Transthoracic Echocardiography in Obstetric Anesthesia

*Is it time we knew our patient’s hearts?*

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A pregnant patient suddenly collapses...

- Bleeding
- Embolism
- Anesthetic
- Uterine atony
- Cardiac disease
- Hypertensive/preeclampsia/eclampsia
- Other
- Placental abruption/previa
- Sepsis
ECHO TO THE RESCUE
ECHO TO THE RESCUE
ECHO TO THE RESCUE
What if you saw this?
OBJECTIVES

- Review the use of bedside TTE in obstetric anesthetic care
- Present case examples of clinical benefits
- Explore options for training and implementation of TTE in clinical practice
The not-so-hidden curriculum ...

…acquiring even *basic* echocardiographic skills can be *genuinely valuable* to *any* obstetric anesthesiologist on a regular basis…
Disclosure

- I have not received any financial or in-kind compensation for this presentation.
- I have no financial relationship with any of the entities in any way related to obstetric anesthesia or perioperative echocardiography.
Echocardiography in Acute Care Specialties

- Performed by non-cardiologists
- Point-of-care
- Driven by clinical question/context
- Focused

- Often qualitative
- Dynamic
- Conclusions inform care in real time
Transthoracic Echocardiography in Acute Care Specialties

- Emergency Medicine embraced point of care ultrasound in the late 90s
- Critical Care Medicine caught up in the last 5-8 years
- Anesthesiology (other than cardiac) is in the early stages
  - 75% of anesthesia residents in Canada and 36% of anesthesia residents in US get some form of teaching/training
  - 12% of anesthesiologists who teach residents have POC Echo skills

J Can Anesth 2017; 64:441
Adoption of Echocardiography in Anesthesia

- **BARRIERS**
- **CATALYSTS**

- We’re really good at hemodynamics
- OR is the last hold-out of the pulmonary artery catheter
- Technology and training
- POC ECHO may not be billable

- We like the immediate gratification
- Toys are cool
- Improved understanding of the hemodynamics
- “That resident can no longer upstage me”
OB anesthesia and transthoracic echo are a good fit

- OB anesthesiologist is a peripartum physician and birth unit intensivist
- Pregnant women are comfortable with US technology
- Left lateral tilt moves the heart closer to the chest wall
- Anatomic changes in pregnancy facilitate insonation of the heart
- Obtain information in real time – important in rapidly evolving situations
Cardiopulmonary reserve in pregnancy

Healthy non-pregnant patient
Healthy pregnancy
Preexisting cardiovascular disease
Preeclampsia
Hemorrhage
EDITOR'S CHOICE

Incidence and prevalence of pregnancy-related heart disease

Karen Sliwa  Michael Bohm


Published: 23 January 2014  Article history..-

Weeks gestation

- Pre-eclampsia
- Gestational hypertension
- Chronic hypertension
- Post-partum hypertension
TTE in OB anesthesia is a growing field

- Contributing **new knowledge** to understanding of normal maternal hemodynamics
- **Preeclampsia** – early changes, post-pregnancy changes
- **Peripartum cardiomyopathy**
- **Volume responsiveness**
- New ways of using echo to:
  - DIAGNOSE
  - MONITOR
  - GUIDE

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TTE in OB anesthesia is a growing field

- The literature examining TTE use in obstetrics has exploded in recent years
- Increasingly published in non-cardiology literature
Focused POC ECHO – current evidence

- Patient outcome studies in acute care are virtually non-existent
  

- Improved decision making
  
  Jones AE, Tayal VS, Sullivan DM, Kline JA. *Randomized, controlled trial of immediate versus delayed goal-directed ultra-sound to identify the cause of nontraumatic hypotension in emergency department patients*. Crit Care Med 2004;32:1703–8

- Pregnant women have traditionally been excluded from major research in echocardiography

- Studies in obstetric anesthesia suffer from small sample sizes

- POC studies necessary to capture the dynamic nature of peri-partum maternal hemodynamics

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“The use of transthoracic echocardiography as a research tool compliments its clinical application in pregnant women and may therefore be able to bridge the divide between experimental research work and clinical practice.”

Alicia T. Dennis
TTE IN OB ANESTHESIA - INDICATIONS

- OB specific
  - Guidelines: SOGC, ACOG, SOAP – cardiac disease, no recommendation for routine use in severe preeclampsia
  - Saving Mother's lives recommends echo for any OB patient with unexplained hypotension, dyspnea or orthopnea and edema.

