Implementation of the Alliance for Innovation on Maternal Health Program to Reduce Maternal Mortality in Malawi

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OBJECTIVE: To evaluate maternal mortality and changes in the culture of safety before and after the implementation of the Alliance for Innovation on Maternal Health (AIM) Malawi program.

METHODS: This was a prospective cohort study at a central hospital and a district health center in Malawi from March 2016 to November 2017. The AIM Malawi program included classroom didactics on obstetric hemorrhage, teamwork protocols, skills laboratory activities, and simulation training. The time periods of comparison were preintervention, education period, and postintervention. Hospital birth paper records were used to collect data on patient demographics and obstetric and neonatal information. The Hospital Survey of Patient Safety was used to measure the culture of safety before and after the program.

RESULTS: We trained 128 participants. In the postintervention period, 16 procedural interventions were performed to manage postpartum hemorrhage, including B-lynch sutures (n=7), condom balloon catheter (n=5), nonpneumatic antishock garment (n=3), and uterine artery ligation (n=1). There was a significant increase in the use of B-lynch sutures for the management of uterine atony in the postintervention compared with preintervention period (P=.014). In the postintervention period, the rate of maternal mortality from obstetric hemorrhage decreased significantly from 1.2% to 0.2% (P=.02), a relative decrease of 82.1% from the preintervention rate. Hospital safety culture scores improved significantly from baseline in four out of five domains after the AIM Malawi training.

CONCLUSION: After implementation of the AIM Malawi program, we found an increased use of postpartum hemorrhage procedural interventions, a decreased rate of maternal mortality and an increase in Hospital Survey of Patient Safety composite safety scores. The AIM Malawi program may be an effective framework for adaptation to improve maternal mortality in a low-resource setting.

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An estimated 303,000 women died from pregnancy and its complications in 2015, with 99% of those deaths occurring in developing countries.[1] Sub-Saharan Africa accounts for two thirds of maternal deaths worldwide.[1,2] Common causes of maternal mortality include hemorrhage, hypertension and sepsis,[1–3] with hemorrhage as the leading cause of maternal death.[4] With the promotion of facility-based deliveries in the past decade, the volume of births and pregnancy-related complications have increased at health facilities. As a result, there is a renewed focus on quality improvement at all delivery sites.[5] In Malawi, a country-wide ban on home births since 2007 has led to 91% of all deliveries occurring in a health facility.[6] However the maternal mortality ratio has not shown improvement over the past decade, despite the increase in facility-based deliveries. The maternal mortality ratio in Malawi remains one of the highest in the world, at 634 deaths per 100,000 live births.[1]

In 2001, the Institute for Healthcare Improvement developed the "bundle" concept–a small set of evidence-based interventions to standardize clinical practice and improve patient outcomes.[7] Funded by the U.S. Health Resources and Services Administration, a coalition led by the American College of Obstetricians and Gynecologists developed the Alliance for Innovation on Maternal Health (AIM) program, a maternal safety and quality-improvement initiative that uses bundles to address the rising rate of maternal mortality in the United States. It is currently adopted in 18 states,[8] but had not been adopted in global low-resource settings.

We introduced the AIM Malawi program by modifying the AIM hemorrhage bundle[9] to use interventions that are available and effective in low-resource settings. In addition, we integrated a comprehensive patient safety curriculum to the AIM program. Safety culture has been defined as "the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management."[10] Hospitals with a strong safety culture have been associated with better outcomes and less adverse events.[11,12]

The primary objective of the study was to compare the rate of maternal mortality in a low-resource hospital before and after the implementation of the AIM Malawi program. The secondary objective was to measure changes in the culture of safety before and after the program at a central hospital and a district health center.

METHODS

This was a prospective observational cohort study from March 2016 to October 2017. The primary objective was to evaluate the utilization of postpartum hemorrhage procedural interventions, prevalence of obstetric hemorrhage, and maternal mortality attributed to hemorrhage before and after the implementation of the AIM Malawi program. The secondary objective was to assess changes in the perceived culture of safety before and after the AIM Malawi program.

