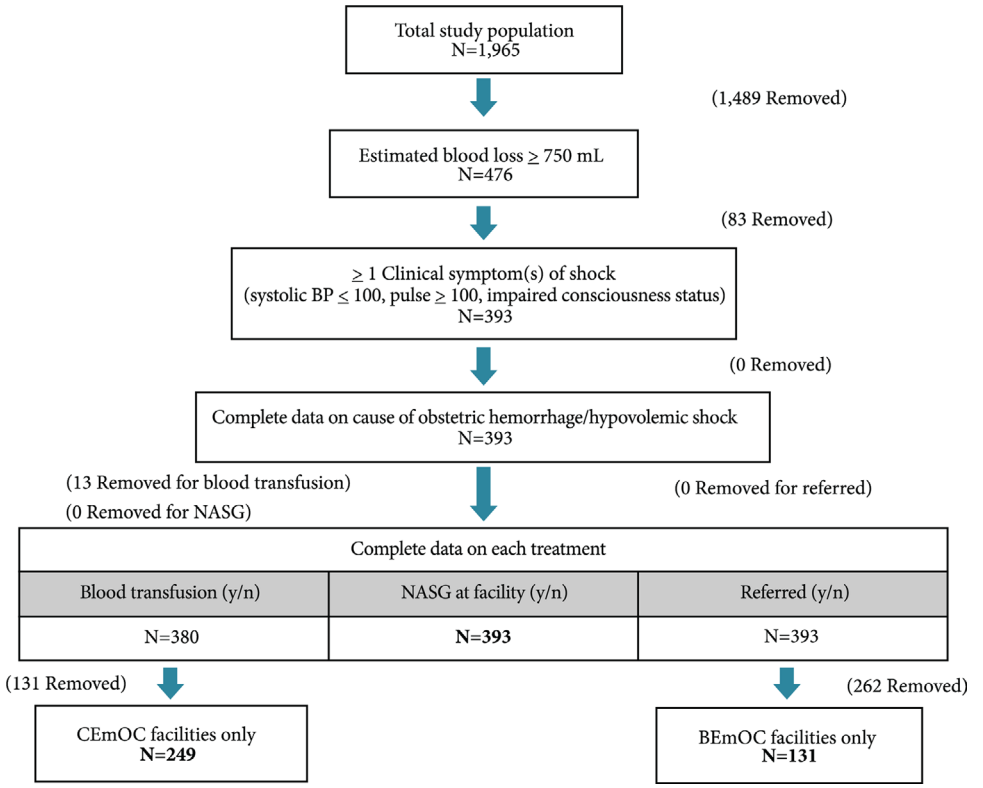
Women were eligible for inclusion if they presented to any participating health-care facility and were diagnosed with both obstetric hemorrhage (defined as estimated blood loss $\geq$500 milliliters [ml]) and hypovolemic shock (defined as systolic blood pressure less than 90 mm Hg, pulse greater than or equal to 100 beats per minute [bpm], and other symptoms of shock). However, data were recorded for all individuals whom health-care providers felt were experiencing obstetric hemorrhage and hypovolemic shock regardless of whether they met this strict criterion. All etiologies of obstetric hemorrhage were included, and women were included regardless of whether they began hemorrhaging at the facility, or before arriving at or being transferred to the facility.

For each participant, a number of health variables were recorded on one of two data-collection forms (either Form F or Form G) and reported back to IHI. Form F was used by BEmOC facilities, and Form G was given to CEmOC facilities. Forms F and G contained the same information except that Form G included additional information related to blood transfusions and other medical interventions. Both forms included data related to obstetric hemorrhage etiology, treatment, severity, and outcome. All program records were reviewed by clinicians, and onsite supervision was conducted three times during program implementation. During the on-site supervision, project staff demonstrated their skills, and electronic reports were verified against paper records. These measures were taken to help verify the accuracy of the data collected (Mbaruku et al. 2018).

