



# FOCUS SULL' ECOCARDIOGRAFIA IN ETA PEDIATRICA Nel neonato: come, quando e perché?

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VILLA BARILE  
CALTANISSETTA

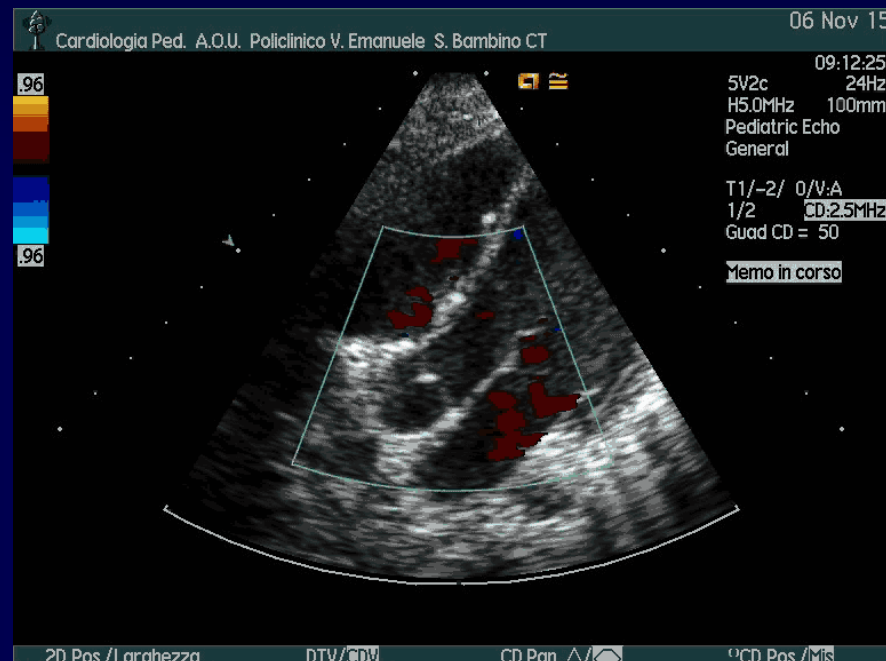
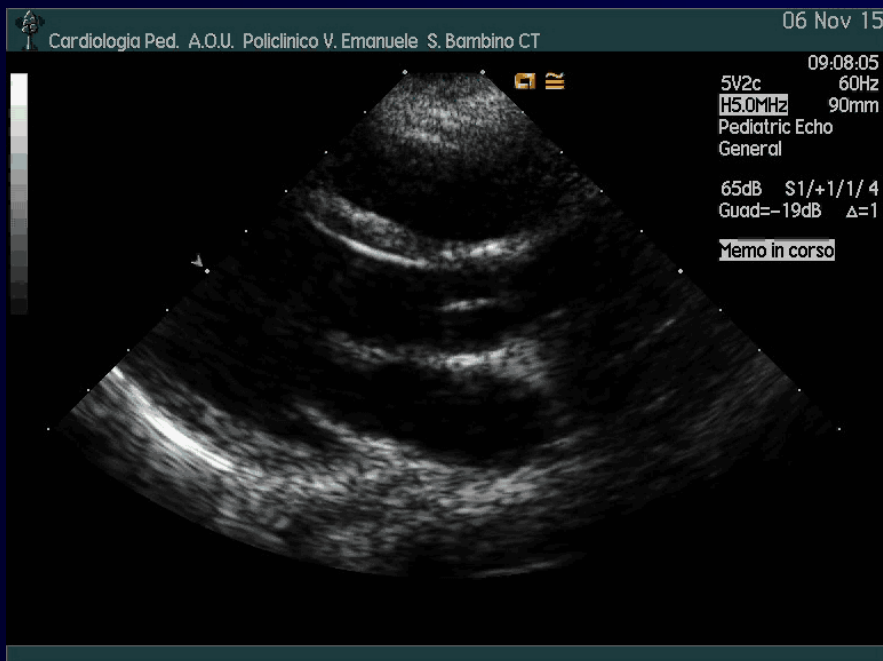
24 CREDITI ECM

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Caltanissetta 23-3-2016

# Ecocardiografia

In ecocardiografia, in tempo reale, vengono generate immagini in movimento del cuore, insieme con i dati quantitativi sul flusso sanguigno e il movimento dei tessuti

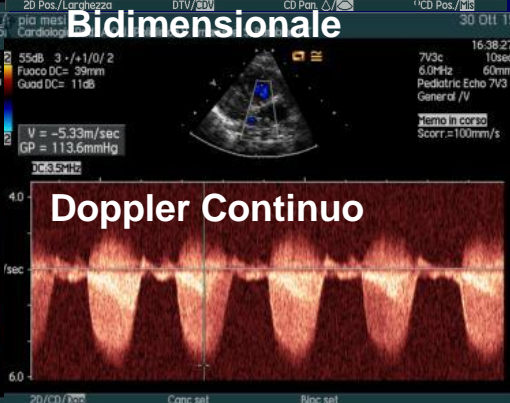
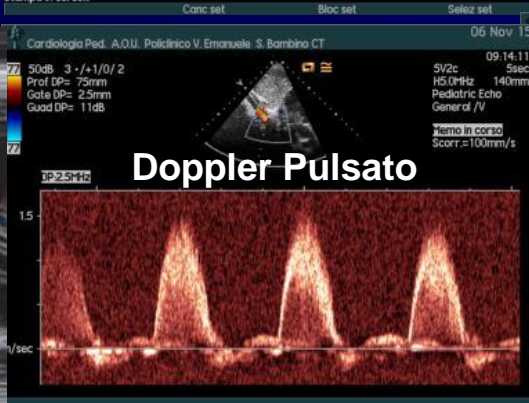
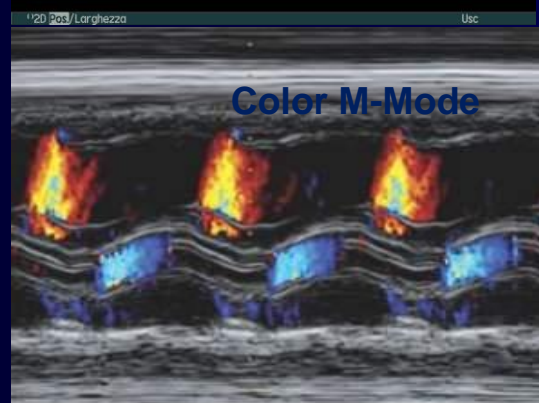
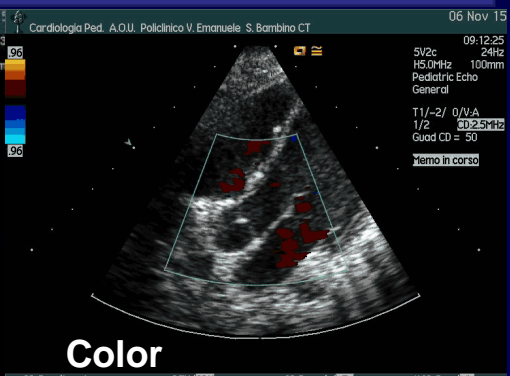
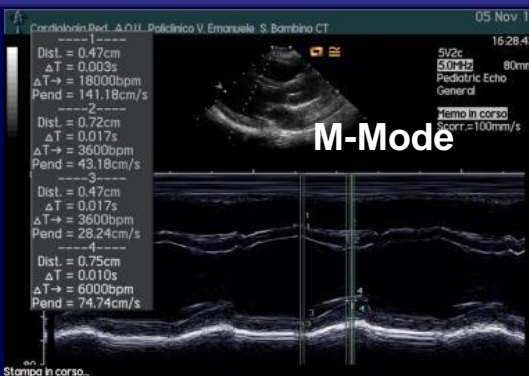




# Caratteristiche ecografo

Immagine di **Buona qualità**  
**Alta Risoluzione**

- Moduli necessari in real -Time :
  - a. Funzione bidimensionale , Funzione M-mode
  - b. Funzione Doppler: colore, pulsato, continuo, HPRF, tissutale



# Settaggio ecografo

**Accorgimenti che aumentano il frame rate**

**Ridurre la profondità**

**Ridurre il settore di scansione (angolo)**

**Fuoco: usare singolo fuoco**



Sonda a più alta frequenza

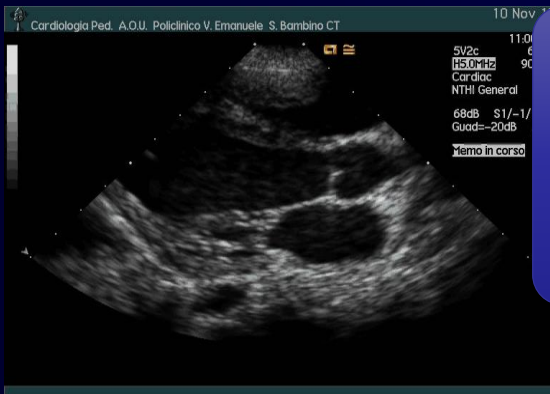
- **Vantaggi:** > risoluzione spaziale > capacità di discernere le strutture
- **Non presentano i limiti della** ridotta penetrazione nei tessuti visto che la profondità da analizzare è 5-6 cm

in età neonatale/ pediatrica per le alte frequenze sono **Necessarie sonde ad alte frequenze, Frame Rate Elevato**, evita sovrapposizioni di strutture

**GAIN e Time-gain compensation** rapporto tra il segnale d'ingresso e segnale amplificato

Aumenta/diminuisce il livello di ricezione del segnale, senza variare l'intensità di emissione degli ultrasuoni

