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Original Article

Positive Effects of the Non-pneumatic Anti-shock Garment on Delays in Accessing Care for Postpartum and Postabortion Hemorrhage in Egypt and Nigeria

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Abstract

Background: We examined whether the non-pneumatic anti-shock garment (NASG) ameliorates the effects of delays in transport to and treatment at hospitals for women with postpartum hemorrhage (PPH) and postabortion hemorrhage (PAH) and investigated the effects of NASG use on timing of delivery of interventions in-hospital.

Methods: Pre/post studies of the NASG were conducted at hospitals in Cairo ($n = 349$ women), Assuit ($n = 274$), Southern Nigeria ($n = 57$), and Northern Nigeria ($n = 124$). In *post-hoc* analyses, comparisons of delays were conducted using analysis of variance (ANOVA), and associations of delays with extreme adverse outcomes (EAO, mortality or severe morbidity) were examined using chi-square tests, odds ratios (ORs), and multivariate logistic regression.

Results: Median minutes from hemorrhage start to study admission differed by site, ranging from 15 minutes in Cairo to 225 minutes in Northern Nigeria ($p < 0.001$). Median minutes from study admission to blood transfusion ranged from 30 minutes in Cairo to 209 minutes in Southern Nigeria ($p < 0.001$). Twenty percent of women with $\geq$60 minutes between hemorrhage start and study admission experienced an EAO without the NASG compared with only 6% with the NASG ($\chi^2 = 13.71$, $p < 0.001$). In-hospital delays in receiving intravenous (IV) fluids and blood were more common in the NASG phase.

Conclusions: Women with PPH or PAH in Egypt and Nigeria often face delays in reaching emergency obstetrical care facilities and delays in receiving definitive therapies after arrival. Our results indicate that the NASG can reduce the impact of these delays. Stabilization does not replace treatment, however, and delays in fluid/blood administration with NASG use must be avoided.

Introduction

Maternal mortality is a major public health problem in low-resource settings, with the lifetime risk of maternal mortality as high as 1 in 8 in some African countries.[1] Much of this burden of disease is preventable using known effective interventions, such as skilled birth attendance[2] and provision of comprehensive emergency obstetrical care (CEmOC).[3] However, a variety of economic, social, cultural, and political constraints prevent many women from accessing these services.

Obstetrical hemorrhage continues to be the leading cause of maternal death in low-resource settings, representing an estimated 34% of maternal deaths in Africa.[4] Most hemorrhage occurs postpartum (PPH), which is defined by a postdelivery blood loss exceeding 500 mL; the largest proportion of PPH is

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attributed to uterine atony in which the uterus fails to effectively contract and retract once the baby is delivered.[5] Active management of the third stage of labor (AMTSL) is effective at preventing 40%–60% of these atonic PPH cases, but it requires skilled delivery attendance.[6] Another cause of obstetrical hemorrhage is postabortion hemorrhage (PAH), which is also caused by uterine atony or retained tissue.[7] When PPH or PAH does occur, obtaining treatment quickly is essential to save the woman's life; a woman bleeding from PPH due to uterine atony can die in 2 hours.[8] Moreover, once a woman has bled sufficiently to go into shock, fluids and blood must be administered rapidly to restore hemodynamic stability and prevent irreversible damage or tissue death.

Delays in obtaining care have been identified as important contributors to maternal mortality in low-resource settings.[9–11] The Delays Framework describes these factors leading to preventable maternal mortality for women who deliver at home or in the community: (1) delay in recognizing complications, (2) delay in the decision to seek care, (3) delay in arrival at the point of care, and (4) delay in the provision of adequate care.[12]

The non-pneumatic anti-shock garment (NASG) is a low-cost first-aid device that may help women with obstetrical hemorrhage survive these delays without long-lasting adverse effects.[13] Its simple design incorporates nine neoprene segments that close tightly with Velcro over the woman's legs, pelvis, and abdomen (Fig. 1). The abdominal segment also has a foam compression ball that applies pressure to the uterus. Once in place, the NASG supplies enough circumferential counterpressure to reverse shock by shunting blood from the lower extremities and abdomen to the heart, brain, and lungs. By compressing blood vessels, it also decreases the rate of blood flow through the vessels, which in turn decreases blood loss.

