RABIN MEDICAL CENTER
BEILINSON • HASHARON

TEL AVIV UNIVERSITY

APPROACH TO THE ICCU PATIENT WITH PULMONARY HYPERTENSION

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Indication for admission of PHT patients

- Right heart failure (RHF)
- Respiratory failure from causes other than RHF
- Sepsis, GI bleeding
- Arrhythmia and/or syncope
- Postoperative monitoring – cardiac and noncardiac surgery
- Post delivery – natural or cesarean section
- Rebound phenomenon due to intentional cessation of therapy or infusion-pump failure

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ELSEVIER

Journal of Critical Care

Prognostic factors and outcomes of patients with pulmonary hypertension admitted to the intensive care unit☆,☆☆

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Table 1 Baseline characteristics of patients with PH requiring ICU admission

Sex (female/male)	64/35
Age, y, mean (SD)	51.9 (13.6)
Type of PH (n)	
Dana Point Group 1 (PAH)	72
Idiopathic PH	30
Associated with connective tissue disease	20
Drug/toxin induced	5
Portopulmonary	10
Associated with HIV	3
Associated with congenital heart disease	4
Dana Point Group 3 (due to lung disease/ hypoxia)	27
Idiopathic pulmonary fibrosis	10
Obesity hypoventilation syndrome/ obstructive sleep apnea	5
Bronchiolitis obliterans after lung transplant	3
Chronic obstructive pulmonary disease	2
Sarcoidosis	2
Other (pulmonary alveolar proteinosis, recurrent pneumonia, radiation-induced interstitial lung disease, postpneumonectomy syndrome, bronchiectasis)	5

Table 2 Bivariate baseline characteristics association with mortality

Variable	6-mo mortality		ICU mortality	
	OR (95% CI)	*P*	OR (95% CI)	*P*
APACHE II (per point)	1.19 (1.10-1.29)	<.0001	1.21 (1.11-1.31)	<.0001
Reason for admission [a]				
Respiratory failure not due to RHF	3.73 (1.33-10.5)	.01	5.09 (1.71-15.1)	.003
Sepsis	7.20 (1.30-39.8)	.02	14.0 (2.42-80.9)	.003
Female sex	0.34 (0.14-0.80)	.013	0.33 (0.14-0.81)	.015
BNP >1000 (n = 80)	2.81 (0.98-8.10)	.054	2.44 (1.01-5.87)	.046
Dana Point Group 3 vs Group 1	2.35 (0.95-5.78)	.063	2.40 (0.95-6.07)	.064
Age (per year)	1.03 (0.99-1.06)	.091	1.02 (0.98-1.05)	.23
On prior prostacyclin	1.96 (0.83-4.63)	.12	1.75 (0.71-4.32)	.22
Most recent right ventricular systolic pressure on echocardiogram (per point)	0.99 (0.97-1.00)	.17	0.99 (0.97-1.01)	.20
Time since PH diagnosed ≤3 months	1.55 (0.67-3.62)	.31	3.33 (1.29-8.59)	.013

[a] Reference group, patients admitted for RHF.

APACHE II ("Acute Physiology and Chronic Health Evaluation II")

- severity-of-disease classification system (Knaus et al., 1985), one of several ICU scoring systems.
- It is applied within 24 hours of admission of a patient to an intensive care unit (ICU)
- An integer score from 0 to 71 is computed based on several measurements; higher scores correspond to more severe disease and a higher risk of death.

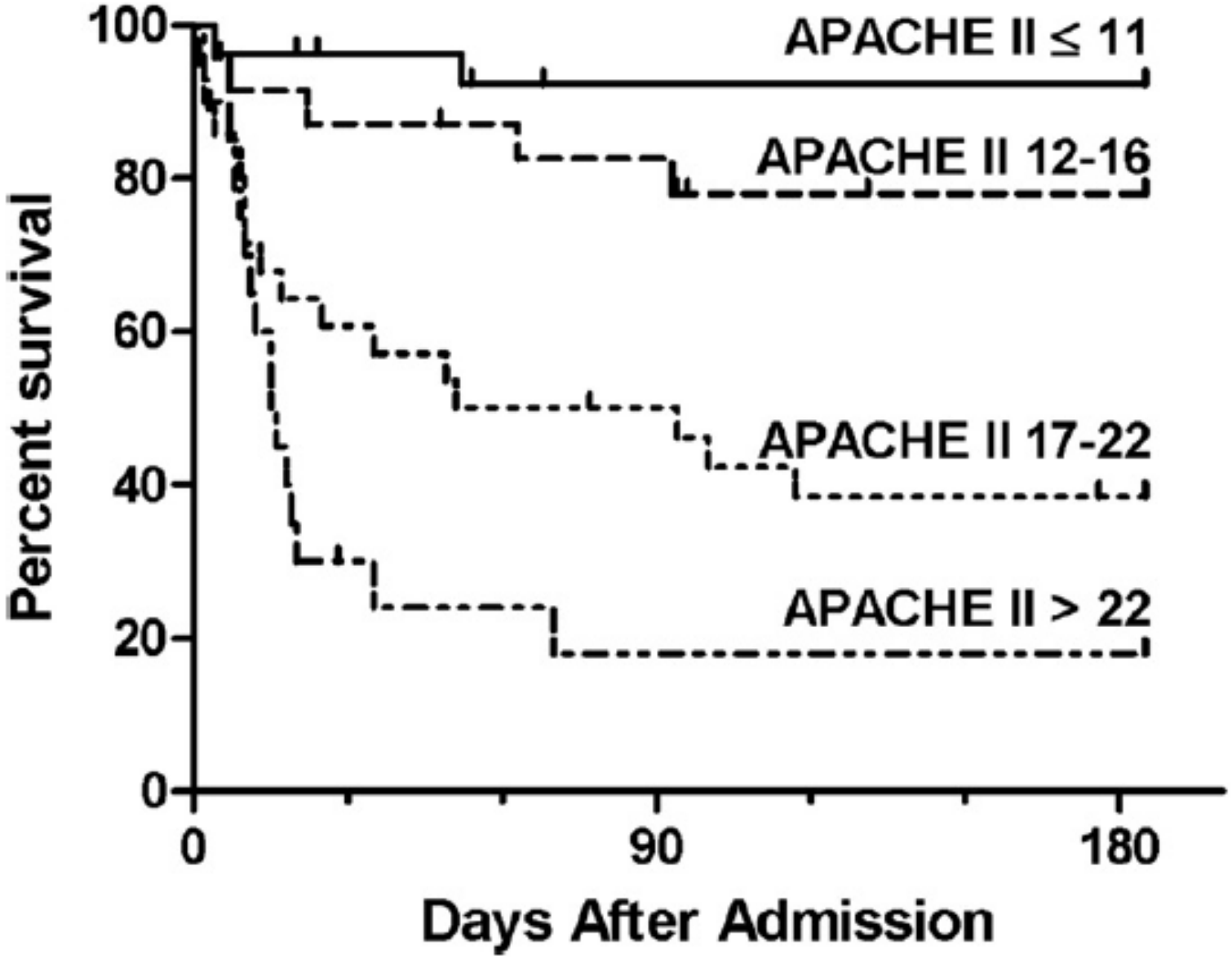


Fig. 1 Mortality by APACHE II quartiles.

Table 4 Bivariate association of individual ICU interventions with mortality

Intervention	6-mo mortality		ICU mortality	
	OR (95% CI)	*P*	OR (95% CI)	*P*
Dialysis	13.80 (3.68-51.64)	<.0001	9.19 (3.05-27.67)	<.0001
Vasopressors	4.58 (1.94-10.84)	.001	8.05 (2.98-21.73)	<.0001
Mechanical ventilation	9.25 (3.56-24.08)	<.0001	23.6 (7.72-72.17)	<.0001
NO	2.43 (1.04-5.66)	.039	3.01 (1.23-7.32)	.015
PAC within 3 d	0.41 (0.18-0.94)	.035	0.59 (0.24-1.44)	.25
Newly initiated on prostacyclin	0.62 (0.23-1.70)	.35	0.44 (0.13-1.42)	.17
New PH medication Initiated	0.63 (0.27-1.43)	.27	0.91 (0.38-2.18)	.83

Results

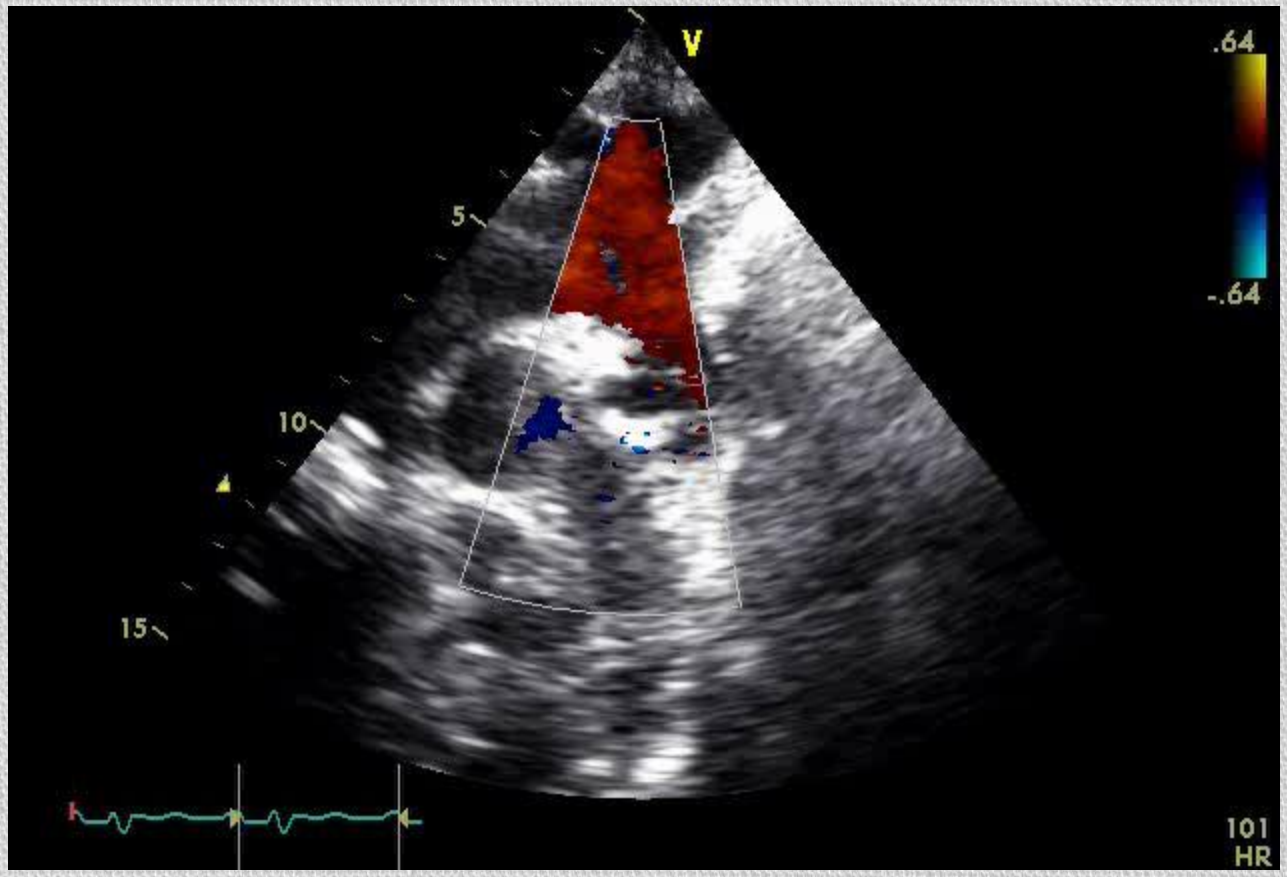
- 30% ICU mortality, 40% six months mortality
- Worst outcome – renal impairment, hemodialysis
- Mechanical ventilation
- CPR – 100% mortality
- Previous prostacycline (marker of severity)
- Early invasive hemodynamic monitoring resulting in change of treatment – regarding diuretics or PHT treatment, might be helpful on the long run (improving 6 mths but not ICU survival).

