

WHAT'S NEW IN INTENSIVE CARE



Point-of-care ultrasound in the critically ill pregnant or postpartum patient: what every intensivist should know

Pablo Blanco^{1*}  and Anselmo Abdo-Cuza²

© 2019 Springer-Verlag GmbH Germany, part of Springer Nature

Pregnant and postpartum women needing intensive care account for a low proportion of admissions to the intensive care unit (ICU), approaching one ICU admission for every 370 deliveries [1]. The most common causes requiring critical care are hypertensive disorders of pregnancy and obstetric hemorrhage [1, 2], and the majority of ICU admissions occur in the puerperium [1].

While the use of point-of-care ultrasound (POCUS) in the general ICU patient is widely accepted [3, 4], intensivists should also strongly consider using this method in caring for the critically ill pregnant or puerperium patient, as it can aid in detecting and monitoring many of the complications that occur in this population. In this article, we focus specifically on the main scenarios involving the pregnant or puerperium patient in which POCUS may be useful for diagnostic and monitoring purposes. Using a multi-organ ultrasound (US) approach (Fig. 1 and ESM 1) seems to be the best pathway to making accurate diagnoses and focusing on treatments. Importantly, POCUS is not a standalone diagnostic tool—it should always be used within the context of medical history, physical examination, laboratory, and other imaging techniques.

Women presenting with dyspnea/acute respiratory failure (ARF) during pregnancy or the puerperium

Transthoracic echocardiogram (TTE), often coupled with lung US (LUS) and venous US, aids in discriminating

between cardiac, pulmonary or mixed causes of dyspnea/ARF.

LUS showing diffuse B lines (i.e., pulmonary edema) and an abnormal echocardiogram point out towards a cardiogenic mechanism of dyspnea/ARF. In this setting, three main entities deserve attention. A dilated left ventricle (LV) with impaired left ventricular ejection fraction (LVEF) should raise suspicion of peripartum cardiomyopathy (ESM 2), a condition which often appears in the puerperium. The other two entities needing consideration often appear antepartum and with preserved LVEF on TTE: hypertensive heart failure of pregnancy and severe mitral stenosis. Elevated LV filling pressure (e.g., E/e' ratio >9) is the key finding for the former while a reduced opening of the mitral valve (MV) leaflets (MV area < 1 cm²) and a mean MV gradient > 10 mmHg define the latter (ESM 3) [5].

Women with sudden-onset dyspnea, shock, or hemoptysis with TTE showing dilation of the right ventricle (RV) (ESM 4a), plus altered RV systolic function, should be suspected of having pulmonary thromboembolism (PTE). Additional findings indicating PTE are the presence of a thrombus in transit in the right heart chamber or straddling in the foramen ovale, a venous US scan demonstrating a deep venous thrombosis (DVT) (ESM 4b and c), and/or subpleural consolidations on LUS. DVT may occur in pelvic veins as well (i.e., ovarian vein thrombophlebitis) (ESM 4d) [6].

Amniotic fluid embolism (AFE), a diagnosis of exclusion, is similar in presentation and in TTE to PTE and may be differentiated from the latter based on LUS showing B lines (noncardiogenic pulmonary edema) and the absence of DVT on the venous US scan [7]. TTE may also

