AT THE FOREFRONT OF KIDS MEDICINE
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Practical and Novel Neonatal Point of Care Ultrasound

Alex Gall, MD

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Disclosure

- I have no financial relationships to disclose or conflicts of interest to resolve

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Point-of-Care Ultrasound (POCUS)

- Performed by the bedside provider
- Answers focused, often critical clinical questions
- Leads to immediate intervention
- Real-time and serial assessments
- Medication/therapy titration
- Procedural assistance

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Benefits

- No radiation
- Does not require sedation
- Less expensive than MRI / CT
- Portable and readily available
- Suited for resource/provider limited settings

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POCUS Training Programs

EDUCATION

CREDENTIALING

CLINICAL PRACTICE

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2020 ESPNIC POCUS Guidelines

Singh et al. Critical Care (2020) 24:65
https://doi.org/10.1186/s13054-020-2787-9

Critical Care

RESEARCH Open Access

International evidence-based guidelines on Point of Care Ultrasound (POCUS) for critically ill neonates and children issued by the POCUS Working Group of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC)

Yogen Singh[1,2*], Cecile Tissot[3], Maria V. Fraga[4], Nadya Yousef[5], Rafael Gonzalez Cortes[6], Jorge Lopez[7], Joan Sanchez-de-Toledo[7], Joe Brierley[8], Juan Mayordomo Colunga[9], Dusan Rafay[10], Eduardo Da Cruz[11], Philippe Durand[12], Peter Kenderessy[13], Hans-Joerg Lang[14], Akira Nishisaki[15], Martin C. Kneyber[16], Pierre Tissieres[17], Thomas W. Conlon[1,2] and Daniele De Luca[2,17]

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Singh. Crit Care. 2020

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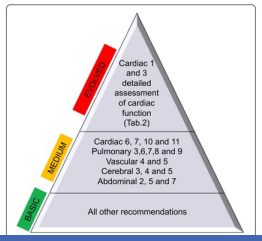
2020 ESPNIC POCUS Guidelines



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PROCEDURAL APPLICATIONS

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Procedural Applications

- Vascular Access
- Fluid drainage
- Lumbar puncture
- Endotracheal intubation

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Journal of Perinatology (2013) 33, 791–794
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www.nature.com/jp

ORIGINAL ARTICLE

A randomized controlled trial of ultrasound-guided peripherally inserted central catheters compared with standard radiograph in neonates

AC Katheria, SE Flem

Table 2. Results of PICC placement using ultrasound guidance compared with standard placement in 49 neonates

	Ultrasound group	*Standard group*	*P-value*
Total time for PICC placement with radiograph (minutes)	69 ± 49	99 ± 49	0.034
Time from PICC securement to radiograph read	41 ± 20	34 ± 16	0.219
Number of radiograph (interquartile range)	1 (1–1)	2 (1–2)	<0.001
Infants with additional radiograph (%)	4 (2) two not done after manipulation	16 (68)	<0.001
Number of manipulations (interquartile range)	0 (0–1)	1 (1–2)	0.032
Infants with additional manipulation (%)	6 (30)	19 (68)	0.01
Number of attempts (interquartile range)	2 (1–3)	2 (1–3)	0.676

Abbreviation: PICC, peripherally inserted central catheter.

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European Journal of Pediatrics (2022) 181:2097–2108
https://doi.org/10.1007/s00431-022-04412-z

ORIGINAL ARTICLE

Point-of-care ultrasound for neonatal central catheter positioning: impact on X-rays and line tip position accuracy

Serena Rossi[1] · K. Haran Jogeesvaran[2] · Eugen Matu[1] · Hammad Khan[1] · Elisabetta Grande[3] · Virginie Meau-Petit[1]

Received: 15 December 2021 / Revised: 3 February 2022 / Accepted: 6 February 2022 / Published online: 12 February 2022

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Table 3 Demographics, number of X-rays, position accuracy and inter-rater agreement among whole population, US and no-US groups and sub-groups

