

Review

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Review

Ultrasound Assessment Before Complex or Difficult Cesarean Section

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Abstract

Complex or difficult cesareans are associated with significant short- and long-term complications. The complications rate increases with increasing number of cesareans, and the incidence of cesarean section is increasing. To accurately identify women at high risk of surgical difficulty during a cesarean, ultrasound, in addition to clinical assessment, can be used to evaluate many risk factors including placenta previa, placenta accreta spectrum (PAS) disorders, fibroids, severe pelvic adhesions and membranous fetal vessels. Ultrasound is a well-established practice in obstetrical care as ultrasound is easily available, accessible, easy to perform, and well acceptable to the women. However, there are few studies on the role of preoperative ultrasound in the management of complex or difficult cesareans beyond the risk assessment of PAS. Currently, preoperative ultrasound is performed in selected cases only. The aim of this review article is to discuss the benefits and the use of ultrasound assessment before different types of complex or difficult cesareans. Whether ultrasound assessment should be performed before all cesarean sections will also be discussed.

Keywords: ultrasound; cesarean section; placenta accreta; placenta previa; fibroid

1. Introduction

Although simple elective first-time cesareans are usually safe, complex or difficult cesareans are associated with significant short- and long-term complications [1]. Over the years, the incidence of cesarean section is increasing worldwide. The risks of placenta accreta spectrum disorder (PAS), viscera injuries, the need for postoperative ventilation, intensive care unit admission, hysterectomy, and blood transfusion requiring 4 or more units, and the duration of operative time and hospital stay increased with increasing number of cesareans [2]. In particular, PAS is a life-threatening complication associated with massive postpartum hemorrhage (PPH). Another complication is severe pelvic adhesions after multiple cesareans. Other examples of complex or difficult cesareans are large uterine fibroids in the anterior lower uterine segment (LUS), and anterior major placental previa. These complex or difficult cesareans can cause major PPH, urological or bowel injuries [1] which may require reoperation [3].

To minimize cesarean complications, the International Federation of Gynaecology and Obstetrics (FIGO) has published good practice recommendations for effective surgical techniques [4]. In complex cesareans, expert surgical skills as well as multidisciplinary team management are required. However, over the last two decades, obstetric doctors' surgical training opportunities for complex cesareans was reduced because of decreased working hours, reduced number of deliveries, and the use of laparoscopy for most gynecologic operations [1].

To accurately identify women at high risk of surgical difficulty during a cesarean [1], ultrasound, in addition to clinical assessment, can be used to evaluate many risk factors including placenta previa, PAS, fibroids and severe pelvic adhesions [1,5]. Ultrasound is a well-established practice in obstetrical care as ultrasound is easily available, accessible, easy to perform, and well acceptable to the women. However, there are few studies on the role of preoperative ultrasound in the management of complex or difficult cesareans beyond the risk assessment of PAS [5]. Currently, preoperative ultrasound is

performed in selected cases only. The aim of this review article is to discuss different types of complex or difficult cesareans, and the pre-operative use of ultrasound assessment.

2. Complex or Difficult Cesarean Sections

Complex or difficult cesareans can be divided into four categories [6].

2.1. Abnormal Placentation

Abnormal placentation (placenta previa and PAS), and pelvic adhesions can cause bleeding during a cesarean section although the most common cause is uterine atony [7]. In France, surgical injury during a cesarean is increasing over the years, in particular, among these women with previous cesarean and second-stage cesarean, among other characteristics [8].

Cesarean sections for placenta previa can be a complex surgery, particularly when the placenta is anterior and/or covering the internal os of the cervix because of the associated risk of massive obstetrical hemorrhage (MOH) [9]. In anterior low-lying placenta, LUS is usually poorly formed and vascular [6].

If a patient presents with antepartum hemorrhage associated with anterior placenta previa in a subsequent pregnancy after repeated cesarean sections, bleeding risk during subsequent emergency cesarean delivery will be very high [5]. Intraoperative problems encountered will likely include severe adhesions in the LUS, bladder, and rectus sheath, increased vascularization under the placental bed, and large areas of myometrial dehiscence [5]. PAS, if present, may cause life-threatening bleeding, and injury to the urinary tract, resulting in transfusion, intensive care unit admission, cesarean hysterectomy and other interventions [10].

