



# Advanced Diagnostic Topic for Austere Providers: Obstetric

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## Introduction

Obstetrical and gynecological emergencies in an austere setting can be challenging for the provider and patient alike. Gravid patients may need management of traumatic injuries, abdominal pain, vaginal bleeding, and complications of pregnancy, among other complaints. This chapter describes the ultrasound techniques used to identify an intrauterine pregnancy (IUP) and how to evaluate fetal condition by identifying fetal heart tones (FHTs). If the gestational age of the fetus is advanced (e.g. suspected to be greater than 20 weeks,) US can also be used to identify the fetal head position. When appropriate in the trauma setting, FAST exam for pregnant patients is recommended and guidelines described in the Trauma Section should be followed. In addition, if no IUP is identified in a patient known or suspected to be pregnant, US can be used to assess for signs of ectopic pregnancy, a potentially life threatening condition. The literature is sparse regarding use of point of care ultrasound (POCUS) in the prehospital setting to evaluate obstetrical and gynecologic emergencies. However, based on the review of curricula used to train prehospital providers in the use of POCUS, it is reasonable to include limited transabdominal obstetric pelvic US, referred to as pelvic POCUS throughout this chapter, in the toolkit of skills available to EMS providers and health care providers in austere settings [1, 2].

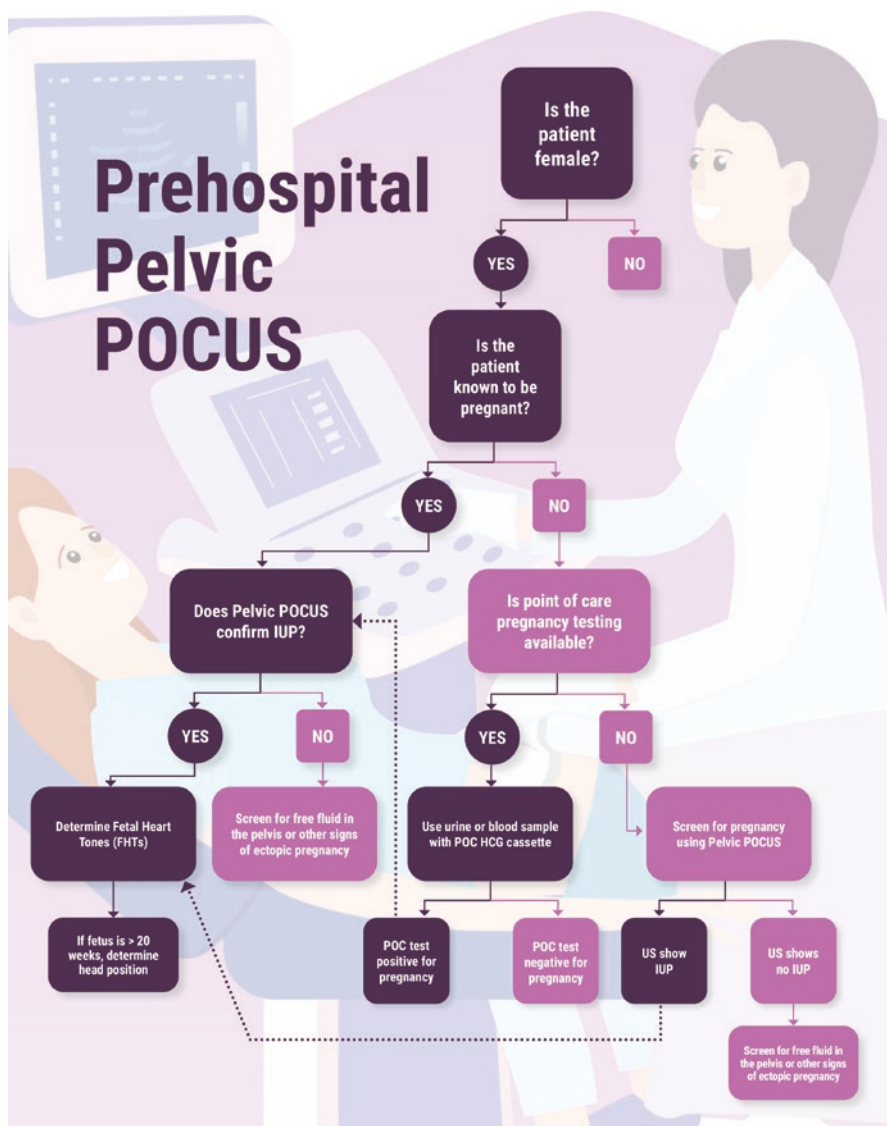
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## Topic Discussion