Study Population

Overall, 1,965 women presented to participating health-care facilities with obstetric hemorrhage and hypovolemic shock. We restricted the dataset to women with severe hemorrhage (N = 476), defined as estimated blood loss $\geq$750 mL, because individuals with

FIGURE 2 Inclusion criteria for study population



abortion-related hemorrhage tended to have lower estimated blood loss, higher systolic blood pressure, lower pulse, and higher levels of consciousness than women with other hemorrhage etiologies, and we wanted to compare rates of appropriate treatment among cases of similar potentially life-threatening severity. The cutoff of 750 ml was selected because it is midway between the accepted global definition of obstetric hemorrhage (estimated blood loss ≥500 mL) (Gulmezoglu, Souza, and Mathai 2012) and severe obstetric hemorrhage (estimated blood loss ≥1,000 mL) (Martel et al. 2002). We further excluded women who were not experiencing one or more clinical symptom(s) of shock (N = 83), defined as systolic blood pressure ≤100, pulse ≥100, or an impaired state of consciousness, defined as an individual who was agitated/confused or unconscious (Martel et al. 2002), for a sample size of 393. All patients had complete information on treatment with NASG for a final sample size of N = 393 for NASG use. Thirteen individuals were missing information on transfusion status and 131 individuals attended BEmOC facilities where blood transfusions were not available, yielding a final sample size of N = 249 for the blood transfusion analysis. We limited the analysis of referral status to women who initially presented at BEmOC facilities and were referred out to CEmOC facilities, leaving a final sample size for referral analysis of N = 131 (Figure 2).

TABLE 1 Characteristics of women with hypovolemic shock by obstetric hemorrhage etiology (N = 393)

Characteristic	Abortion N = 93	Other hemorrhage etiologies N = 300	P-value
	Mean (SE)	Mean (SE)	
Blood loss (mL)	1,112.47 (44.53)	1,123.93 (26.09)	0.83
Pulse (bpm)[a]	98.07 (2.03)	100.84 (1.05)	0.21
Systolic BP (mm Hg)[a]	90.51 (2.17)	86.02 (1.09)	**0.05**
	N (%)	N (%)	
Location of hemorrhage onset			**<0.001**
Home or other	89 (95.70)	119 (39.67)	
Health-care facility	4 (4.30)	181 (60.33)	
Levels of consciousness			0.59
Conscious	44 (47.31)	140 (46.67)	
Confused/Agitated	34 (36.56)	98 (32.67)	
Unconscious	15 (16.13)	62 (20.67)	
Region[a]			**<0.001**
Rukwa	29 (31.18)	65 (21.67)	
Singida	34 (36.56)	48 (16.00)	
Geita	21 (22.58)	86 (28.67)	
Shinyanga	8 (8.60)	101 (33.67)	
Facility level			0.08
CEmOC	55 (59.14)	207 (69.00)	
BEmOC	38 (40.86)	93 (31.00)	

[a]Ns do not add up to 393 because of missing values for pulse (N = 7), systolic blood pressure (N = 10), and region (N = 1).

Definition of Variables

The main independent variable of interest was obstetric hemorrhage etiology (abortion versus other), which clinic staff recorded on the data-collection form. Hemorrhage etiology was entered as 1 through 11: placenta previa (1), placental abruption (2), uterine atony (3), ruptured uterus (4), retained placenta (5), genital lacerations (6), abortion-related hemorrhage (7), ectopic pregnancy (8), molar pregnancy (9), disseminated intravascular coagulation (DIC) (10), and other (11). For our analysis, we recoded this into a binary variable where "1" was "Abortion-related hemorrhage" and "0" was "All other etiologies of hemorrhage" grouped together.

The outcomes of interest were receipt of NASG, blood transfusion, and referral. The NASG outcome variable was created by combining two other questions from the data collection form: (1) "Did the patient arrive at the hospital wearing a NASG?" and (2) "Did the patient receive a NASG at the hospital?" Blood transfusion and referral to a CEmOC facility were both originally coded as binary variables in the dataset and remained binary variables in the analysis.

Basic demographic information including age, parity, marital status, and education, was not available in the dataset. Covariates were coded as seen in Table 1. Estimated blood loss, pulse, and systolic blood pressure were coded as continuous variables; all other covariates were categorical.

Data Analysis

STATA 14.2 was used for all data analysis. We examined the associations of the covariates of interest with obstetric hemorrhage etiology and with receipt of each treatment using chi-square tests for categorical and binary variables and *t*-tests for continuous variables. Three separate crude and multivariable logistic regression models were conducted to examine the

association of obstetric hemorrhage etiology with NASG, blood transfusion, and referral. All models included the "vce (cluster clustvar)" command in STATA to allow the calculation of standard errors to factor in intragroup correlation by facility (StataCorp 2019).