- CURRENT GUIDELINES DO NOT ADDRESS THE EVOLVING CLINICAL PRACTICE
Recent reviews affirm the role of echocardiography in preeclampsia.

11

Preeclampsia in 2017: Obstetric and Anaesthesia Management

Ross Hofmeyr, MMed(Anaes), FCA(SA), Consultant Anaesthesiologist<sup>a</sup>,<sup>*</sup>, Mushi Matjila, PhD, FCOG(SA), Consultant Obstetrician<sup>b</sup>, Robert Dyer, PhD, FCA(SA), Professor & Second Chair<sup>a</sup>

<sup>a</sup>Department of Anaesthesia & Perioperative Medicine, University of Cape Town, South Africa
<sup>b</sup>Department of Obstetrics & Gynaecology, University of Cape Town, South Africa
"Anaesthesiologists should with point-of-care ultrasor subsequently refer the pat when indicated"
How do we do all this with TTE? MODALITIES USED

► 2D
  ► Outlines structures
  ► Shows movement
  ► Qualitative assessment ("eyeballing")
  ► Quantitative assessment (measuring)

► DOPPLER
  ► Shows movement of blood – color Doppler
  ► Velocity of flow (color – qualitative, wave Doppler – velocity/pressure gradients)
2D LV size and function, the pericardium
2D IVC size and collapsibility
Color Doppler – bicuspid aortic valve
2D quantitative analysis LVEF
LUNG US

SLIDING SIGN

B-lines
BASIC TTE WINDOWS

- 3 echocardiographic windows
  - Parasternal
  - Apical
  - Subcostal
BASIC TTE Views

- 3-6 views
  - PLAX
  - PSAX
  - Apical 4CH
  - Apical 5CH
  - Subcostal 4CH
  - Subcostal IVC

Echoanatomy  www.lifeharmony.me
FoCUS - POCUS

developed for non-cardiologists

FATE, FEEL, FAST, RUSH, BLEEP, HART, BLUE

None are OB specific

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What about OB anesthesia?

The ROSE scan

- Rapid
- Obstetric
- Screening
- Echocardiography

- Developed by Dr. Alicia Dennis of ANZCA

Dennis AT *Transthoracic echocardiography in women with treated severe pre-eclampsia* Anaesthesia 2014, 69, 436

Assessing heart function of critically ill pregnant women

Developed by a Women’s anaesthetist, Clinical Associate Professor, Dr Alicia Dennis, the ROSE Scan lets doctors, for the first time, instantly see the inner workings of heart function in pregnant women without invasive high-risk monitoring.
ROSE Scan

- 2 echocardiographic windows
  - Parasternal
  - Apical
ROSE Scan

- 4 views
  - PLAX
  - PSAX
  - Apical 4CH
  - Apical 5CH

Echoanatomy  www.lifeharmony.me
ROSE Scan

- A systematic examination for causes of hemodynamic compromise that are **common** and **OB specific**
  - Differentiate between causes of shock/hypotension in OB population
  - Identify preeclamptic patients who are at risk of HFrEF

- The ROSE exam includes more **advanced** elements of echocardiography
  - ventricular regional wall motion function
  - valve function
  - diastolic function
### Table 2. The Rapid Obstetric Screening Echocardiography Scan

<table>
<thead>
<tr>
<th>Transthoracic Images</th>
<th>Modality</th>
<th>Measurements</th>
<th>Structure</th>
<th>Size and Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasternal long axis</td>
<td>20 video, M-mode</td>
<td>Left ventricular outflow tract diameter, left atrial diameter, aortic root diameter, fractional shortening, left ventricular end-diastolic diameter, heart rate and rhythm</td>
<td>Presence of a pericardial effusion, presence of an intracardiac mass, aortic dissection</td>
<td>Left ventricular size and systolic function</td>
</tr>
<tr>
<td>Parasternal short axis</td>
<td>20 video, M-mode</td>
<td>Fractional area change, movement of the interventricular septum, fractional shortening, left ventricular end-diastolic diameter, left ventricular end-diastolic diameter</td>
<td>Presence of regional wall motion abnormalities, presence of a pericardial effusion, presence of an intracardiac mass, position of the interventricular septum</td>
<td>Left ventricular size and systolic function</td>
</tr>
<tr>
<td>Apical 4-chamber</td>
<td>20 video, pulse wave Doppler, septal tissue Doppler</td>
<td>Left atrial volume, mitral valve E velocity, mitral valve A velocity, mitral valve deceleration time, mitral valve A wave duration, septal s' velocity, septal e' velocity, septal a' velocity, isovolumetric relaxation time, mitral valve E/septal e' ratio</td>
<td>Presence of increased right ventricular size compared with left ventricular size, presence of regional wall motion abnormalities, presence of a pericardial effusion, presence of an intracardiac mass, position of interventricular septum, position of interatrial septum</td>
<td>Left ventricular diastolic function, Left ventricular size and systolic function, right ventricular size and function</td>
</tr>
<tr>
<td>Apical 5-chamber</td>
<td>Pulse wave Doppler</td>
<td>Left ventricular outflow tract velocity time integral, cardiac output</td>
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</tbody>
</table>
EDITORIAL