This study was approved by the Malawi National Health Sciences Research Center and Baylor College of Medicine's Institutional Review Board. It was funded by the American College of Obstetrician and Gynecologists and Baylor College of Medicine. Baylor College of Medicine's Global Women's Health program, established in 2013, maintains a full-time presence and continuous ongoing support of women's health in Malawi through capacity building, education, and clinical research. The primary site was Kamuzu Central Hospital, the tertiary referral hospital for the capitol city of Lilongwe and the central region of Malawi, a 1,200 bed facility with 3,000 deliveries each year. The nurse-midwives performed vaginal deliveries; clinicians and physicians performed all operative deliveries and cesarean deliveries. There were obstetrics and gynecology residents in house at all times, with attending physicians on call for complicated vaginal deliveries, postpartum hemorrhage and major surgical procedures. The second study site was Area 25 health center, a rural district health center staffed by midwives without physician coverage and delivering approximately 3,600 women per year. Patients with complications are referred to Kamuzu Central Hospital, which is 10 kilometers away with a travel time of 45 minutes.

We introduced the AIM Malawi program–a 2-day course with three components: classroom didactics, skills laboratory, and simulation training (Box 1). An initial clinical assessment of the study site revealed common use of intravenous oxytocin and occasional use of misoprostol for the management of postpartum hemorrhage. Methylergonovine and carboprost were not routinely available. Procedural and surgical interventions were not routinely performed, other than a hysterectomy as a life-saving intervention. Blood transfusions were possible, but there were limited blood products precluding massive transfusion protocols. There were no qualified social workers to support patients and their family, or trained personnel to provide peer-support for staff. To adapt to these limitations in resources, the AIM Malawi hemorrhage bundle did not include the use of methylergonovine, carboprost, a massive transfusion protocol, or a support program for the patient, patient's family and staff members. Because the staff had limited training in teamwork fundamentals and other safety concepts, we included a comprehensive patient safety curriculum focused on teamwork and communication. We introduced the nonpneumatic antishock garment, a first-aid device to manage shock, to the labor units.

The bundle contains 13 "best practices" that are divided into four clinical domains: 1) recognition and prevention of maternal hemorrhage by accurately quantifying blood loss, employing hemorrhage risk assessment tools, and active management of the third stage of labor; 2) readiness for a maternal hemorrhage by performing practice drills and having rapid access to medications and supplies; 3) rapid response using a standardized hemorrhage protocol and checklist;

and 4) reporting techniques (huddles, debriefs and structured communication protocols) and rapid cycle data reporting of adverse events. These best practices were modified by the principle investigators in accordance with the Malawian clinical guidelines and adapted to the limited resources in consultation with a local steering committee composed of clinical staff, nurse midwives, and hospital administrators. The didactic training reviewed the causes, risk factors, and management of antepartum and postpartum hemorrhage. There were dedicated presentations and training sessions in teamwork and communication protocols. The skills laboratory provided hands-on training on postpartum hemorrhage procedural interventions, including quantification of blood loss, use of the nonpneumatic antishock garment construction and use of a condom catheter balloon for uterine tamponade, placement of B-Lynch uterine compression sutures, and performance of uterine artery ligation. The curriculum development, didactics, and skills laboratory were led by Malawian steering committee members and the principle investigators. The simulation training offered several clinical scenarios of postpartum hemorrhage in a hospital setting, in which teams of providers simulated a postpartum hemorrhage rapid response. The principle investigators led debriefing sessions to discuss management plan and communications skills after each simulation.