2.2. Severe Pelvic Adhesion with Risk of Visceral Laceration or Organ Damage

Pelvic adhesions, particularly of the vesicouterine pouch, are found in more than a third of patients with a history of one or two previous Cesareans [11]. Adhesions become more frequent and severe with each cumulative cesarean [12], and after postoperative wound infection [11]. Previous cesarean section, previous pelvic surgery, and the presence of adhesions are risks factors of bladder and bowel injuries as well as bleeding [7].

2.3 Difficult Access to the LUS

It may take a long time to extract a fetus because of difficult access to the LUS due to uterine fibroids, severe adhesion or obesity [1]. Expert surgical skills are required to avoid or manage potential life-threatening bleeding and visceral injuries [1]. If caesarean sections are performed under general anaesthesia (GA), fetal risks will be increased with increased GA time. Besides, prolonged incision to delivery interval can increase the fetal risks in cases of fetal hypoxia or abnormal cardiotocography.

2.4. Complex Fetal Extraction

In cases of impacted fetal head, failed instrumental delivery or impacted transverse lie, difficulty in disimpacting the fetal head or delivering the fetus will be encountered [6,13]. The difficulty increases maternal complications including hemorrhage and injury to adjacent organs, as well as neonatal complications including skull fractures, brain hemorrhage, hypoxic brain injury, and, rarely, death [6,13].

In cases of velamentous cord insertion, the abnormally located fetal vessels within the membranes are prone to rupture because they are attached to the chorion without protection by Wharton's jelly [14]. During a cesarean delivery, the membranous fetal vessels under or near the usual location of the uterine incision or LUS are at risk of being incised or torn without awareness, resulting in acute fetal blood loss which can be life-threatening [15].

3. Benefits of Ultrasound Assessment Before Complex or Difficult Cesareans

3.1. Management in Experience Centers

Prenatal identification of PAS allow management in or referral to a hospital with a multidisciplinary team with expertise in complex cesareans, urinary and gastrointestinal repair, and additional resources including transfusion services, maternal and neonatal intensive care units [5,16]. In view of the diminishing advanced surgical skills among obstetrician-gynecologists, particularly among new graduates, referring complex cesarean deliveries to experienced centers has become a common practice [16].

Prenatal diagnosis of placenta previa allows arrangement of delivery in a maternity unit with on-site blood transfusion services and access to critical care [9]. Women with placenta praevia and anterior low-lying placenta are at increased risk of MOH and hysterectomy. Cesarean delivery should be carried out by an appropriately experienced operator [9]. A senior obstetrician and senior anaesthetist should be present for a planned delivery [9].

3.2. Improved Outcomes

Compared with those managed by standard obstetrical care, women with PAS managed in experience centers are less likely to require massive blood transfusion and reoperation for bleeding complications [17]. Prenatal diagnosis of PAS at any gestational age is associated with improved maternal outcome, by allowing treatment in experience centers [18,19]. Besides, visceral injuries (to the bladder, the ureters and the gastrointestinal tract), if any, can be promptly diagnosed and repair them with the appropriate surgical technique or by specialist surgeons [6]. As such, better outcomes can be resulted.

3.3. Proper Surgical Plan

In complex or difficult cesareans, preoperative ultrasound assessment allows formulation of proper surgical plan regarding the type of skin and uterine incision. Although a suprapubic transverse skin incision is usually performed for most cesareans, a subumbilical midline incision with or without upper extension is required for a classical cesarean [20].

A low transverse uterine incision is usually performed for cesarean section, with the feasibility of extending the uterine wound with T-extension (vertical) in the midline, J-extension (upward) in the either side or U-extension (upward) in both sides [20]. In cases in which it is difficult to access the LUS, due to dense adhesion, PAS, or fibroids, a vertical midline uterine incision (classical cesarean section) may be needed [20].

In case of anterior placenta previa, placental incision should be avoided, especially if PAS is suspected prenatally and engorged uterine superficial vessels are found intraoperatively. Instead, it is safer to perform a classical incision or a fundal transverse incision to deliver the fetus [20]. Midline skin and/or classical uterine incisions should be considered when the fetus is in a transverse lie to avoid the placenta, particularly below 28 weeks of gestation. If the placenta is transected during the uterine incision, the umbilical cord should be clamped immediately after fetal delivery to avoid excessive fetal blood loss [9].