Subsets of patients likely to present to the ICCU with PHT

- End stage heart failure – biventricular failure
- Severe mitral stenosis (rare but still seen occasionally)
- Mitral regurgitation including para-valvular leak
- Aortic stenosis (regurgitation)
- Acute pulmonary embolism
- Syncope
- Fontan (clot, positive pressure ventilation) - no PHT but reduced pulmonary perfusion
- Previously undiagnosed idiopathic pulmonary hypertension, congenital heart disease, HIV-AIDS etc.

Icu may be the first encounter with PHT patient

- Absolutely essential to r/o secondary pulmonary hypertension
- CTEPH – chronic thromboembolic pulmonary hypertension
- Congenital heart disease – PDA – differential cyanosis
- Sinus venosus defects and anomalous pulmonary veins
- Repaired or rare native anomalies with aorto pulmonary collaterals etc. – continuous murmurs r/o hypertensive lung
- History of congenital heart surgery
- Drug exposure – anorexigens
- Myeloproliferative disorders
- HIV - AIDS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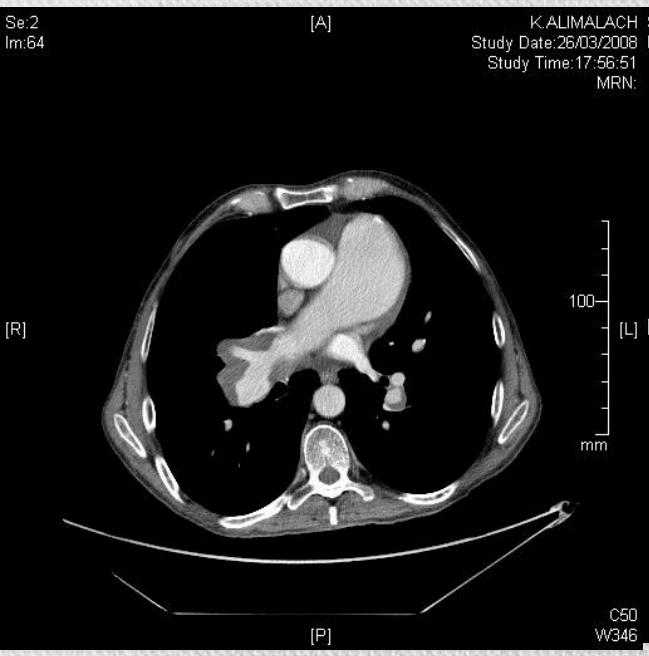
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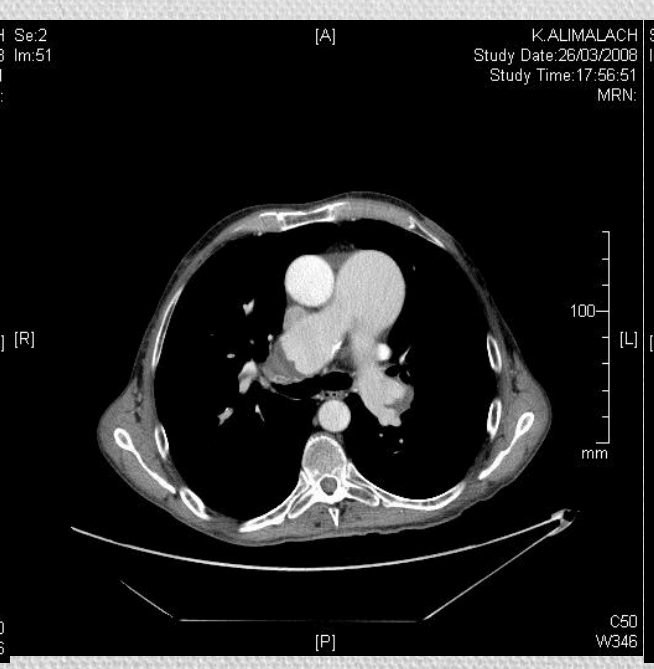
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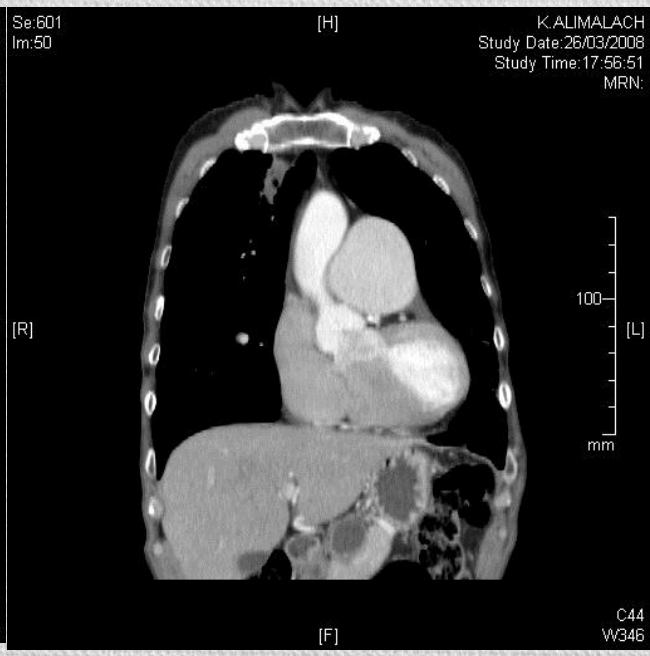
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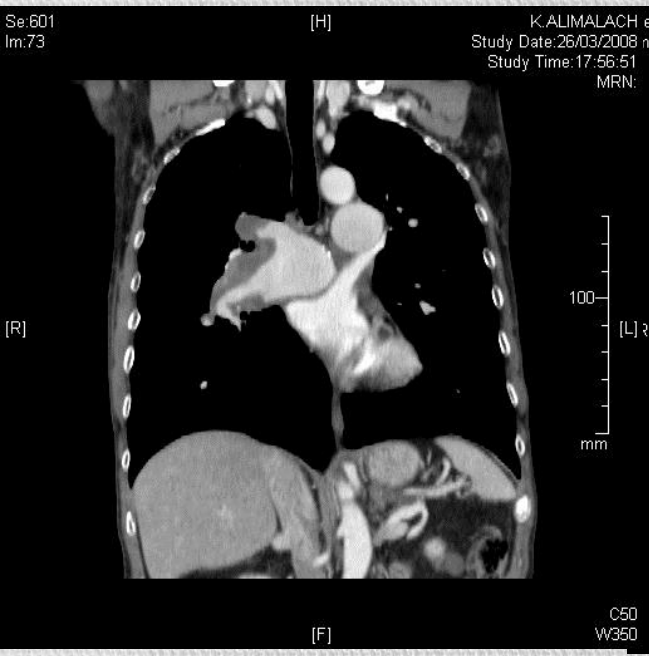
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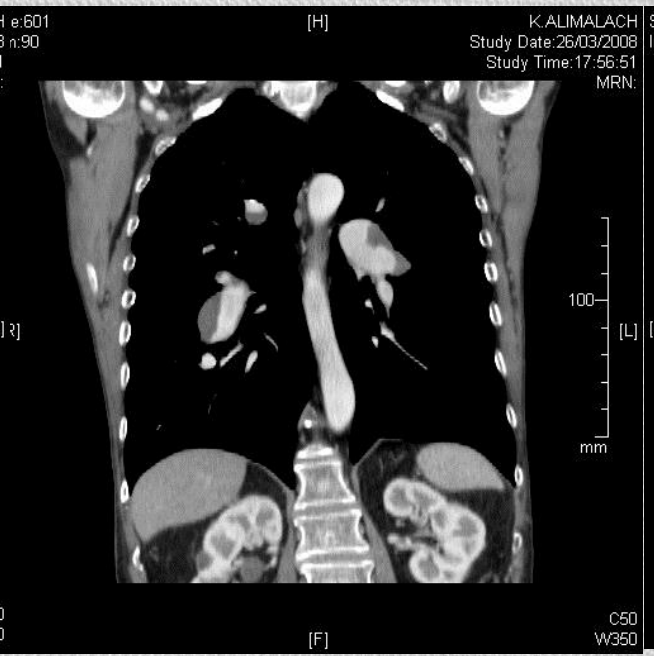
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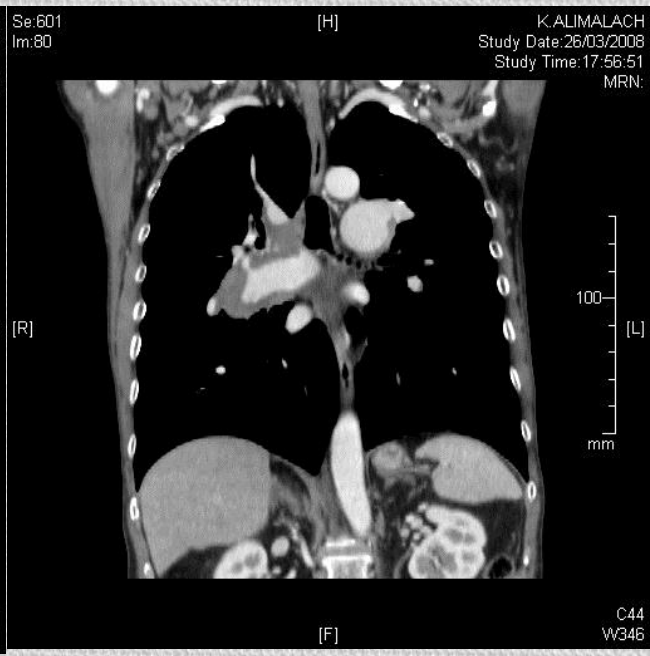
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Milrinone