We compared the rates of obstetric hemorrhage and maternal mortality secondary to obstetric hemorrhage before and after the AIM Malawi program was implemented at Kamuzu Central Hospital. We did not collect clinical data at the rural health center because there were no on-site physicians or operating rooms to manage cases of severe postpartum hemorrhage. Hospital birth records and birth logs were used to collect data on patient demographics, as well as obstetric and neonatal outcomes. Medical and birth records were paper medical charts that were completed by physicians and nurses. At the time of each patient's discharge, the paper chart was sent to the hospital's data clerks per the hospital's protocol. After the chart had been reviewed by the hospital's data clerk for governmental data collection, two trained research data clerks retrieved individual patient charts, based on the birth logs, for data extraction. Two obstetrician–gynecologists manually reviewed the charts of the patients with obstetric hemorrhage, including the maternal deaths, for data accuracy. Missing charts based on the birth logs were excluded from analysis.

We assessed the change in utilization rate of postpartum hemorrhage procedural interventions, including nonpneumatic antishock garment use, condom catheter balloon use, placement of B-Lynch sutures, and uterine artery ligation. The time periods of comparison were categorized as preintervention, education period, and postintervention. The preintervention period was from March to May of 2016. The education period was November 2016 to January 2017. We included all full-time obstetrician–gynecologists, obstetrics and gynecology residents, medical and clinical officers, nurse midwives, nurse administrators, and anesthetists who worked in labor units. Medical students, nursing students and nonclinical hospital staff were excluded from the study. In Malawi, all nurses are trained as nurse-midwives. Given work schedules and other commitments, we trained the participants in small groups over 3 months. As a result, we analyzed the education period separately because we did not expect to see the full effects of the AIM Malawi course during this time period. The postintervention period was from February 2017 to May 2017. We adjusted for the difference in the length of time periods in our data analysis by comparing proportions.

Patients who delivered a live or dead fetus that weighed more than 1,000 g or delivered after 28 weeks of gestation (the local threshold for viability) were included for retrospective review. Information collected included: age, gravidity, parity, gestational age, delivery outcome, estimated blood loss at time of delivery, and any interventions needed to manage obstetric hemorrhage in the immediate postpartum period. Multiple gestations were counted as a single birth. Neonatal outcomes were also recorded. In our definition of obstetric hemorrhage, we included both antepartum and postpartum hemorrhages. All cases with a documented estimated blood loss greater than 500 mL with a vaginal delivery or an estimated blood loss greater than 1,000 mL with a cesarean delivery were included. The obstetric hemorrhage rate was calculated from the number of obstetric hemorrhages out of all the retrieved and verified files. The maternal mortality rate from obstetric hemorrhage was calculated from the number of maternal deaths out of all the verified cases of obstetric hemorrhage. Based on the clinical documentation, the causes of obstetric hemorrhage were further classified as: uterine atony, placenta abruption, ruptured uterus, vaginal and cervical laceration, placenta previa, placenta accreta, surgical bleeding during cesarean delivery, disseminated intravascular coagulopathy, and retained products. Cases of obstetric hemorrhage without an indicated cause were recorded as "not documented." We recorded hysterectomies performed only for obstetric hemorrhage, thus excluding hysterectomies performed for endomyometritis or pelvic abscesses.

To evaluate the effect of the AIM Malawi program on the culture of safety, the Agency for Healthcare Research and Quality's Hospital Survey on Patient Safety was used to measure health workers' perceptions on the patient safety culture at the central referral hospital and the rural health center.[13] The steering committee, composed of representatives from the hospital administration, nursing staff, clinical staff, and ancillary staff, completed the Hospital Survey on Patient Safety survey before program implementation for a baseline assessment in June 2016. The composition of the steering committee was similar to the composition of the general staff. Follow-up surveys were completed by all eligible staff members, including those who were in the steering committee, 6 and 16 months after implementation of the program. The survey was conducted in English, which is the working language for Malawi. All full-time obstetrician–gynecologists, obstetrics and gynecology residents, medical and clinical officers, nurse midwives, nurse administrators, and anesthetists who worked in labor units at either facility were eligible to participate in the survey. Medical students, nursing students and nonclinical hospital staff were excluded from the study. Informed consent was obtained from all participants. The surveys were collected in a confidential and anonymous manner. The percent positive composite scores were calculated using the percentage of positive responses within each domain, as described in the Hospital Survey on Patient Safety users' guide.[13] The responses of 32 survey questions were aggregated into five domains of safety culture: 1) teamwork between and within units: 2) communication, handoffs, and event reporting; 3) management support and continuous improvement; 4) overall patient safety grade; and 5) the use of a nonpunitive approach to errors.

