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Building Hospital Systems for the Care of Women with Major Obstetric Hemorrhage

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Here we describe a proven program of changes within a hospital setting designed to decrease morbidity and mortality of women with major obstetric hemorrhage[1]. This program hinges on building, developing and improving all existing hospital systems that are necessary for the care of women with major obstetric hemorrhage.

BACKGROUND

In the US, the incidence of major obstetric hemorrhage and cesarean hysterectomy have increased in recent years, most likely due to the increase in the rates of cesarean and repeat cesarean delivery[2–4]. Repeat cesarean delivery, in particular, has been associated with a marked increase in the rate of placenta previa and accreta[2–4]. In the setting of intractable obstetric hemorrhage, emergency peripartum hysterectomy often is used as a life-saving procedure (see also Chapter 55), and additional techniques are also available for use in such circumstances (see Chapters 46–58 and 51–54). According to one recent article, the incidence of emergency peripartum hysterectomy is approximately 2.5 per 1000 births[3], and hemorrhage associated with uterine atony is the most frequent indication, followed by placenta accreta[5]. Apart from whether hysterectomy is necessary, maternal death is a known complication of major obstetric hemorrhage[6].

TACKLING THE PROBLEM OF MAJOR OBSTETRIC HEMORRHAGE

Recently developed programs[1,7,8] to improve outcomes for women with major obstetric hemorrhage have focused on at least two important factors: the initial response to the hemorrhage and the prevention of hemorrhage in those patients who can be identified as being at high risk for hemorrhage. This latter effort is in recognition of the fact that two of the three most common causes of hemorrhage (uterine atony, placenta previa and placenta accreta) cannot be identified in advance[4]. Only placenta previa is reliably able to be diagnosed in advance.

Programs aimed at improving outcomes from major obstetric hemorrhage must also consider the interface between individuals and departments not traditionally thought of as being important in the process of caring for women with obstetric hemorrhage, including hospital administration and the department of surgery. This chapter describes in detail these hospital systems and how they have undergone changes at a major New York teaching hospital, with a corresponding decrease in morbidity and mortality.

IMPORTANCE OF COMMUNICATION AND EDUCATION

Two extremely important processes (communication and education) underpin the success of any program aimed at improving outcomes related to obstetric hemorrhage. Clear and open channels of communication must be developed between all personnel and departments involved in caring for women with major obstetric hemorrhage. These include the rapid and coordinated communications that are inevitably necessary for any rapid response team to work at maximum capacity. Communication must be comprehensive and include a far wider field than the members of the obstetric department. In order for communication to be truly effective it must include hospital administration, the emergency department, anesthesiology, the labor and delivery suite, nursing administration, the operating rooms, neonatology and the blood bank.

Basic education is equally important. It is imprudent (and indeed dangerous) to believe that attending physicians or house staff will know (*a priori*) all the component parts of the program in place based on their past experience and training. All care providers who evaluate bleeding patients and institute therapy must possess requisite knowledge of the pathophysiology of hemorrhagic shock in order to identify the presence and assess the severity of this problem, and to begin the process of treatment. It cannot be overemphasized to all levels of staff that the diagnosis of major obstetric hemorrhage is not always as easy as training manuals might suggest. The involvement of departmental leaders who are experienced with the management of obstetric hemorrhage and who are available 24 hours a day for all 365 days each year is key. Training for less experienced care providers must

be developed and be repeated on a regular basis. Such training must be thought of as a continuous and never-ending process – something that has to be repeated to every new rotation of house staff and attending consultants.

EVENTS AT NEW YORK HOSPITAL MEDICAL CENTER OF QUEENS

The New York Hospital Medical Center of Queens (NYHQ), an acute care 480 bed hospital in Flushing, New York, is affiliated with the Weill Medical College of Cornell University as well as the New York Presbyterian Healthcare System. The hospital serves an urban community of great ethnic diversity whose care is paid for by both commercial and governmental health insurance. The hospital is designated for the highest level (level III) of neonatal intensive and maternal care, and has been afforded the highest designation for a trauma center (level I). Separate critical care units are dedicated to surgical, medical and cardiac services.

Two maternal deaths following major obstetric hemorrhage, one each in the years 2000 and 2001, prompted the creation of a patient safety team that worked to improve all hospital systems at NYHQ caring for women at risk for, or suffering from, major obstetric hemorrhage. This patient safety team created a mission involving an improved management scheme (clinical pathway) for the identification and management of major obstetric hemorrhage, with the express intent of reducing maternal deaths due to hemorrhage. The team was very successful in this mission, so much so that the New York State Assembly proposed legislation mandating the management pathway in other hospitals in the State of New York and the management pathway in various modified forms is now in widespread use in Illinois and California.