Adding diagnostic power to the physical exam: can employing focused cardiac ultrasound lead to improved obstetric outcomes?

J.T. Sullivan

Department of Anesthesiology, St. Clair Hospital
Pittsburgh, PA, USA
TTE - Assessment of volume status

- PRELOAD
  - LV filling (LV end diastolic volume)
  - RA pressure (IVC diameter and collapsibility index)

- Response to volume augmentation
  - Change in stroke volume after fluid bolus or leg raise
IVC diameter and collapsibility RA pressure = VENOUS RETURN

<2 cm, >50% collapse = RAP 3mmHg

>2cm, <50% collapse = RAP 15 mmHg

In between = RAP 8mmHg

J Am Soc Echocardiogr 2010;23:685
ASE GUIDELINES for echocardiographic assessment of the right heart

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Changes in the size of maternal inferior vena cava during pregnancy:

- Enlarges early (4-7 W)
- Contracts until 16 W
- After 16 W which it doesn’t change in supine position
- Ongoing enlargement in left decubitus

Left Lateral Table Tilt for Elective Cesarean Delivery under Spinal Anesthesia Has No Effect on Neonatal Acid–Base Status: A Randomized Controlled Trial

Prediction of post-spinal hypotension


Zieleskiewicz L¹, Noel A¹, Duclos G¹, Haddam M¹, Delmas A¹, Bechis C¹, Loundou A², Blanc J³, Mignon A¹, Bouvet L⁴, Einav S⁵, Bourgoin A¹, Leone M¹,⁶.

- Change in LVOT velocity time index (VTI) pre and post PLR
- ≤ 8% predicted hemodynamic stability
- ≥ 21%, predictive for hypotension
Fluid responsiveness in OB anesthesia

Clément Brun
Laurent Zieleśkiewicz
Julien Textoris
Laurent Muller

Prediction of fluid responsiveness in severe preeclamptic patients with oliguria

- PLR dVTI >12 % accurately predicts fluid responsiveness
- IVC CI had no predictive value
- only 52 % of patients with severe preeclampsia who develop oliguria responded to fluid challenge

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Twins, treated preeclampsia, urgent C section

27 y, mono-di twins (A breech/IUGR) with preeclampsia diagnosed at 28 weeks. Now 32 weeks with diastolic flow reversal for semi urgent CS.

Rx: Adalat XL 60mg PO QD
    Labetalol 300 mg PO TID

NPO for >8h

BP 150/96, HR 82 NSR, diffuse peripheral edema

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Twins, treated preeclampsia, urgent C section

CONCERNS:

IS SHE AT RISK OF SIGNIFICANT POST SPINAL HYPOTENSION?

What is her intravascular volume status?
Systemic adrenergic and calcium channel blockade
Twins – exaggerated aorto-caval compression
No change at the site of collapsibility but a significantly smaller IVC when supine

LUD IVCd 1.2 cm, CI 50%

SUPINE IVC d 1.3 cm, CI 50%
LVOT velocity time index
\[ \text{pre} = 24 \text{ cm} \]
LVOT VTI post leg raise = 28 cm

dVTI = 28-24/28 x 100

dVTI = 14%
<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
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<tbody>
<tr>
<td>Dipivacaine hyperbaric (mg)</td>
<td>12 mg</td>
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<tr>
<td>ceFAZolin (mg) (IV)</td>
<td>2000 mg</td>
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<tr>
<td>ePHEDrine (mg) (IV)</td>
<td>25 mg</td>
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<tr>
<td>fantaNYL 6P (mg) (SAB)</td>
<td>1.5 mg</td>
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<tr>
<td>glycopyrrolate (mg) (IV)</td>
<td>0.4 mg</td>
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<tr>
<td>meclomipramide (mg) (IV)</td>
<td>10 mg</td>
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<tr>
<td>morphine BP (mg) (SAB)</td>
<td>0.15 mg</td>
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<tr>
<td>mephenytoin (mg) (IV)</td>
<td>30 mg</td>
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<tr>
<td>oxytocin (unit) (IV)</td>
<td>2 unit</td>
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<tr>
<td>OXYTOCIN INF (unit/hr) (IV)</td>
<td>30.2 unit</td>
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<tr>
<td>PHENYLEPHRIHE INF (mcg/min) (IV)</td>
<td>1500 ml</td>
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<tr>
<td>Ringers Lactate (ml) (IV)</td>
<td>1000 ml</td>
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<tr>
<td>Estimated Blood Loss (ml) (OR)</td>
<td>15 ml</td>
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### EVENTS