*Correspondence: ohtusabes@gmail.com

¹ Intensive Care Unit, Clínica Cruz Azul, 2651, 60 St., 7630 Necochea, Argentina

Full author information is available at the end of the article

Multi-organ POCUS in the critically-ill pregnant or puerperium patient

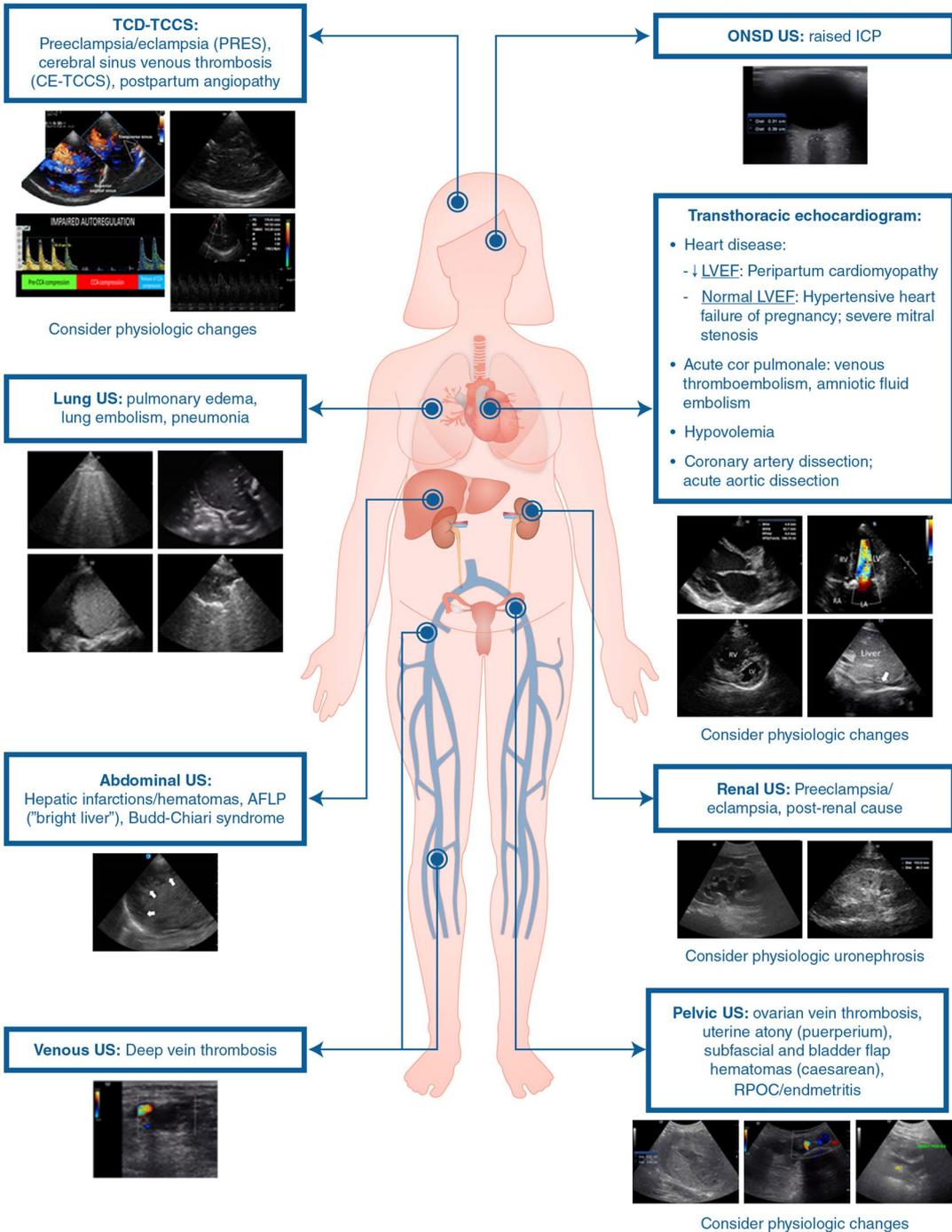


Fig. 1 Multi-organ point-of-care ultrasound (POCUS) in the pregnant or puerperium patient. The most important pathologies of this period that may be considered, and are able to be evaluated by POCUS, are indicated. To avoid incorrect interpretations, intensivists should know physiologic changes and their POCUS correlations well. TCD transcranial Doppler, TCCS transcranial color-coded duplex sonography, CE contrast-enhanced, PRES posterior reversible encephalopathy syndrome, ONSD optic nerve sheath diameter, ICP intracranial pressure, HELLP hemolysis, elevated liver enzymes, low platelet count, AFLP acute fatty liver of pregnancy, LVEF left ventricular ejection fraction, RPOC retained products of conception

show a highly mobile “threadlike” mass in the right heart chambers in hyperacute AFE [8].

An abnormal LUS, coupled with an unremarkable echocardiogram and a normal venous US, indicates a pulmonary cause of dyspnea/ARF (e.g. pneumonia). This information must be integrated with the clinical context to make an accurate diagnosis.

Women presenting with acute chest pain during pregnancy or the puerperium

Two conditions deserve special attention: coronary artery dissection (CAD) and acute aortic dissection (AAD) [6]. In CAD, TTE may be used to demonstrate regional wall motion abnormalities, to rule out acute aortic dissection and to detect complications such as heart failure or mitral regurgitation. In AAD, TTE may be used to identify dilation of segments of the thoracic aorta, an intimal flap or complications such as aortic regurgitation or pericardial effusion.

Women presenting with hemodynamic instability, abdominopelvic pain, and vaginal bleeding during pregnancy or the puerperium

This presentation is mainly observed in the puerperium, where uterine atony should always be considered first. Depleted cardiac chambers and inferior vena cava, as well as hyperdynamic ventricles, are the hallmark TTE signs observed in hypovolemia (ESM 5). Uterine atony is shown on pelvic US as an enlarged uterus with heterogeneous myometrium and gross endometrial fluid contents. Hemorrhagic complications of the caesarean section should also be considered, such as bladder flap hematomas and subfascial hematomas (ESM 6a), or the coexistence of both. These appear on the US as complex cystic masses [9].