All models controlled for region, location of hemorrhage onset, level of consciousness, estimated blood loss, and pulse and systolic blood pressure at shock diagnosis. For the NASG model, we also controlled for BEmOC versus CEmOC facility. For blood transfusion, the model additionally adjusted for blood stock status and was restricted only to CEmOC facilities. Blood stock status represented whether or not that facility had blood in reserve in the blood bank. The model for referral status was restricted to BEmOC facilities and did not include any additional covariates. Hosmer-Lemeshow goodness of fit tests were run for all three models to evaluate whether data predicted by the model were similar to the actual observed data (Hosmer, Lemeshow, and Sturdivant 2013). The criterion for statistical significance was set at $p < 0.05$.

We additionally examined whether associations differed by geographic region of health-care facility by including a cross-product term between hemorrhage etiology and geographic region of health-care facility in the model for NASG use. A Wald test was performed for the interaction terms to determine whether the model with the interaction terms fit the data significantly better than the model without the interaction terms (Bewick, Check, and Ball 2005). Sample sizes for the blood transfusions and referral models were too small to examine interaction.

RESULTS

Table 1 compares the characteristics of women with abortion-related hemorrhage versus women with other obstetric hemorrhage etiologies. Women with abortion-related hemorrhage and women with other obstetric hemorrhage etiologies had no significant differences in blood loss, pulse, or degree of consciousness. However, women with abortion-related hemorrhage did have higher mean systolic blood pressure at shock diagnosis (90.5 mm Hg) than women with other hemorrhage etiologies (86.0 mm Hg). Additionally, women who experienced obstetric hemorrhage and hypovolemic shock secondary to abortion-related hemorrhage were more likely to begin hemorrhaging at home or at another location outside of a health-care facility (95.7 percent) than women with other hemorrhage etiologies (39.7 percent). The distribution of etiologies differed significantly by geographical region in Tanzania with 36.6 percent of women with abortion-related hemorrhage coming from the Singida region, 31.2 percent from Rukwa, 22.6 percent from Geita, and only 8.6 percent from the Shinyanga region. Although not statistically significant at the $p < 0.05$ level, slightly more individuals with abortion-related hemorrhage (40.9 percent compared to individuals with obstetric hemorrhage from other etiologies (31.0 percent) attended BEmOC facilities.

As shown in Table 2, women who received NASG were more likely to have more severe shock symptoms, including higher pulse and lower systolic blood pressure at shock diagnosis (103.7 bpm and 83.2 mm Hg) than women who did not receive NASG (93.2 bpm and 94.9 mm Hg). Women who were confused/agitated or were unconscious were also more likely to receive NASG (79.6 percent and 71.4 percent respectively) than women who were

TABLE 2 Characteristics of women with obstetric hemorrhage by NASG use (N = 393)

Characteristic	NASG		P-value
	No (N = 130)	Yes (N = 263)	
	Mean (SE)	Mean (SE)	
Blood loss (mL)	1,133.23 (43.03)	1,115.29 (26.11)	0.71
Pulse (bpm)[a]	93.18 (1.55)	103.68 (1.11)	**<0.001**
Systolic BP (mm Hg)[a]	94.87 (1.65)	83.22 (1.15)	**<0.001**
	N (%)	N (%)	
Location of hemorrhage onset			**<0.001**
Home or other	88 (42.31)	120 (57.69)	
Health-care facility	42 (22.70)	143 (77.30)	
Levels of Consciousness			**<0.001**
Conscious	81 (44.02)	103 (55.98)	
Confused/Agitated	27 (20.45)	105 (79.55)	
Unconscious	22 (28.57)	55 (71.43)	
Region[a]			**<0.001**
Rukwa	36 (38.39)	58 (61.70)	
Singida	46 (56.10)	36 (43.90)	
Geita	19 (17.76)	88 (82.24)	
Shinyanga	28 (25.69)	81 (74.31)	
Facility level			
CEmOC	96 (36.64)	166 (63.36)	
BEmOC	34 (25.95)	97 (74.05)	**0.03**

[a]Ns do not add up to 393 because of missing values for pulse (N = 7), systolic blood pressure (N = 10), and region (N = 1).

conscious (56.0 percent). Individuals who began hemorrhaging outside of a health-care facility were less likely to receive NASG (57.7 percent) than women who began hemorrhaging in a health-care facility (77.3 percent). The distribution of NASG use varied significantly by region; 82.2 percent of women from the Geita region, 74.3 percent of women from Shinyanga, 61.7 percent of women from Rukwa, and only 43.9 percent of women from the Singida region received NASG. Women who attended BEmOC facilities received NASG more frequently (74.1 percent) than women who attended CEmOC facilities (63.4 percent). Only estimated blood loss was not associated with use of NASG.

