Successful Use of the B-Lynch Uterine Compression Suture in Treating Intractable Postpartum Hemorrhage after Cesarean Delivery in Rajavithi Hospital

Surasak Kaoiean MD*

** Department of Obstetrics and Gynecology, Rajavithi Hospital, College of Medicine, Rangsit University, Bangkok, Thailand*

Objective: *To evaluate the effectiveness of the uterine compression suture (B-Lynch and modified B-Lynch suture) in avoiding hysterectomy in cases of postpartum hemorrhage and in eliminating the need for surgical intervention to arrest bleeding.*
Material and Method: *This was a retrospective study using data all from women giving birth in Rajavithi Hospital between July 2010 and June 2012. Data were gathered exclusively from the medical records of patients who underwent the B-Lynch suture procedure, and details were recorded of risk factors, managements, and outcomes.*
Results: *There were 17,692 deliveries during this period with postpartum hemorrhage (PPH) occurring in 4.2% of total vaginal and cesarean deliveries. Of these, the B-Lynch suture procedure was performed in treating postpartum hemorrhage in 24 cases. Hysterectomy could not be avoided in one woman who had excessively prolonged massive bleeding resulting in disseminated intravascular coagulopathy (DIC). The success rate in this study was 95.8% with 95% confidence interval 79.8-99.3.*
Conclusion: *The present study showed that the B-Lynch suture is an effective and safe surgical option for treatment of intractable postpartum hemorrhage with no apparent adverse outcomes. The procedure should be taught to any physician who deals with parturition and should be applied as standard protocol for the management of PPH in the operating room.*

Keywords: *B-Lynch suture, Postpartum hemorrhage, Cesarean section*

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Postpartum hemorrhage (PPH) is a major factor in maternal morbidity and mortality. It accounts for 25-30% of maternal deaths in both the developing and developed countries; it is responsible for the deaths of 125,000 to 140,000 women each year or one maternal death every four minutes[1,2]. In addition, 64.7% of severe maternal morbidity is the result of obstetric hemorrhage[3]. Available methods to control PPH vary according to its cause, but in general delaying diagnosis and treatment may lead to a life threatening situation especially in case of massive hemorrhage (>1,500 ml) and failed standard medical therapy. When intractable hemorrhage is encountered by most obstetricians and midwifes, then surgical intervention is usually inevitable. For many decades, ligation of major vessels and hysterectomy were the standard, conventional approach, resulting in many maternal deaths that were still prominently reported especially in developing countries. In 1997, Christopher B-Lynch reported a new approach for surgical management: a so-called B-Lynch uterine compression suture[4]. This report described a technique, which used a continuous suture to apply vertical compression to an atonic uterus in an attempt to avoid hysterectomy. This suturing technique, when applied correctly, has been highly successful without any problems or apparent complications[4]. Various modifications of the B-Lynch suture have come into practice and there have been numerous reports of its success in controlling PPH. Nowadays, the B-Lynch procedure is used worldwide to treat various causes of PPH, especially in developing countries as in Africa and Asia where the incidence of PPH has been high. Because the procedure is faster and simpler than hysterectomy and internal iliac artery ligation, and it produces excellent outcomes, most obstetricians are very keen to learn and practice this innovative suture technique in order to improve their maternity care skills. Currently there are numerous reviews in publications around the world extolling the merits of this technique and declaring its successful

Correspondence to:
Kaoiean S, Department of Obstetrics and Gynecology, Rajavithi Hospital, College of Medicine, Rangsit University, Rachathewi, Bangkok 10400, Thailand.
Phone: 0-2354-8165-74 ext. 3226, 3210, Fax: 0-2354-8084
E-mail: surasak_k@yahoo.com

outcomes[4-8]. In Thailand and some other countries in Southeast Asia, there are few reports of this uterine compression suture even though they may have been numerous case series in each country.