Patient safety teams

Beginning in 2001, a multidisciplinary patient safety team was established that included individuals from obstetric anesthesiology, maternal fetal medicine, neonatology, the blood bank, nursing, communication and administration. Over the course of 6–12 months, meeting usually every week for 1–2 hours, this patient safety team evaluated the totality of the medical center's care of the two women who died from major obstetric hemorrhage, considered both the proximate and systems-related causes of these unfortunate outcomes, discussed possible recommended changes in management, and decided on the best manner in which to change the systems at NYHQ that were then present for the care of these women.

Objective of our study

In order to assess the impact of the patient safety team's proposed changes in hospital systems on the future outcomes of our patients, we carefully recorded outcomes prospectively from that point (2001) forward, and looked back retrospectively to record the same outcomes for the 2 years in which the deaths had occurred. The team was of the opinion that the accurate recording of outcomes was essential to demonstrate any effect of changes in management over time. *Specifically, we hypothesized that the changes we implemented in our hospital systems would lead to improved outcomes for women with major obstetric hemorrhage.*

Methods

Our multifaceted approach included the following:

(1) We formed an obstetric rapid response team (Team Blue) modeled after the cardiac arrest team, and included quarterly mock drills on all shifts for various emergency clinical scenarios.

(2) We developed clinical pathways – guidelines and protocols – specifically designed to provide for early diagnosis of patients at risk for major obstetric hemorrhage and for streamlined care in emergency situations.

(3) In response to a marked increase in the volume of gynecologic emergency cases and births at NYHQ, we separated the in-house obstetric and gynecologic responsibilities by adding an additional in-house attending physician at all times. This allowed the in-house obstetrician to focus on obstetrical emergencies without fear of neglecting gynecological emergencies.

(4) We revised the duties of the 24-hour in-house attending obstetrician to include continuous and frequent monitoring of all patients on the labor and delivery unit. This monitoring included those patients who had private obstetricians who might or might not be present on a continuous basis.

(5) We empowered all obstetric care providers (including physician assistants, nurses, resident physicians and the in-house attending physician) to immediately involve senior members of the Department whenever there was disagreement with or concern about the management scheme (particularly when there was a possible delay in recognition of the severity of hemorrhage). A senior member of the Department was then required to discuss the issue immediately with the attending physician to avoid delay.

(6) Through weekly didactic sessions, we educated all of our staff to recognize the severity of hemorrhage described in the Advanced Trauma Life Support Manual of the American College of Surgeons[9], and disseminated information regarding the new protocols for patient care. The attending, nursing and ancillary staffs were all also informed regarding the intent of the changes (i.e. to improve patient safety) and the importance of early diagnosis of major hemorrhage.

(7) We established a role for the Trauma Team of the Surgical Department, with the full agreement of the Director of Trauma Services, which was to respond and assist in cases of severe obstetrical hemorrhage. We chose the Trauma Team because they were the most experienced in resuscitation of patients with hemorrhagic shock within our institution. The Trauma Team includes surgical house officers working under the direction of the surgical trauma attending physician. These team members are expert in the placement of large bore intravenous lines (by venous cutdown if necessary), knowledgeable about the physiology of volume resuscitation, ready to assist in obtaining adequate amounts of blood products for massive blood replacement, and are the most experienced in inserting intraluminal lines directly into the major vessels for monitoring and obtaining requisite samples.

The creation of new protocols and guidelines

The following protocols and guidelines were created to enhance the identification of women at risk for major obstetric hemorrhage, the reception of new patient safety activities and the perpetuation of these activities.

(1) We prepared for major hemorrhage in patients with known placenta previa (Figure 1). This preparation included antenatal consultation with maternal fetal medicine, obstetric anesthesiology and senior gynecologic surgeons; liberal use of ultrasound to identify placenta accreta in patients with prior uterine surgery and/or placenta previa. When such patients were identified, they underwent twice weekly type and screen of blood to allow for more rapid availability of blood products if major hemorrhage were to occur. Amniocentesis for fetal lung maturity was performed at 36 weeks of gestation followed by planned cesarean delivery if the fetal lungs were shown to be mature.