- Used extensively in PHT patients
- Many papers on the use in newborns and infants including persistent PHT of the newborn and congenital cardiac surgery
- Comparisons with other PDE inhibitors including PDE 5 inhibitors (sildenafil) – more cardioselective
- Effects of inhaled milrinone – avoiding systemic hypotension?
- Head to head comparisons with other vasopressors are rare and don't show a decisive advantage

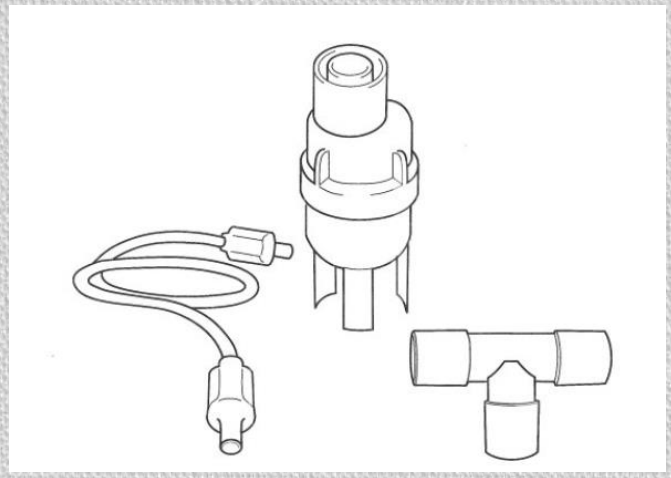
Comparison of dobutamine versus milrinone therapy in hospitalized patients awaiting cardiac transplantation: a prospective, randomized trial.

Aranda JM Jr, Schofield RS, Pauly DF, Cleeton TS, Walker TC, Monroe VS Jr, Leach D, Lopez LM, Hill JA
University of Florida College of Medicine, American Heart Journal [2003, 145(2):324-329]

Both dobutamine and milrinone can be used successfully as pharmacologic therapy for a bridge to heart transplantation. Despite similar clinical outcomes, treatment with milrinone incurs greater cost.

Advantages of aerosolized drug delivery

- Very **large delivery surface** - alveolar surface area is around 100 msq
- Blood vessels in close proximity
- **Avoids first pass metabolism** in the liver – enables lower doses
- **Non-invasive**



Inhaled iloprost in eight heart transplant recipients presenting with post-bypass acute right ventricular dysfunction

*Acta Anaesthesiol Scand 2006; **50**: 1213–1217*

K. Theodoraki[1], D. Tsiapras[2], L. Tsourelis[3], D. Zarkalis[3], P. Sfirakis[3], E. Kapetanakis[4], P. Alivizatos[3] and T. Antoniou[5]

Conclusion: During heart transplantation procedures, episodes of pulmonary hypertension can be successfully treated with inhaled iloprost administration, without untoward side-effects or significant systemic impact.

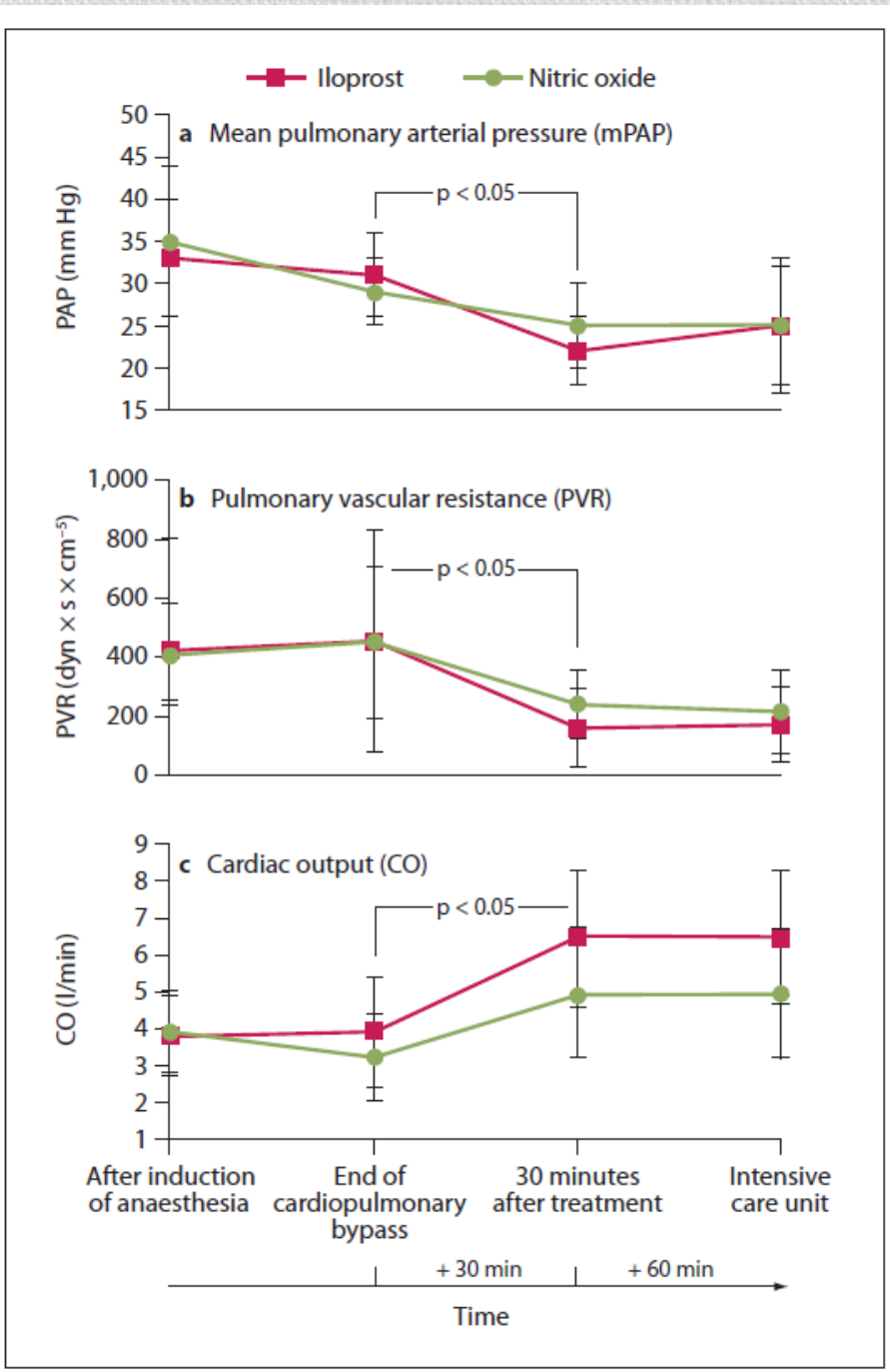
Iloprost given during operation

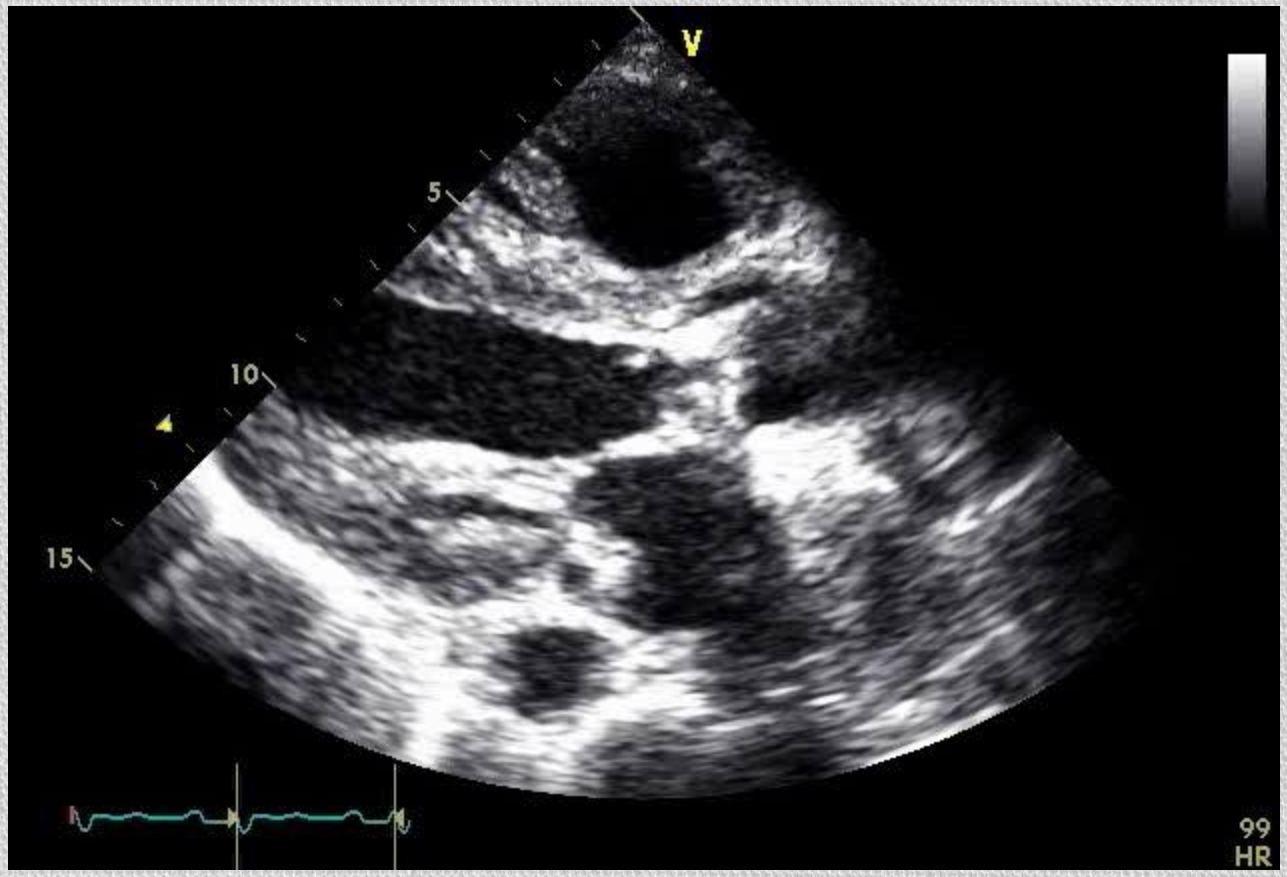
Inhaled iloprost to control pulmonary artery hypertension in patients undergoing mitral valve surgery: a prospective, randomized-controlled trial

Acta Anaesthesiol Scand 2008; 52: 65–72

S. Rex[1], G. Schaelte[1], S. Metzelder[1], S. Flier[2], E. E. C. de Waal[2], R. Autschbach[3], R. Rossaint[1] and W. Buhre[4]

20 pts (MVP) randomized during **weaning** from cpb:
pvr decreased, RVEF increased,
Transpulmonary gradient decreased.
All weaned successfully.