Material and Method

The ethics committee of Rajavithi Hospital approved the present study. It was a retrospective study of consecutive patients diagnosed with intractable PPH who were subsequently treated with the B-Lynch compression suture between July 2010 and June 2012 in Rajavithi Hospital, a teaching and referral tertiary center of the Ministry of Public Health of Thailand. The aim of the present study was to examine the clinical outcomes of cases in which the B-Lynch suture was used as a hemostatic measure in intractable PPH. The cases were identified by review of medical records and data were gathered on risk factors, managements, and outcomes. The data were then analyzed and discussed from a clinical point of view. The procedure was considered successful, if the bleeding stopped and the uterus was preserved after the B-Lynch suture was completely inserted. Whether the compression suture was combined with vessel ligation or ended with hysterectomy depended on the severity of the bleeding or hemodynamic status.

Statistical analysis

Descriptive results of continuous variables were expressed as mean, range, and standard deviation (SD) and categorical variables were expressed as numbers and percentages. Statistical analysis was performed using Chi-square or Student's t-test as appropriate and a p-value <0.05 was considered statistical significant. Analysis was done with the software program SPSS for Window version 17.0.

Results

There were 17,692 deliveries during this period with PPH occurring in 742 cases (4.2%) of total vaginal and cesarean deliveries. Forty-seven cases of intractable hemorrhage were identified and needed surgical intervention. Of these, four cases achieved successful hemostasis by bilateral internal iliac (hypogastric) artery ligation (BHAL) as a first choice procedure, 24 cases were managed by uterine compression suture (the B-Lynch suture and its modifications), and 20 cases, nine of which had failed prior BHAL, ended up being treated by hysterectomy.

In the present study, out of the 24 cases (Table 1) in which the B-Lynch suture was attempted by skilled operators: 15 cases (62.5%) were emergency C/S and nine (37.5%) were elective C/S. No incidence of B-Lynch suture performed on PPH and caused by vaginal delivery between the study periods. Hysterectomy was unavoidable in one case (patient No. 14) even in the first parity because of the severity of bleeding from the atonic uterus resulting from an elective cesarean section in an elderly twin pregnancy. There was a lot of bleeding and numerous units of blood component were transfused resulting in disseminated intravascular coagulopathy (DIC). In a re-exploratory laparotomy, BHAL was attempted before insertion of the B-Lynch suture, but both procedures failed to control the bleeding and were ultimately followed by a hysterectomy in order to save the life of the patient. Thus, the success rate of the present study was 95.8% (95% CI 79.8-99.3). The estimated blood loss ranged from 600 to 6,600 mL (median 1,750) and patients received a median of 1.67 units of packed red cells intra-operatively and postoperatively (range, 0-10). The causes of intractable PPH were mostly uterine atony (83%) and bleeding from the placental bed caused by placenta previa (17%). Out of a total of 24 cases, the B-Lynch suture was the only intervention in 16 cases (66.7%); a combination of B-Lynch suture with bilateral uterine artery ligation (BUAL) was used in six cases (25%); the Hayman surgical technique (a modified B-Lynch suture) alone was used in one case (4.2%); and in the other case (4.2%) hysterectomy was required after failure of BHAL and B-Lynch suture. Twenty-three cases required all three kinds of uterotonic agents before application of the compression suture. One patient was given both oxytocin and ergometrine (case No. 9) in which the B-Lynch suture was applied for prophylaxis of placenta previa.

The ages of the present study population ranged from 18 to 42 years (mean 30.6±6.5 years); gestational age ranged from 32 to 41 weeks (mean 37.6±2.5); and parity varied from 0 to 4 with 46% of participants nulliparous and 54% multiparous. Pregnancies were at term in 21 cases (88%) while three patients were operated at weeks 32, 33, and 34 of gestation. All three cases were due to twin pregnancy with pre-term labor. Mean postoperative hemoglobin concentration was significantly higher than pre-operatively (10.4±0.5 mg/dl vs. 7.8±0.8 mg/dl; $p<0.001$ by the χ^2 test) (Table 2).