(2) We prepared for major hemorrhage in patients in whom we suspected placenta accreta (Figure 1). This included autologous blood donation as often as every week for a period of 4–5 weeks before the planned cesarean delivery; erythropoietin, iron and vitamin therapy in an effort to boost red blood cell production; consultation with interventional radiology regarding consideration of placement of ports preoperatively, so that embolization of major pelvic blood vessels could occur rapidly in the event of substantial hemorrhage during the operation; judicious placement of additional

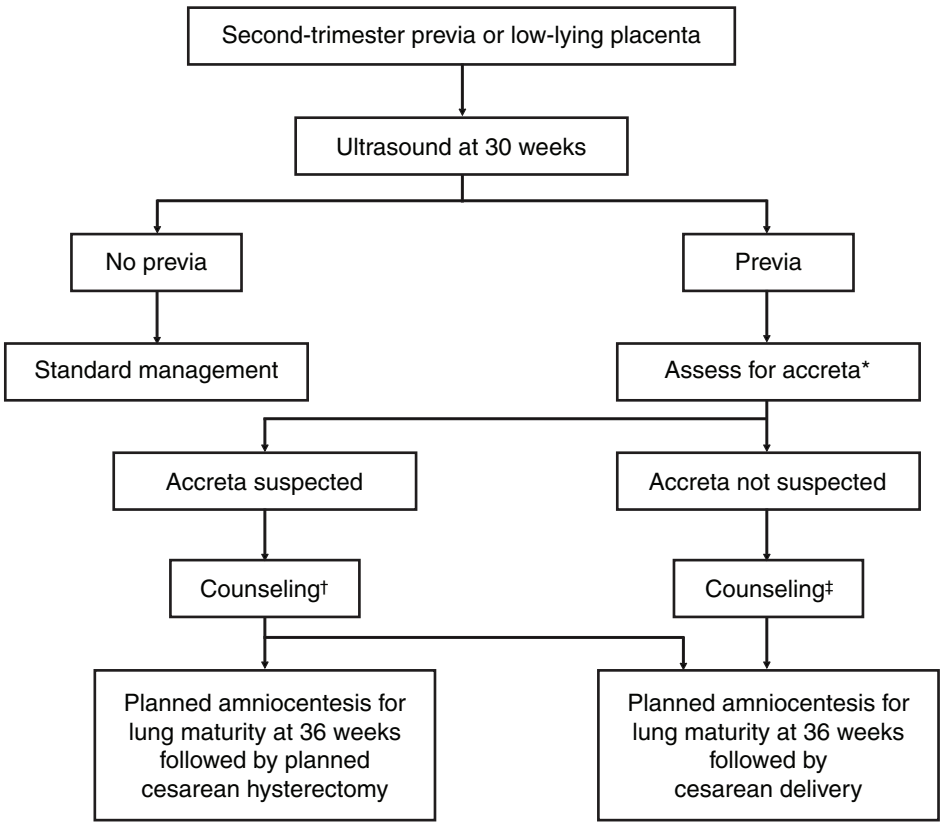

Figure 1 Proposed management scheme for patients at risk for major obstetric hemorrhage. *Suspicion for accreta is markedly increased with prior cesarean delivery and anterior placenta; ‡includes bed rest, pelvic rest, preparation for cesarean delivery, serial complete blood count, consider erythropoietin, iron and vitamin supplements and serial autologous blood donation; †includes the counseling above and a recommendation for cesarean hysterectomy. Low parity may decrease the strength of the recommendation if future child bearing is desired

intravenous lines and a 7.5 Fr internal jugular cordis for invasive monitoring and volume replacement; intraoperative monitoring with an arterial line and central venous pressure; and transfer to the surgical intensive care unit as needed. In addition, we used the cell saver (see Chapter 70), but only after delivery of the fetus and after copious peritoneal irrigation had been performed[4]. Weekly autologous blood donation was used not only to prevent the introduction of blood-borne infection by transfusion, but also to help resolve any potential shortage of blood in our area.

(3) We obtained consultation with the trauma team as necessary.

(4) For patients with suspected placenta accreta, we discussed the likely decreased maternal mortality of planned cesarean hysterectomy[10]. Planned cesarean hysterectomy was then performed for those who agreed.

(5) For patients with suspected placenta accreta, cesarean delivery and cesarean hysterectomy were scheduled in the main operating room under the direction of senior gynecologic surgeons (Figure 1), because the staff and facilities of the main operating room are better equipped to perform hysterectomy than is the case with the labor and delivery suite. This procedural change also avoided the problem of consuming staff and resources on labor and delivery that were considered necessary for the care of other patients.