**Gain regolare al minimo indispensabile (cavità nera), tutte le strutture distinguibili**



# 1° Indicazione: sospetto di cardiopatia congenita



Soffio con  
caratteristiche di  
cardiopatia (A9)



Cianosi:  
dopo 24 ore  $< 90\%$   
 $\neq$  SAO2 tra braccio dx e  
gambe  $> 3\%$  (A9)



Scompenso cardiaco  
(A9)

A 7-9 = appropriata; M 4-6 = potrebbe essere appropriata; R 1-3 = raramente appropriata

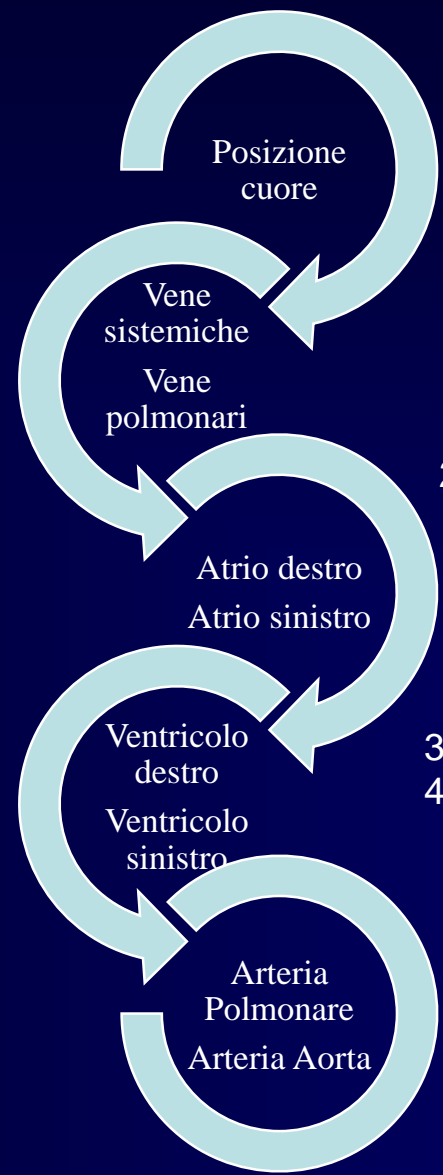
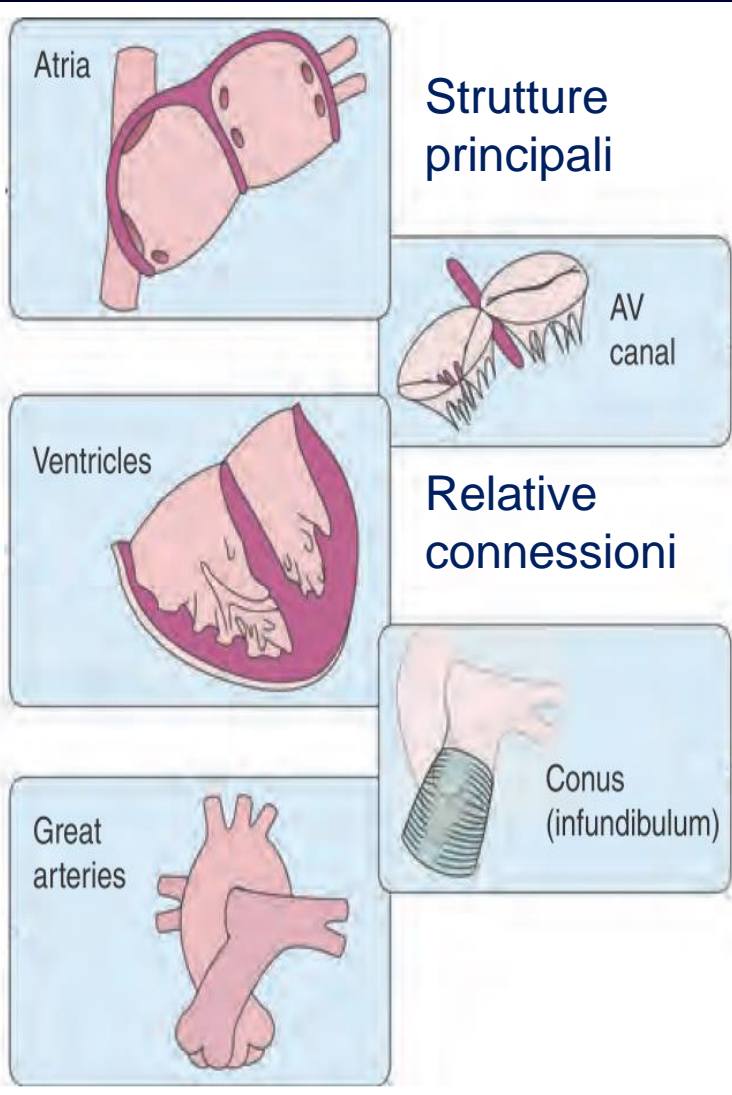
ACC/AAP/AHA/ASE/HRS/  
SCAI/SCCT/SCMR/SOPE  
2014 Appropriate Use Criteria for  
Initial Transthoracic Echocardiography  
in Outpatient Pediatric Cardiology

# Ecocardiografia

Importante, nell'approccio delle cardiopatie congenite, è seguire un metodo, cioè un percorso sequenziale



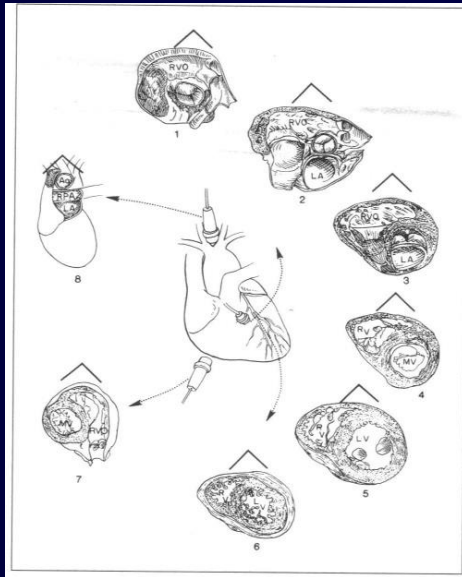
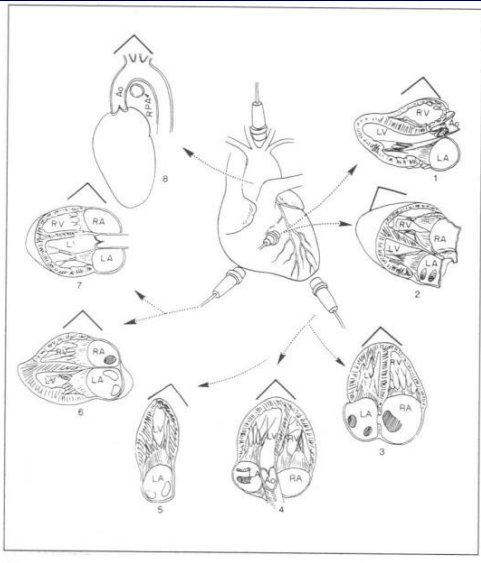
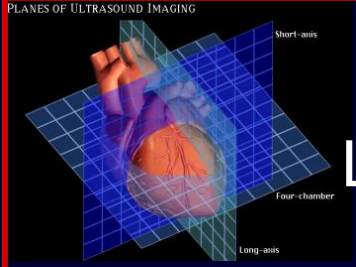
# Approccio Sequenziale



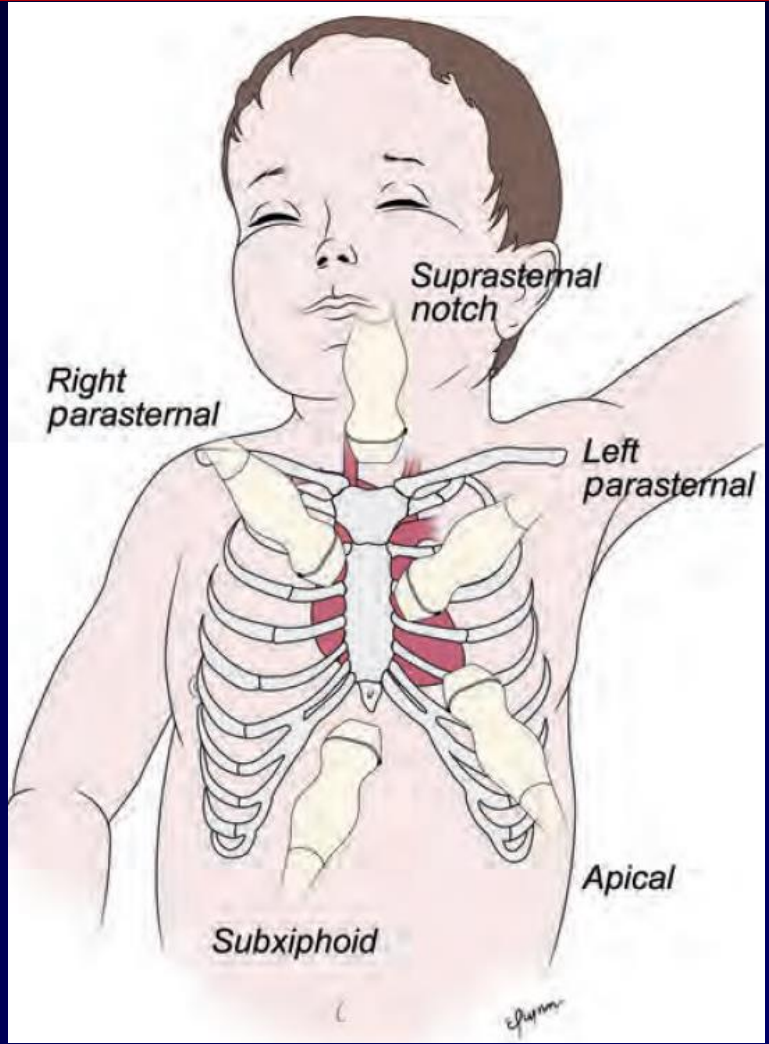
1. Relazione con organi addominali (situs)
2. Connessione veno-atriale
3. Connessione atrio-ventricolare
4. Studio delle valvole atrioventricolari
5. Connessione ventricolo-arteriosa
6. Studio delle valvole semilunari