DIC occurred in case No. 14 (the only intra-operative complication that occurred in the present study) due to massive hemorrhage; however, all

Table 1. Clinical characteristic and outcomes of intractable PPH treated with B-Lynch suture

Patient No.	Age	Parity	GA	Mode of delivery	Cause of PPH	Procedure to arrest bleeding	Other adjunctive treatment	EBL (ml)	Transfusion	Intrapartum and postpartum complication	Hospital stay (day)
1	19	G1P0	40	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,400	PRC 1 unit	None	4
2	32	G2P0A1	32	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,800	None	None	4
3	37	G1P0	36	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,500	PRC 1 unit	None	5
4	34	G1P0	39	Elective C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs, BUAL	2,300	PRC 2 units	None	4
5	29	G2P1	38	Elective C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,800	PRC 1 unit	None	4
6	42	G4P2A1	37	Elective C/S	Placenta previa Atony	B-Lynch	Oxytocin, ergometrine, PGs, BUAL	1,700	PRC 1 unit	None	3
7	23	G1P0	41	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	2,000	PRC 2 units	None	4
8	35	G1P0	33	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,600	None	None	6
9	39	G2P1	39	Elective C/S	Placenta previa	B-Lynch	Oxytocin, ergometrine	600	None	None	3
10	29	G2P1	38	Elective C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,400	None	None	4
11	21	G3P1A1	37	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,500	None	None	4
12	29	G2P0A1	41	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,500	None	None	4
13	30	G3P2	34	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,800	PRC 2 units	None	4
14	37	G1P0	37	Elective C/S	Atony	BHAL B-Lynch Hysterectomy	Oxytocin, ergometrine, PGs	6,600	PRC 10 units FFP 8 units Cryo 20 units	DIC	8
15	23	G2P1	37	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,400	None	None	5
16	18	G1P0	38	Elective C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,100	None	None	4
17	36	G2P1	39	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs, BUAL	3,500	PRC 6 units FFP 4 units	None	5
18	31	G2P1	37	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	2,400	PRC 2 units	None	5
19	35	G5P4	41	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs, BUAL	3,400	PRC 4 units FFP 4 units	None	5

PPH = postpartum hemorrhage; GA = gestational age; EBL = estimated blood loss; PGs = prostaglandins; C/S = cesarean section; BUAL = bilateral uterine artery ligation; BHAL = bilateral hypogastric artery ligation; PRC = pack red cell; FFP = fresh frozen plasma; DIC = disseminated intravascular coagulopathy

Table 1. Clinical characteristic and outcomes of intractable PPH treated with B-Lynch suture

Patient No.	Age	Parity	GA	Mode of delivery	Cause of PPH	Procedure to arrest bleeding	Other adjunctive treatment	EBL (ml)	Transfusion	Intrapartum and postpartum complication	Hospital stay (day)
20	37	G2P1	36	Emergency C/S	Atony	Modified B-Lynch (Hayman)	Oxytocin, ergometrine, PGs	2,200	PRC 2 units	None	4
21	28	G4P3	36	Emergency C/S	Placenta previa	B-Lynch	Oxytocin, ergometrine, PGs, BUAL	2,000	PRC 2 units	None	5
22	30	G2P0A1	41	Emergency C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,400	None	None	4
23	31	G0P0	38	Elective C/S	Atony	B-Lynch	Oxytocin, ergometrine, PGs	1,300	PRC 2 units	None	5
24	33	G2P1	39	Elective C/S	Placenta previa	B-Lynch	Oxytocin, ergometrine, PGs, BUAL	3,000	PRC 3 units FFP 3 units	None	5

PPH = postpartum hemorrhage; GA = gestational age; EBL = estimated blood loss; PGs = prostaglandins; C/S = cesarean section; BUAL = bilateral uterine artery ligation; BHAL = bilateral hypogastric artery ligation; PRC = pack red cell; FFP = fresh frozen plasma; DIC = disseminated intravascular coagulopathy

Table 2. Demographics of study population (concluded from Table 1, n = 24)

Clinical characteristics	Value
Age (years)	30.6±6.5
Gestational age (weeks) (range)	37.6±2.5 (32-41)
Parity	1 (0-4)
Blood loss (ml)	1,750 (600-6,600)
Blood transfusion (unit of pack red cell)	1 (0-10)
Mode of delivery (percentages)	
Elective C/S	62.5
Emergency C/S	37.5
Hospital stay (days)	4 (3-8)
Hemoglobin (g/dL)	
Preoperative	7.8±0.8
Postoperative	10.4±0.5

Values were represented as mean ± SD or median (range)

patients had a good postoperative recovery. The length of hospital stay ranged from three to eight days with a median of four days. Postoperative complications that occurred during a hospital stay were puerperal fever in two patients (case No. 17 and 19) with good recovery before hospital discharge. No case required intensive care unit treatment postoperatively.