Data are presented as mean with SD or proportion or median with interquartile range for integers or nonnormative distributions. Chi-squared and Fisher exact tests were used to compare proportions. A P value of .05 or less was considered statistically significant and all tests were two-sided. Statistical analysis was performed using SAS 9.4.

RESULTS

During the education period, 128 participants out of 141 eligible staff (90.8%) were trained over seven sessions. The types of participants include: 94 nurse midwives, 18 clinicians (clinical officers, residents, and attending physicians), 14 anesthetists, and two ancillary staff who worked in the department of Obstetrics and Gynecology.

The patient and hospital characteristics across all three periods are found in Table 1. In the postintervention period, patients were older, had larger neonates, had a higher rate of twin gestation, and had a lower rate of cesarean delivery. In the preintervention period, we retrieved and reviewed 682 files out of 890 births (76.6% chart retrieval rate). In the education period, we retrieved and reviewed 682 files out of 759 births (89.9% chart retrieval rate). In the postintervention period, we retrieved and reviewed 953 files out of 1,045 births (91.2% chart retrieval rate) (Table 1). The cause of obstetric hemorrhage can be found in Table 2. There was a higher rate of patients with ruptured uterus in the education compared with the preintervention period (P=.004), and a higher rate of patients with retained products in the postintervention to the preintervention period (P=.02).

The rate of uterine atony did not change significantly before and after the AIM Malawi program was introduced (Table 3). In the preintervention period, postpartum hemorrhage procedural interventions were not commonly used (one patient had a condom catheter balloon placed for uterine atony). Most cases were managed medically with misoprostol and oxytocin. In the education period, there were two patients for whom interventions were performed–one condom catheter balloon and one nonpneumatic antishock garment placed to manage postpartum hemorrhage. This was not a significant change from the preintervention period. In the postintervention period, there were a total of 16 procedural interventions, with a B-lynch suture being the most common (n=7), followed by condom balloon catheter (n=5), nonpneumatic antishock garment use (n=3), and uterine artery ligation (n=1). There was a significant increase in the use of B-lynch sutures for the management of uterine atony in the postintervention period (P=.014) (Table 4).

The rate of obstetric hemorrhage was 9.7%, 10.3%, 8.3% in the preintervention, education and postintervention period, respectively (Table 3). Maternal mortality from obstetric hemorrhage was similar in the preintervention and education period with a prevalence of 1.2% and 1.3%, respectively. In the postintervention period, the rate of maternal mortality from obstetric hemorrhage decreased significantly to 0.2% (P=.02), which is a relative decrease of 82.1% from the baseline preintervention rate.

The baseline Hospital Survey on Patient Safety was completed by 17 of 23 (73.9%) steering committee members. The 6-month survey was completed by 18 of 23 (78.3%) steering committee members, and 117 of 133 (87.9%) departmental

Box 1. AIM Malawi Training Program Curriculum

Day 1: Team training and communication
I. Teams in health care
  Leadership skills
  High functioning teams
  Shared mental models
  Situational awareness
  Interactive team training exercise
II. Communication skills
  SBAR and closed loop communication
  Situational awareness
  Chain of command and two challenge rule
  Conflict resolution
  Briefs, huddles and debriefing
III. Maternal hemorrhage
  Quantification of blood loss
  Antepartum hemorrhage
  PPH guideline and checklist
Day 2: Simulations and skills training
IV. PPH procedural interventions laboratory
  B-Lynch suture and uterine artery ligation
  Uterine balloon tamponade using a condom catheter
  NASG
  Quantification of blood loss
V. PPH simulation and debriefing

SBAR, situation, background, assessment, recommendation; PPH, postpartum hemorrhage; NASG, Nonpneumatic antishock garment.