### General Strategy

Prehospital pelvic POCUS is most useful to determine if the patient is pregnant, identify basic signs of fetal distress, and presentation if beyond 20 weeks. Pregnancy should be considered in any female between the ages of 10–55. We recommend the following systematic approach to using pelvic POCUS in evaluating a patient in the prehospital or austere setting:



If a female patient is known to be pregnant either by history or by point of care testing, pelvic POCUS can be used to confirm IUP. If no IUP is identified, consideration should be given to a possible diagnosis of ectopic pregnancy. This obstetrical complication typically develops in the first trimester and epidemiologic studies report an incidence somewhere between 6.4 and 20.7 out of 1000 pregnancies [3, 4]. Risk factors such as prior history of PID, prior ectopic pregnancy, IUD use, and a history of infertility can significantly increase the patient's risk of ectopic pregnancy [5]. In addition, a history of having undergone infertility treatments in order to achieve the current pregnancy significantly increases a patient's risk for heterotopic pregnancy, a condition where there is simultaneously an IUP and an ectopic pregnancy.

Definitive identification of ectopic pregnancy may not be possible by transabdominal US, and transvaginal US in the prehospital setting is not recommended. However, a scan for free fluid in the pelvis can be used to risk stratify the patient for likelihood of ruptured ectopic pregnancy. If a pregnant patient with abdominal pain or vaginal bleeding in the first trimester is found to have no clear evidence of IUP and has significant amounts of free fluid in the pelvis or abdomen, ectopic pregnancy should be considered high on the differential, and immediate stabilization and treatment in the hospital setting should be sought.

While the clinical scenario is exceedingly rare, US may also have a role in maternal and fetal monitoring in the case of cardiac arrest in the gravid patient. For maternal resuscitation, ACLS or ATLS guidelines should be followed with appropriate modifications for gravid women of greater than 20 weeks gestation. Recommendations for prehospital resuscitative hysterotomy/peri-mortem C-Section (RH/PMCS) have been published, however, we recommend consulting with local medical directors to determine local protocols appropriate to your specific situation. US may be used to monitor cardiac status of the mother and/or the fetus [6].

In women in whom pregnancy is identified, POCUS may be used to assess the status of the fetus by measuring fetal heart tones. Fetal cardiac activity is generally present at 6–6.5 weeks of gestation, however, it may be difficult to obtain adequate images using transabdominal US at this early stage. Transabdominal pelvic US is most likely to visualize an intrauterine embryo by 8 weeks of gestational age or later. Cardiac activity at this stage can be visualized as a flickering within the thorax of the embryo. We recommend measuring fetal heart rate (FHR) using M-Mode. Typical embryonic and fetal heart rates are as follows:

- 6 weeks: 100–115 beats/minute.
- 8 weeks: 145–170 beats/minute.
- 9 weeks and greater: 137–144 beats/minute.

If the level of the uterus is palpated to be at or above the level of the umbilicus of the patient, then the gestational age is estimated to be 20 weeks or greater. In this case, POCUS can be useful to determine fetal head presentation.