Characteristics of interest among women who did and did not receive blood transfusion and referral are reported in Tables 3 and 4, respectively. Among women who attended CEmOC facilities, those who received a blood transfusion had a higher mean estimated blood loss (1,139.3 mL) and higher pulse at shock diagnosis (99.3 bpm) than women who did not receive a transfusion (986.2 mL and 93.1 bpm, respectively). Women who were confused/agitated or unconscious were more likely to receive a blood transfusion (89.3 percent and 83.7 percent, respectively) than women who were conscious (73.5 percent), and those who began hemorrhaging outside of a health-care facility were less likely to receive a blood transfusion (76.4 percent) than women who began hemorrhaging in a facility (86.1 percent). The distribution of blood transfusion varied significantly by region; 92.9 percent of women in the Shinyanga region, 88.5 percent of women in the Geita region, 70.8 percent of women in the Rukwa region, and 62.0 percent of women from the Singida region received a transfusion. Systolic blood pressure at shock diagnosis and blood stock status of the health-care facility were not associated with receipt of a blood transfusion. Of note, individuals could still receive a blood transfusion from family or friends even if there was no blood in stock at the health-care facility.

For individuals who presented to BEmOC facilities, those referred to CEmOC facilities had higher estimated blood loss (1,177.1 mL) and pulse (106.9 bpm) than women who were

TABLE 3 Information on covariates by blood transfusion status (in CEmOC facilities; N = 249)

Characteristic	Blood transfusion		P-value
	No (N = 47)	Yes (N = 202)	
	Mean (SE)	Mean (SE)	
Blood loss (mL)	986.17 (54.47)	1,139.31 (32.89)	**0.04**
Pulse (bpm)[a]	93.13 (2.12)	99.29 (1.19)	**0.02**
Systolic BP (mm Hg)[a]	90.31 (3.08)	86.62 (1.41)	0.27
	N (%)	N (%)	
Location of hemorrhage onset			**0.05**
Home or other	30 (24.00)	97 (76.38)	
Health-care facility	17 (13.71)	105 (86.07)	
Levels of Consciousness			**0.01**
Conscious	30 (26.55)	83 (73.45)	
Confused/Agitated	10 (10.75)	83 (89.25)	
Unconscious	7 (16.28)	36 (83.72)	
Region[a]			**<0.001**
Rukwa	14 (29.17)	34 (70.83)	
Singida	19 (38.00)	31 (62.00)	
Geita	6 (11.54)	46 (88.46)	
Shinyanga	7 (7.14)	91 (92.86)	
Blood stock status			
Blood on reserve	32 (21.33)	118 (78.67)	
No blood on reserve	15 (15.15)	84 (84.85)	0.22

[a]Ns do not add up to 249 because of missing values for pulse (N = 2), systolic blood pressure (N = 3), and region (N = 1).

TABLE 4 Information on covariates by referral status (in BEmOC facilities; N = 131)

Characteristic	Referred to a CEmOC facility		P-value
	No (N = 46)	Yes (N = 85)	
	Mean (SE)	Mean (SE)	
Blood loss (mL)	1,023.91 (41.46)	1,177.06 (45.87)	**0.03**
Pulse (bpm)[a]	96.89 (2.89)	106.89 (2.38)	**0.01**
Systolic BP (mm Hg)[a]	91.07 (2.33)	85.23 (2.01)	0.07
	N (%)	N (%)	
Location of hemorrhage onset			0.46
Home or other	24 (32.43)	50 (67.57)	
Health-care facility	22 (38.60)	35 (61.40)	
Levels of Consciousness			0.81
Conscious	25 (35.71)	45 (64.29)	
Confused/Agitated	12 (34.29)	23 (65.71)	
Unconscious	9 (29.03)	22 (70.97)	
Region			0.33
Rukwa	15 (33.33)	30 (66.67)	
Singida	5 (22.73)	17 (77.27)	
Geita	23 (43.40)	30 (56.60)	
Shinyanga	3 (27.27)	8 (72.73)	

[a]Ns do not add up to 131 because of missing values for pulse (N = 5) and systolic blood pressure (N = 7).

not referred (1,023.9 mL and 96.9 bpm, respectively). No other covariates were significantly associated with referral status.