Discussion

Since implementation of the active management of the third stage of labor in Rajavithi Hospital in 2006, the PPH rate of vaginal birth has dropped from more than 5% to less than 2%, but PPH during cesarean delivery has remained high and is tending to increase, especially massive PPH which occurs about 8 to 10 fold more than in vaginal delivery. We have been conducting the B-Lynch uterine compression procedure and its modified forms in Rajavithi Hospital since 2007, and it still plays an important role today in decreasing maternal morbidity from PPH and preserving the fertility of many patients.

A review by Doumouchtsis et al evaluated the various interventions of conservative treatment of intractable PPH[9]. There was no significant difference in success rates in arresting PPH using balloon tamponade, arterial embolization, iliac artery ligation or uterine devascularization and uterine compression suture. They concluded that all of these options appear to be effective and safe procedures that do not impair subsequent fertility and pregnancy outcomes[9]. The B-Lynch suture is the most common technique for

uterine compression: several variations of this technique have been described and no technique has been proven significantly more effective than another[8,10-14]. The specific placement of compression sutures is determined by the operator at the time of laparotomy. If uterine atony persists after administration of uterotonic drugs, compression sutures should be inserted promptly, as delaying placement by more than an hour increases the likelihood that a hysterectomy will be needed[8,15]. Gilles et al studied risk factors associated with failure of uterine compression suture in the treatment of 211 women with severe PPH in the UK. Gilles concluded that a prolonged delay of two to six hours between delivery and insertion of uterine compression suture was associated with a fourfold increase in the chances of hysterectomy being required[8]. In the present study, only one of 24 cases of treatment by B-Lynch suture failed when used in re-exploring laparotomy in an elderly twin pregnancy. The cause of this failure was that uterine atony was initiated after prior elective cesarean section with a time interval of 9.30 hours to perform a B-Lynch suture. In this case, BHAL was tried before insertion of B-Lynch suture. A lot of blood components and fluids were transfused to keep normal circulation and coagulopathy, but finally DIC occurred, and then inevitably hysterectomy. Thus, the success rate in this study was 95.8% (Table 3) which is similar to results reported in many publications[10,15-17]. It is important to note that these suturing techniques may not always achieve adequate control of bleeding, particularly when there is coagulopathy and diffuse bleeding from an atonic uterus. Delay in performing surgery may further compromise the patient's condition[18,19]. Thus, it is crucial to evaluate blood carefully for loss after delivery to avoid any prolonged delay in recognizing hemorrhage. According to Price and Lynch, other possible causes of B-Lynch suture failure are a lack of tightness or improper suture application[20].

Surprisingly, there was no case of B-Lynch suture application on intractable PPH after vaginal delivery in the study period and all 24 cases involved in the use of the B-Lynch technique during caesarean section. This may result from high efficiency in the hemostatic strategy of the labor room resulting in a much lower incidence of non-responsive medical PPH in vaginal delivery. In the case of intractable hemorrhage after vaginal delivery, however, where surgical intervention is required, the procedure usually takes much longer and is more severe than an intra-operative hemorrhage; and there are no other possible treatment modalities available[8]. Another reason could be the increase in the rate of cesarean sections in cases where the risk factors are associated with a tendency to increase the chance of hemorrhage such as multiple pregnancy, elderly pregnancy, prolonged labor, induction of labor, macrosomia, placenta previa, and operative delivery, especially in emergency cesarean section[21].