The effectiveness of the NASG in reducing blood loss and time to recovery from shock was initially shown in pilot studies in Egypt.[14,15] Larger pre-post studies in Egypt and Nigeria indicate that NASG use can significantly reduce maternal mortality and extreme adverse outcomes (EAO) (maternal death or severe maternal morbidity). In Nigeria, the relative risk (RR) of mortality in the NASG intervention phase, compared to the pre-intervention phase was 0.32 (95% confidence interval [CI] 0.14-0.72),[16] and in Egypt, the RR of EAO with the NASG was 0.36 (95% CI 0.16-0.80).[17]

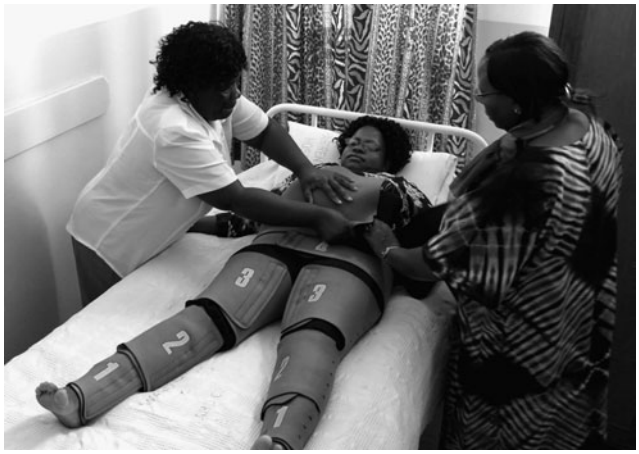

FIG. 1. The non-pneumatic anti-shock garment (NASG) being applied.

Although it is assumed that the NASG reduces maternal mortality and morbidity by buying time and stabilizing women during delays in transport and receiving appropriate care, the effects of the NASG in the context of different types of treatment delays have not been specifically explored. In addition, it is not known if using the NASG might cause changes in the timing of delivery of interventions in the hospital. We, therefore, conducted *post-hoc* analyses to further elucidate how the NASG works in the context of different types of delays in treatment and to investigate the possibility (based on reports from some sites) that NASG availability might lead some providers to take more time to provide definitive therapies, such as blood transfusion. Thus, the objectives of the *post-hoc* analyses presented in this article are (1) to examine if the NASG ameliorates the adverse effects of delays in obtaining transport and treatment for women with PPH and PAH and (2) to determine the effects of NASG use on the timing of delivery of intravenous (IV) fluids and blood transfusions in the hospital.

Materials and Methods

Sites

Data for these analyses come from four referral hospitals, two in Egypt (Cairo and Assuit) and two in Nigeria (Southern Nigeria and Northern Nigeria), that participated in pre-post studies of the NASG during 2004–2008. These sites represent a range of settings, from the relatively well resourced urban setting in Cairo to the very low resource rural/periurban setting in Northern Nigeria.

Study design and methods

In both countries, nonrandomized intervention studies with a pre-intervention phase for controls were conducted.[16,17] Women with hypovolemic shock secondary to obstetrical hemorrhage from any etiology were eligible for enrollment with an estimated blood loss of $\geq$750 mL ($\geq$1000 mL in Egypt) and one or more clinical signs of hypovolemic shock (systolic blood pressure [SBP] $<$ 100 mmHg and/or pulse $>$ 100 beats per minute [BPM]). Blood loss before study admission was estimated visually by providers or, in the case of concealed blood loss, estimated based on vital signs, level of consciousness, and urine output.[18] Women were eligible if they began to hemorrhage outside the facility and were transferred in or if they began to hemorrhage in the facility. Before the pre-intervention phase, all providers were trained to manage women with a standardized, evidence-based hemorrhage and shock protocol; the intervention phase added the NASG as part of this protocol. Blood loss after study entry in both phases was measured using a closed-end, calibrated, plastic blood collection drape (BRASSS-V Fixable Drape™, Madurai, India).[19] Staff in the facilities were trained in the standardized protocol, blood collection and measurement, NASG use, and completion of data collection forms (completed during or immediately after caring for the patient). The current analyses included only women with PPH or PAH in order to have a clinically cohesive group.