# Proiezioni

## Longitudinali e Trasversali



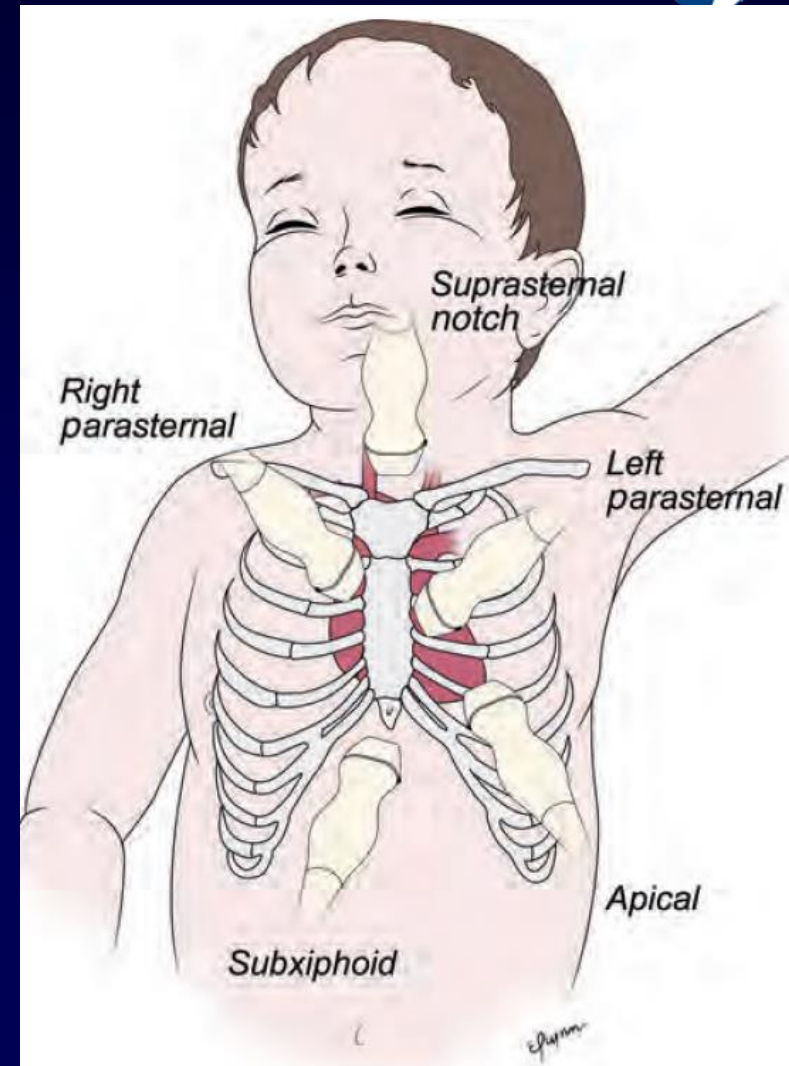
In età neonatale è possibile eseguire un esame completo utilizzando le sole proiezioni sottocostali e soprasternale







# flow-chart



# Definizione Situs

## Corrispondenza

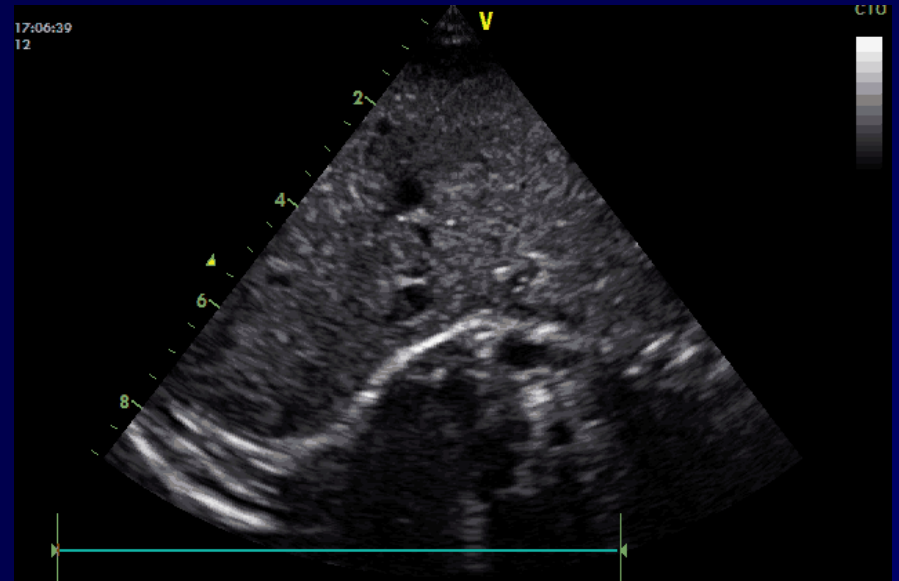
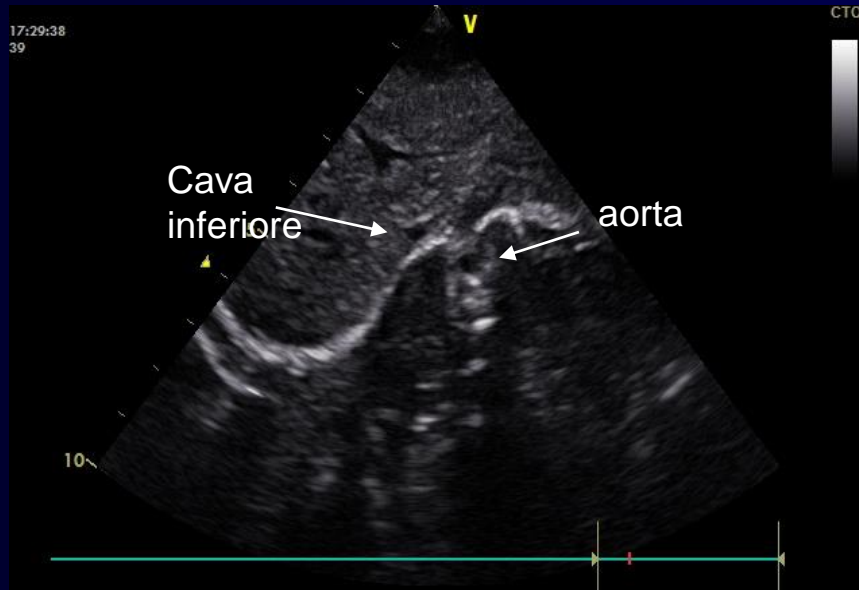
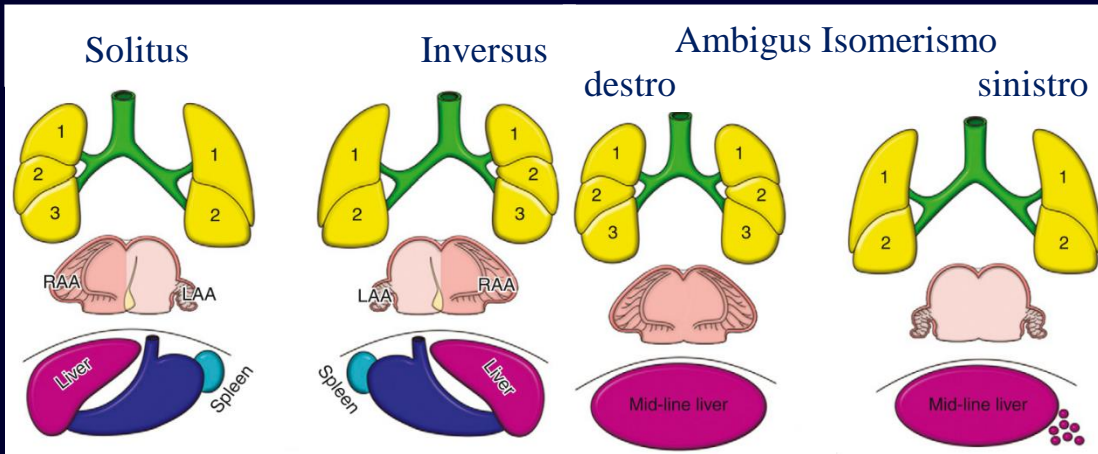
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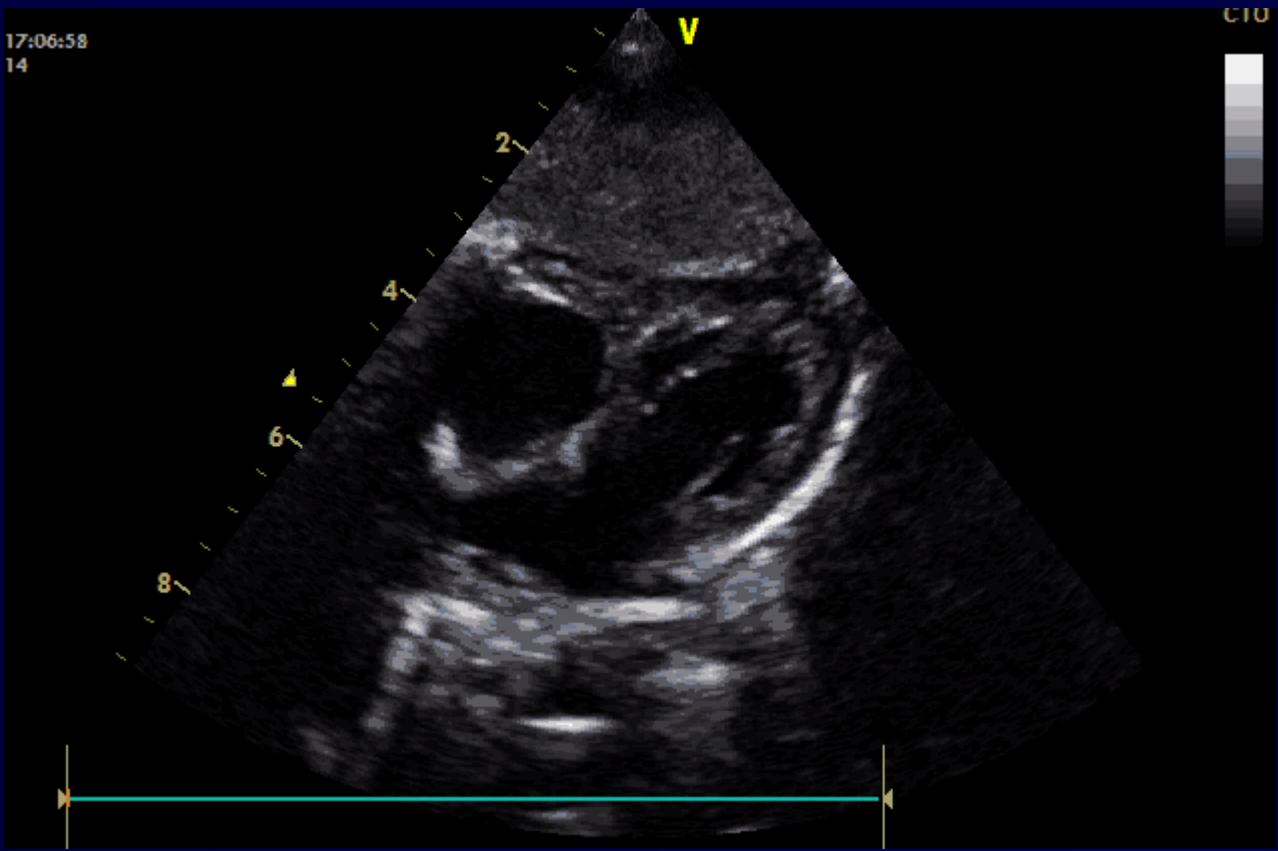
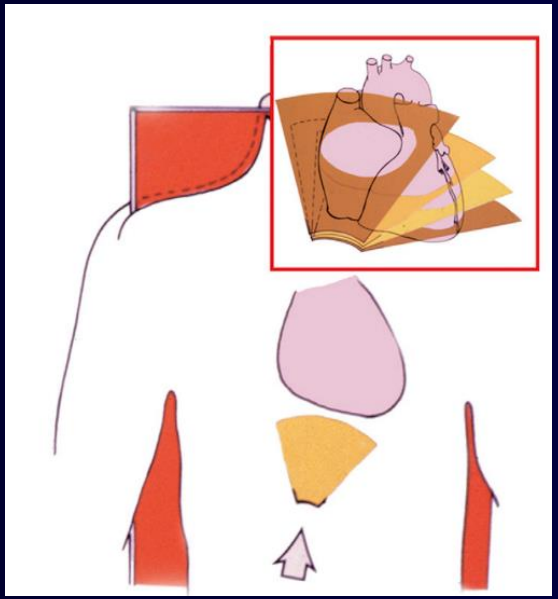
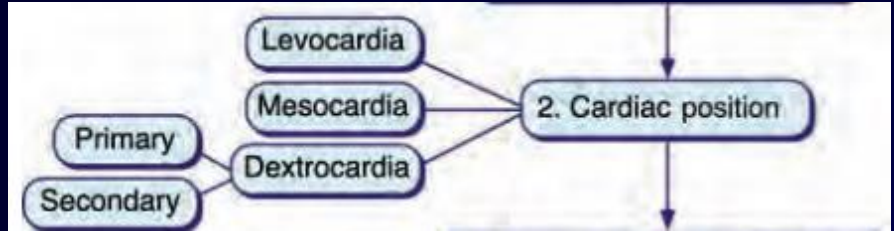
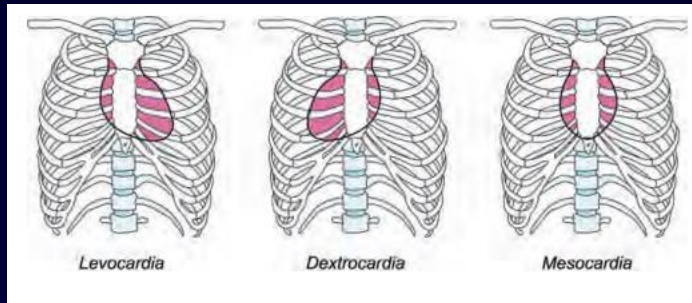
Bronchi – polmoni- **Cuore**