Rarely, a classical cesarean section may be required in cases in which it is difficult to deliver gently through a low transverse incision in (a) a backdown transverse lie of a large fetus with ruptured membranes, and impacted shoulder in the birth canal, or (b) special type of fetal anomaly including conjoined twins, macrocrania, large sacrococcygeal teratoma or myelomeningocele [20].

In modern obstetrics, most of the indications of classical cesarean section were placenta previa type I-IV, fibroids, poorly-formed lower segment, transverse/ unstable lie, and lower-segment adhesions [21].

When velamentous cord insertion is found with the membranous fetal vessels under or near the usual location of the uterine incision or LUS, extreme caution should be taken during cesarean section

to avoid incising both the membranes and the fetal vessels [22]. During uterine incision, the membranes are separated gently, and dissected at the vessel-free areas [22,23].

3.4. Proper Perioperative Management

In cases of dense pelvic adhesions, a long dissection time is required before delivering the fetus. Obstetricians need to take this into account when managing cases with immediate threat to the life of the woman or fetus. In these cases, cesarean delivery should be performed as soon as possible, and preferably within 30 minutes of making the decision [24].

Third trimester scan allows detection of breech presentation, transverse lie, large-for-gestational age fetus, small-for gestational age/ fetal growth restriction, oligohydramnios, or polyhydramnios [25]. These abnormal findings may affect the timing, and conduct of cesarean delivery including preparation for PPH [26].

Sometimes, the indication of cesarean section such as breech or transverse lie may longer be present during pre-operative ultrasound assessment because of spontaneous version to cephalic presentation, and thus an unnecessary caesarean can be avoided.

A meta-analysis provides support for the accurate use of antenatal LUS measurements (myometrial or full thickness) using a standardized method in the prediction of a uterine defect (dehiscence and rupture) during trial of labour (TOL) in women with a scarred uterus. The pooled sensitivity and specificity of myometrial LUS thickness for cut-offs between 2.1 and 4.0 mm was 0.94 and 0.64, respectively. A thick LUS is less likely to have uterine rupture and therefore suitable for a TOL, whereas a thin LUS is likely to have a uterine rupture and therefore suitable for repeat cesarean [27].

Although accurate assessments of the fetal head position, station and flexion by intrapartum ultrasound can help management of labour, there was no evidence to show an improvement in maternal, neonatal or labor outcomes [28]. Whether ultrasound findings of an impacted fetal head can help facilitate the disimpaction during cesarean deliver, and hence improve outcomes has not been studied.

4. Ultrasound Assessment Before Complex or Difficult Cesareans

Before undergoing complex or difficult cesareans, all at-risk women should preferably be examined with transabdominal ultrasound, with special emphasis on the characteristics of the LUS, and the location of the placenta [1]. Transvaginal ultrasound can be added if the placenta is low-lying or previa. The sonographic signs associated with PAS, major LUS dehiscence and severe pelvic adhesions should be assessed [5]. Other obstetric conditions such as large anterior fibroid, large superficial vessels or membranous fetal vessels in the LUS, fetal macrocephaly or transverse lie can also be detected [1].

4.1. PAS

Screening for risk factors for PAS and assessing placental location by antenatal ultrasound are keys to timely diagnosis [10]. The most common risk factor is placenta previa diagnosed in a patient with a history of cesarean delivery. Other risk factors include a history of myomectomy, disorders of endometrial scarring, Asherman's syndrome, uterine instrumentation, endometrial ablation, in vitro fertilization, other uterine surgeries, or multifetal pregnancy [10].

At-risk women should undergo systematic evaluation of the placenta by serial scan starting early in pregnancy [10]. The echostructure of the placenta should be evaluated in the first trimester, in particular for PAS in at-risk pregnancies [18]. Ultrasound signs suggestive of PAS disorders include low anterior implantation of the placenta/gestational sac, next to or in the scar niche, subplacental or uterovesical "hypervascularity [10,30]. Transvaginal ultrasound at the time of the late first-trimester scan can be offered to women with prior Cesarean delivery to exclude placental implantation over an exposed scar [18]. However, not all ongoing cesarean scar ectopic pregnancies in the first trimester

develop into true PAS in the third trimester because some may develop into a placenta previa under a myometrial dehiscence in LUS that may involve part of the cervix [5].