staff members. The 16-month survey was completed by 146 of the 156 (93.6%) departmental staff members. Baseline percent positive composite scores in our study were low in all reported safety domains (Table 5). The percent positive composite scores of teamwork, communication, management support, and overall safety grade significantly improved at 6 months after program implementation at both facilities. After 16 months, composite scores in both facilities increased in the domains of teamwork (44.1–70.1%; *P*<.001), communication (22.4–46.4%; *P*<.001), management support (36.6–66.7%; *P*<.001) and overall patient safety grade (0.0–55.7%; *P*<.001). Scores for "non-punitive response to error," a safety domain that was not addressed in the AIM program, did not improve after 16 months (23.5% vs 33.8%; *P*=.18).

DISCUSSION

The AIM Malawi program used postpartum hemorrhage procedural interventions, obstetric bundles tailored to a low-resource setting, and team training to create a unique program with an emphasis on clinical knowledge, technical skills, culture of safety and teamwork. After the introduction of the AIM Malawi program we found a significant increase in the use of B-Lynch suture for the management of uterine atony and a significant decrease in maternal mortality from obstetric hemorrhage. There were no significant differences in the rates of obstetric hemorrhage and uterine atony in the postintervention period. The Hospital Survey on Patient Safety percent positive composite scores were significantly increased in four out of five domains after the AIM program.

The AIM program, in a modified version, was introduced for the first time in a low-resource setting focusing on prevention, early recognition, readiness and management of postpartum hemorrhage. Participants in the program learned to assess hemorrhage risk, quantify blood loss, actively manage the third stage of labor and respond to a postpartum hemorrhage with procedural interventions. Skills such as the placement of B-Lynch sutures have been shown to decrease maternal mortality by controlling the

Table 1. Patient and Hospital Characteristics

Characteristic	Preintervention (n=890)	Education Period (n=759)	*P*	Postintervention (n=1,045)	*P*
Patient					
Age (y)	25 (21–31)	26 (21–31)	.36	26 (22–32)	.005
Gravidity	2 (1–3)	2 (1–3)	.54	2 (1–3)	.90
Parity	1 (0–2)	1 (0–2)	.08	1 (0–2)	.08
Gestational age (wk)	36±3.9	36±3.2	.99	37±3.3	.58
5-minute Apgar score	10 (8–10)	10 (8–10)	.84	10 (8–10)	.95
Neonatal weight (g)	2,558±1,112.8	2,844±750.0	<.001	2,908±752.2	<.001
Hospital					
Total no. of births	890	759		1,045	
Total charts reviewed	682 (76.6)	682 (89.9)	<.001	953 (91.2)	<.001
No. of cesarean deliveries	356 (40.0)	304 (40.0)	.99	350 (33.0)	.001
Twin gestations	43 (4.8)	38 (5)	.85	103 (9.9)	<.001
Operative vaginal deliveries	52 (5.8)	31 (4.1)	.12	79 (7.6)	.12

Data are median (interquartile range), mean±SD, or n (% of total births) unless otherwise specified.

Table 2. Causes of Obstetric Hemorrhage and Indications for Peripartum Hysterectomy

	Preintervention	Education Period	P*	Postintervention	P†
Total no. of obstetric hemorrhages	66	70		79	
Cause of obstetric hemorrhage‡					
Uterine atony	27 (40.1)	30 (42.9)	.74	34 (43.0)	.73
Placenta abruption	3 (4.5)	6 (8.6)	.66	8 (10.1)	.21
Ruptured uterus	2 (3.0)	13 (18.6)	.004	8 (10.1)	.09
Vaginal and cervical laceration	3 (4.5)	4 (5.7)	.75	8 (10.1)	.21
Placenta previa	5 (7.6)	4 (5.7)	.66	6 (7.6)	.99
Placenta accreta	2 (3.0)	1 (1.4)	.52	1 (1.3)	.48
Surgical bleeding during cesarean delivery	0 (0)	1 (1.4)	.99	3 (3.8)	.25
DIC	0 (0)	1 (1.4)	.99	1 (1.3)	.99
Retained products	2 (3.0)	5 (7.1)	.28	11 (13.9)	.02
Not documented	22 (33.3)	12 (17.1)	.03	21 (26.6)	.39
No. of peripartum hysterectomies	6	8		10	
Indication for hysterectomy					
Ruptured uterus	2 (33.3)	5 (62.5)	.30	6 (60)	.32
Uterine atony	2 (33.3)	2 (25.0)	.74	3 (30)	.89
Placenta accreta	2 (33.3)	1 (12.5)	.37	1 (10)	.26