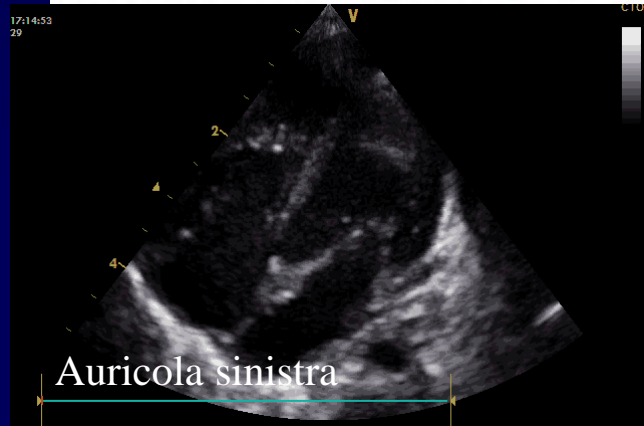
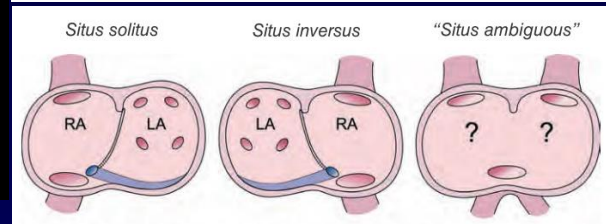
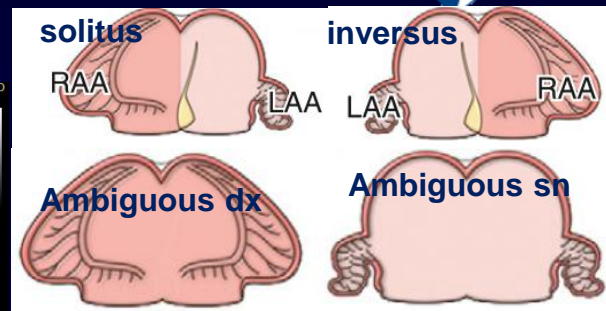
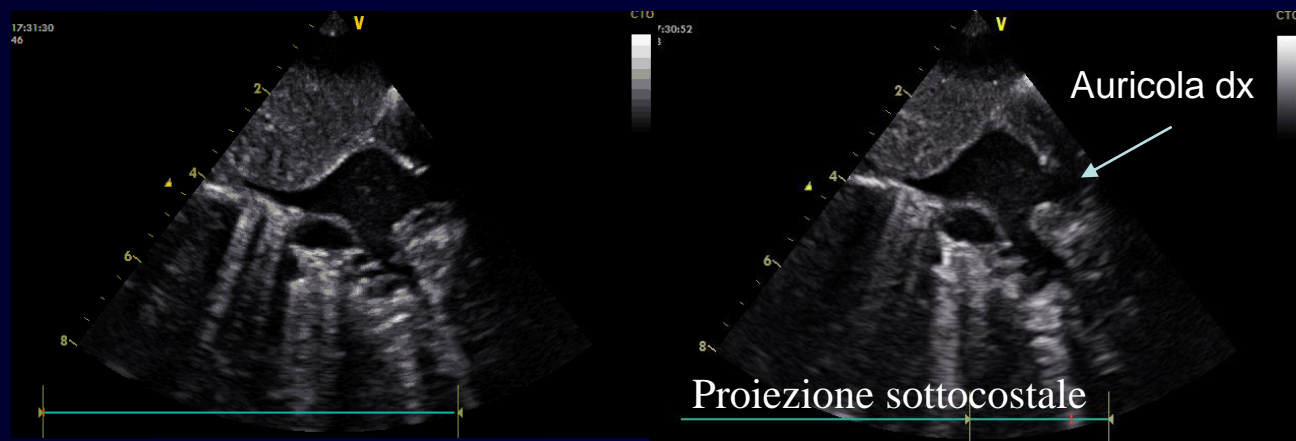
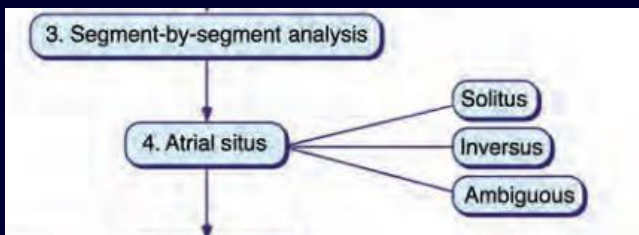
Sito Addominale:

Fegato-stomaco- milza

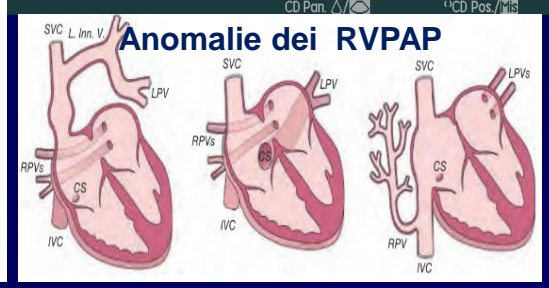
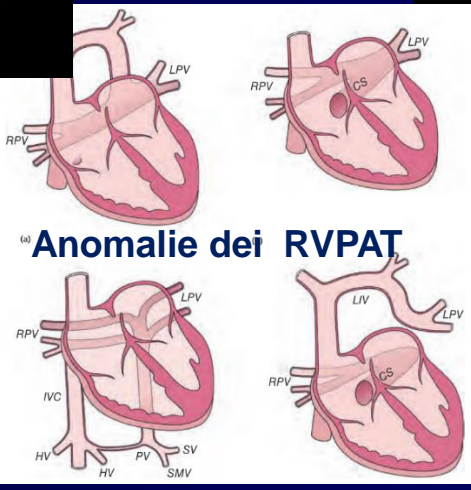
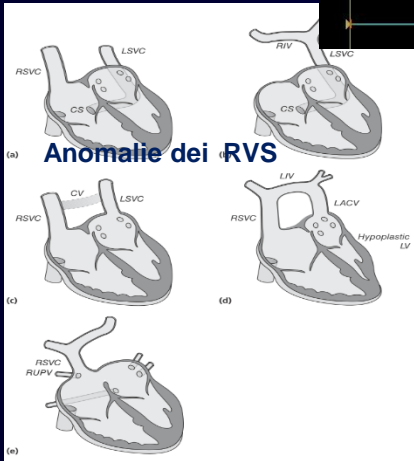
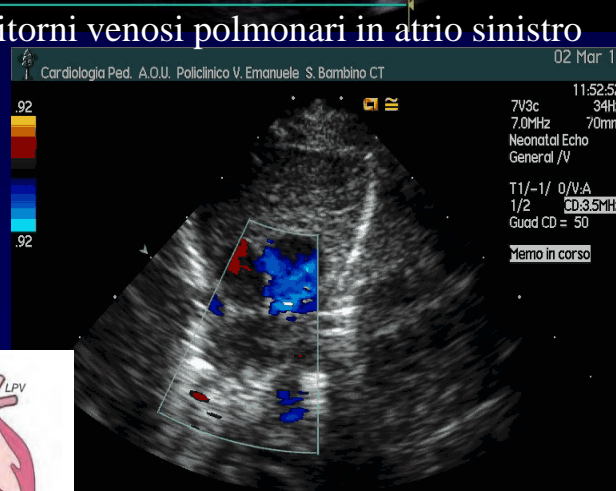
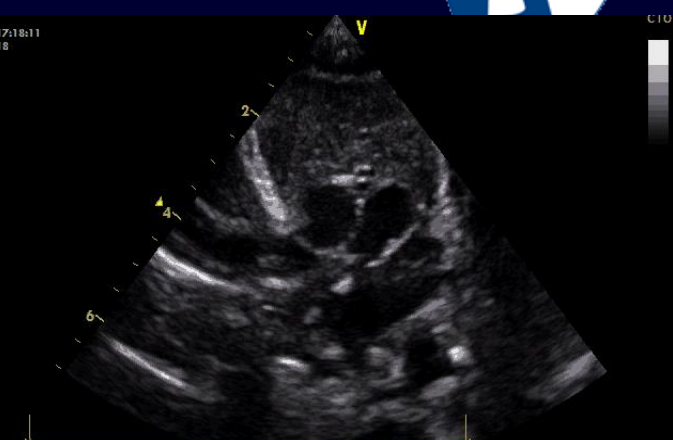
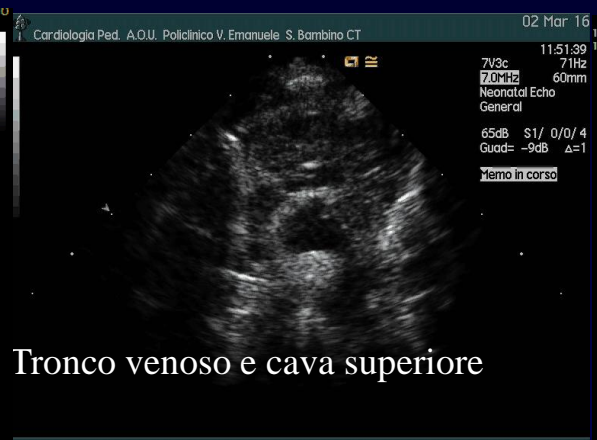
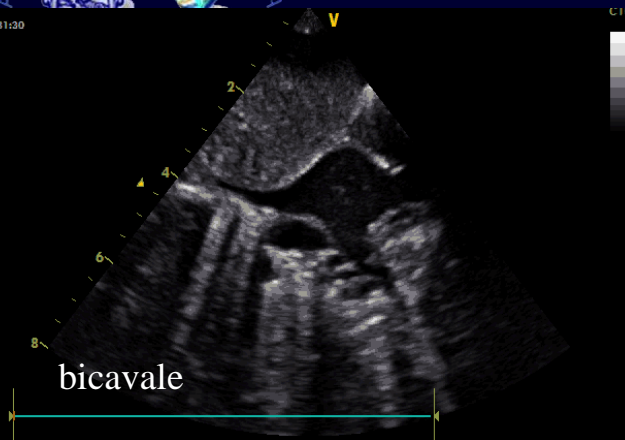
## Sito addominale



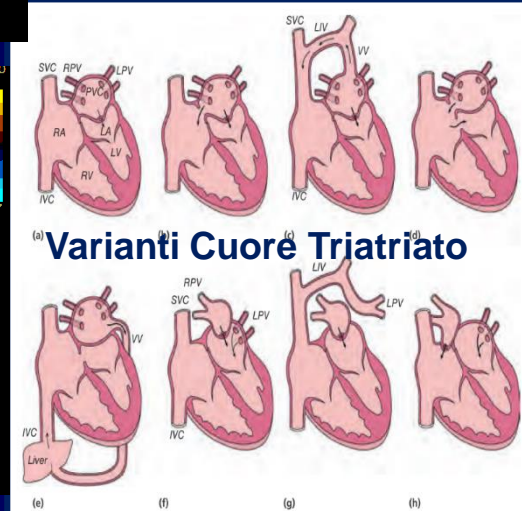
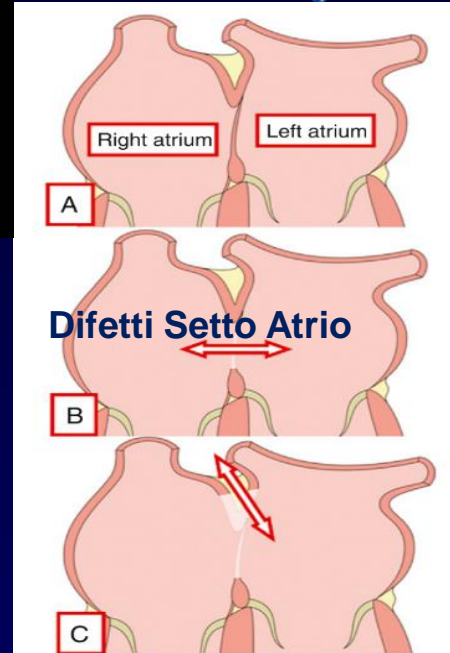
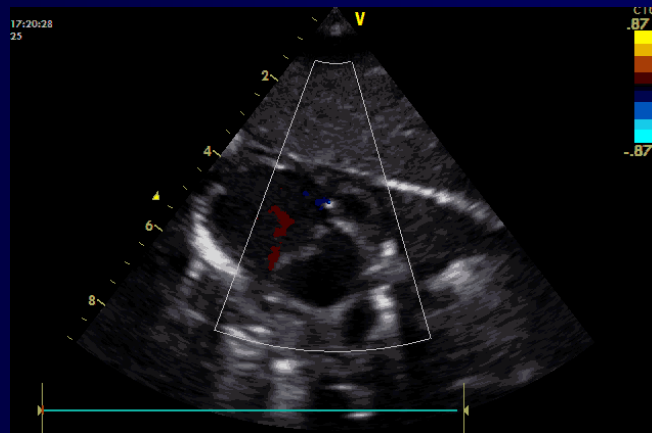
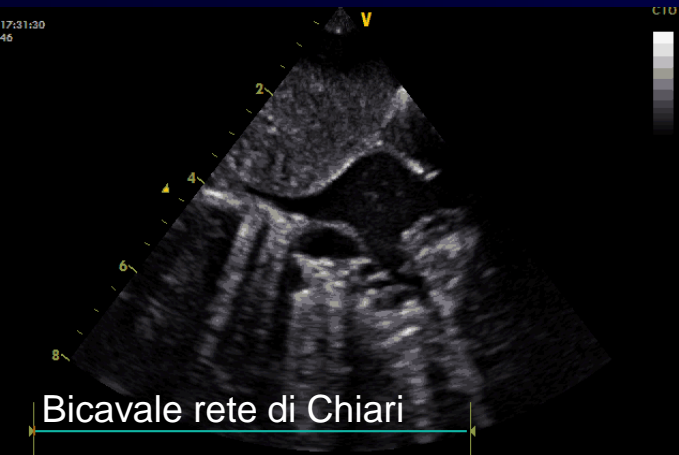
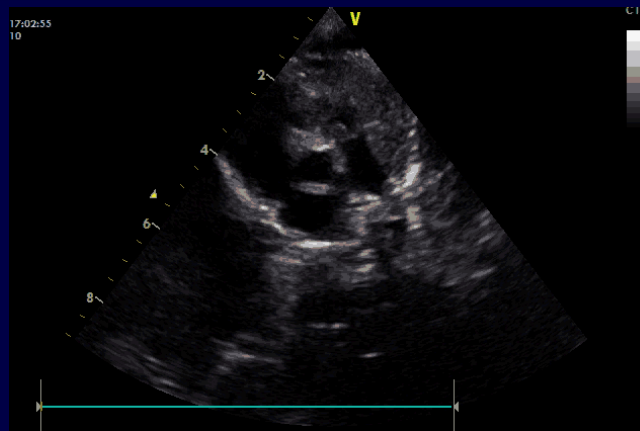
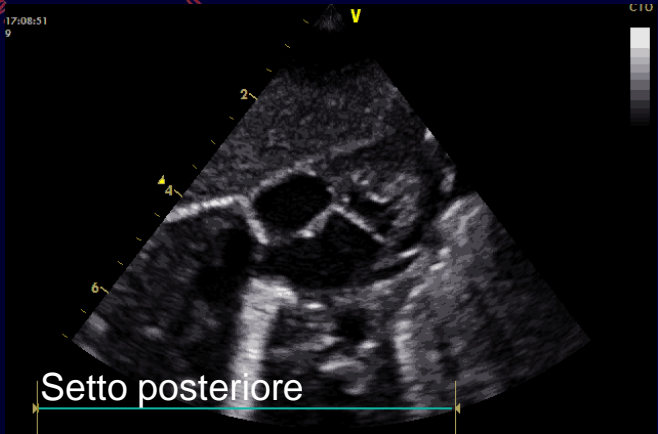