## Anatomy

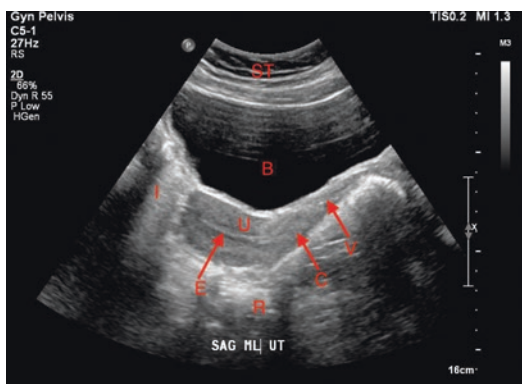
The non-gravid female pelvis includes many important structures which can be often be identified by pelvic POCUS though image quality can vary greatly, depending on operator experience and the patient's body habitus. The pelvic cavity is the space enclosed by the bony pelvis and extends from the iliac crests superiorly to the pelvic floor inferiorly. The female pelvis contains the following structures: uterus, vagina, fallopian tubes, ovaries, urinary bladder, rectum, intestines as well as major blood vessels, muscles and ligaments. The uterus is a pear-shaped muscular structure that lies posterior to the urinary bladder. In a post-pubertal adult female, the non-gravid uterus typically measures 8 cm long, 5 cm wide and 3 cm deep [14].

Understanding the peritoneal spaces within the pelvis will help the health care provider to identify normal and abnormal fluid within the pelvis. The posterior cul-de-sac, or Pouch of Douglas, is the space posterior to the uterus and anterior to the rectum. If the patient is in the supine position, it is the most dependent intraperitoneal space and the most likely space for intraperitoneal fluid to accumulate. A small amount of free fluid in the posterior cul-de-sac, 5–21 ml, can be physiologically normal, especially in menstruating females, and can often be seen on ultrasound [7]. A full bladder helps to create a good acoustic window for visualization of the uterus and posterior cul-de-sac, and image visualization may be more challenging in a patient with an empty bladder (Fig. 1).

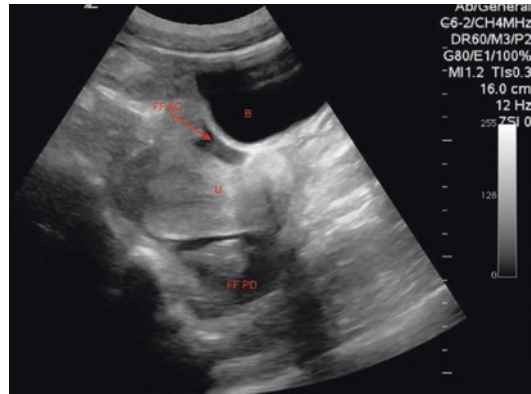
The anterior cul-de-sac, or vesicouterine pouch, is the space anterior to the uterus and posterior the urinary bladder. Ultrasonic visualization of fluid within this space in a supine patient should be considered abnormal and could represent intra-abdominal hemorrhage (Fig. 2).

The uterus is a remarkable organ which during pregnancy can increase to 20 times its original weight. Before 12 weeks, the uterus remains an intrapelvic organ, being contained below the pelvic brim. By 20 weeks, it reaches the umbilicus and at 34–36 weeks is at the level of the costal margins. At term, the uterus has often enlarged from 6 to 8 cm in length to over 30 cm which alters the normal anatomic

**Fig. 1** Normal non-gravid sonographic anatomy in sagittal plane highlighting: subcutaneous tissue (ST), bladder (B), intestines (I), uterus (U), endometrial stripe (E), cervix (C), vaginal stripe (V), rectum (R)



**Fig. 2** Long axis view of a pelvis with large free fluid (FF) pooling in the anterior cul-de-sac (AC), Pouch of Douglas (PD) with uterus (U) and bladder (B) highlighted



location and function of multiple structures including the bladder, abdominal viscera, and diaphragm. These changes are particularly important to consider when evaluating the pregnant trauma patient, but are pertinent in medical and obstetrical considerations as well [30].