Iloprost
Nitric oxide
a Mean pulmonary arterial pressure (mPAP)
PAP (mm Hg)
50
45
40
35
30
25
20
15
p < 0.05
b Pulmonary vascular resistance (PVR)
PVR (dyn × s × cm⁻⁵)
1,000
800
600
400
200
0
p < 0.05
c Cardiac output (CO)
CO (l/min)
9
8
7
6
5
4
3
2
1
p < 0.05
After induction of anaesthesia
End of cardiopulmonary bypass
30 minutes after treatment
Intensive care unit
+ 30 min
+ 60 min
Time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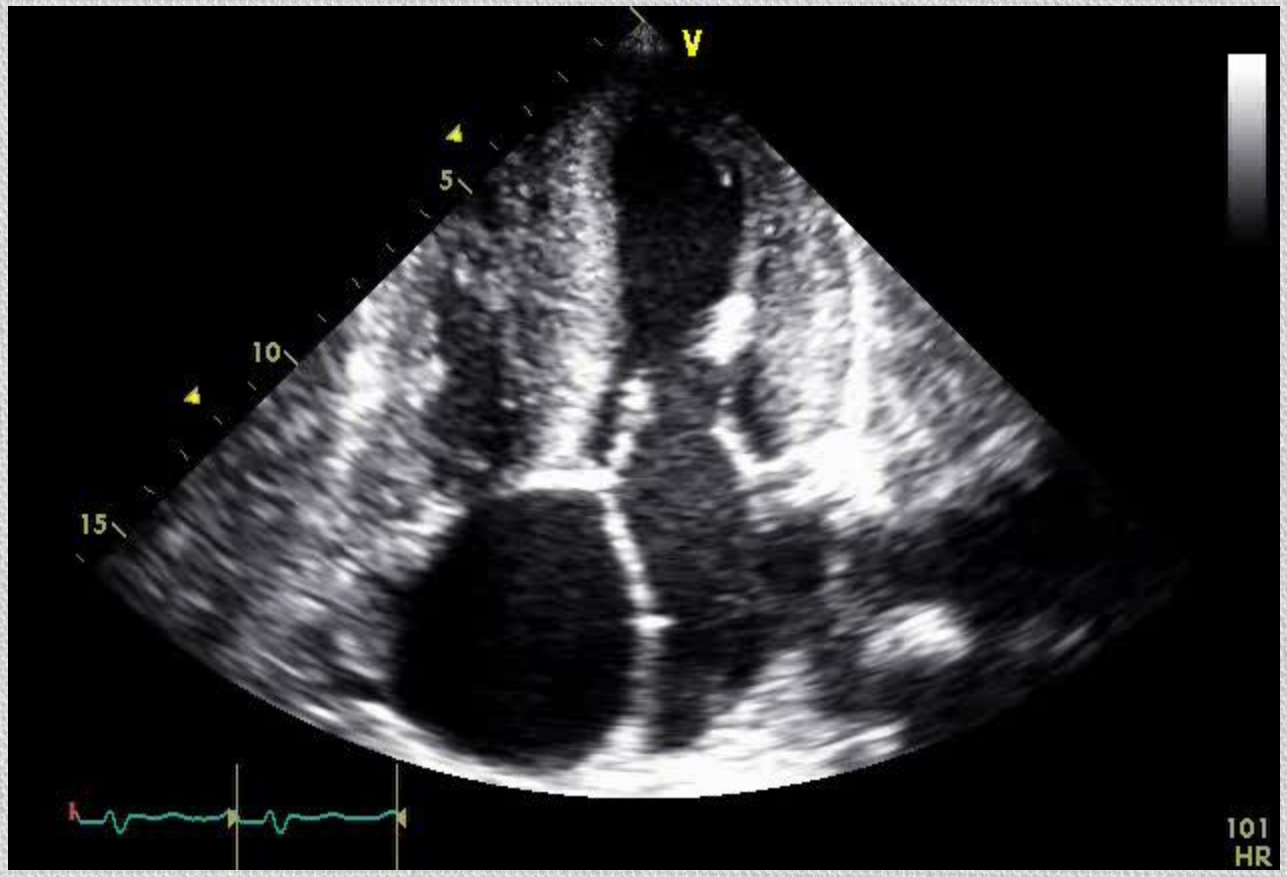
V
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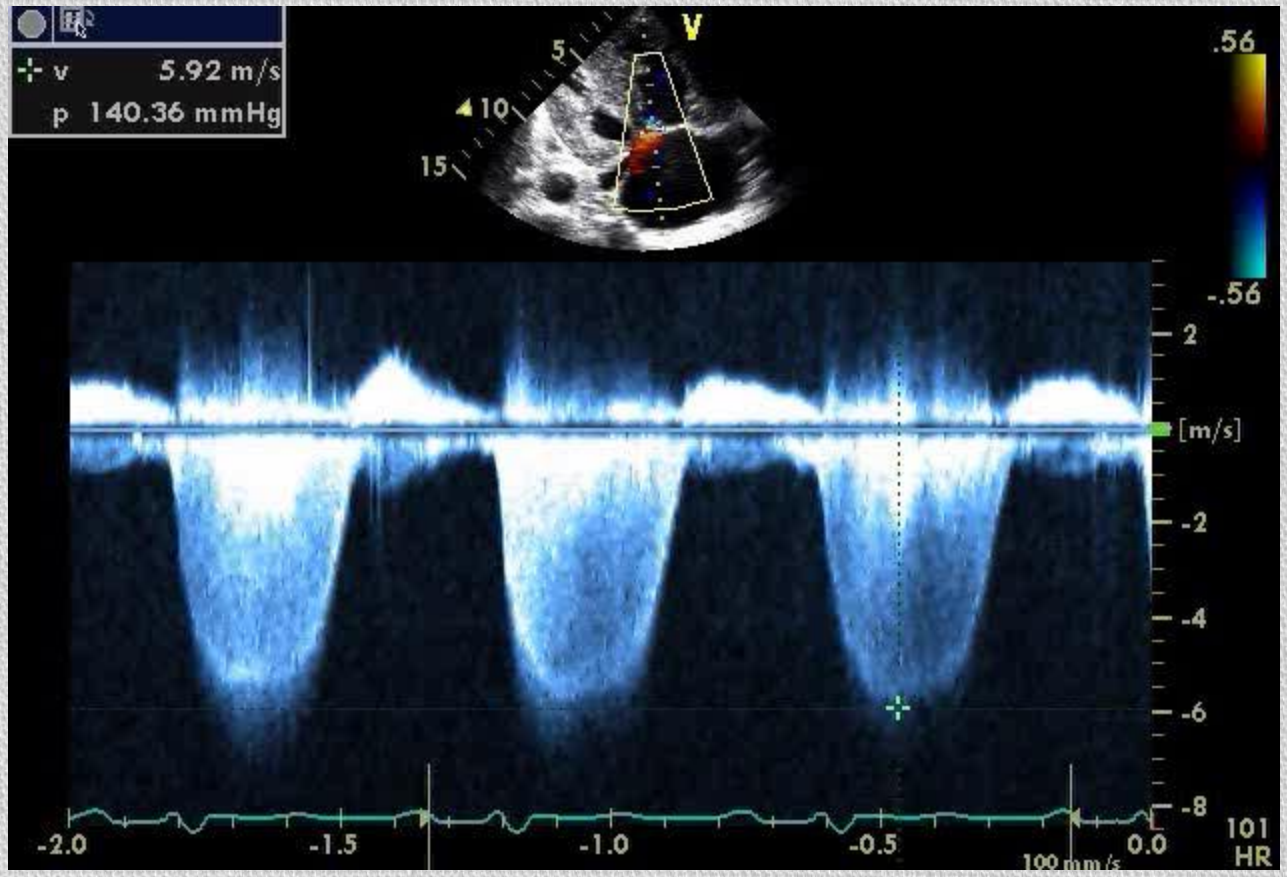
v 5.92 m/s
p 140.36 mmHg
5
10
15
V
.56
-.56
2
[m/s]
-2
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-6
-8
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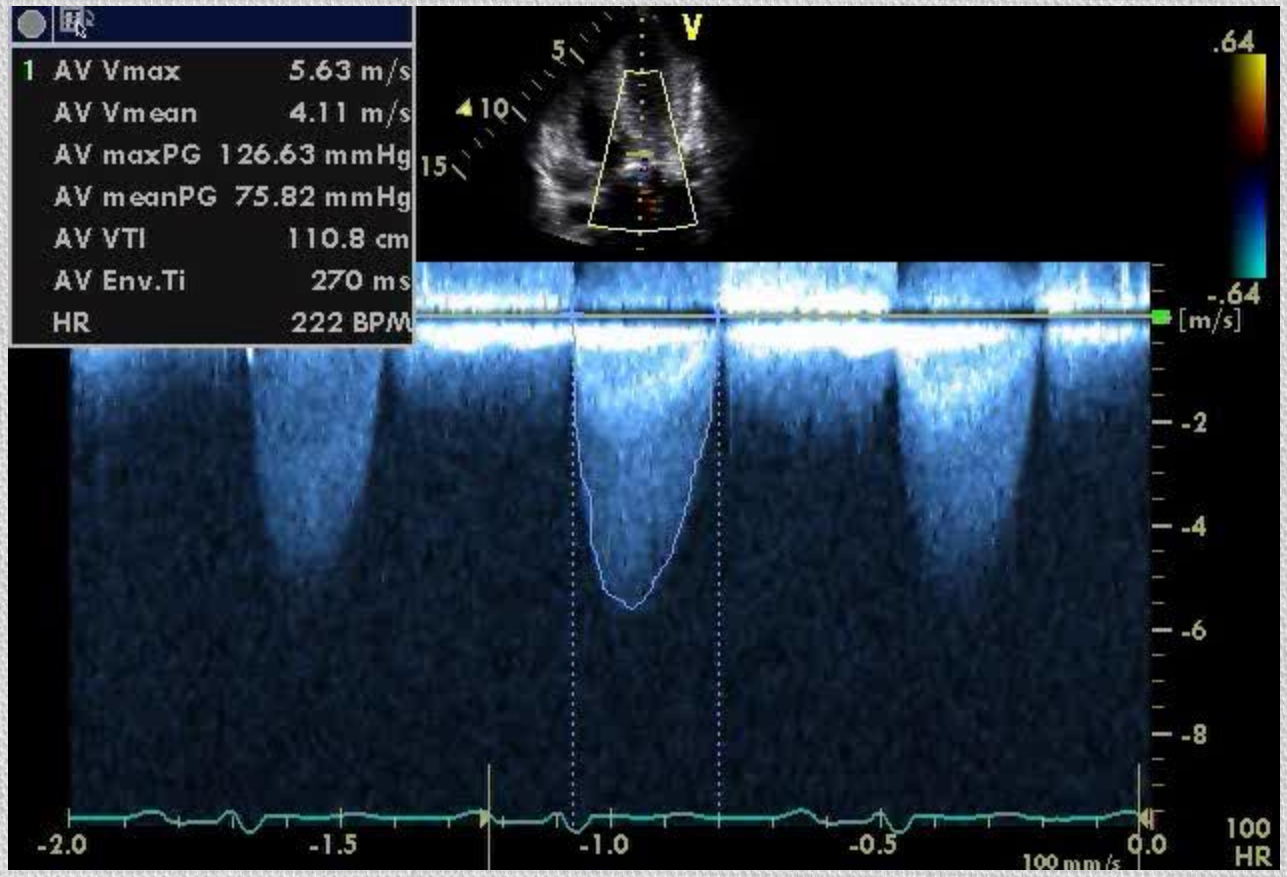
-1.5
-1.0
-0.5
0.0
100 mm/s
101
HR