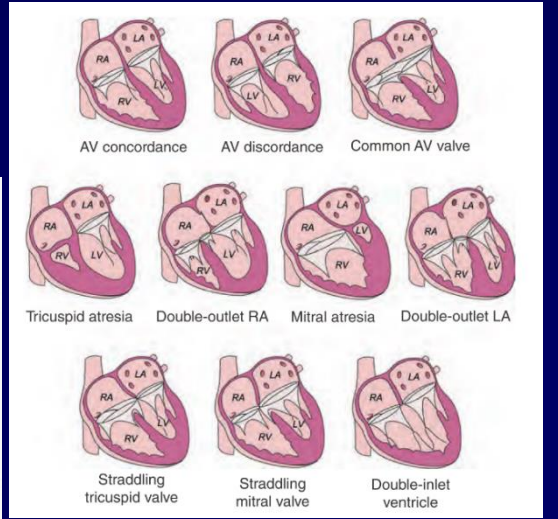
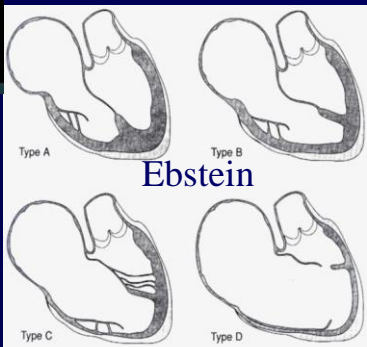
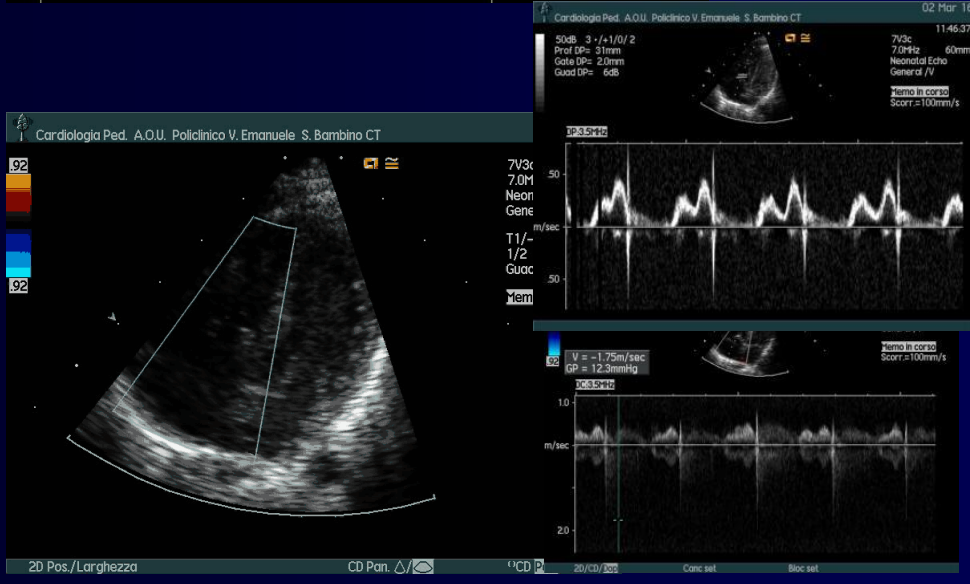
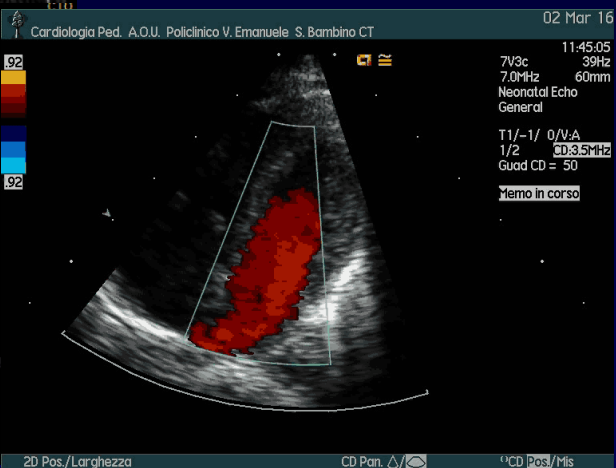
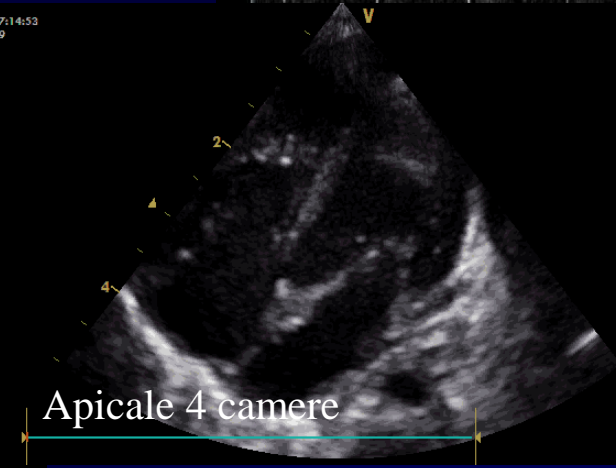
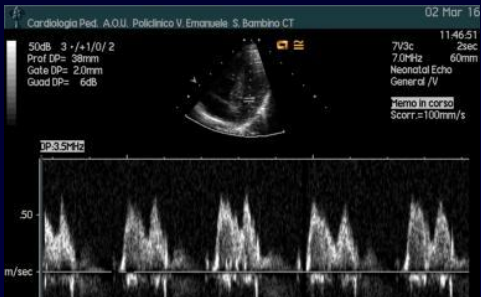
# Atri e connessione venose