Table 3. Final outcomes:success and failure rate of the B-Llynch compression suture

Outcomes	Number of cases	% (95% CI)
Success	23	95.8 (79.8-99.3)
Failure (hysterectomy after B-Lynch suture)	1	4.2 (0.7-20.25)

In the present study, there were four cases of placenta previa as a cause of bleeding, three of which were combined with BUAL. Atonic uterus has been satisfactorily treated with B-Lynch compression suture as described originally by Christopher B-Lynch in 1997[4]. In placenta previa, bleeding usually originated from vessels at the placental bed in lower uterine segment that cannot be accessed enough by the compression effect, thus B-Lynch suture will be more effective in stopping bleeding when combined with BUAL[18]. BUAL is preferable to BHAL because the uterine arteries are more readily accessible, the procedure is technically easier, and there is less risk of damage to major adjacent vessels and the ureter. Although BUAL alone will not control bleeding from uterine atony or placenta accreta, it may decrease blood loss while other interventions are being attempted[18,22]. The other case of hemorrhage with placenta previa (case No. 9) had the least blood loss of 600 ml, and the B-Lynch suture was applied early as a prophylaxis of further bleeding.

In 23 (95.8%) cases, the classical B-Lynch suture was applied, and in the remaining (4.2%) case (case No. 20), the Hayman suture, a modified B-Lynch technique, was inserted to an atonic uterus with failed medical treatment after the uterine incision was closed and bleeding continued. The lithotomy position was used to assess the effectiveness of the suture, and the procedure was successful in stopping bleeding. The advantage of the Hayman suture technique is that it is easier and faster than the B-Lynch technique, as it takes probably only two or three minutes to complete the suture after gaining some familiarity

with the technique, and it can be undertaken without reopening the uterine cavity[7,10,23].

With regard to the suture material used in the study population, a 90-cm-long number 1 soluble Monocryl suture attached to a 70-mm-long blunt semicircular needle was used in every case to apply for every patient as suggested by Price and Lynch[20] and many other publications. Some other types of material have been used since the implementation of the B-Lynch procedure in Rajavithi Hospital in 2007 including chromic catgut and Vicryl. In general, good hemostasis usually takes place in not more than 24 hours and uterine involution begins at 48 hours. Hence, the ideal suture should be rapidly absorbable, otherwise late complications from bowel entrapment through material loops may be occur. There have been a few reports of complications after B-Lynch application, such as uterine erosion[24], partial necrosis of the uterus[25] and bowel adhesion[10]. The present study found no postoperative complications during hospital stay. The longest admission was eight days owing to the need for training in postnatal care of small twins by their mother whose uterus was excised. This study was unable to follow-up long-term outcomes of the population such as menstruation, pelvic pain, and further pregnancy because the data were gathered retrospectively. Many publications have reported good outcomes without late complications, and in some cases, patients whose uteruses were conserved have been able to conceive[4,18,26,27].

With regard to the steps of the procedure, either Pfannenstiel or vertically low midline skin incision can be suitable for performing the B-Lynch procedure in the case of life-threatening hemorrhage instead of the Pfannenstiel incision alone as suggested by the original paper[4]. Because exposure and operating time are nearly the same, the Lloyd Davies positioning of the patient was used in the original B-Lynch procedure, but in the present study some patients were placed in the supine position during the application of the brace suture because they were bleeding so quickly that the suture had to be inserted immediately; furthermore, the bleeding could be also assessed by an assistant using digital vaginal examination from below in a semi-lithotomy position after completion of the suture. In the case of atonic PPH occurring after complete closure of the uterine incision, the Hayman suture is an effective option that is faster and easier than the B-Lynch suture[7,10].

Obstetricians should make an early diagnosis of intractable hemorrhage and make an early decision to put the B-Lynch suture in place, as delaying could severely compromise the patient's condition. Obstetricians should promote the implementation of B-Lynch suture more often as a prophylaxis in cases of high risk of PPH, and it should be one of their duties to train unskilled physicians responsible for parturition. Nowadays, most oncogynecologic staff in this study center, who are likely to treat intractable PPH with BHAL and sometimes hysterectomy, are familiar with the B-Lynch procedure, and currently a rising number of B-Lynch suture cases are being performed by these gynecologists with a high success rates.