Women presenting with right upper quadrant pain and/or alteration of the hepatogram during pregnancy or the puerperium

Unique conditions observed in this period, such as acute fatty liver of pregnancy (AFLP), liver infarction/hematoma, and Budd–Chiari syndrome (BCS), deserve special attention.

In the context of acute liver failure with or without ascites, a “bright liver” manifested in the US suggests AFLP [10]. Liver infarctions or/and hematomas often occur in the setting of preeclampsia and HELLP syndrome. Liver infarctions are seen by POCUS as geographic hypoechoic areas in the liver (early-stages) and as well-defined wedge-shaped hypoechoic areas (late-stages) (ESM 6b) [11, 12]. Liver hematomas are shown as heterogeneous fluid collection below the liver capsule (subcapsular hematomas) or within the hepatic

parenchyma (intraparenchymal hematomas) [11, 13]. The presence of free intraperitoneal fluid accompanying a liver hematoma should raise suspicion of a hepatic rupture; these patients are often in shock. For BCS, the main US finding is the detection of a lack of blood flow or thrombus within one or more hepatic veins, or within the inferior vena cava [14].

Women presenting with alterations in serum creatinine and/or urine output during pregnancy or the puerperium

POCUS may aid in distinguishing between post-renal and pre-renal causes of renal failure.

After ruling out post-renal causes, the most common disorder that should be considered is pre-eclampsia/eclampsia, where POCUS may show enlarged kidneys with increased renal parenchymal echogenicity (ESM 6c) [15]. However, these signs are not specific to preeclampsia/eclampsia, as acute tubular necrosis or glomerulonephritis, for example, may look very similar. Accordingly, correlation with history is essential [15].

Women presenting with pelvic pain, vaginal bleeding, and fever during pregnancy or the puerperium

Retained products of conception (RPOC) and endometritis are the two main diagnoses to be considered [9]. RPOC are observed as an echogenic endometrial mass, usually vascularized. Endometritis may coexist with RPOC and is shown as a heterogeneous endometrial fluid collection in a patient presenting with vaginal bleeding, fever, and fetid vaginal secretions [9].

Women presenting with neurologic complaints during pregnancy or the puerperium

Patients presenting with neurologic manifestations such as headaches, seizures, focal neurologic deficits or altered mental status, should be considered first as having complications from preeclampsia/eclampsia (e.g., posterior reversible encephalopathy syndrome or PRES). Postpartum angiopathy (PPA) and cerebral sinus venous thrombosis (CSVT), less common entities, should also be taken into account. Transcranial Doppler (TCD) may provide clues supporting these diagnoses, and may also be useful for monitoring purposes. In preeclampsia/eclampsia, TCD often shows elevated velocities (occasionally reaching criteria of vasospasm) or/and impaired autoregulation (ESM 7) [16]. For PPA, vasospasm is a key finding [17]. Of note, PRES and PPA may coexist. Prominent bilateral venous signals adjacent to the middle cerebral arteries are indirect signs that may indicate CVST [18].

Using transcranial color-coded duplex sonography (TCCS), it is also possible to evaluate for complications

such as cerebral hemorrhage and midline shift [19], as well as to evaluate the cerebral sinus veins using the US contrast agents [18]. In addition, the US measurement of the optic nerve sheath diameter can provide a non-invasive estimation of the intracranial pressure [19].

Conclusions

Point-of-care ultrasound provides a safe and feasible tool for whole-body assessment for diagnosis and monitoring of the critically ill pregnant and postpartum women. This tool may aid intensivists in both diagnosis and monitoring, thereby potentially improving patient care.

Electronic supplementary material

The online version of this article (<https://doi.org/10.1007/s00134-019-05682-2>) contains supplementary material, which is available to authorized users.

Author details

¹ Intensive Care Unit, Clínica Cruz Azul, 2651, 60 St., 7630 Necochea, Argentina.

² Intensive Care Unit, Centro de Investigaciones Médico-Quirúrgicas, 11-13 and 216 St., 12100 Siboney, La Habana, Cuba.

Author contributions

Both authors contributed to the writing of this manuscript equally. Both authors read and approved the final manuscript.

Funding

The authors do not receive any funding.