Table 1 shows the hospital systems and individual changes involved, along with an assessment of the impact on improving outcomes in women with major obstetric hemorrhage and the relative amount of work involved in each change.

In addition to the changes in systems detailed above, data on obstetric volume, mode of delivery, occurrence of major obstetric hemorrhage and outcomes important in identifying improvements were collected from 2000 to 2005. Cases were identified prospectively for the entire patient cohort (2000–2005). Demographic and outcome data on each patient were recorded retrospectively during the time period of January of 2000 to May of 2001 and prospectively beginning in June 2001.

The data collection program also involves monitoring by senior departmental leaders who receive reports on a daily basis from care providers regarding all cases of major obstetric hemorrhage. These cases were highlighted and included in the database as they occurred. Outcomes analysed included maternal deaths, lowest documented maternal pH, lowest documented maternal temperature and the occurrence of coagulopathy.

Our definition of major obstetric hemorrhage included one or more of the following: estimated blood loss of 1500 ml or more, need for blood transfusion, need for uterine packing, performance of uterine artery ligation, and performance of cesarean hysterectomy. Admittedly, this definition is different from that of postpartum hemorrhage (PPH) that is detailed in other chapters of this volume. Accordingly, the rate of major obstetric hemorrhage by our definition was expected to be lower than the known incidence of PPH. Data were compared between the 2 years before and the 3 years after the systemic changes were implemented, 2000–2001 versus 2002–2005.

Results

During each successive year of the study the following important changes occurred simultaneously: increasing obstetrical volume, increasing rate of cesarean delivery, an increasing rate of repeat cesarean delivery, and an increasing number of cases of major obstetric hemorrhage (Table 2). The increases in cesarean delivery, repeat cesarean delivery and cases of major obstetric hemorrhage were all significant when comparing the time period of 2000–2001 to that of 2002–2005, but no difference was shown in the rate of cesarean hysterectomy (Table 2).

Table 1 Impact of hospital system changes on the outcomes of women with major obstetric hemorrhage

System	*Specific change*	*Impact*	*Amount of work involved*
Administrative	Patient safety team	Critical	Extensive
	Trauma team involvement	Minor	Moderate
Departmental	Obstetric rapid response team	Critical	Extensive
	Development of clinical pathways or guidelines	Major	Moderate
	Dissemination of clinical pathways or guidelines	Major	Moderate
	Separation of in-house obstetrician and gynecologist	Minor	Moderate
	Culture change to proactive attending physician	Major	Moderate
	Care provider empowerment	Major	Moderate
	Didactic teaching about physiology and treatment of hemorrhagic shock	Major	Moderate
Clinical pathways or guidelines	Antenatal management of known placenta previa	Major	Moderate
	Preparation for hemorrhage in suspected placenta accreta	Minor	Moderate
	Counseling about planned cesarean hysterectomy	Minor	Minimal
	Scheduled cesarean delivery for previa and accreta in the main operating room	Minor	Minimal
Nursing	Culture change to team participation	Major	Extensive
	Empowerment of nurses	Major	Moderate

Clinical characteristics, measures of severity of hemorrhage and outcomes are shown in Table 3. The patient groups from the two time periods (2000–2001 versus 2002–2005) were similar in demographics as measured by age, parity and incidence of prior cesarean delivery. The severity of obstetric hemorrhage also appeared to be similar between the time periods. The severity measures were APACHE II scores[11], occurrence of placenta accreta and estimated blood loss (Table 3).

The major result of this combined effort was that maternal deaths were significantly reduced in the time period following the systemic changes ($p = 0.036$). This was supported by the additional findings of significant differences (improvement) in lowest pH ($p = 0.004$) and lowest temperature ($p < 0.0001$). There also was a trend toward less coagulopathy ($p = 0.09$). These findings were very important because it is known that a triad of physiologic derangements occurs in hemorrhagic shock that can lead to death. This triad comprises acidemia, hypothermia and coagulopathy. The presence of this triad confirms that our major finding of reduced maternal death is not a statistical chance event, and also argues that our response to the event of a major obstetric hemorrhage became better as time passed and as care providers became more experienced and knowledgeable.