The studies were approved by ethical review committees at the University of California, San Francisco (UCSF) and the

National Reproductive Health Research Committee of the Nigerian Federal Ministry of Health and the Institutional Review Boards of El Galaa Maternity Teaching Hospital and Assiut University Women's Health Center. In the pre-intervention phases, women gave informed consent to use their data; all women in the intervention phase provided written informed consent for application of the NASG and to use their data. A U.S federal waiver of consent/authorization for minimal risk research was obtained (45 CFR 46, 45 CFR 164.512) so that women who were unconscious or confused at study entry were enrolled and treatment was begun, but their data would be used only if they gave informed consent after they regained normal sensorium or if a relative gave consent on their behalf.

Measurement of key variables

Data collectors were trained to record the specific date and time of all key events in obstetrical hemorrhage occurrence and management as per the protocols of these studies. In cases in which the woman was transferred into the hospital bleeding, an estimate of the date and time of the start of the hemorrhage was obtained from the woman or accompanying relatives when possible. The date and time entries were used to create variables to measure delays in obtaining treatment. The following variables were constructed and used in the analyses:

- Minutes from start of hemorrhage to study admission (Interval 1)
- Minutes from study admission to start of first IV infusion (Interval 2)
- Minutes from study admission to start of first blood transfusion (Interval 3)

Figure 2 illustrates these time intervals for all women, including those transferred into the hospital already bleeding and those who started bleeding at the hospital. It should be noted that for women transferred in bleeding, Interval 1 represents a delay in getting to the referral hospital (after starting to bleed at a lower level hospital/clinic or at home), as distinct from those who started bleeding in the referral hospital, in which case Interval 1 is an in-hospital delay. For most analyses, these time interval variables were dichotomized to identify those women who experienced significant delays. The first hour after shock begins is called "the golden hour" and is critical for receiving life-saving interventions.[20] Thus, Interval 1 and Interval 3 were dichotomized as <60 minutes and ≥ 60 minutes. Given the relatively short intervals from study admission to start of IV fluids, Interval 2 was dichotomized as <5 minutes and ≥ 5 minutes.

The main outcome variable used in these analyses is a combined variable, EAO. The woman had an EAO if she died or had a cardiac, respiratory, renal, or cerebral dysfunction lasting for >24 hours after resuscitation.[21] Other key predictors of EAO included in the analyses were severity of the woman's condition at study admission, indicated by mean arterial pressure[22] (MAP) < 60 (MAP = [2*diastolic blood pressure + systolic blood pressure]/3); if she was transferred in bleeding or began bleeding in the referral hospital; PPH vs. PAH diagnosis; and study phase (pre-intervention phase vs. NASG intervention phase).

Analysis strategy and statistical methods

As a first step, we described and compared the lengths of the different time intervals experienced by women at the study hospitals. Differences in the lengths of the three intervals for women at the different hospitals were compared using analysis of variance (ANOVA) (after using a log transformation, because of nonnormal distributions of these variables). In the second step, we compared proportions of women experiencing long delays in treatment in the pre-intervention phase vs. the NASG phase of the study using chi-square tests. In the third step, we examined the unadjusted relationships of the delay variables, as well as other key predictors, with our primary outcome, EAO. Associations of predictor variables with the dichotomous outcome EAO were assessed by calculating odds ratios (OR) and 95% confidence intervals (CI). In the final step, multivariate logistic regression was used to examine the independent effects of a long Interval 1 (≥ 60 minutes) and NASG use on EAO, while adjusting for other key predictors of EAO (place where bleeding began, diagnosis group, and MAP level at study admission). In multivariate analyses, estimates were also adjusted for site (hospital), age, and parity. Statistical analyses were conducted using PASW Statistics 17.0.