	All lines 274 lines		*p* value	nPICC 142 lines		*p* value	UVC 92 lines		*p* value
	US 83 lines (30.3%)	No-US 191 lines (69.7%)		US 43 lines (30.3%)	No-US 99 lines (69.7%)		US 38 lines (41.3%)	No-US 54 lines (58.7%)	
Number of X-rays mean (95% CI), median	1.19 (1.07–1.32), 1	1.5 (1.40–1.61), 1	0.001	1.26 (1.06–1.45), 1	1.88 (1.51–1.84), 2	0.001	1.11 (0.94–1.27), 1	1.44 (1.27–1.62), 1	0.02
Number of X-rays for each line			0.004			0.01			0.03
0 X-ray	2 (2.4%)	0					2 (5.3%)	0	
1 X-ray	67 (80.7%)	117 (61.3%)		35 (81.4%)	49 (49.5%)		31 (81.6%)	34 (63%)	
2 X-rays	11 (13.3%)	56 (29.3%)		6 (14%)	37 (37.4%)		4 (10.5%)	16 (29.6%)	
3 X-rays	2 (2.4%)	15 (7.9%)		1 (2.3%)	10 (10.1%)		1 (2.6%)	4 (7.4%)	
4 X-rays	1 (1.2%)	2 (1%)		1 (2.3%)	2 (2%)		0	0	
5 X-rays	0	1 (0.5%)		0	1 (1%)		0	0	
Agreement on position (Cohen's kappa)	0.80			0.80			0.80		
Line position X-ray			0.05			0.003			0.35
Good	69.2% (54)	52.1% (98)		79.1% (34)	45.5% (45)		55.9% (19)	46.4% (21)	
Satisfactory	7.7% (6)	17% (32)		11.7% (5)	28.3% (28)		2.9% (1)	5.8% (3)	
Bad	23.1% (18)	30.9% (58)		9.2% (4)	26.2% (26)		41.2% (14)	53.8% (28)	

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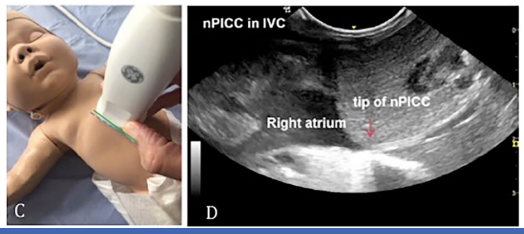
Lower Extremity PICC



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Rossi. Eur J Pediatr. 2022 13

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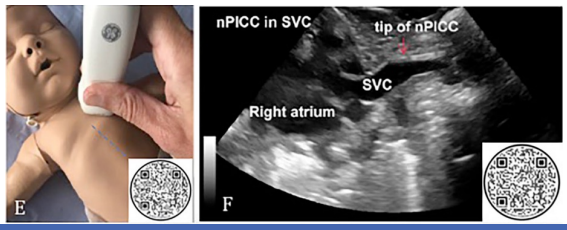
Upper Extremity PICC



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Pediatric Anesthesiology

Section Editor: **James A. DiNardo**

"Modified Dynamic Needle Tip Positioning" Short-Axis, Out-of-Plane, Ultrasound-Guided Radial Artery Cannulation in Neonates: A Randomized Controlled Trial

Lifei Liu, MD,*† Yanzhe Tan, MD,*‡ Shangyingying Li, MD,*§ and Jie Tian, MD‖

Table 2. Cannulation Time, First-Attempt Success Rate, Total Success Rate, and Complications

Parameter	Ultrasound Group (N = 30)	Palpation Group (N = 30)	Relative Risk	95% CI	P
Cannulation time (s)	91.4 ± 55.4	284.7 ± 153.6	—	−256 to −130	<.001[a]
First-attempt success rate	12 (40)	3 (10)	4.0	1.3–12.8	.007[b]
Total success rate	29 (96.7)	18 (60.0)	1.61	1.19–2.17	.001[b]
Hematoma	1 (3.3)	8 (26.7)	0.13	0.02–0.94	.026[c]
Thrombosis	0	0	—	—	—