In crude analyses, women with abortion-related hemorrhage received each of the interventions (NASG, blood transfusion, and referral) less often than women with other obstetric hemorrhage etiologies (Figure 3). However, these findings do not account for differences in severity or other factors between women with abortions versus other hemorrhage etiologies.

Table 5 presents the odds ratios for treatment with NASG before and after controlling for the other factors. After adjusting for all relevant covariates, women with abortion-related hemorrhage had a 78 percent decreased odds of receiving NASG compared to women who had hemorrhage and shock from other etiologies ($p < 0.001$). Furthermore, effect modification by region was found (interaction $p < 0.001$) when the cross-product terms were

FIGURE 3 Crude comparison of percent of women receiving each treatment intervention among women with abortion-related hemorrhage and women with all other hemorrhage diagnoses

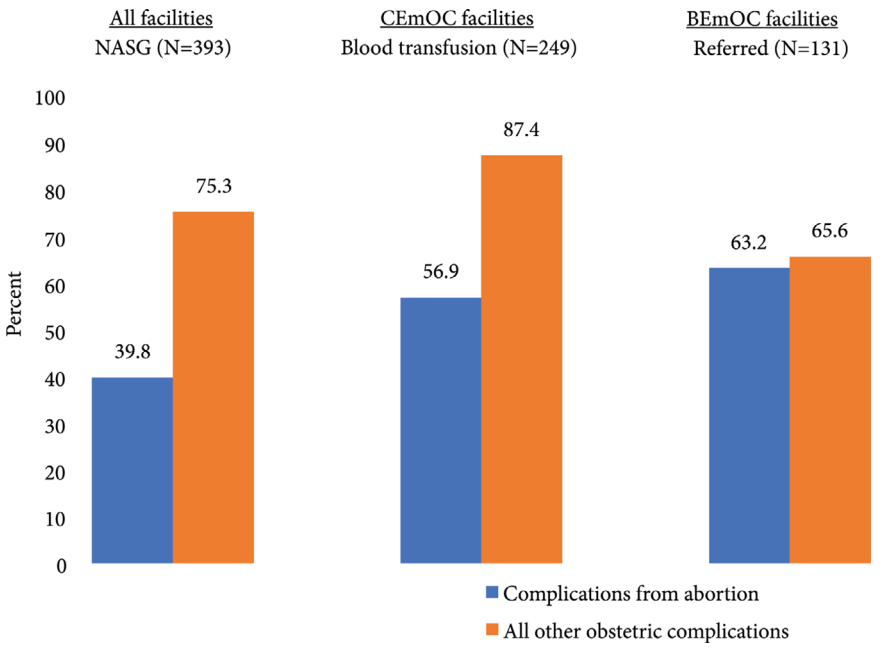


TABLE 5 Odds ratios (OR) for NASG use: Overall and by region

	Overall		By region				
	NASG (N = 393) Crude OR (95% CI)	NASG (N = 376)[a] Adjusted OR[b] (95% CI)	Rukwa (N = 94)[a] Adjusted OR[b] (95% CI)	Singida (N = 82)[a] Adjusted OR[b] (95% CI)	Geita (N = 107)[a] Adjusted OR[b] (95% CI)	Shinyanga (N = 109)[a] Adjusted OR[b] (95% CI)	P-value of interaction
Cause							
Other hemorrhage etiologies	R	R	R	R	R	R	
Abortion	0.21 (0.13, 0.35)*	0.22 (0.08, 0.60)*	0.06 (0.02, 0.19)*	0.75 (0.31, 1.80)	0.07 (0.01, 0.39)*	2.20 (0.22, 22.50)	<0.001

*Significant at $p < 0.005$. R = Reference category.
[a]Ns do not add up to 393 because of missing covariates.
[b]Adjusted for systolic blood pressure at shock diagnosis, pulse at shock diagnosis, estimated blood loss, consciousness status, location of hemorrhage onset, region of health-care facility, and facility level.

included. Therefore, we report the odds ratios for NASG use by region in Table 5. Women with abortion-related hemorrhage are significantly less likely to receive NASG in the Rukwa and Geita regions, but no significant differences in NASG treatment were seen in the Singida and Shinyanga regions. In Rukwa and Geita, women with abortion-related hemorrhage had 94 percent ($p < 0.001$) and 93 percent ($p = 0.002$) decreased odds, respectively, of receiving NASG compared to women with complications from other obstetric etiologies.