The two time periods were also analysed according to other characteristics: need for cesarean hysterectomy, volume of transfusion, operative time, need for intubation for more than 24 hours, and number of hours intubated (Table 3). No significant differences were seen in these measures between 2000–2001 and 2002–2005. The incidence of peripartum hysterectomy was 1.3/1000 (24/18,723) during the entire study period (2000–2005). Placenta accreta with prior cesarean delivery accounted for 14/24 (58.3%) cases of cesarean hysterectomy; we suspected accreta in seven cases and confirmed it in four cases at delivery. The operative characteristics, morbidity and mortality of patients undergoing peripartum hysterectomy are shown in Table 4. The numbers here are different from those in Table 3, because the data in Table 3 show all patients during the entire study period, and the data in Table 4 are confined to those patients who underwent cesarean hysterectomy. A significant difference was also present in the lowest pH in patients

Table 2 Major obstetric hemorrhage 2000–2005

Year	*Births*	*Total cesarean births**	*Repeat cesarean births†*	*Cases of major obstetric hemorrhage‡*	*Cesarean hysterectomy§*	*Mortality*
2000	2705	516	217	3	1	1
2001	3106	801	287	8	5	1
2002	3323	903	332	8	5	0
2003	3395	932	326	14	4	0
2004	3648	1053	374	18	5	0
2005 (8 months)	2546	759	275	12	4	0
Total	18,723	4964	1811	63	24	2

*2000–2001 compared to 2002–2005, $p < 0.0001$

†2000–2001 compared to 2002–2005, $p = 0.002$

‡2000–2001 compared to 2002–2005, $p = 0.02$

§Rate of cesarean hysterectomy as a function of the total number of major obstetric hemorrhage cases 2000–2001 compared to 2002–2005, $p = 0.37$

Table 3 Major obstetric hemorrhage: comparison of demographics, measures of severity and outcomes

	2000–2001 (n = 12)	*2002–2005 (n = 49)*	*P value*
Demographics			
Age, mean (SD)	36.5 (6.0)	34.2 (5.9)	0.23
Parity, median (range)	1 (0–3)	1 (0–5)	0.70
Prior cesarean delivery, *n* (%)	6 (50.0)	32 (65.3)	0.33
Severity measures			
Occurrence of placenta accreta, *n* (%)	4 (33.3)	11 (22.4)	0.46
APACHE score, median (range)	11.5 (7–31)	10 (6–18)	0.07
Estimated blood loss in ml, mean (SD)	2725 (1289)	2429 (1214)	0.46
Outcomes			
Maternal death, *n* (%)	2 (16.7)	0 (0.0)	0.036*
Lowest pH, median (range)	7.23 (6.8–7.39)	7.34 (7.08–7.44)	0.004*
Lowest temperature (°C), median (range)	35.2 (30.2–35.8)	36.1 (35.2–37.8)	<0.0001*
Coagulopathy, *n* (%)	7 (58.3)	15 (30.6)	0.09
Cesarean hysterectomy, *n* (%)	6 (50.0)	18 (36.7)	0.51
Volume of transfusion in ml , mean (SD)	1313 (1029)	1194 (1547)	0.80
Operative time, mean (SD)	185 (91)	184 (79)	0.99
Intubation >24 h, *n* (%)	7 (58.3)	16 (32.7)	0.18

*Significant difference

undergoing cesarean hysterectomy between the time periods of 2000–2001 versus 2002–2005. This observation underscores the likelihood that our response to women with hemorrhagic shock from blood loss improved over the course of time.

Deciphering the data

The response to major obstetric hemorrhage must be multifaceted and rapid in order to be successful. A quality assurance committee would be the traditional departmental or institutional response to a poor outcome such as a maternal death from hemorrhage, and after this peer review, specific physician education would occur regarding the components of early identification and 'best' treatment, as determined by departmental leaders. However, this traditional response ignores the lessons learned from the Institute of Medicine report regarding errors that lead to morbidity and mortality during hospital stays[12]. When clinical judgment fails and hemorrhagic shock is not recognized or when a patient presents in an advanced state of hemorrhagic shock, hospital systems need to improve in order to provide a safety net for patients; this is as important as is the education of a specific physician or group of physicians after an adverse outcome.