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Liu. Anesth Analg. 2019 15

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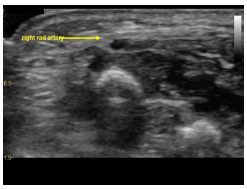
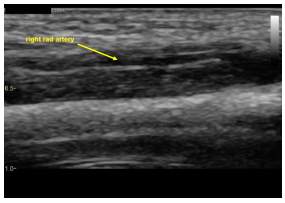
Arterial Access





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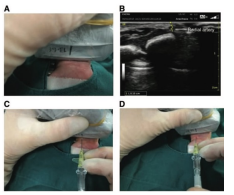
Vascular Access



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Liu. Anesth Analg. 2019.; Fraga. Pediatrics. 2019 17

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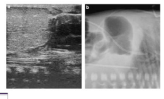
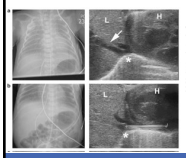
ORIGINAL ARTICLE

Ultrasound-guided umbilical catheter insertion in neonates

SR Fleming and JH Kim

Division of Neonatology, UCSD Medical Center, San Diego, CA, USA





Resuscitation

Clinical Paper

Comparison of ultrasound and X-ray in determining the position of umbilical venous catheters

Optimal radiologic position of an umbilical venous catheter tip as determined by echocardiography in very low birth weight newborns

UChicago Medicine Comer Children's

Fleming. J Perinatol. 2011.; Michel. Resuscitation. 2012.; Karber. J Neonatal Perinatal Med. 2017 18

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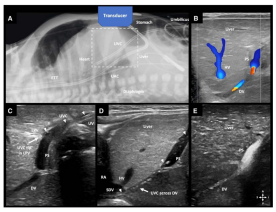
Real-Time US Guidance for Umbilical Venous Cannulation in Neonates with CHD



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Kozyak. Pediatr Crit Care Med. 2022 19

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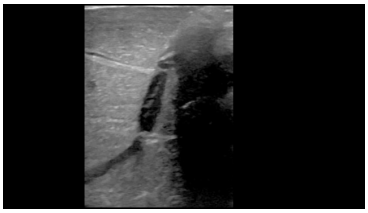
Real-Time US Guidance for Umbilical Venous Cannulation in Neonates with CHD



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Real-Time US Guidance for Umbilical Venous Cannulation in Neonates with CHD

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Kozyak. Pediatr Crit Care Med. 2022 21

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Rubortone *et al. Italian Journal of Pediatrics* (2021) 47:68
https://doi.org/10.1186/s13052-021-01014-7

Italian Journal of Pediatrics

RESEARCH Open Access

Real-time ultrasound for tip location of umbilical venous catheter in neonates: a pre/post intervention study

Serena Antonia Rubortone[1*], Simonetta Costa[1], Alessandro Perri[1], Vito D'Andrea[1], Giovanni Vento[1] and Giovanni Barone[2]

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Table 3 Primary and secondary outcomes. Data are shown as number (%) or median (interquartile range), mean (standard deviation)

	Pre-Intervention Phase N = 26	Post-Intervention Phase N = 28	P
Real-time US	4 (15.3)	25 (89.2)	< 0.0001
Chest X-Ray	24 (92.3)	9 (32.1)	< 0.0001
Time to visualize UVC tip (h)	2 [1–3]	0 [0–1]	0.0012
N of manipulations first 24 h	11 (42.3)	5 (17.8)	0.0740
UVC in a good position	8 (30.7)	21 (75.0)	0.0023
Double lumen UVC	21 (80.7)	21 (75.0)	0.7471
Size 3.5–4 Fr	18 (69.2)	16 (57.1)	0.4082
Size 5 Fr	8 (30.8)	12 (42.9)	0.4082
UVC dwell time (days)	4.7 (2.7)	5.4 (2.5)	0.3306
Sepsis	2 (7.7)	0	0.2271
Elective UVC removal	19 (73.1)	24 (85.7)	0.3198
Catheter-related complications	2 (7.7)	0	0.2271
Antibiotic therapy	20 (76.9)	20 (71.4)	0.3187

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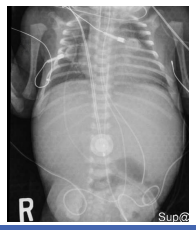
Patient Case



- 37wga with HIE undergoing cooling
- Routine f/u XR 24 hours after placement
- Is the UVC deep?