Table 6 presents the crude and adjusted odds ratios for the blood transfusion and referral outcome models. After adjusting for all relevant covariates, women with abortion-related hemorrhage had 77 percent decreased odds of receiving a blood transfusion in CEmOC fa-

TABLE 6 Odds ratios (OR) for transfusion and referral status for all four regions

	Transfusions		Referral	
	CEmOC facilities only		BEmOC facilities only	
	(N = 249) Crude OR (95% CI)	(N = 243)[a] Adjusted[b] OR (95% CI)	(N = 131) Crude OR (95% CI)	(N = 120)[a] Adjusted[c] OR (95% CI)
Cause				
Other hemorrhage etiologies	R	R	R	R
Abortion	0.19 (0.10, 0.38)*	0.23 (0.12, 0.46)*	0.90 (0.41, 1.97)	0.94 (0.27, 3.24)

*Significant at $p < 0.001$. R = Reference category.

[a]Ns do not add up to crude analysis sample size because of missing covariates.

[b]Adjusted for systolic blood pressure at shock diagnosis, pulse at shock diagnosis, estimated blood loss, consciousness status, location of hemorrhage onset, region of health-care facility, and blood stock status.

[c]Adjusted for systolic blood pressure at shock diagnosis, pulse at shock diagnosis, estimated blood loss, consciousness status, location of hemorrhage onset, and region of health-care facility

cilities compared to women with hemorrhage and shock from other etiologies ($p < 0.001$). Referral from BEmOC facilities did not differ significantly by obstetric hemorrhage etiology.

The Hosmer-Lemeshow goodness of fit tests were nonsignificant ($p > 0.05$) for all three models demonstrating that the observed and expected data did not differ significantly.

DISCUSSION

Overall, we found that within the health-care facilities where the Empower II program was implemented in Tanzania, women with obstetric hemorrhage and hypovolemic shock secondary to abortion were significantly less likely to receive NASG and blood transfusions than women with hemorrhage and shock from other etiologies, after controlling for severity of condition (systolic blood pressure, pulse, blood loss, and level of consciousness), location of onset, and region. The results of this study add to the evidence that women with abortion-related hemorrhage are at risk of receiving substandard care (Camacho et al. 1996; Chiarotti, Jurado, and Alucia 2003; Mayi-Tsonga et al. 2009; Sorensen et al. 2010; Butrick et al. 2014). While other studies have noted delays in care experienced by women with abortion-related hemorrhage (Camacho et al. 1996; Chiarotti, Jurado, and Alucia 2003; Mayi-Tsonga et al. 2009; Sorensen et al. 2010; Butrick et al. 2014), this study demonstrates that, within the health-care facilities participating in the Empower II program, women with abortion-related hemorrhage and shock may actually receive fewer essential interventions than women with other obstetric hemorrhage etiologies.

As may be expected, the results demonstrated that women who presented to BEmOC facilities received NASG more frequently (74.1 percent) than women who presented to CEmOC facilities (63.4 percent) (not shown). This is likely due to the fact that CEmOC facilities had definitive treatments such as access to blood transfusions and surgery. If there were no delays in obtaining these definitive therapies, CEmOC facilities were less likely to use NASG to temporize blood loss and stabilize individuals.

Additionally, we found that the relationship between hemorrhage etiology and treatment with NASG varied significantly by region of Tanzania. We believe some of this variation may have been due to differences in health-care provider beliefs and practices. One previous qualitative study in Mexico demonstrated varying levels of NASG acceptance among

health-care providers ranging from complete acceptance and utilization to total rejection in which providers were unwilling to use the device (Berdichevsky et al. 2010). Further, while there is little information available regarding specific demographic characteristics of the four regions involved, differences in literacy and education, population growth, economic activity, culture, religion, and education could impact abortion stigma among providers and the quality of care received by women with abortion-related hemorrhage. Our data indicate that treatment differences for women with abortions are stronger in certain regions of the country, suggesting that these regions might benefit most from interventions and programs aimed at ameliorating the disparities in care for post-abortion patients. However, analysis by region was exploratory and, due to the small sample size, was limited only to the use of NASG, thus its interpretation also should be limited. Future studies could compile demographic characteristics among the four regions, evaluate provider acceptance of NASG, and collect more data to explore the extent to which disparities in treatment among women with abortion complications compared to women with other hemorrhage etiologies by region.