Compliance with ethical standards

Conflicts of interest

Authors have no conflicts of interest related to this submission.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received: 15 May 2019 Accepted: 26 June 2019

Published online: 3 July 2019

References

- Pollock W, Rose L, Dennis CL (2010) Pregnant and postpartum admissions to the intensive care unit: a systematic review. *Intensive Care Med* 36(9):1465–1474
- Rios FG, Riso-Vázquez A, Alvarez J, Vinzio M, Falbo P, Rondinelli N, Bienzobas DH (2012) Clinical characteristics and outcomes of obstetric patients admitted to the intensive care unit. *Int J Gynaecol Obstet* 119(2):136–140
- Veillard-Baron A, Millington SJ, Sanfilippo F, Chew M, Diaz-Gomez J, McLean A, Pinsky MR, Pulido J, Mayo P, Fletcher N (2019) A decade of progress in critical care echocardiography: a narrative review. *Intensive Care Med*. <https://doi.org/10.1007/s00134-019-05604-2>
- Volpicelli G, Elbarbary M, Blaivas M, Lichtenstein DA, Mathis G, Kirkpatrick AW, Melniker L, Gargani L, Noble VE, Via G, Dean A, Tsung JW, Soldati G, Copetti R, Bouhemad B, Reissig A, Agrícola E, Rouby JJ, Arbelot C, Liteplo A, Sargsyan A, Silva F, Hoppmann R, Breikreutz R, Seibel A, Neri L, Storti E, Petrovic T, International Liaison Committee on Lung Ultrasound (ILC-LUS) for International Consensus Conference on Lung Ultrasound (ICC-LUS) (2012) International evidence-based recommendations for point-of-care lung ultrasound. *Intensive Care Med* 38(4):577–591
- Liu S, Elkayam U, Naqvi TZ (2016) Echocardiography in pregnancy: part 1. *Curr Cardiol Rep* 18(9):92
- Plowman RS, Javidan-Nejad C, Raptis CA, Katz DS, Mellnick VM, Bhalla S, Cornejo P, Menias CO (2017) Imaging of pregnancy-related vascular complications. *Radiographics* 37(4):1270–1289
- Acker LC, Jones RC, Rasouli MR, Bronshteyn YS (2019) Focused cardiac ultrasound during amniotic fluid embolism. *Anesthesiology* 130(6):1032–1033
- Maack KH, Munk K, Dahl K, Jørgensen HH, Christiansen A, Helmig RB (2018) Right heart masses demonstrated by echocardiography in a patient with amniotic fluid embolism during labour. *Acta Anaesthesiol Scand* 62(1):134–137
- Steinkeler J, Coldwell BJ, Warner MA (2012) Ultrasound of the postpartum uterus. *Ultrasound Q* 28(2):97–103
- Zhang YP, Kong WQ, Zhou SP, Gong YH, Zhou R (2016) Acute fatty liver of pregnancy: a retrospective analysis of 56 cases. *Chin Med J (Engl)* 129(10):1208–1214
- Perronne L, Dohan A, Bazeries P, Guerrache Y, Fohlen A, Rousset P, Aubé C, Laurent V, Morel O, Boudiaf M, Hoeffel C, Soyer P (2015) Hepatic involvement in HELLP syndrome: an update with emphasis on imaging features. *Abdom Imaging* 40(7):2839–2849
- Kronthal AJ, Fishman EK, Kuhlman JE, Bohlman ME (1990) Hepatic infarction in preeclampsia. *Radiology* 177(3):726–728
- Nunes JO, Turner MA, Fulcher AS (2005) Abdominal imaging features of HELLP syndrome: a 10-year retrospective review. *AJR Am J Roentgenol* 185(5):1205–1210
- De Gottardi A, Berzigotti A, Buscarini E, García Criado A (2018) Ultrasonography in liver vascular disease. *Ultraschall Med* 39(4):382–405
- Schutz K, Siffring PA, Forrest TS, Hill WC, Frick MP (1990) Serial renal sonographic changes in preeclampsia. *J Ultrasound Med* 9(7):415–418
- Costa A, Filipe JP, Santos R, Ferreira C, Abreu P, Azevedo E (2015) The role of transcranial Doppler ultrasonography in posterior reversible encephalopathy syndrome. *Cerebrovasc Dis* 39(suppl 1):1–52
- Chen SP, Fuh JL, Chang FC, Lirng JF, Shia BC, Wang SJ (2008) Transcranial color doppler study for reversible cerebral vasoconstriction syndromes. *Ann Neurol* 63(6):751–757
- Stolz EP (2008) Role of ultrasound in diagnosis and management of cerebral vein and sinus thrombosis. *Front Neurol Neurosci* 23:112–121
- Robba C, Goffi A, Geeraerts T, Cardim D, Via G, Czosnyka M, Park S, Sarwal A, Padayachy L, Rasulo F, Citerio G (2019) Brain ultrasonography: methodology, basic and advanced principles and clinical applications. A narrative review. *Intensive Care Med*. <https://doi.org/10.1007/s00134-019-05610-4>