Results

Characteristics of participants

Definitive diagnoses included complications of abortion (16.4%), uterine atony (57.4%), retained placenta/fragments (13.4%), vaginal/cervical lacerations (10.6%), and placenta

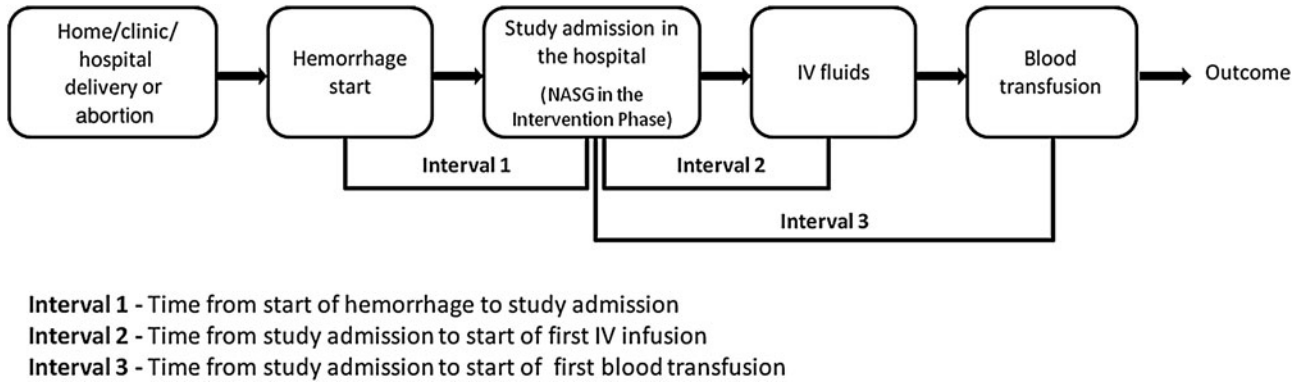

FIG. 2. Time intervals in accessing care experienced by women with hemorrhage and hypovolemic shock. IV, intravenous.

accreta (1.9%). Mean age was 28.9 years (standard deviation [SD] 6.1), mean parity was 3.0 (SD = 2.6), and mean gestational age was 34.0 years (SD = 10.3). At study entry, mean estimated blood loss was 1260.7 mL (SD = 410.7), and 28% of women had MAP < 60. Women in Nigeria tended to be older, of higher parity, and be admitted to the study in worse condition than those in Egypt (data not shown).

Comparison of delays in transport to and obtaining treatment for PPH and PAH in four different settings

In all four settings, Interval 1 was longer for those who were transferred in bleeding compared with those who started bleeding in the referral hospital. Overall, delays were shortest in Cairo, followed by Assuit, followed by the Nigerian hospitals (Table 1).

Comparison of delays by study phase

There were statistically significant differences in the proportions of women experiencing delays in the two study phases (pre-intervention and NASG). In terms of the delay between start of hemorrhage to study admission (Interval 1), 46% of women in the pre-intervention phase experienced a delay of ≥60 minutes compared with 35% of women in the NASG phase ($p < 0.01$). In terms of in-hospital delays in receiving IV fluids and blood, these tended to be more common in the NASG phase; 31% of women in the NASG phase experienced a delay of ≥60 minutes before receiving a blood transfusion (Interval 3) compared with 19% of women in the pre-intervention phase ($p < 0.05$). (This trend toward longer in-hospital delays in blood transfusion in the NASG phase was observed in only two of the four hospitals.)

Relationships of delays and other predictors with EAO

Table 2 presents the unadjusted odds of having an EAO for women with longer intervals of different types, as well as the relationships of other predictor variables with EAO. When looking at the delay variables, only the start of hemorrhage to study admission delay (Interval 1) was significantly associated with EAO (OR 5.26, $p < 0.001$). All other types of predictors examined (country, diagnosis group, severity of shock at admission, place where bleeding began, and study phase) were also significantly associated with EAO. The odds of EAO were higher for Nigerian women, women with PPH as opposed to PAH, women who were transferred in bleeding, and women who were admitted to the study with MAP < 60. Women treated with the NASG in the intervention phase were 0.27 times less likely to experience an EAO than women in the pre-intervention phase (95% CI 0.15-0.50).