There also appeared to be significant differences in the distribution of hemorrhage and shock etiology by region. The percent of cases of hemorrhage and shock secondary to abortion-related causes ranged from 36.6 percent in Singida, 31.2 percent in Rukwa, 22.6 percent in Geita, to only 8.6 percent in Shinyanga (Table 1). While there may have been differences by region due to other factors, we recognize that Shinyanga was the only facility with a physical separation between the gynecology and obstetric wards and was known to have difficulty in maintaining communication between them; the poor communication may have led to the low reported percentage of abortion-related hemorrhages in Shinyanga. Effective communication between the wards was required because the maternity wards were responsible for reporting the data, but early pregnancy complications including abortions would have been managed in the gynecology unit. While other hospitals had separate obstetric and gynecology wards, they were more closely physically connected and had better communication. Additionally, there were new staff in the Shinyanga gynecology ward, and there was a delay in providing the new staff with adequate training on collection of the Empower II program forms. Future studies should make sure to collect data from both maternity and gynecology wards without relying on effective communication between the wards.

The disparity in health care received by women with abortion-related hemorrhage could be attributable to a number of causes. Two possible explanations are health-care provider bias and/or lack of knowledge of evidence-based practices. A number of studies in sub-Saharan Africa have documented that health-care providers stigmatize women with post-abortion complications. A study from Zambia, a country where abortion is permitted only for specific reasons, found that approximately 50 percent of nurse-midwives said they would "feel annoyed" at a patient presenting with symptoms from an abortion, and nearly all nurse-midwives interviewed (94 percent) felt that abortions should not be allowed for adolescents who had unwanted pregnancies (Warenius et al. 2006). A review of 36 studies in sub-Saharan Africa and Southeast Asia evaluating health-care providers' views of induced abortions found similar results (Rehnström Loi et al. 2015). Throughout the 36 qualitative and quantitative studies, biases toward and differential treatment of patients who were seeking or had received an induced abortion were prevalent (Rehnström Loi et al. 2015). The widespread stigmatization and bias toward abortion patients noted in these studies may be present within

health-care facilities in Tanzania and could impact provider-patient relationships, delay care-seeking, and prevent women from receiving appropriate care when they present to health-care facilities. Discovering or documenting provider bias was not an original aim of the Empower II intervention, therefore there was no baseline or post-intervention data collected regarding provider bias. Future interventions could focus on provider bias and make this one of the aims of the intervention, providing more focused provider bias trainings and supervision. If stigma is impacting patient care, awareness campaigns, values clarification activities (Mitchell et al. 2005), and hospital and national policies could be directed to decreasing health-care providers' bias toward women with abortion complications.

Another explanation could be a lack of knowledge of evidence-based practices for women with abortion-related hemorrhage within participating health-care facilities. A recent review found that despite maternal mortality reductions in the past few decades, the rates of preventable deaths in low- and middle-income countries remain high, and care can often be characterized as "too little, too late" (TLTL) (Miller et al. 2016). TLTL care could be associated with insufficient evidence-based care guidelines for abortion-related hemorrhage or differential provider adherence to the existing guidelines based on knowledge gaps and preconceived ideas. Given the lack of current comprehensive guidelines, bolstering post-abortion care guidelines and creating nationally standardized PAC recommendations could lead to improved care for women with abortion-related hemorrhage.

Limitations

This study had relatively large sample sizes of women with obstetric hemorrhage (N = 393; N = 249; N = 131). However, hemorrhage of this severity is fortunately quite rare and thus it is difficult to obtain large enough numbers to complete all possible analyses. For example, because of the limited sample size spread out over four geographic regions in Tanzania, the interpretation of effect modification by region for NASG use is limited, and we were unable to evaluate interaction by region for blood transfusion and referral.