1 AV Vmax 5.63 m/s
AV Vmean 4.11 m/s
AV maxPG 126.63 mmHg
AV meanPG 75.82 mmHg
AV VTI 110.8 cm
AV Env.Ti 270 ms
HR 222 BPM
V
5
10
15
.64
-.64
[m/s]
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-4
-6
-8
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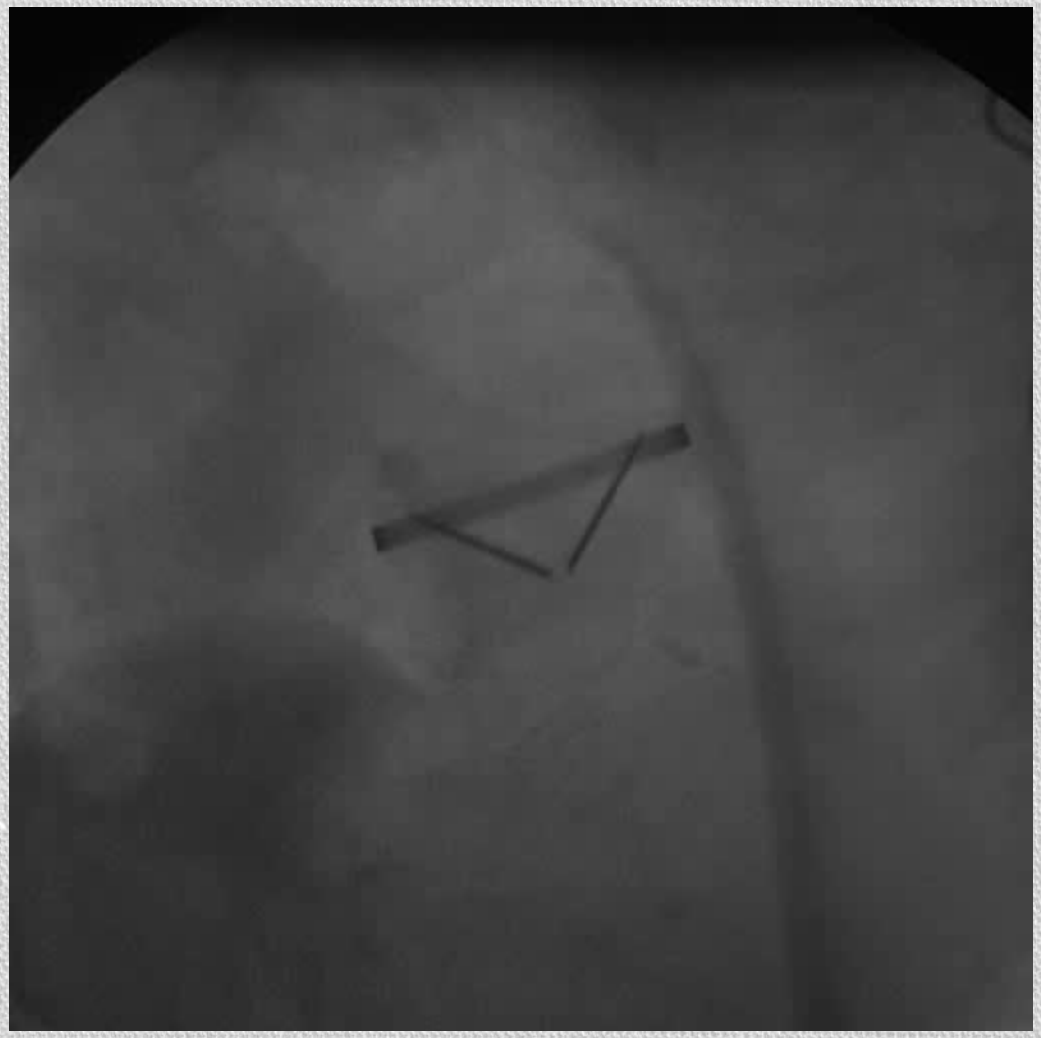
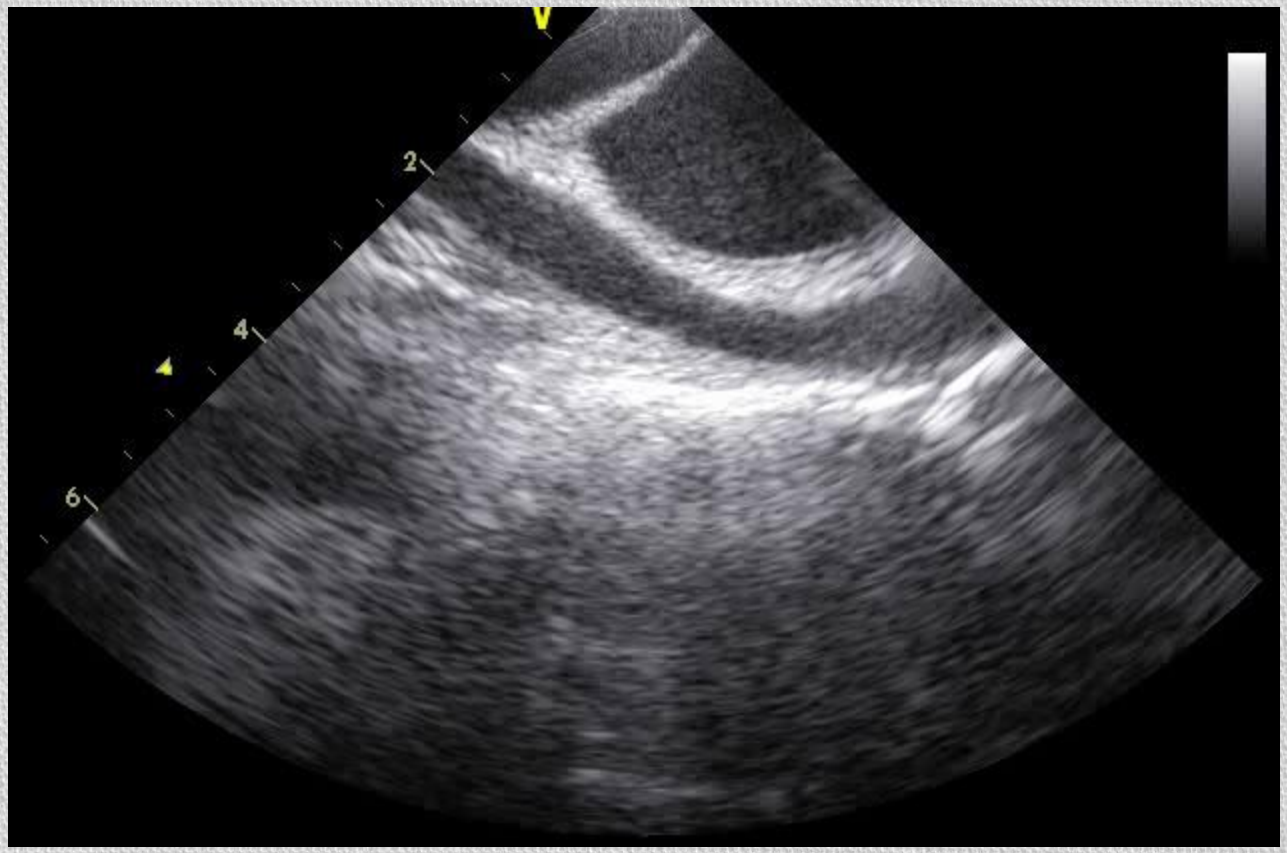
0.0
100 mm/s
100
HR