Conclusion

The data of the present study showed a high success rate of 95.8% with the B-Lynch procedure in treating PPH and no apparent adverse clinical outcomes. The advantages of the procedure are that it is technically simple, rapid, effective, and relatively safe, with satisfactory hemostasis immediately after insertion. Futhermore, it has the capacity to preserve the uterus and thus, fertility. The uterine compression suture should be applied within 1 to 2 hours in order to avoid the need for hysterectomy. There are many situations in which the B-Lynch procedure can be a treatment option, in particular in uterine atony, placenta previa, placenta accrete/increta and as a prophylaxis in cases where there is a high risk of hemorrhage. In treating bleeding from abnormal placentation, the B-Lynch suture combined with BUAL is suggested to increase effectiveness in reducing the pulse pressure of the lower uterine segment. A modified B-Lynch suture, especially the Hayman technique, can be effectively applied in cases of atonic bleeding after closure of uterine incision or intractable PPH after vaginal birth; this procedure has the advantage of being easier and faster than the original B-Lynch suture. Finally, the uterine compression suture should be a standard protocol for management of PPH in any operating room where it is available, even in settings with low technical resources, and certainly in training centers throughout the world.

Potential conflicts of interest

None.

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ผลสำเร็จของการเย็บมดลูกด้วยวิธี B-Lynch suture ในการห้ามเลือดโดยการผ่าตัดในมารดาตกเลือดหลังผ่าตัดคลอดในโรงพยาบาลราชวิถี

สุรศักดิ์ เก้าเอี้ยน

วัตถุประสงค์: *เพื่อประเมินประสิทธิภาพของการเย็บมดลูกแบบ B-Lynch suture เพื่อหลีกเลี่ยงการตัดมดลูกในผู้ป่วยตกเลือดหลังคลอด ที่จำเป็นต้องผ่าตัดห้ามเลือด*

วัสดุและวิธีการ: *เป็นการศึกษาโดยเก็บรวบรวมข้อมูลย้อนหลัง (retrospective study) จากหญิงคลอดบุตรในโรงพยาบาลราชวิถี ที่ได้รับการทำ B-Lynch suture ระหว่างเดือนกรกฎาคม พ.ศ. 2553 ถึง เดือนมิถุนายน พ.ศ. 2555 วิเคราะห์ข้อมูลด้านปัจจัยเสี่ยง วิธีการรักษา และผลการรักษา*

ผลการศึกษา: *มีหญิงมาคลอดบุตรทั้งสิ้น 17,692 ราย ในระหว่างระยะเวลาดังกล่าว พบว่ามีการตกเลือดหลังคลอดทั้งในการคลอดทางช่องคลอด และการผ่าตัดคลอด ร้อยละ 4.2 ในจำนวนนี้มีผู้ป่วยที่ได้รับการผ่าตัดคลอดจำนวน 24 ราย ได้รับการรักษาภาวะตกเลือดหลังคลอดด้วยวิธี B-Lynch suture มีผู้ป่วย 1 ราย ที่เสียเลือดมากและเกิดภาวะ DIC และต้องตัดมดลูกในที่สุด ในการศึกษานี้พบอัตราความสำเร็จของการเย็บมดลูกด้วยวิธี B-Lynch suture ในการห้ามเลือด ร้อยละ 95.8 และค่าความเชื่อมั่นที่ 95% เท่ากับ 79.8-99.3*

สรุป: *การเย็บมดลูกโดยวิธี B-Lynch suture เพื่อรักษาภาวะตกเลือดหลังคลอด เป็นวิธีที่มีประสิทธิภาพและปลอดภัย ดังนั้นควรมีการฝึกสอนวิธีการเย็บมดลูกด้วยวิธีนี้แก่แพทย์ทุกคนที่ต้องดูแลการคลอด โดยเฉพาะอย่างยิ่งควรมีการนำไปใช้เป็นแบบมาตรฐานในการรักษาภาวะตกเลือดหลังคลอด ในที่ซึ่งอย่างน้อยมีห้องผ่าตัดอยู่*