DIC, disseminated intravascular coagulopathy.
Data are n (%) unless otherwise specified.
* Comparison of education period with preintervention period.
† Comparison of postintervention with preintervention period.
‡ Patients may have more than one diagnosis for obstetric hemorrhage; therefore, the total percentage of obstetric hemorrhage may be greater 100.

severity of postpartum hemorrhage.[14] Although there was a significantly higher rate of uterine rupture in the postintervention period compared with the education period, the indications for hysterectomy were not significantly different.

Although other factors may have contributed to the improvements in clinical outcomes and safety culture, the AIM Malawi program was the only quality improvement program being conducted in both study sites throughout the entire study period. This suggests that the program was a major factor in improving clinical quality and patient safety. Our results are comparable with similar quality improvement programs that originated in high resource settings. Programs in the United States that implemented an institution-wide postpartum hemorrhage patient safety program resulted in enhanced obstetric interventions and improved maternal outcomes.[5] Additional programs have noted an increased use of uterotonics, earlier resolution of maternal bleeding, the use of fewer blood products, with increased perceptions of patient safety.[15–18] Similarly, the benefits of postpartum hemorrhage protocols and training have been seen in developing countries. In Tanzania, a 2-day Advanced Life Support in Obstetrics Program focused on the technical management skills of postpartum hemorrhage and noted an improvement in staff performance and reduction of postpartum hemorrhage.[19] In Kenya, the Advances in Labor and Risk Management International Program improved

Table 3. Rates of Obstetric Hemorrhage, Maternal Mortality, and Uterine Atony Before, During, and After the AIM Malawi Program

	Preintervention (n=682)	Education Period (n=682)			Postintervention Period (n=953)		
		n (%)	% Change*	P†	n (%)	% change*	P‡
Obstetric hemorrhage	66 (9.7)	70 (10.3)	6.1	.72	79 (8.3)	−14.3	.33
Maternal mortality due to obstetric hemorrhage	8 (1.2)	9 (1.3)	12.5	.81	2 (0.2)	−82.1	.02
Uterine atony	27 (4.0)	30 (4.4)	11.1	.69	34 (3.6)	−9.9	.68
Hysterectomy	6 (0.9)	8 (1.2)	33.3	.59	10 (1.1)	22.2	.73

Data are no. of patients (% charts reviewed) unless otherwise specified.
* Relative % change from prevalence in the preintervention period.
† Comparison of education period with preintervention period.
‡ Comparison of postintervention with preintervention period.

Table 4. Changes in Utilization of Postpartum Hemorrhage Procedural Interventions for the Management of Uterine Atony, Before, During, and After the AIM Malawi Program

	Preintervention	Education Period	P*	Postintervention	P†
Total interventions for the management of uterine atony*	1	2	NA‡	16	NA
Condom catheter balloon uterine tamponade	1 (3.7)	1 (3.3)	1	5 (14.7)	.21
B-Lynch suture placement	0 (0)	0 (0)	1	7 (20.6)	.01
NASG use	0 (0)	1 (3.3)	1	3 (8.8)	.25
Uterine artery ligation	0 (0)	0 (0)	1	1 (3)	1