Atrial septostomy

- Performed frequently in countries where the costly PHT drugs are not available, e.g Mexico.
- Seldom performed in other countries
- Reserved for very advanced disease, with very low cardiac index and recurrent syncope
- The aim is to decompress the right atrium and increase cardiac index, by bypassing the lungs.
- Results in arterial desaturation and risk of paradoxical emboli. Better performed on previously anti-coagulated patients.
- Should be performed in experienced centers. The enlargement of the initial perforation should be gradual, to prevent O2 sat. drop of more than 10%.
- Risk increases significantly when RA pressure exceeds 20 mmHg.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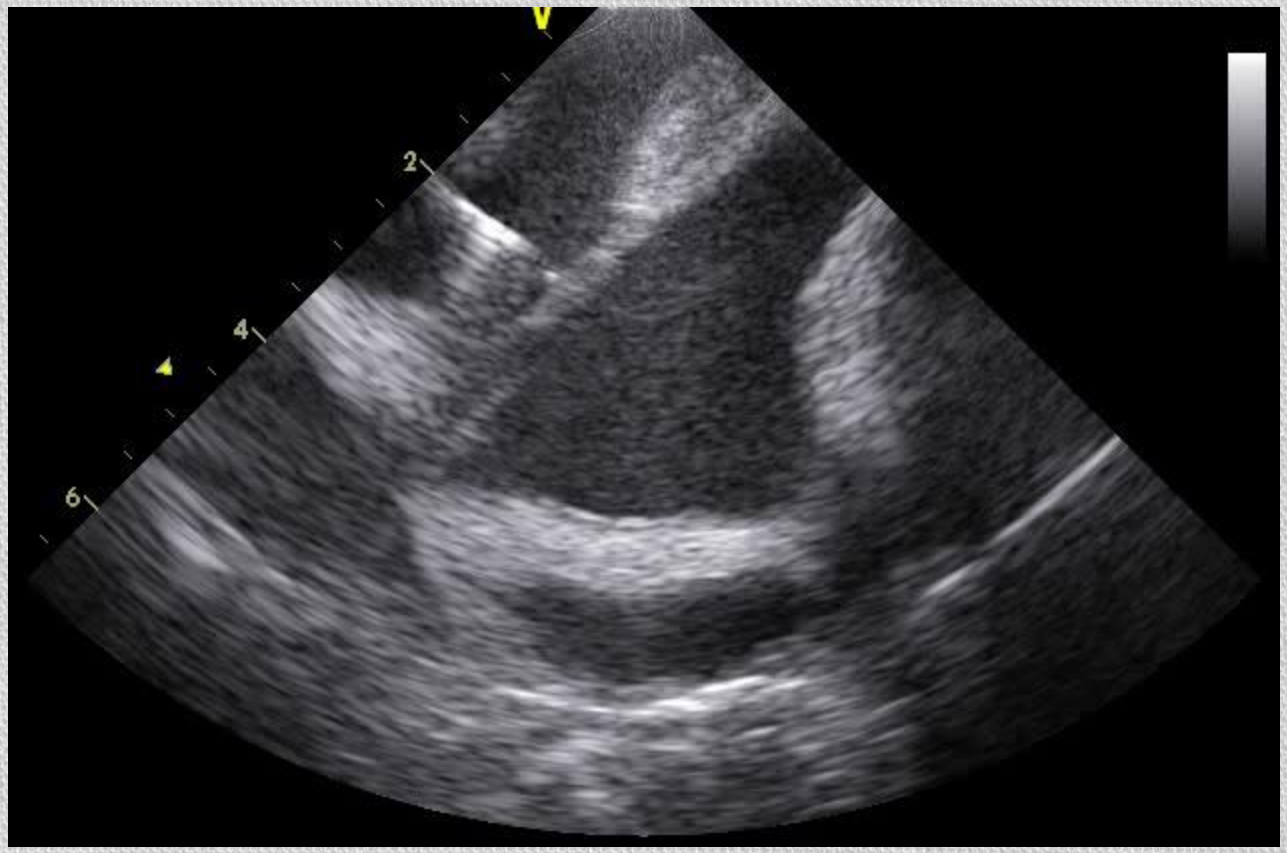
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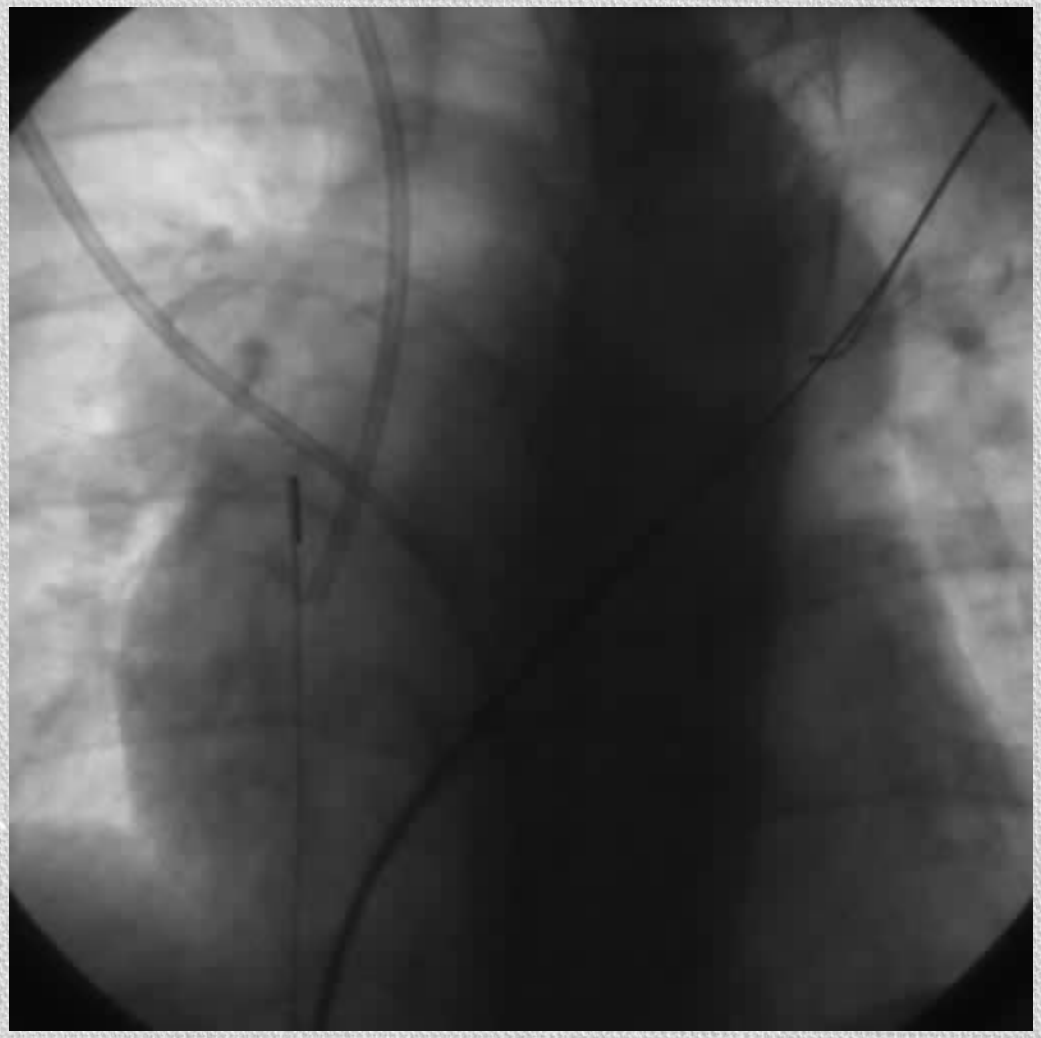