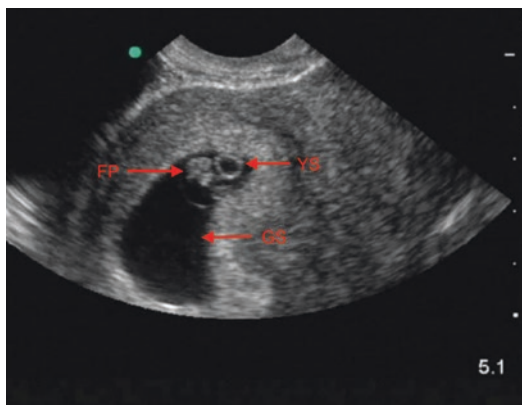
### Ultrasound Evaluation for Intrauterine Pregnancy (IUP)

Transabdominal pelvic US is best performed using a low frequency curvilinear probe (5–2 MHz). Many ultrasound machines have an obstetrical preset that can be selected for this exam. The ability to identify IUP depends on both the gestational age of the fetus, discussed above, and the mother’s body habitus. Prior to scanning, place an adequate amount of ultrasound gel directly onto the patient’s lower abdomen. The probe is positioned above the pubic symphysis in the midline. Begin with the longitudinal view by positioning the probe marker toward the patient’s head. The bladder, when full, will be noted as a dark, anechoic structure with the relatively hyperechoic uterus lying posteriorly. Be sure to decrease the gain to such that the fluid in the bladder appears black. If the gain is too high, there may be posterior acoustic enhancement which could hide free fluid or distort the operator’s ability to identify an IUP.

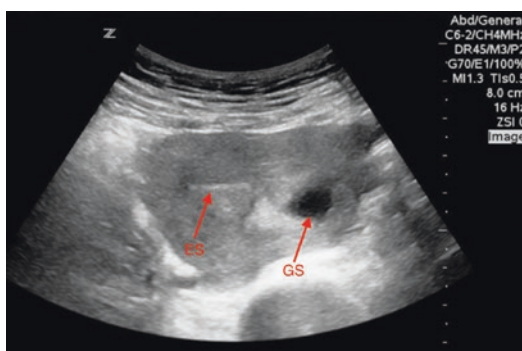
Fan or translate the probe from the iliac fossa on the right to the one on the left to visualize the entire pelvis. Look first at the hyperechoic endometrial stripes and then for signs of IUP such as a gestational sac and yoke sac. Then place the probe in the transverse plane with the probe marker toward the patient’s right and fan through the entire length of the uterus inferiorly to superiorly. The earliest definitive sign of IUP is the presence of a gestational sac with a yolk sac within the endometrium of the uterus which occurs around 5 weeks gestation (Fig. 3). After 6 weeks, the formation of a fetal pole adjacent to the yolk sac can be identified with a flickering of cardiac activity indicating a viable IUP.

Identification of an IUP excludes the diagnosis of ectopic pregnancy in most cases. An exception to this is in the case of patients undergoing fertility treatments.

**Fig. 3** A gravid uterus with pregnancy including gestational sac (GS), yolk sac (YS), fetal pole (FP)



**Fig. 4** Interstitial pregnancy demonstrating a gestational sac (GS) imbedded in the myometrium outside the endometrial stripe (ES)