Relationships of delay and EAO, stratified by NASG use

Table 2 presents stratified analyses indicating that an Interval 1 ≥ 60 minutes had a negative effect on outcomes in both phases of the study but that the impact of this delay was greater in the pre-intervention phase than in the NASG phase. Twenty-percent of women with a long Interval 1 experienced

Table 1. Comparison of Delays in Accessing Care for Postpartum Hemorrhage or Postabortion Hemorrhage Across Study Locations (N = 804)

	Egypt		*Nigeria*		p *value from statistical test comparing sites*[a]
	Cairo	*Assuit*	*Southern Nigeria*	*Northern Nigeria*	
Number of cases	349	274	57	124	–
Cases that started bleeding outside hospital,[b] *n* (%)	40 (12%)	214 (78%)	31 (60%)	99 (80%)	<0.001
Interval 1: Minutes from start of hemorrhage to study admission for those who started bleeding outside hospital, median (IQR)	126 (64–187) (*n* = 40)	150 (84–270) (*n* = 135)	252 (116–529) (*n* = 30)	255 (110–375) (*n* = 98)	<0.001
Interval 1: Minutes from start of hemorrhage to study admission for those who started bleeding in hospital, median (IQR)	15 (14–19) (*n* = 308)	9 (5–11) (*n* = 56)	15 (10–56) (*n* = 20)	45 (10–130) (*n* = 23)	<0.001
Interval 1: Minutes from start of hemorrhage to study admission (Interval 1) for all cases, median (IQR)	15 (14–20) (*n* = 348)	99 (10–200) (*n* = 191)	112 (15–388) (*n* = 54)	225 (84–349) (*n* = 122)	<0.001
Interval 2: Minutes from study admission to first IV fluids, median (IQR)	0 (0–0) (*n* = 349)	3 (2–5) (*n* = 267)	2 (0–5) (*n* = 19)	5 (2–15) (*n* = 90)	<0.001
Interval 3: Minutes from study admission to first blood transfusion for those who got BT, median (IQR)	30 (28–35) (*n* = 340)	33 (24–64) (*n* = 274)	209 (74–742) (*n* = 35)	182 (110–298) (*n* = 98)	<0.001
Extreme adverse outcomes, *n* (%)	6 (1.7%)	21 (7.6%)	3 (5.3%)	20 (16.1%)	<0.001

[a]Analysis of variance (ANOVA) on log-transformed values for continuous variables and chi-square test for categorical variables.

[b]For Egypt, cases that had hospital admission diagnoses that were "bleeding diagnoses" were considered to have been transferred into the referral hospital already bleeding. For Nigeria, hospital admission diagnoses were not always available. In these cases, those who had hospital admission times later than hemorrhage start times were considered to have been transferred in bleeding.

BT, blood transfusion; IQR, interquartile range; IV, intravenous.

Table 2. Relationships of Delay Variables and Other Predictors with Extreme Adverse Outcome (Unadjusted) for Postpartum Hemorrhage and Postabortion Hemorrhage: Cases from All Four Sites

Variable	*EAO* n *(%)*	*OR*	*95% CI*
Delay Variables			
Interval 1: Start of hemorrhage to study admission for those who started bleeding outside referral hospital ($n=303$)			
<60 minutes ($n=40$) (Ref)	2 (5.0)		
60 minutes or longer ($n=263$)	32 (12.2)	2.63	0.61-11.44
Interval 1: Start of hemorrhage to study admission for those who started bleeding in hospital ($n=407$)			
<60 minutes ($n=389$) (Ref)	8 (2.1)		
60 minutes or longer ($n=18$)	2 (11.1)	5.95*	1.17-30.33
Interval 1: Start of hemorrhage to study admission for all cases ($n=715$)			
<60 minutes ($n=433$) (Ref)	11 (2.5)		
60 minutes or longer ($n=282$)	34 (12.1)	5.26**	2.62-10.57
Interval 2: Study admission to first IV fluids ($n=722$)			
<5 minutes ($n=533$) (Ref)	33 (6.2)		
5 minutes or longer ($n=189$)	10 (5.3)	0.86	0.42-1.78
Interval 3: Study admission to first blood transfusion ($n=748$)			
<60 minutes ($n=550$) (Ref)	26 (4.7)		
60 minutes or longer ($n=198$)	8 (4.0)	0.85	0.38-1.91
Other Predictors			
Country ($n=804$)			
Egypt ($n=623$) (Ref)	27 (4.3)		
Nigeria ($n=181$)	23 (12.7)	3.21**	1.79-5.76
Definitive diagnosis group ($n=804$)			
Postabortion hemorrhage ($n=132$) (Ref)	2 (1.5)		
Postpartum hemorrhage ($n=672$)	48 (7.1)	4.95*	1.19-20.83
Severity of shock at admission ($n=803$)			
MAP $\geq$ 60 ($n=577$) (Ref)	10 (1.7)		
MAP < 60 or nonpalpable BP ($n=226$)	40 (17.7)	12.19**	5.98-24.86
Place where bleeding began ($n=798$)			
At referral hospital ($n=414$) (Ref)	12 (2.9)		
Transferred in already bleeding ($n=384$)	37 (9.6)	3.57**	1.83-6.96
Phase ($n=804$)			
Pre-intervention ($n=295$) (Ref)	33 (11.2)		
Intervention/NASG ($n=509$)	17 (3.3)	0.27**	0.15-0.50
Interval 1 stratified by study phase			
Pre-intervention phase (no NASG)			
Interval 1: Start of hemorrhage to study admission ($n=268$)			
<60 minutes ($n=144$) (Ref)	6 (4.2)		
60 minutes or longer ($n=124$)	25 (20.2)	5.81**	2.30-14.69
NASG phase			
Interval 1: Start of hemorrhage to study admission ($n=456$)			
<60 minutes ($n=289$) (Ref)	5 (1.7)		
60 minutes or longer ($n=158$)	9 (5.7)	3.43*	1.13-10.42