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<thead>
<tr>
<th>Event</th>
<th>1</th>
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<tbody>
<tr>
<td>NIBP Sys (mm Hg) (DAS3:5)</td>
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<td>NIBP Dias (mm Hg) (DAS3:5)</td>
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<tr>
<td>NIBP Mean (mm Hg) (DAS3:5)</td>
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<td>Heart Rate (bpm) (DAS3:5)</td>
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<tr>
<td>SpO2 (%) (DAS3:5)</td>
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<tr>
<td>SpO2 Pulse (bpm) (DAS3:5)</td>
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</table>

**Physiological Graph**

- Physiological Graph
- NIBP Sys (mm Hg) (DAS3:5)
- NIBP Dias (mm Hg) (DAS3:5)
- NIBP Mean (mm Hg) (DAS3:5)
- Heart Rate (bpm) (DAS3:5)
- SpO2 (%) (DAS3:5)
- SpO2 Pulse (bpm) (DAS3:5)
Post C/S, preeclampsia, pulmonary edema and oliguria despite diuresis

24 year old with preeclampsia post CS day 1, pulmonary edema. Low urine output, without response to 1st dose of furosemide.

BP 147/95, HR 88, RR 26, SaO2 93% on 2L O2 by NP

Should we persist with diuresis?
Post C/S, preeclampsia, pulmonary edema and oliguria despite diuresis.

What is the hemodynamic profile contributing to pulmonary edema and oliguria?

- Decreased LV systolic function

- HFpEF (diastolic dysfunction) with high LV filling pressures but low intravascular volume

- Normal LV function with high intravascular volume and acute renal failure
RVSP 50mmHg (normal<35)
LVEF 45-50%
Preeclampsia, oliguria and pulmonary edema

**Hemodynamic profile:**
- Total intravascular volume was low/normal
- Mildly reduced LV systolic function + moderate diastolic dysfunction
- Elevated LA pressures
- High systemic vascular resistance

**Management?**
Afterload reduction (amlodipine)
Further Lasix was held
She started to diurese within a few hours.
Hypertension

BRIEF REVIEW

Should Maternal Hemodynamics Guide Antihypertensive Therapy in Preeclampsia?

Kelsey McLaughlin, Ralph R. Scholten, John C. Kingdom, John S. Floras, John D. Parker

Hypertension. 2018;71:550-556
Originally published February 5, 2018
Proof of concept is there, however ...

- **Is this normal?** - many measurements not yet validated in pregnancy

- Full scope of TTE capabilities is not available to those with limited expertise
  - POCUS/FoCUS require relatively basic skill level
  - Advanced skills required for diastology, valvular lesions, myocardial ischemia
Perioperative Echocardiography Training and Certification

TRAINING

- Commercial online courses for FoCUS
- CanPOCUS – guidelines, training, certification for EM/FM
- Fellowship opportunities
- Conference workshops + self guided

- No current formal training/credentialing requirement
- ACC/AHA and CCS/CSE - Level 1 expertise may be attainable by the average anesthesiologist

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2010 CCS/CSE Guidelines for Training and Maintenance of Competency in Adult Echocardiography

CCS/CSE
Level 1 Echocardiographer

- An introductory level of training
- The training for **LIMITED echocardiographic examination**
  - Must be supervised by trained sonographer or Level 3 expert
  - 4W duration
  - Min **40** exams performed/interpreted, **90** reviewed

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EnABLE Course
Echocardiography for Anesthesiologists Blended Learning Course

- IWK W&O group planned and developed
- Basic Echocardiography with advanced primer
- Online learning and hands on workshops
- Emphasis on regular practice
- Longitudinal local expert support

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Conclusion

- Further research is needed
- TTE is the advanced modality of choice
- Technology is more portable and accessible
- There are several training options
- Find an ENTHUSIASTIC local expert

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Conclusion

We should OWN maternal hemodynamics
Questions?

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