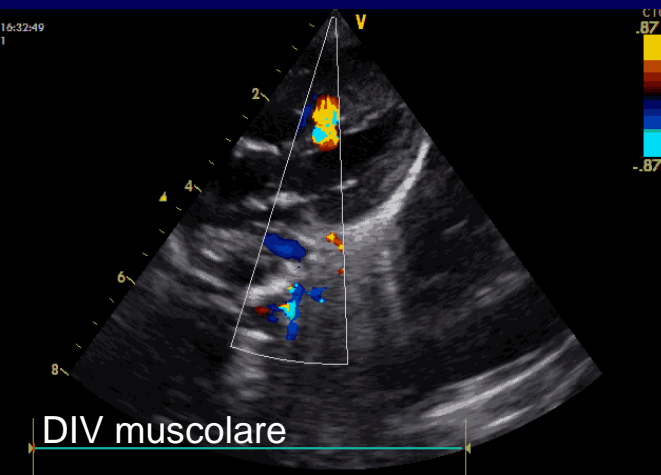
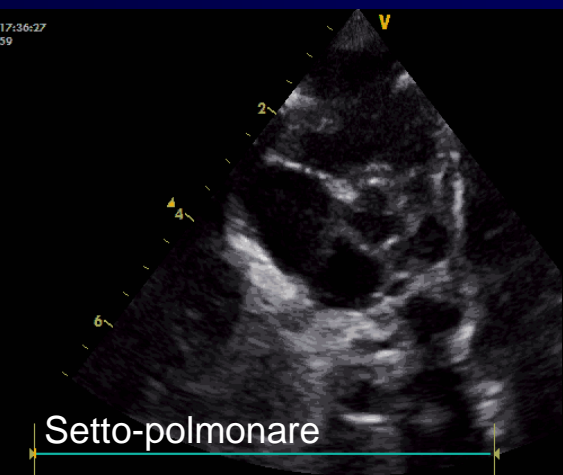
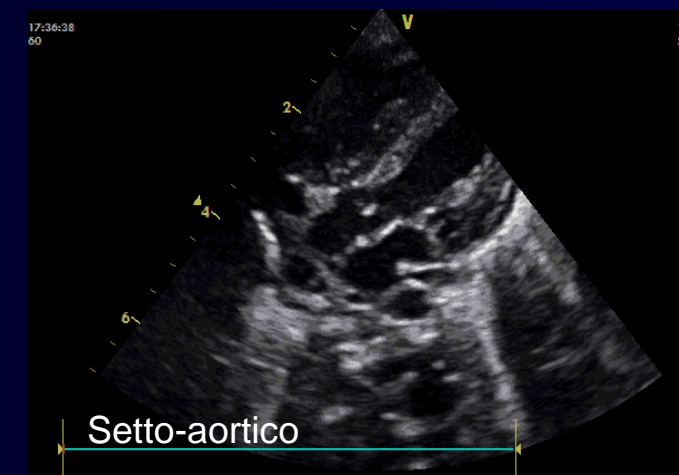
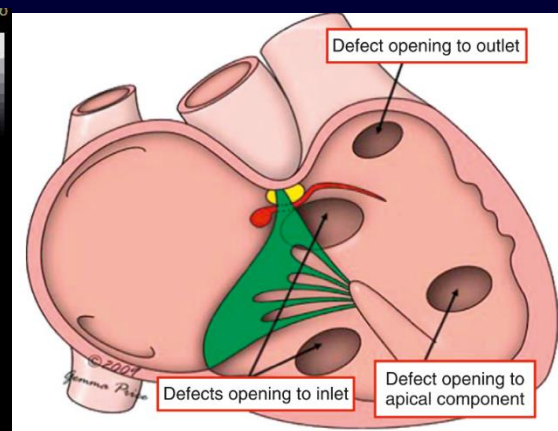
# Atri e Setto



**6. AV Alignments/Connections  
 (concordant, discordant,  
 straddling, atresia, etc.)**

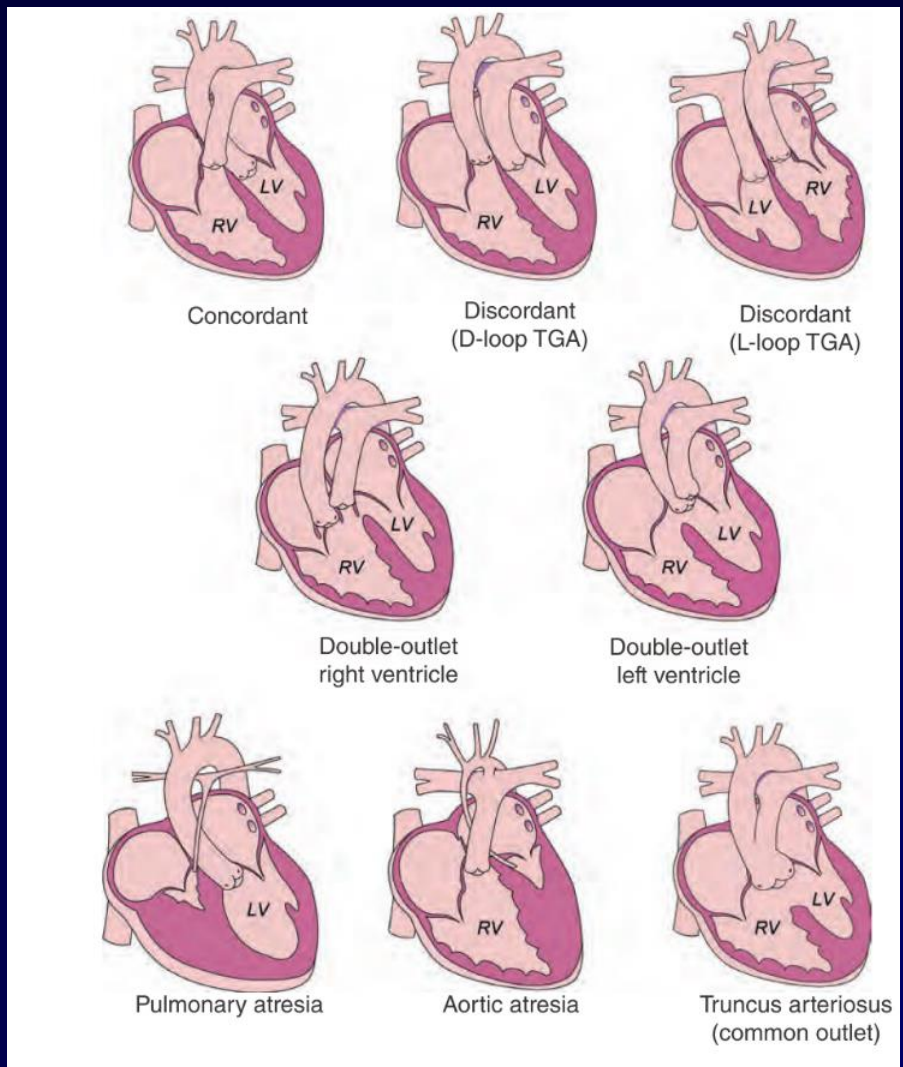


# Ventricoli studio setto ventricolare

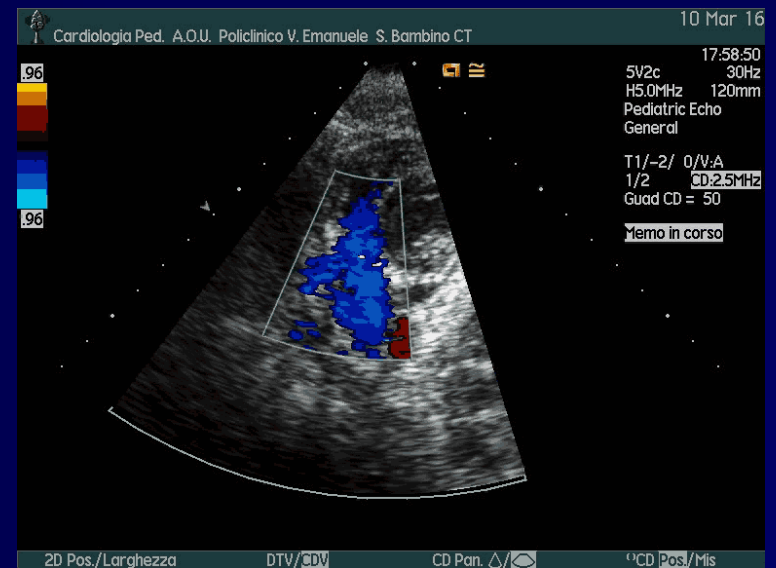
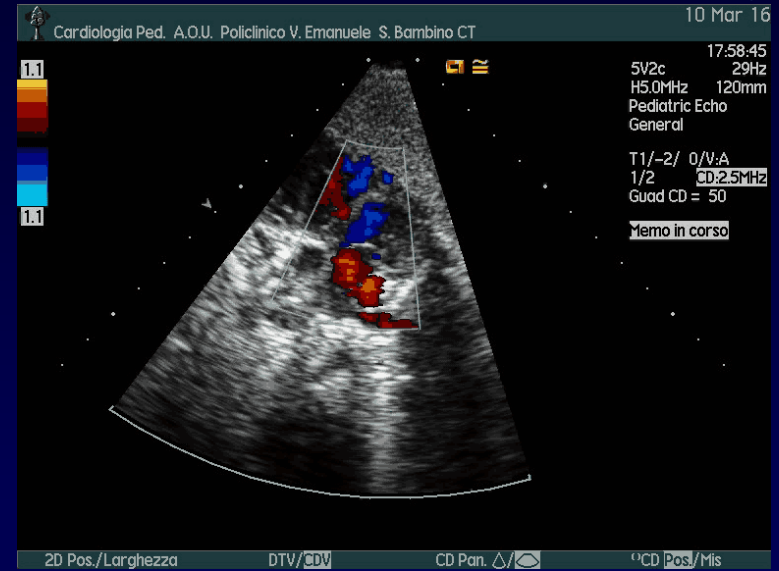