*p from chi-square test <0.05; **p from chi-square test <0.001.

BP, blood pressure; Cl, confidence interval; MAP, mean arterial pressure; NASG, non-pneumatic anti-shock garment; EAO, extreme adverse outcomes; OR, odds ratio; Ref, reference group.

an EAO in the pre-intervention phase, while only 6% of women with such delays experienced an EAO in the NASG phase (chi-square = 13.71, $p < 0.001$).

Multivariate analysis

We conducted multivariate logistic regression analyses with EAO as the dependent variable; with severity, where bleeding started, diagnosis group, and Interval 1 $\geq$ 60 minutes as predictors in the first step, and then adding NASG use to the equation in the second step (Table 3), adjusting all estimates for site (hospital), age, and parity. In the first step, all variables, except for being transferred in bleeding, retained their strong significant relationships with EAO. When NASG was added in the second step, only NASG use (i.e., study phase) and MAP < 60 retained statistical significance. Of note, a long Interval 1 no longer had a significant effect on EAO when NASG use was included in the regression model. The interaction between NASG use and Interval 1 was tested to see if the effects of a long Interval 1 on EAO differed significantly by study phase in this adjusted model, but the interaction term was not statistically significant ($p = 0.648$ in the final model).

Discussion

Women with PPH or PAH in Egypt and Nigeria may face delays getting to a CEmOC facility as well as delays in

Table 3. Multivariate Logistic Regression of Delay and Other Predictor Variables on Extreme Adverse Outcomes Before and After Adjustment for Non-pneumatic Anti-shock Garment Use ($N = 703$)

Variable	*Model 1 All predictors except NASG use, OR (95% CI)*[a]	*Model 2 All predictors including NASG use, OR (95% CI)*[a]
Interval 1: $\geq$ 60 minutes between start of hemorrhage to study admission	4.17 (1.08-16.09)*	3.18 (0.80-12.68)
Transferred into referral hospital already bleeding	0.99 (0.27-3.62)	0.97 (0.26-3.69)
Postpartum hemorrhage diagnosis (vs. postabortion)	4.80 (1.02-22.58)*	4.51 (0.91-22.24)
MAP $<$ 60 at study admission	17.53 (6.51-47.19)**	16.35 (5.98-44.66)**
NASG use		0.32 (0.15-0.69)**

[a]All estimates adjusted for site (hospital), age, and parity.
*$p < 0.05$; **$p < 0.01$.

receiving definitive therapies once at the referral hospital. Across the four different settings, the length of these delays differed significantly and seemed to be roughly correlated with the resource status of the setting, with delays shortest in the relatively higher-resourced urban Cairo setting (where most participants started hemorrhaging when already in the hospital for a delivery) and longest in the lowest-resource setting, Northern Nigeria, where the majority of participants started hemorrhaging at home or at a lower-level clinic.