In the second trimester, the placental location should be defined in relation to the cervix and the area of cesarean scar(s) (low-transverse or classical) [10,29]. If the placenta overlies the anterior LUS in a woman with a prior lower segment cesarean section, the risk of PAS will be high, and a systematic evaluation for PAS by antenatal ultrasound is recommended [10,29]. Conversely, if the placenta is located far away from the level of the prior scar(s), the risk of PAS will be low.

The common signs of PAS are a loss of the clear zone (the normal hypoechoic zone between the placenta and myometrium), myometrial thinning (less than 1 mm), placental lacunae, subplacental hypervascularity, bridging vessels, placental bulging, bladder wall interruption, exophytic mass, and uterovesical hypervascularity [10]. A combination of scan findings and a woman's a priori risk helps to determine the overall risk of PAS [10]. In women with placenta previa and clinical risk factors, presence of abnormal signs increase the risk of PAS. However, these signs can be present in a regular placenta previa without PAS because these signs are due to LUS scarification and remodeling rather than to PAS [5]. Thus PAS can be over diagnosed [5].

It is difficult to define subplacental or uterovesical "hypervascularity" [30]. However, when these signs are associated with placental lacunae with large feeder vessels, these combined signs increased the risks of cesarean hysterectomy and massive transfusion, independent of the presence of PAS at delivery [31]. The prenatal evaluation of the size and vascular mapping of the suspected accreta area including entire LUS circulation, parametrial circulation, and existing arterial anastomoses with the bladder may help the surgical team in planning the procedure [5].

Prenatal ultrasonographic examination with a full bladder is required to assess PAS. The midpoint of the posterior wall of the full bladder is the reference point separating sectors S1 and S2 [1] which corresponds to the peritoneal reflection which is found during cesarean section when the bladder is empty [1]. In contrast to sector S1, sector S2 corresponds to the lower uterine segment and cervix, which receives main blood supply from the colpouterine arteries. Because the location of S2 is subperitoneal and retrovesical, mobilisation of urinary bladder is required before applying low compression sutures (B-Lynch 2 or Ho-Cho) to control the bleeding due to placenta previa or PAS [1].

Recently, the traditional categorical terminology of PAS (placenta accreta, increta, percreta) is replaced by a descriptive grading system developed by the FIGO [32] and the Society for Pediatric Pathology [33]. In particular, superficial types of PAS (placenta creta or adherent) is differentiated from subacute abruption or accessory lobes or other causes. The deep types of PAS (increta or percreta terminology) are replaced by grade 3 for all cases where the uterine wall under the placenta is thinned by >75% and qualified as to the degree of preoperative or intraoperative surgical disruption of the LUS [5]

The absence of abnormal signs does not exclude the diagnosis, and thus PAS can be underdiagnosed. [5,10] MRI can be added in cases of inconclusive ultrasound diagnosis, severe PAS, PAS in uncommon locations or when parametrial invasion is suspected [25]

4.2. Placenta Previa

Antenatal ultrasonography should be performed to determine the placental location and hence the optimal site for uterine incision [34]. In mid-trimester scan, the distance between the lower placental edge and the internal cervical os should be examined [29]. Transvaginal scan, requiring a separate consent, is useful to confirm the diagnosis of a low-lying placenta or placenta previa with or without PAS [35], especially in patients with high body mass index. If TVS shows a short cervical length (<3 cm) and a placenta with a thick edge (>1 cm), the risk of massive obstetrical hemorrhage and emergent cesarean hysterectomy will be increased [36]. If the distance is ≤ 15 mm on transvaginal scan, a follow-up examination in the third trimester is recommended. If placenta accreta is suspected, a more detailed evaluation is suggested [29].

4.3. Intra-Abdominal Adhesions

At present, it is not a common practice to perform ultrasound to assess intra-abdominal adhesions before all cesareans. To assess intra-abdominal adhesions, transabdominal ultrasound examination can be performed to assess the sliding of the uterus under the inner part of the rectus fascia during deep breathing [5]. 'Sliding' is a normal finding whereas 'no sliding' is a sign of severe intra-abdominal adhesions between the uterus and rectus fascia [5]. Another sign of visceroperitoneal adhesion is atrophy of the fascia-peritoneum complex which shows abnormal tissue of various acoustic character and possible vascularisation in color Doppler examination [37]. However, this sign is not diagnostic as similar features may be present after a laparotomy.