Our findings indicated that significant improvements in outcomes occurred after we introduced systemic changes at our institution; improvements were noted in maternal deaths, frequency of low pH and frequency of low temperature. There were no differences in measures of severity of obstetric hemorrhage in spite of significant increases in the number of cases of major obstetric hemorrhage between the study time periods, leading us to the conclusion that this improvement in outcomes is a true finding. When comparing the time periods before and after the systemic changes, the significant differences in lowest temperature and in lowest pH (Table 3) suggest that the team's response to massive hemorrhage improved after the system-wide interventions. The reduction in maternal mortality, however, cannot be considered a robust observation, because this observation is hospital-based and may not be replicated in a population-based sample. This caveat in no way diminishes the value of our findings in terms of their broad applicability in other hospitals throughout the US and other countries.

The process of implementing the systemic changes required considerable effort by many individuals and

Table 4 Peripartum hysterectomy 2000–2005. All data are expressed as number of cases unless otherwise designated. Incidence 24/18,723 (1.3/1000)

	2000–01[†]	*2002–05*[‡]	*Total*[§]
Etiology			
Placenta accreta	4	10	14
Placenta accreta with prior CD	4	10	14
Uterine atony	2	6	8
Morbidity			
Cystotomy	1	1	2
Pulmonary embolus	1	0	1
Coagulopathy	5	8	13
Acute tubular necrosis	0	0	0
ARDS	0	0	0
Myocardial infarction	0	0	0
Pneumonia	0	0	0
Mortality			
Placenta percreta	1	0	1
Other characteristics			
Operative time in min, mean (SD)	259 (52.3)	250 (66.6)	252 (62.4)
EBL in ml, median (range)	3500 (2500–5200)	3000 (1000–7000)	3250 (1000–7000)
Transfusion total volume in ml, mean (SD)	2125 (847.8)	2292 (2076.4)	2250 (1829.9)
FFP/platelets given (*n*)	5	10	15
Lowest pH, mean (SD)	7.15* (0.17)	7.27* (0.07)	7.24 (0.12)
Intubated	5	12	17
Intubated >24 h	3	3	6
Days to discharge, median (range)	6 (4–7)	4 (3–11)	5 (3–11)
Anesthetic management			
Regional anesthesia only	1	3	4
Conversion to general	2	12	14
General anesthesia only	3	3	6

*Significant difference $p = 0.02$

[†]2000–2001 hysterectomy $n = 6$, total births $n = 5811$

[‡]2002–2005 hysterectomy $n = 18$, total births $n = 12,912$

[§]2000–2005 (total) hysterectomy $n = 24$, total births $n = 18,723$

CD, cesarean delivery; ARDS, adult respiratory distress syndrome; EBL, estimated blood loss; FFP, fresh frozen plasma; SD, standard deviation

was very time intensive. The patient safety team met numerous times and deliberated on the specifics of our response. These efforts included repeated education of care providers on the diagnosis and management of hypovolemic shock. It is of considerable interest that the entire staff accepted these additional time expenditures as a part of their ongoing self-education and were proud of the outcome and the results (Table 1).

This study design does not allow a determination of which of several interventions may have accounted for improvements in outcome. We strongly believe that the data presented in this chapter support the conclusion that a well reasoned, carefully constructed and multifaceted program focusing on patient safety can improve outcomes, although we cannot attribute any specific improvement to any specific change that was undertaken. We also strongly believe that our experience demonstrates that focusing on the problem of obstetric hemorrhage by the medical and administrative departments in a given hospital can and does lead to improved outcomes. The effort involved is substantial, but rewarding.

CONCLUSION

Prospective data[14,15] corroborate retrospective data[13] on the substantial risk of accreta associated with previa and prior cesarean[16]. Placenta previa is a detectable condition, allowing for a preventive clinical pathway such as that developed in Figure 1 to be implemented. We believe that the preparation that takes place after the early identification of patients at risk is an important component in the ability to improve outcomes in our program.

When confronted with adverse outcomes, principles of quality improvement require that 'systems' thinking takes place. It is tempting to attempt to correct the proximate cause (e.g. an individual physician's lack of attention to detail or suboptimal clinical judgment on an individual case) without addressing the 'systems'. We believe these data support a clear need for a systemic response and hope they are useful to others faced with the task of improving safety in obstetric suites. The specific series of changes in systems at our institution was uniquely adapted to the circumstances we encountered. It is possible that these changes may not be as important or as easily achievable in other areas of the world. However, in any institution's response to major obstetric hemorrhage it is important to keep in mind the numerous and potentially changing nature of obstacles to system changes and the need to put together a multidisciplinary response to overcome these obstacles. Though this is a challenging task, the result of improvements in outcomes for women with obstetric hemorrhage remains rewarding and, most importantly, achievable.

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