A delay of $\geq$60 minutes from start of hemorrhage to study admission was strongly related to EAO. This finding supports previous literature on delays and maternal health.[9,23,24] Delays of $\geq$60 minutes from hemorrhage start to study admission were associated with EAO regardless of where the delay occurred (before or after reaching the referral hospital). The proportions of women with an Interval 1 $\geq$ 60 minutes who experienced an EAO were very similar for those who were transferred in bleeding and those who started bleeding in the hospital (12.2% vs. 11.1%). We recognize that Interval 1 (time from hemorrhage start to study admission) can include multiple types of and opportunities for delay—delay in recognizing PPH, delay in getting to the hospital, delay in being admitted to the study—and these should be examined in more detail in future studies.

Our analyses confirm that receiving medical attention for hemorrhage and shock during the first, or golden, hour after the start of shock is crucial for better outcomes.[20] Although delay between start of hemorrhage and obtaining medical attention was harmful in both phases, the use of the NASG immediately after the delay appeared to ameliorate the negative outcomes of that delay.

Longer delays in obtaining IV fluids and blood transfusions were observed in the NASG phase at two of the hospitals. Perhaps this is because when a woman is placed in the NASG and experiences a dramatic decrease in bleeding and rapid resuscitation from shock, she may appear to need less urgent attention.[17] This is an issue of serious concern, given that women with long initial delays and in more severe condition at the time of study admission were still at higher risk, even with subsequent NASG use (10% of women in very severe condition in the intervention phase had an EAO despite NASG use). Thus, women treated with the NASG still need rapid resuscitation and definitive treatment.

The evidence suggests that the NASG can make a significant contribution to help women with PPH or PAH survive delays, even when the delays are experienced before NASG application. Delay from start of hemorrhage to study admission was more strongly associated with EAO in the pre-intervention phase than in the NASG phase, and the statistically significant effect of a delay of $\geq$ 60 minutes in study admission after hemorrhage start on EAO became nonsignificant after controlling for NASG use. In the fully adjusted model, NASG use reduced EAO by 68% and had this strong effect independent of the severity of the woman's condition.

Strengths of this study include the availability of data on 804 women in hypovolemic shock in differently resourced settings and the fact that objective date and time data were obtained for key events in the occurrence and treatment of shock and hemorrhage. Most studies that have examined the relationship of delays to maternal mortality have used subjective judgments of whether or not a delay occurred or simply specified the type of delay, rather than measuring specific time intervals between events.[9,10,25] The current study also had some limitations. A substantial number of cases in the database had missing data on the time of the start of hemorrhage, particularly for woman transferred into the referral hospital already bleeding; therefore, analyses of hemorrhage start times had a reduced number of cases. Other limitations include those inherent in the nonrandomized, pre-post study designs[16] and the relatively small sample sizes at the Nigerian hospitals.

Conclusions

Major resources and efforts are needed to increase women's access to evidence-based methods to prevent and manage obstetrical hemorrhage.[26,27] It is also crucial to continue efforts to minimize all delays that hemorrhaging women face at the household, community, and health facility levels.[28] Preventing hemorrhage and minimizing delays will require significant human and material resources, which may require a long time to achieve. The NASG is a low-cost technology that is easy to use in very low resource settings.[29] The cost is approximately US $170 per garment, and each garment can be decontaminated with bleach, laundered, and reused up to 40 times. Training for NASG placement and removal takes less than 1 hour, and the garment can be implemented by people with no medical background.

Thus, there is currently an important role for the NASG in prevention of maternal mortality and morbidity. The results of this analysis indicate that at the referral facility level, the NASG can stabilize women suffering from obstetrical hemorrhage and hypovolemic shock and help them survive de-

lays in obtaining treatment. It appears that the NASG has the biggest impact in settings where delays in obtaining treatment are lengthy. However, women with PPH or PAH who have experienced long delays and may be in very severe condition are still at risk of adverse outcomes, even with NASG use. Providers must be trained to never delay definitive treatment.

Many women who experience EAOs related to PPH or PAH begin bleeding at home or at low-level clinics that are not able to provide CEmOC.[26,30] Therefore, it is critically important to determine if the NASG could provide even more benefit if it were applied at these levels. Ongoing research using a cluster-randomized design to examine the effects of applying the NASG at peripheral clinics before transfer to a referral hospital (Clinicaltrials.gov: NCT00488462) should help to determine the full potential of the NASG for preventing maternal morbidity and mortality in low-resource settings.

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Disclosure Statement

No competing financial interests exist.

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