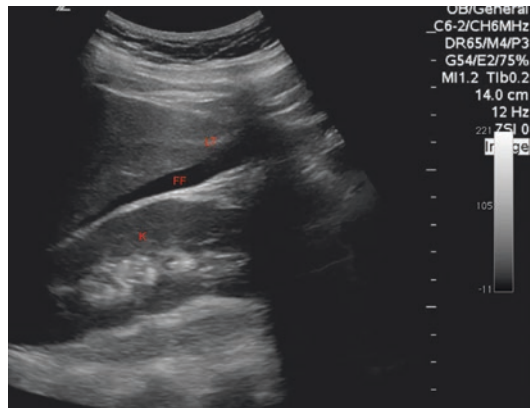


These patients are at significantly increased risk for heterotopic pregnancy where there is simultaneously both an IUP and an ectopic pregnancy. Be sure to ask any symptomatic patient in the first trimester if they have undergone fertility treatments, and have an increased level of concern if they are experiencing symptoms of abdominal pain, vaginal bleeding or shock. Another rare complication of early pregnancy is intramural (or interstitial) ectopic pregnancy where the embryo implants into the uterine wall (Fig. 4). In these cases, the ultrasound can appear to confirm IUP, yet the patient is at risk for uterine rupture, hemorrhage and death if the problem is not detected and treated. The diagnosis of intramural ectopic pregnancy by ultrasound is beyond the scope of this chapter. However, by being aware of this rare diagnosis, the health care provider can use ultrasound to screen for free intraperitoneal fluid in symptomatic patients, even if a previously normal US is reported [8, 9].

## Ultrasound Evaluation of Free Fluid in the Pelvis and Abdomen

In addition to looking for evidence of IUP, transabdominal US can also be used to identify free fluid in the pelvis or abdomen which can be associated with life threatening diagnoses. In the case of a female patient involved in trauma, any evidence of fluid in the abdomen or pelvis should be considered abnormal as the presence of

**Fig. 5** Free fluid (FF) in Morrison's Pouch between kidney (K) and liver tip (LT)



fluid within the abdomen or pelvis after trauma is associated with significantly higher rates of intra-abdominal injury [7]. In the non-traumatic female patient, a small amount of free fluid in the pelvis may be considered physiologic or “normal.” The fluid level, as it tracks along the posterior cul-de-sac, can be measured in comparison to the fundal height of the anteverted uterus. Fluid measuring one third the height of the uterus is considered small, two thirds is moderate, and fluid reaching more than two thirds the height of the uterine wall is considered large (Fig. 5). The likelihood of ectopic pregnancy increases significantly in the presence of moderate or large free fluid [13].

When evaluating for free fluid in the setting of suspected ectopic pregnancy, a scan for intraperitoneal fluid should also be performed by looking at the hepatorenal space (Morrison’s Pouch) (Fig. 5). This is done using the same technique described in the FAST exam. The presence of free fluid in the hepatorenal space of a symptomatic pregnant patient without an IUP is virtually diagnostic of a ruptured ectopic pregnancy [10, 11].

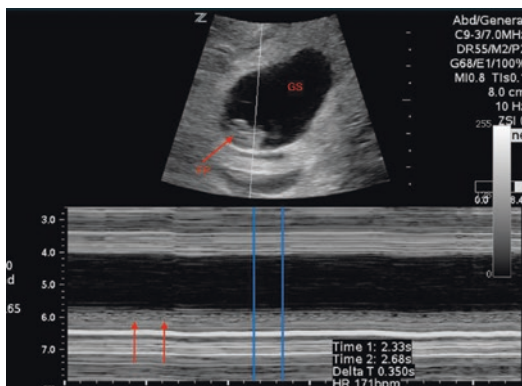
### Obtaining Fetal Heart Tones (FHTs)

To monitor the fetal heart rate, the ultrasound machine should be placed in M-mode with probe situated such that the fetal cardiac activity is consistently visualized. While in M-mode, the marker should be placed directly over the flicker of cardiac activity within the fetus. The alternating black and gray bands represent cardiac chamber movement over time. Using the measurement function while in the obstetrics mode, two lines are situated to mark a cardiac cycle, and the machine will then calculate the heart rate (Fig. 6) [13, 14]. A video clip documenting fetal cardiac activity can also be recorded in B-mode.