In general, it is difficult to detect intraperitoneal adhesions because intestinal gases and fatty abdominal wall adversely affect ultrasound examination [38]. Assessment of the intestinal loop location during special maneuvers like deep respiration, changing positions and compressions applied by the transducer may help locate the intraperitoneal adhesions [37]. Rarely, a distended urinary bladder can be found adherent to the anterior abdominal wall.

An abdominal map consisting of nine segments can be used to document the location and extent of the adhesion. Abdominal ultrasound is accurate for diagnosing adhesions in patients undergoing repeated surgery but is inferior to cine-MRI in detecting intraabdominal organs adhesion [39].

4.4. Uterine Defect After Cesarean or Myomectomy

Uterine rupture in pregnancy is a rare and life-threatening complication. The risk of uterine rupture increases with a history of uterine surgery, such as cesarean section and abdominal or laparoscopic myomectomy [40]. Uterine dehiscence, a separation of the uterine musculature with intact uterine serosa, can be suspected on obstetric scan [40]. Management of uterine dehiscence is difficult. Planned cesarean delivery prior to the onset of labor with careful monitoring of maternal symptoms is preferred [40].

In at-risk women, performing ultrasound assessment of LUS thickness during the first trimester seems to be more informative than second and third trimesters in one study [41]. However, as the pregnant uterus enlarges with gestation, cases of large dehiscence develop progressively [31]. Thus, first-trimester residual myometrial thickness does not correlate well with third-trimester LUS thickness in women with a previous cesarean delivery [5].

4.5. Uterine Fibroids

Uterine fibroids of 5 cm or larger are associated with cesarean delivery performed before labor, and the risk increases with the size of the fibroid [42]. It is important to perform the exact mapping of anterior fibroid before cesarean section. While uterine incision is made to deliver the fetus, the incision should not be made over fibroid as much as possible [6].

It is controversial whether it is safe to perform myomectomy during a cesarean delivery. A meta-analysis in 2021 showed that cesarean myomectomy is associated with clinical insignificant increase in operative time, blood loss and hospital stay [43]. However, a subsequent meta-analysis one year later showed that cesarean myomectomies, especially of intramural fibroids, large fibroids ≥ 7 cm in size, and multiple fibroids, were associated with significant risk of hemorrhage, and prolonged operation duration compared to those who underwent cesarean section only [44]. It may be safe to perform cesarean myomectomy by experienced surgeons using appropriate hemostatic techniques if the fibroids are not located at the cornual or close to large vessels, and in the absence of uterine atony during surgery [44]. Careful characterization (benign fibroids or malignant uterine tumors) and location of myometrial lesions (largely subserosal or submucosal) before a myomectomy is required [45].

4.6. Transverse Lie

Transverse fetal lie can be easily diagnosed by an obstetric scan. Conversion of a traditional low-isthmus transverse uterine incision to an inverted-T incision may be required if there are problems in the fetal extraction [6]. In multifetal pregnancy, it is important to use ultrasound to determine the number of fetuses, their lie, and presentation and the position of placenta before cesarean section [6]. This information can facilitate extraction of fetuses.

4.7. Membranous Fetal Vessels in the LUS

It is controversial whether routine screening for velamentous cord insertion (VCI) and/or vasa previa should be performed at the mid-trimester scan because of the risk of over-diagnosing such abnormalities, and implication on the resources required [29]. If umbilical cord insertion is not detected clearly by ultrasound screening during pregnancy, abnormal cord insertion site should be suspected, and search for. Transabdominal sonography during the second trimester has a low sensitivity of 62.5%, but has a high specificity for VCI [46]. Visualization of the LUS may be obstructed by the fetal head. If VCI is found, a targeted transvaginal examination with color Doppler imaging can be considered to screen for membranous cord vessels in the LUS depending on experience and resources [29].