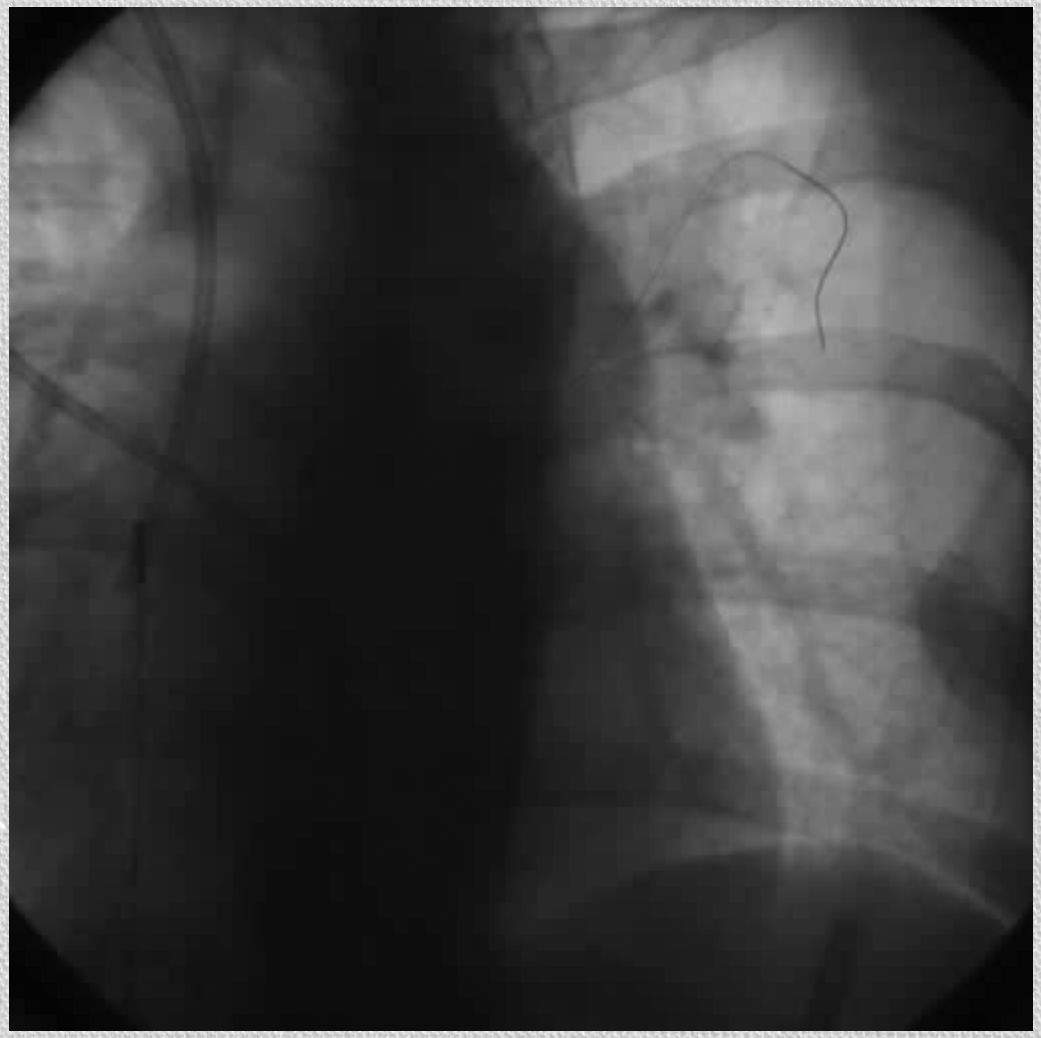


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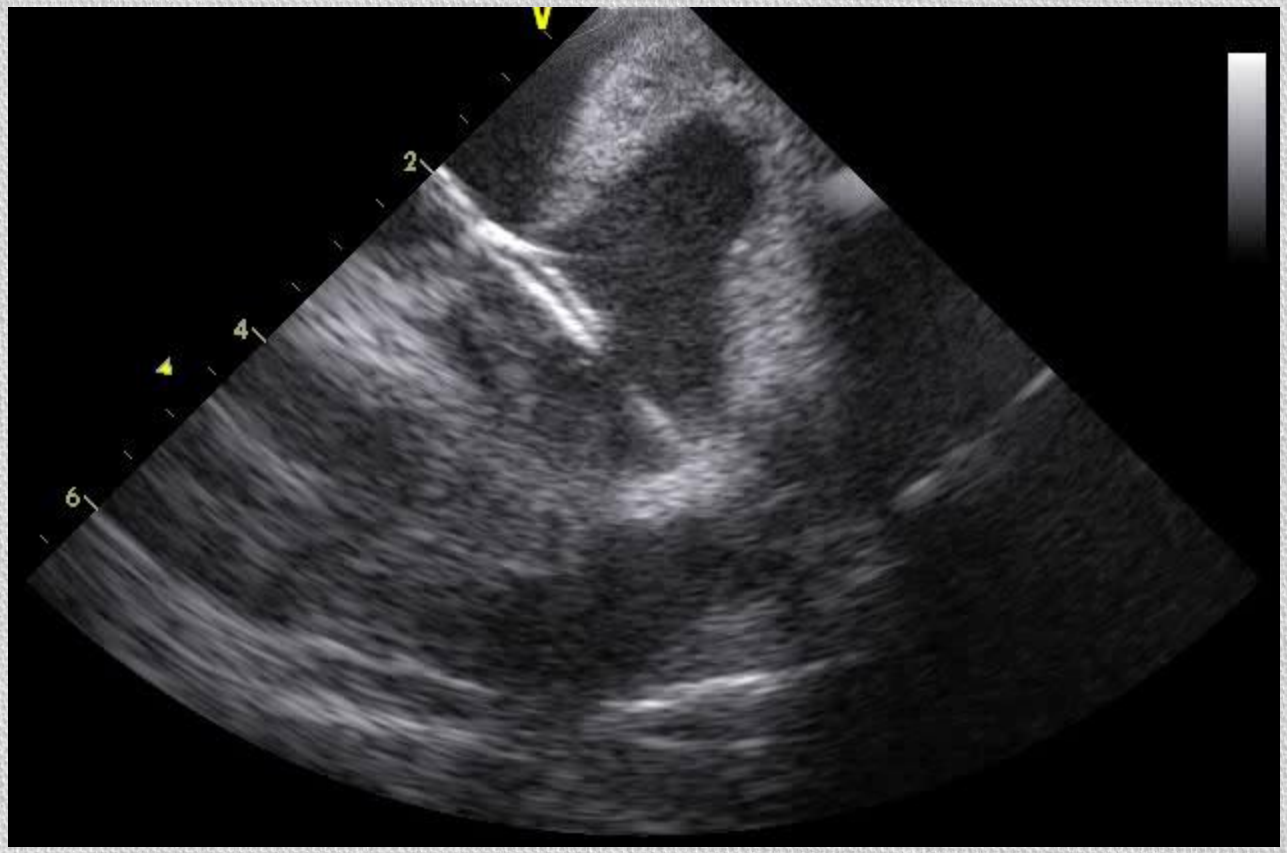
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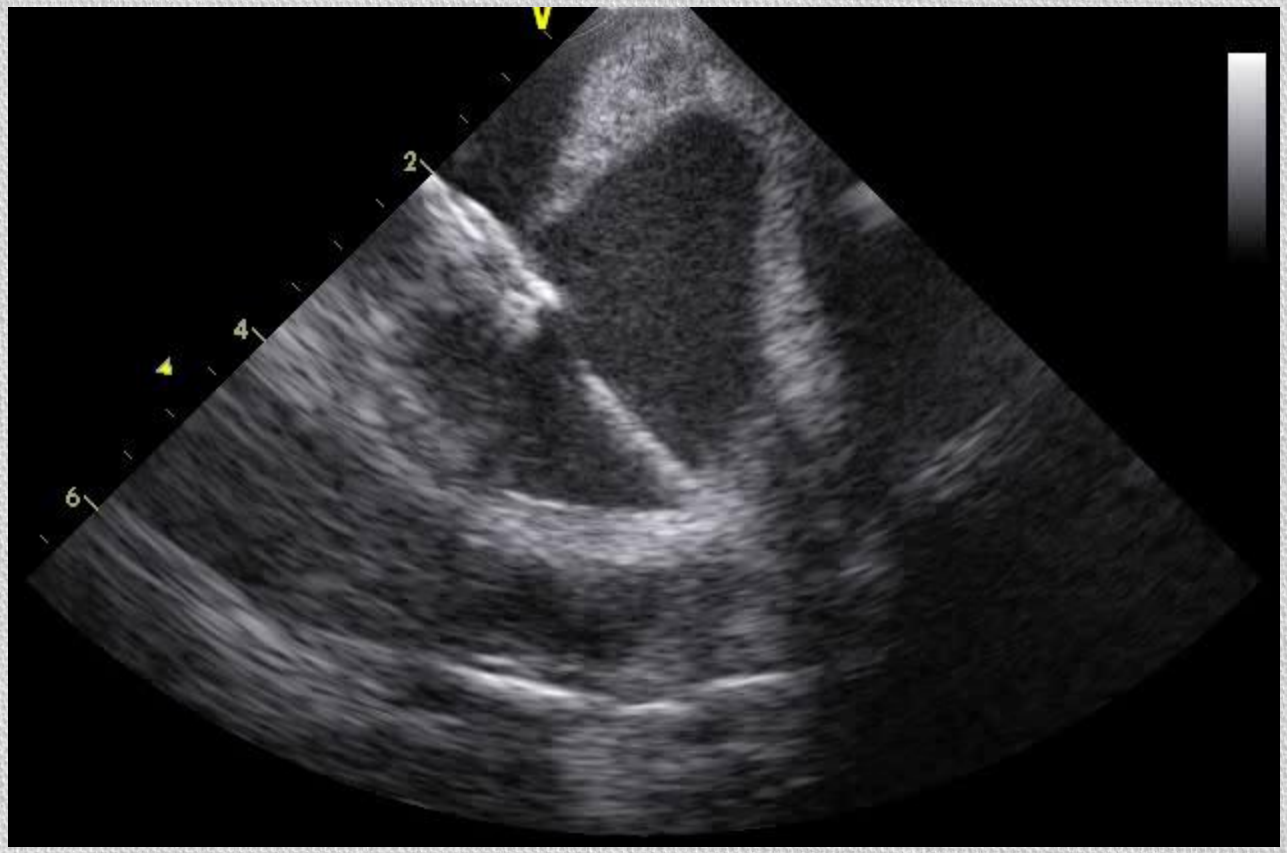
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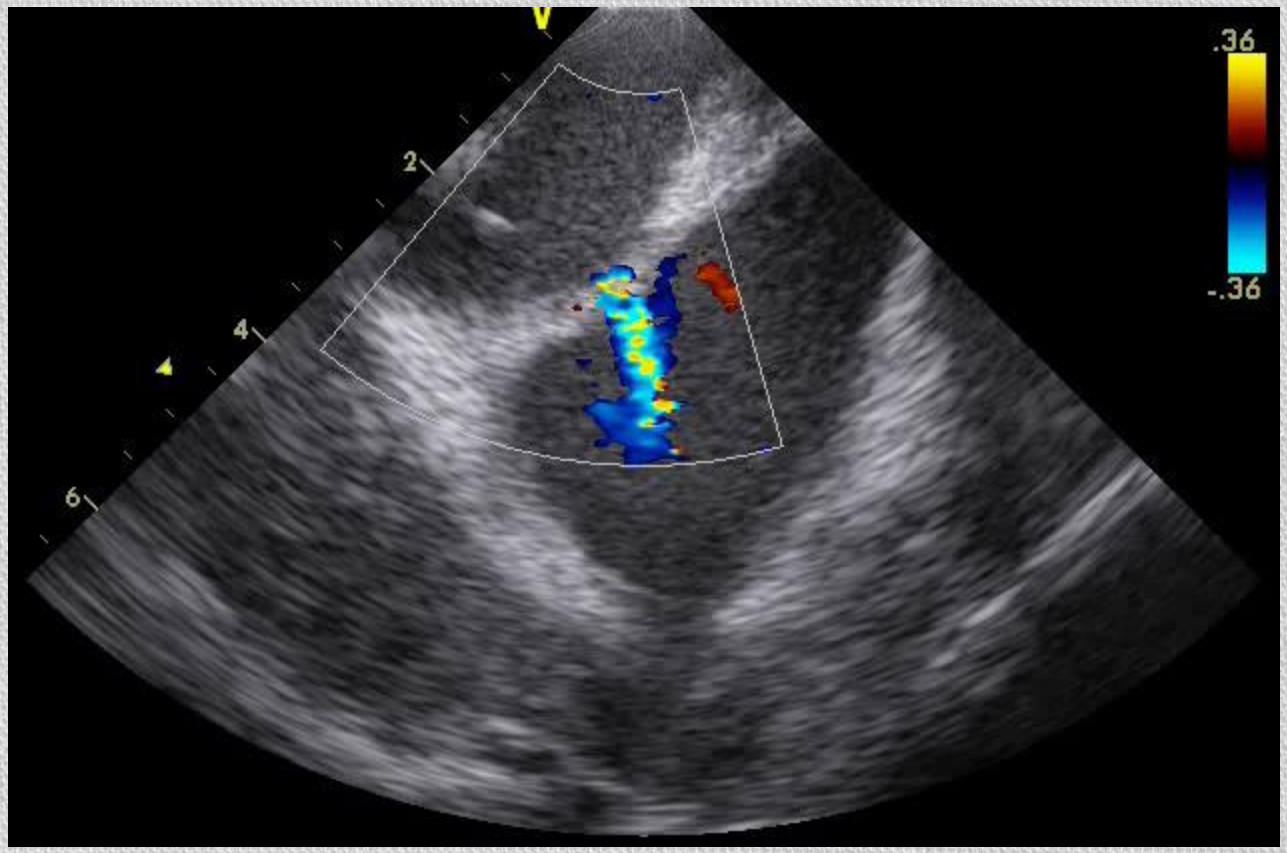