### Ultrasound for Determination of Fetal Presentation

Evaluation of the fetal presentation in patients with a gestational age greater than 20 weeks can be useful in prehospital and austere settings, particularly in the setting

**Fig. 6** M-Mode measuring fetal heart rate. Two red arrows indicating heartbeats used for measurement. Gestational sac (GS) and fetal pole (FP) highlighted

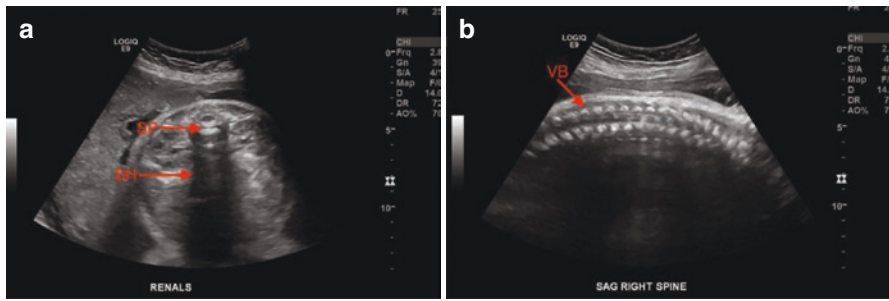


of a patient suspected to be in labor. Fetal presentation refers to the way the fetus is positioned within the uterus presenting to the birth canal and includes cephalic (head), breech, and shoulder presentations. Fetal lie refers to the longitudinal orientation of the fetus in relation to the long axis of the mother and can be longitudinal, oblique or transverse. Fetal position describes the rotational orientation of the head inside the mother's pelvis and can be occiput anterior (OA), occiput posterior (OP) and many different angles in between. If the uterus can be palpated at or above the umbilicus, then the gestational age of the fetus can be estimated to be greater than 20 weeks. If the health care provider suspects that a mother with a potentially viable fetus is showing signs of labor including regular, frequent uterine contractions or passage of amniotic fluid per the vagina, then pelvic POCUS can be used to determine the presentation of the fetus within the uterus. The most common location of a fetus during labor is to be aligned longitudinally within the uterus with the fetal head as the presenting part. Any other position such as breech or transverse fetal lie is considered a malpresentation. These malpresentations can result in increased perinatal morbidity and mortality during delivery and are important to know if managing delivery in the field or giving report to providers administering definitive care.

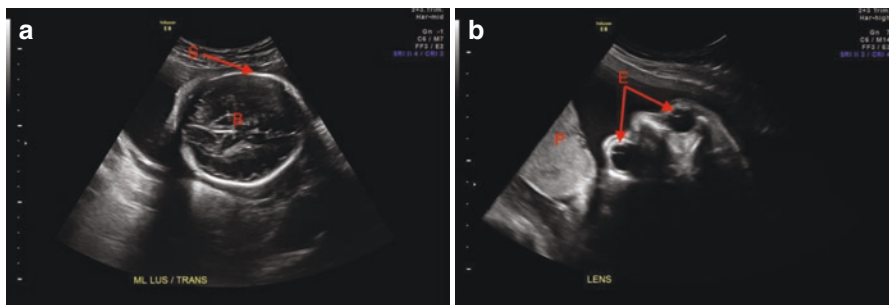
To determine fetal presentation, a low frequency curvilinear probe should again be used (5–2 MHz). The probe should be first placed transversely on the maternal abdomen with the probe marker oriented to the patient's right side. In normal cephalic or "head first" fetal positioning, an axial view of the fetus within the uterus should show evidence of the hyperechoic fetal spine (Fig. 7). By sliding down to the maternal suprapubic region, the fetal head should then be visualized by noting the circular hyperechoic skull, isoechoic brain with anechoic ventricles (Fig. 8). Repeating the transabdominal scan in the longitudinal plane should again reveal the fetal head in the maternal pelvis [17]. If the head is not identified in the pelvis, the entire uterus should be evaluated to determine if the fetus is in a breech or transverse fetal lie.

Studies have demonstrated that US is useful in determining if the fetal head position is occiput anterior (normal position) or occiput posterior (malposition) during the second and third stages of labor, however, that degree of detail is beyond the scope of this text to teach adequately [15].