4.8. Impacted Fetal Head

The use of intrapartum ultrasound has increased over the last two decades, but is not yet a routine practice [28,47]. Common sonographic indicators of the fetal head station include the angle of progression (AoP), and headperineum distance (HPD) which can be obtained using transperineal sonography [28,47]. Midsagittal view allows measuring the AoP, which is the angle between a line through the pubic bone's long axis and the tangent to the deepest bony part of the fetal skull [28,47]. Axial view allows measuring the HPD which is the shortest distance between the outer bony limit of the fetal skull and the transducer edge [28,47]. However, it is not known whether ultrasound findings of an impacted fetal head can help facilitate the disimpaction during cesarean delivery and hence reduce adverse maternal or neonatal outcomes.

5. Ultrasound Assessment Before All Cesarean Section?

At present, pre-operative ultrasonographic assessment is not a routine practice. There is lack of studies in this issue [5]. Without any preceding obstetric ultrasound, unexpected problems like PAS, placenta previa, severe pelvic adhesions, uterine fibroids, membranous fetal vessels, or large superficial vessels in the LUS, or breech presentation may be found during subsequent cesarean section [5,9,10,15,29,42]. Rarely, PAS can be found in women without any risk factors [10]. Given that cesarean section is a common obstetric procedure performed in an elective or an emergent situation, it is worthwhile to consider performing assessment of LUS and placenta localization during commonly indicated obstetric scan. More studies on this issue are required.

According to the ISUOG guidelines, a mid-trimester fetal ultrasound examination or a third-trimester scan should include an evaluation of the placental location among other elements. [25,29]. While assessing the placenta, the operator can also assess the LUS. Any uterine fibroid in the LUS can be detected as well although formal assessment of uterine anatomy is not part of the routine obstetric scan [18,29]. The transvaginal approach is preferred to the transabdominal approach in cases of suspected posterior placenta previa [25]. A detailed ultrasound assessment should be performed to rule out PAS disorders in cases of placenta previa and prior cesarean birth or uterine surgery [25].

More than 40% of FGR cases involving stillbirths without obvious causes of FGR (or in low-risk pregnancies) were not diagnosed until after delivery [48]. The detection rate of SGA or FGR in low-risk pregnancies by serial measurement of the symphysis-fundal height is low. Thus, a routine third-trimester scan at 36 weeks' gestation can be offered to low-risk women to improve the detection rate

of late-onset FGR [49] However, a Cochrane systematic review and meta-analysis in 2015 did not show that ultrasound performed after 24 weeks’ gestation could reduce perinatal mortality [25].

6. Conclusion

Before undergoing complex or difficult cesareans including PAS, major placenta previa, repeated cesareans, all at-risk women should preferably be examined with transabdominal ultrasound, with special emphasis on the characteristics of the LUS, and the location of the placenta [1]. Transvaginal ultrasound can be added if the placenta is low-lying or previa. The signs associated with PAS, and major LUS dehiscence should be assessed [5]. Other obstetric conditions such as anterior fibroid, membranous fetal vessels, or large superficial vessels in the LUS, fetal macrocephaly, transverse lie, severe pelvic adhesions can also be detected and evaluated [1,5,15,42,46].

Future direction

At present, pre-operative ultrasonographic assessment is not a routine practice for all cesarean sections. Without any obstetric ultrasound, unexpected problems like PAS, placenta previa, severe pelvic adhesions, uterine fibroids in the LUS, or breech presentation may be encountered during subsequent cesarean section [5,9,10,15,29,42]. Given that cesarean section is a common obstetric procedure performed in an elective or an emergent situation, it is worthwhile to consider performing assessment of LUS and placenta location during commonly indicated obstetric scan such mid-trimester morphology scan and third-trimester scan [25,29]. Besides, it is not known whether ultrasound findings of an impacted fetal head can help facilitate the disimpaction during cesarean delivery, and hence reduce adverse maternal or neonatal outcomes. More studies on this issue are required.

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Abbreviations

The following abbreviations are used in this manuscript:

PAS	Placenta accreta spectrum disorders
LUS	Lower uterine segment
FGR	Fetal growth restriction
AoP	Angle of progression
HPD	Headperineum distance
VCI	Velamentous cord insertion
MRI	Magnetic resonance imaging
TVS	Transvaginal sonography
TOL	Trial of labour
FIGO	International Federation of Gynaecology and Obstetrics
PPH	Postpartum hemorrhage
MOH	Massive obstetric hemorrhage
GA	General anaesthesia

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