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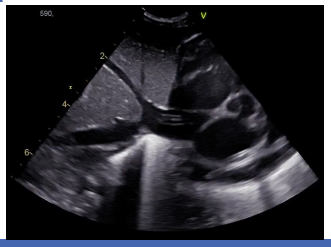
UVC in RA



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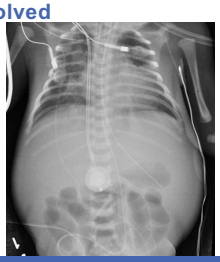
Deep UVC Resolved



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DIAGNOSTIC APPLICATIONS

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Diagnostic Applications

- Lung
- Cardiac
- Abdominal
- Cranial
- Central-line position
- Emergent multiorgan assessment

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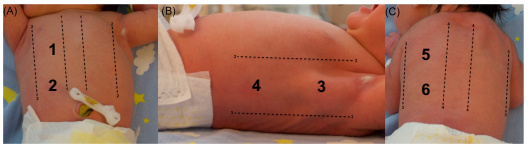
Lung Ultrasound



(A) Anterior region: from parasternal to anterior axillary line

(B) Lateral region: from anterior to posterior axillary line

(C) Posterior region: from posterior axillary to paravertebral line

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Corsini. Pediatr Pulmonol. 2020

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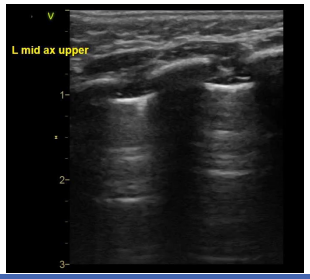
Lung US Artifacts

- Rib shadowing
- Pleural Line/Lung sliding
- A-lines



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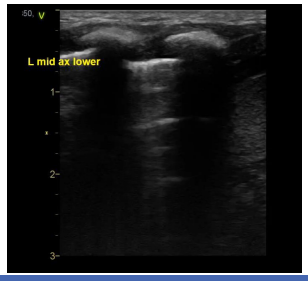
Lung US Artifacts

- Rib shadowing
- Pleural Line/Lung sliding
- A-lines
- **B-lines**



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Patient Case

- 37wga IUGR infant
- Delivered via emergent c/s NRFHT
- Vigorous at delivery with DCC
- Apgar 8 and 9
- NICU called back for grunting
- Is there a pneumothorax?

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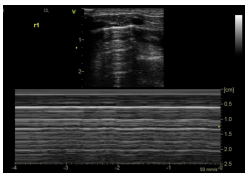
Pneumothorax



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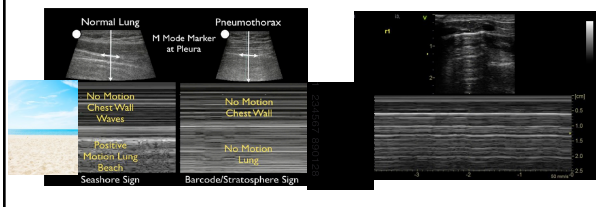
Pneumothorax



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Lobo et al. Crit Care Clin 2014;30:93-117.

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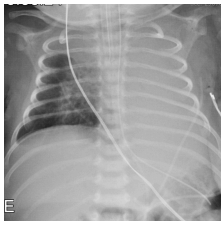
Patient Case

- 2 week old, 36 wga infant with apnea and hypotonia
- Undergoing neurologic evaluation
- Increased FiO2 requirement
- Atelectasis vs pleural effusion?