**Fig. 7** (a) Transverse of 36wk fetus mid abdomen demonstrating fetal spine (SP) anteriorly with shadowing (SH). (b) Sagittal of same fetal spine with vertebral body (VB) indicated. The spine can be followed to the head to determine presentation



**Fig. 8** (a) Transverse of 28 wk fetal head highlighting skull (S) and brain (B) demonstrating longitudinal lie, head presentation. (b) Transverse of a 30 wk fetus demonstrating eye sockets (E) anterior and occiput posterior with placenta (P) highlighted

## Key Literature Reviewed

Research on the use of prehospital pelvic ultrasound for obstetrical evaluation is extremely limited at this time. However, pelvic ultrasound, particularly for the purpose of ruling out ectopic pregnancy in the first trimester in patients presenting to emergency departments, has been studied extensively [10–12, 16, 29].

In the pre-hospital setting, Galisnki et al. reported an exceptional case report of a ruptured ectopic pregnancy diagnosed by prehospital US. The patient reported having a prior pelvic ultrasound which had been interpreted to be a “normal” 11 week pregnancy. However, while under evaluation by EMS, the patient became hypotensive and dizzy. Transabdominal US showed free intraperitoneal fluid. The patient had actually experienced a very rare intramural ectopic pregnancy resulting in uterine rupture. The prehospital diagnosis of hemoperitoneum resulted in prompt intervention with the patient undergoing to emergent laparotomy immediately upon arrival to the hospital [9].

In 2004, Polk et al. published a case series of 3 obstetrical cases managed by and air medical team using prehospital US. In each case, US findings changed the course of patient management. The authors proposed the use of US evaluation they termed

Fetal Evaluation for Transport by Ultrasound (FETUS). FETUS examination performed by the flight team included a direct assessment of fetal heart rate, fetal movement, fetal position, presence of amniotic fluid, and general condition of the placenta [18].

## Limitations of Current Knowledge and Opportunities for Future Research

Virtually no studies have looked at the systematic use of pelvic US in the prehospital setting. Many studies have shown that health care providers including paramedics, EMTs, and first responders can acquire the skills needed for ultrasound evaluation of patients in austere and prehospital settings [19–28]. The most common prehospital applications include using ultrasound for FAST and eFAST exams and cardiac evaluation. Given the similarities in technique between these types of studies, the next logical step is to develop curricula and to research the utility of pelvic POCUS in austere settings.

### Pearls and Pitfalls

- Transabdominal US can be used to rule out ectopic pregnancy by identifying an intrauterine pregnancy with exception in special populations.
- An empty or inadequately filled bladder can make transabdominal pelvic US more difficult while a full bladder provides an excellent acoustic window for viewing of pelvic structures.
- A full bladder may cause posterior acoustic enhancement which may hide free fluid or distort the operator's ability to identify an IUP. Decrease the gain posterior to the bladder to improve imaging.
- When fanning or translating the probe through the pelvic organs, care should be taken to visualize the entire space from iliac fossa on the right to the one on the left. The same philosophy should be applied to the caudal and cephalad scanning in transverse axis.
- All findings should be confirmed on imagine in two perpendicular planes.
- The earliest definitive sign of an IUP is the presence of a gestational sac with a yolk sac within the endometrium of the uterus, often visible on transabdominal pelvic POCUS at 6–8 weeks gestation.
- Identification of an IUP with cardiac activity reliably rules out ectopic pregnancy with rare exceptions.
- Heterotopic pregnancy (presence of ectopic pregnancy IN ADDITION to an IUP) should be considered in any symptomatic pregnant patient who has undergone fertility treatments to achieve their current pregnancy.
- Fetal Heart Rate (FHR) can be calculated using M-Mode.
- Fluid in the anterior cul-de-sac, or vesicouterine pouch should be considered abnormal and may represent intra-abdominal hemorrhage.

- Moderate or large amounts of free fluid seen in the posterior cul-de-sac (>1/3 the fundal height of the uterus) should be considered abnormal.
- Fluid in the right upper quadrant in a non-traumatic patient in the first trimester of pregnancy is highly concerning for ruptured ectopic pregnancy.
- Any fluid in the pelvis after blunt trauma should be concerning for possible intra-abdominal injury.
- Fetal position can be established by using US to locate the fetal head within the uterus.

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