Another important limitation of this dataset is the lack of demographic information on participants, though previous studies in the field have either not controlled for demographics (Sorensen et al. 2010; Butrick et al. 2014) or do not suggest that the relationship between hemorrhage etiology and treatment is confounded by demographics (Mayi-Tsonga et al. 2009). Nonetheless, the size and scope of the previous studies has been limited, and very little is known about the relationship between demographics and treatment received by women with obstetric hemorrhage. Therefore, this study might have been strengthened if we had been able to evaluate and control for demographic characteristics that could potentially confound the relationship between obstetric hemorrhage etiology and treatment received. However, we expect that demographic confounding would be minor relative to the factors that we did control for (i.e., severity of condition, location of hemorrhage onset, and region). Finally, this sample represents a very specific convenience sample of women in Tanzania who presented to health-care facilities that were participating in the Empower II program, suggesting that the generalizability of the results outside of the facilities and individuals involved is limited and the findings should be interpreted with caution.

Strengths

Despite the limitations, this study can contribute significantly to current knowledge on this topic. Although some studies have noted stigma and biases from health-care providers toward women with abortion-related hemorrhage (Warenius et al. 2006; Rehnström Loi et al. 2015), only a small number of studies have demonstrated differences in care for women with abortion-related hemorrhage (Camacho et al. 1996; Chiarotti, Jurado, and Alucia 2003; Mayi-Tsonga et al. 2009; Sorensen et al. 2010; Butrick et al. 2014). Two studies, from Gabon and Tanzania, looked at delays in treatment of women who died from abortion-related complications versus other obstetric complications. While they had extensive information about each of the cases, the number of women with abortion-related hemorrhage was very small at n = 15 and n = 17, respectively (Mayi-Tsonga et al. 2009; Sorensen et al. 2010). Another study from Zambia looked at wait time to transport and type of transport available to women with abortion-related hemorrhage (compared to other hemorrhage etiologies), but did not control for any covariates (Butrick et al. 2014).

Additionally, this study controls for a number of markers of severity of hemorrhage that previous studies have not adjusted for. Disease severity is a critical component of health-care providers' treatment choices. By restricting the sample based on estimated blood loss and clinical symptoms to the most severe cases, as well as additionally controlling for blood loss, pulse, systolic blood pressure, and level of consciousness at shock diagnosis, we were able to evaluate differences in care that are unexplained by disease severity. Providing fewer interventions with NASG and blood transfusions to women with abortion-related hemorrhage because they have less severe disease is clinically justifiable. Nonetheless, in our restricted sample of individuals with similar disease severity (N = 393), we observed differences in care that are unexplained by disease severity, and these differences warrant further investigation.

Overall, the new outcomes evaluated, the relatively large sample size, and the ability to control for disease severity strengthen this study.

CONCLUSION

This study examined differences in care received by women with hypovolemic shock secondary to obstetric hemorrhage in four regions of Tanzania. We hypothesized that women with a similar severity of hemorrhage and hypovolemic shock secondary to abortion would receive NASG interventions, blood transfusions, and health-care facility referrals less often than women with other obstetric hemorrhage etiologies. Results suggest that women with abortion-related hemorrhage received NASG and blood transfusion interventions significantly less often than women with complications from other obstetric hemorrhage etiologies. Furthermore, the differences in care appeared to vary by region of Tanzania. Overall, however, referral rates did not differ between women with abortion-related hemorrhage compared to women with complications from other obstetric hemorrhage etiologies. We theorize that the differences seen in use of life-saving interventions may be in part due to health-care providers' biases against post-abortion patients and the lack of comprehensive national standardized guidelines and training for care of women with post-abortion hemorrhage. The differences in care received by women with abortion-related hemorrhage is a clear example

of inequity and must be addressed. Disparities in care may contribute to the high rates of maternal morbidity and mortality associated with abortion-related hemorrhage in Tanzania.

Future research should explore how the relationship between hemorrhage etiology and treatment varies by region of Tanzania, as well as what specific drivers are contributing to the disparities in care for women with abortion-related hemorrhage. To evaluate another aspect of how stigma affects care and support for women with abortion-related complications, a future study could examine whether women with abortion-related hemorrhage and shock were less likely to receive a blood transfusion donated from relatives than women with obstetric hemorrhage and shock from other etiologies. Finally, given the lack of comprehensive guidelines for obstetric hemorrhage care, we hope this article inspires development of clear, evidence-based national treatment guidelines with specific algorithms, cutoffs, and teaching recommendations for all etiologies of obstetric hemorrhage to help eliminate treatment disparities and reduce maternal mortality in Tanzania.

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