NA, not applicable; NASG, nonpneumatic antishock garment.
Data are n (%) of all cases of uterine atony unless otherwise specified.
* Comparison of education to preintervention period.
† Comparison of postintervention to preintervention period.
‡ Some patients received more than one procedural intervention for the management of uterine atony.

maternal outcomes with increased use of oxytocin and decreased rates of postpartum hemorrhage.[20]

In low-resource settings, there is often a lack of medications, equipment and trained personnel. Certain uterotonics, commercially available uterine tamponade balloons and interventional radiology procedures such as uterine artery embolization are usually not available. Resuscitative efforts are limited owing to shortages of blood, vasopressor agents, and intensive care beds. In such resource-constrained settings, intervention bundles that were developed in high resource countries are often considered impractical for use. However, our results demonstrate that the AIM hemorrhage bundles, originally developed in the United States, can be successfully modified and adopted in developing countries. Our findings also suggest that the AIM program could be successfully modified for low-resource areas in the United States, particularly facilities in rural areas or in the Indian Health Service.

Unique to the AIM Malawi program is the promotion of a patient safety culture through teamwork and communication. The need for a strong patient safety culture in health care facilities to reduce preventable errors and reduce the risk of patient harm was proposed by the landmark publication *To Err is Human*.[21] Training health care providers in the practice of clear and effective communication protocols can mitigate errors and improve outcomes in clinical scenarios. Furthermore, simulations in team training can improve clinical outcomes by enhancing the effectiveness of limited human resources and by employing a "shared mental model" that improves situational awareness. In our findings, the domain with the least improvement was in the nonpunitive approach to errors, which requires the adoption of a "just culture" environment. This safety principle was not addressed in the AIM Malawi training program and will be included in future programs.

Strengths of this study include the 16-month follow-up of safety culture, the multi-faceted assessment of peripartum morbidity, and the inclusion of both clinical outcomes and safety culture to assess the effect of the program. In addition, we used the Hospital

Table 5. Changes in the Perception of Patient Safety Culture Among Staff

	Baseline			6 mo			16 mo		
	Total	Pos	% Positive	Total	Pos	P*	Total	Pos	P*
No. of participants	17			117			146		
Domains									
1. Patient safety grade (very good or excellent)	17	0	0.0	89	44 (49.4)	<.001	134	68 (55.7)	<.001
2. Teamwork	136	60	44.1	922	615 (66.7)	<.001	1,155	810 (70.1)	<.001
3. Communication	219	49	22.4	1,474	624 (42.3)	<.001	1,876	870 (46.4)	<.001
4. Management support, continuous improvement	101	37	36.6	676	407 (60.2)	<.001	865	577 (66.7)	<.001
5. Nonpunitive response to error	51	12	23.5	334	81 (24.3)	.91	429	145 (33.8)	.18

Total, total responses; Pos, positive responses.
Data are n or n (%) unless otherwise specified.
* Compared with baseline scores.

Survey on Patient Safety, a validated survey instrument to assess safety culture.[22] In the postintervention period, with the implementation of a system for prospective chart collection, we had a 91.2% chart retrieval rate. The improvement over the time periods may have lessened the potential for selection bias in our study.

Our post hoc power analysis showed 68.3% power to detect a difference in maternal mortality from obstetric hemorrhage in the preintervention and postintervention periods ($\alpha=0.05$). Long-term follow-up and inclusion of larger cohort of women are necessary to evaluate whether the changes achieved in maternal mortality are sustained. For the Hospital Survey on Patient Safety, we did not survey all staff members at baseline and we were not able to measure paired analysis of the survey responses for each individual participant owing to the rate of staff turnover. Finally, long-term follow-up is necessary to evaluate whether the changes in maternal mortality are sustainable.

In summary, the AIM Malawi program uses locally relevant, evidence-based obstetric hemorrhage bundles combined with training on technical skills, communication and teamwork. After implementing the AIM Malawi program, we found an increased use of postpartum hemorrhage procedural interventions and a decreased rate of maternal mortality. The AIM Malawi program may be an effective framework for adaptation to improve maternal mortality in a low-resource setting.

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