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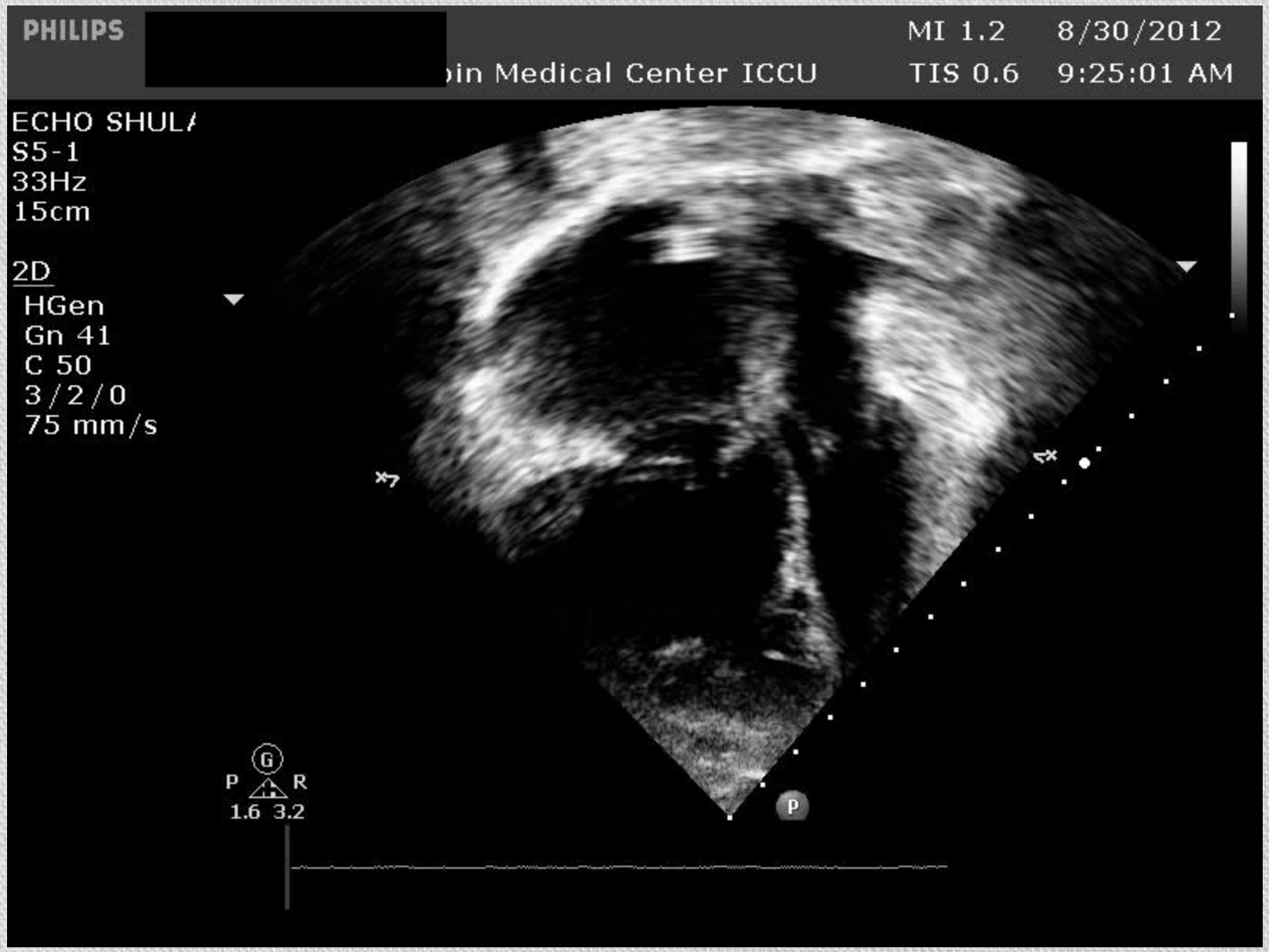
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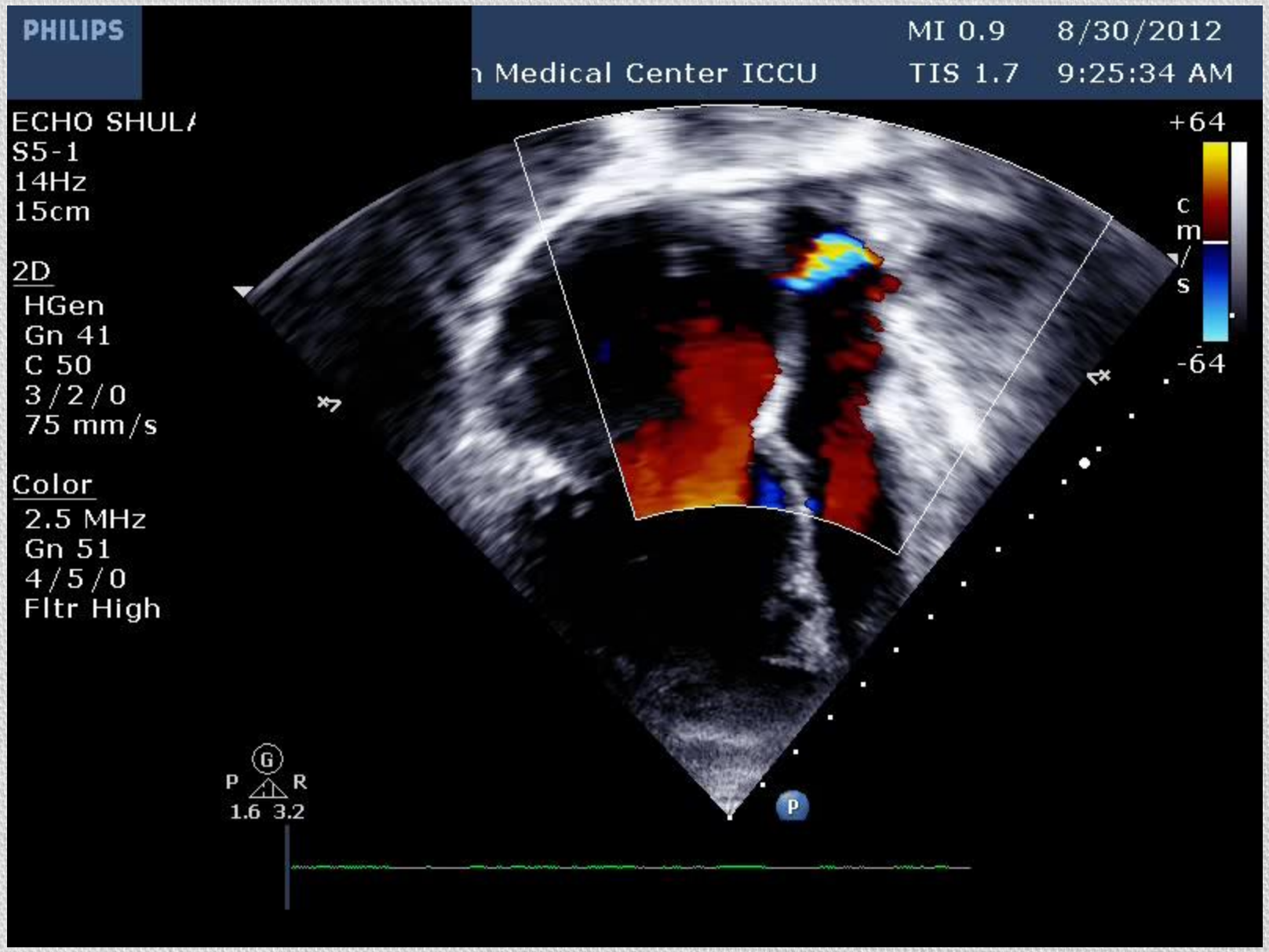
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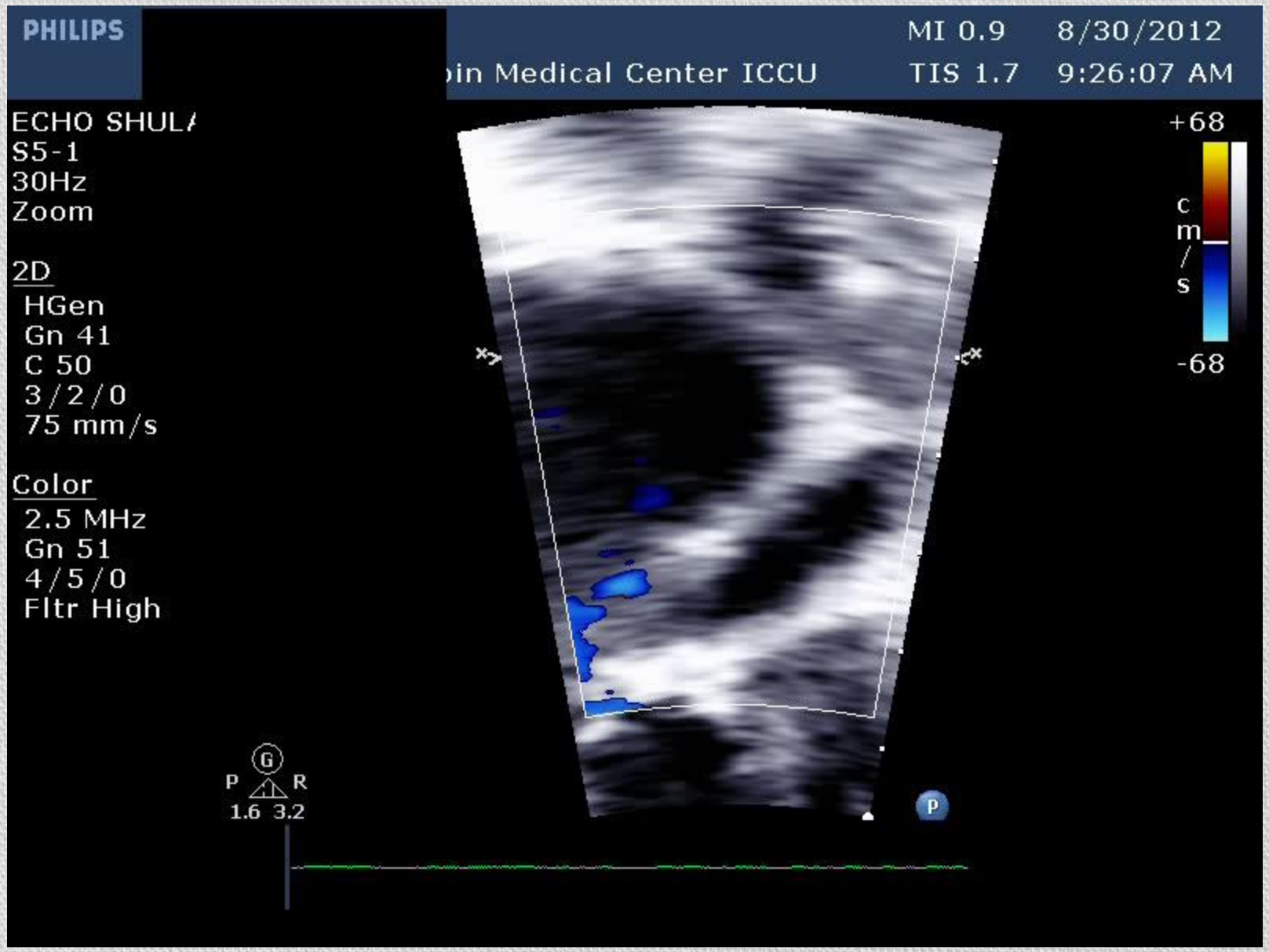
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