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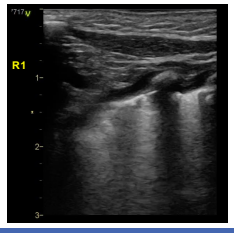
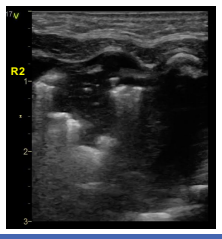
Atelectasis





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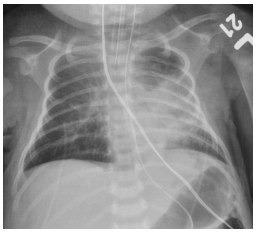
Improving Atelectasis



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Cardiac POCUS

- DX pericardial effusion and guide pericardiocentesis
- Check position of UVC and PICC/ECC lines
- Assess cardiac filling and fluid status
- Qualitative assessment of cardiac function
- Recognize cardiac asymmetry
- Check patency of ductus arteriosus

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Singh. Eur J Pediatr. 2021 38

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European Journal of Pediatrics (2021) 180:3565–3575
https://doi.org/10.1007/s00431-021-04153-5

ORIGINAL ARTICLE

The evolution of cardiac point of care ultrasound for the neonatologist

Yogen Singh [1,2] · Shazia Bhombal [3] · Anup K

Received: 18 February 2021 / Revised: 6 June 2021 / Accepte
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GUIDELINES AND STANDARDS

Recommendations for Cardiac Point-of-Care Ultrasound in Children: A Report from the American Society of Echocardiography*

Jimmy C. Lu, MD, FASE, Alan Riley, MD, FASE, Thomas Conlon, MD, Jami C. Levine, MD, Charisse Kwan, MD, Wanda C. Miller-Hance, MD, FASE, Neha Soni-Patel, MEd, RCCS, RDCS, FASE, and Timothy Slesnick, MD, FASE, *Ann Arbor, Michigan; Houston, Texas; Philadelphia, Pennsylvania; Boston, Massachusetts; London, Ontario, Canada; Cleveland, Ohio; and Atlanta, Georgia*

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Singh. Eur J Pediatr. 2021.; Lu. J Am Soc Echocardiogr. 2023 39

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European Journal of Pediatrics (2023) 182:53–66
https://doi.org/10.1007/s00431-022-04636-z

ORIGINAL ARTICLE

Point-of-care ultrasound (POCUS) protocol for systematic assessment of the crashing neonate—expert consensus statement of the international crashing neonate working group

Yasser Elsayed[1] · Muzafar Gani Abdul Wahab[2] · Adel Mohamed[3] · Nadya Ben Fadel[4] · Shazia Bhombal[5] · Nadya Yousef[6] · María V. Fraga[7] · Jehier Afifi[8] · Pradeep Suryawanshi[9] · Abbas Hyderi[10] · Anup Katheria[11] · Martin Kluckow[12] · Daniele De Luca[2,13] · Yogen Singh[14,15]

Received: 20 April 2022 / Revised: 8 July 2022 / Accepted: 22 September 2022 / Published online: 14 October 2022

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Emergent Neonatal POCUS Applications

- Unresponsive to NRP
- Acute hypoxemic respiratory failure
- Circulatory shock / poor perfusion
- Acute anemia and suspicion for acute bleeding

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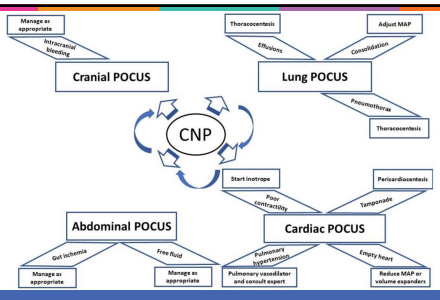

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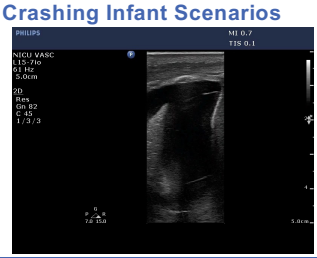
Crashing Infant Scenarios



- Late preterm infant with hydrops fetalis not responding to NRP

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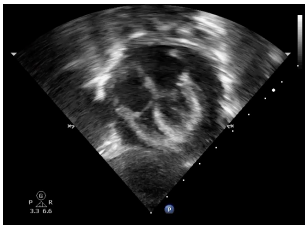
Crashing Infant Scenarios



- Preterm infant 25wks GA, with acute hypotension

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