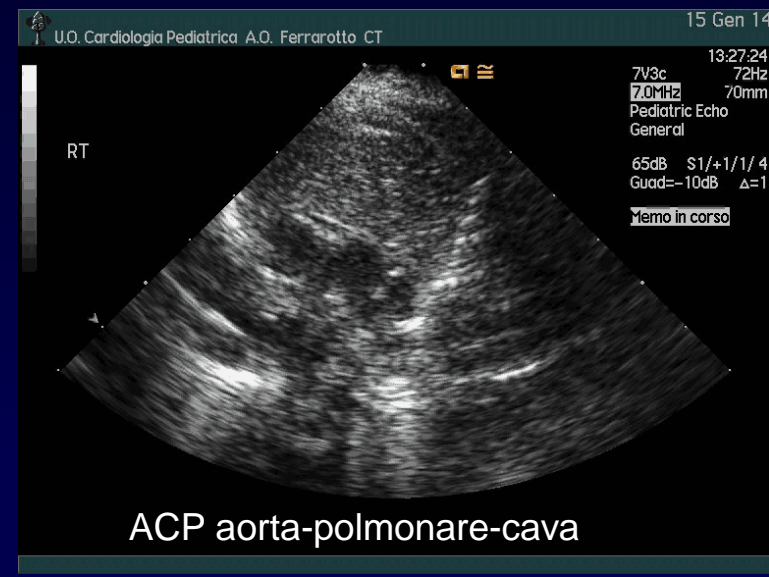
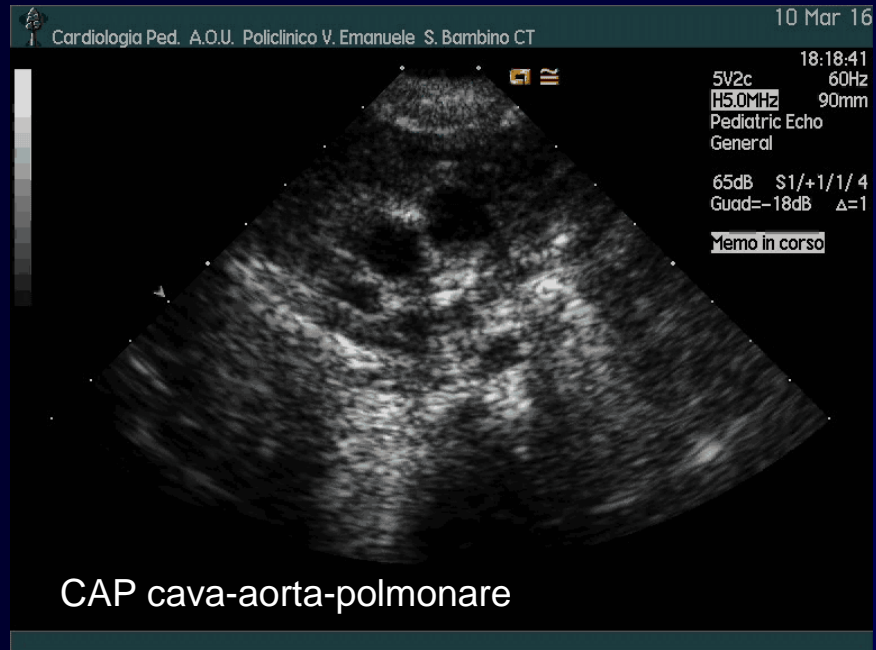
7. Ventriculo-arterial alignments  
(concordant, discordant [TGA],  
DORV, etc.)



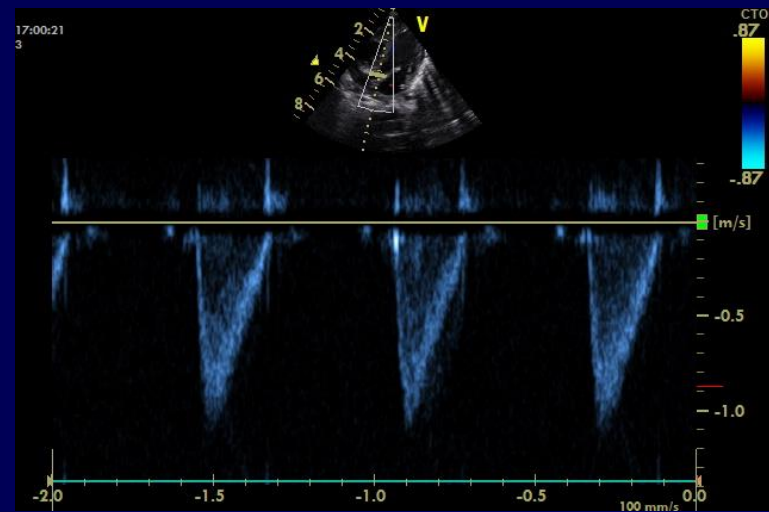
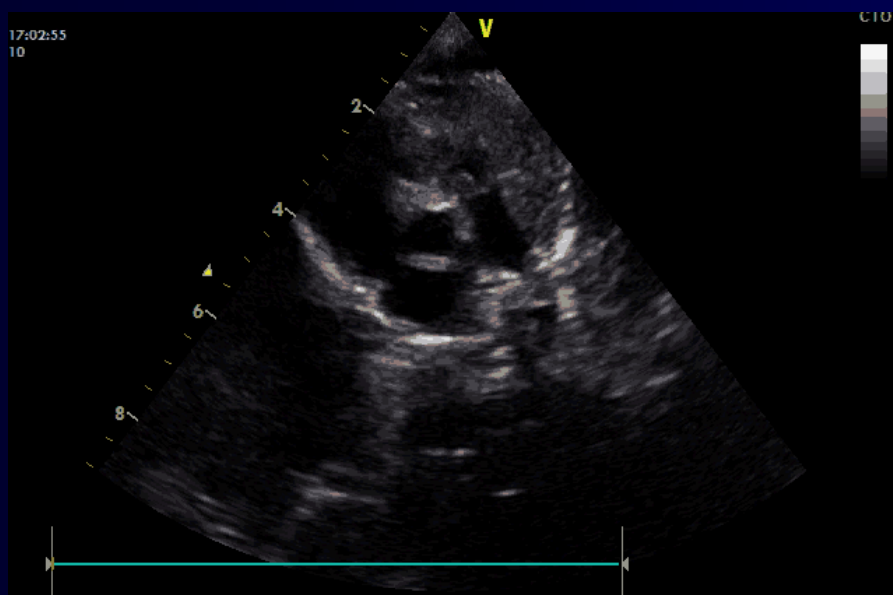
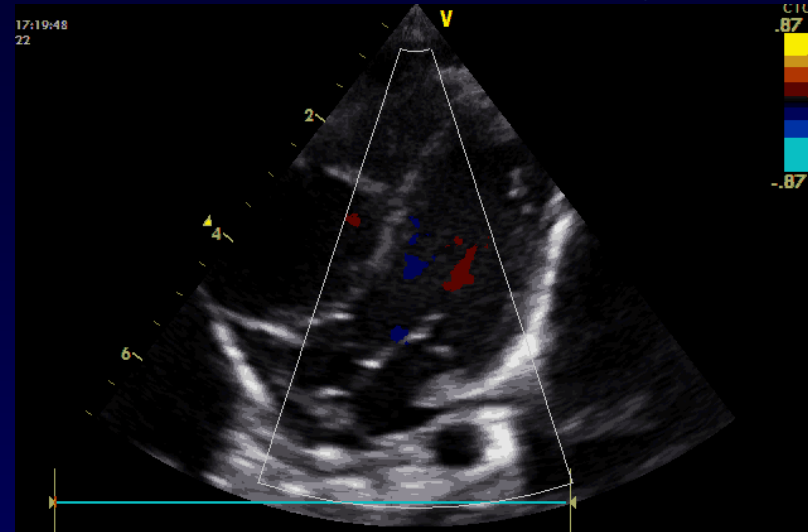
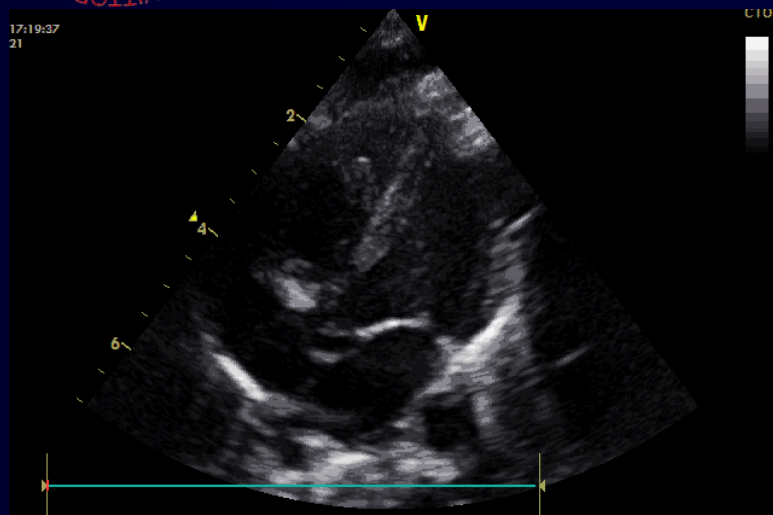
# Proiezione sottocostale



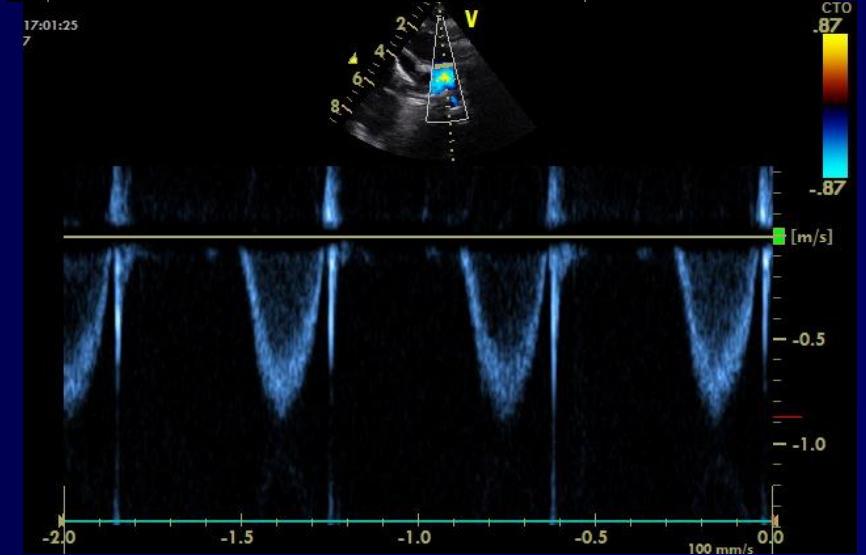
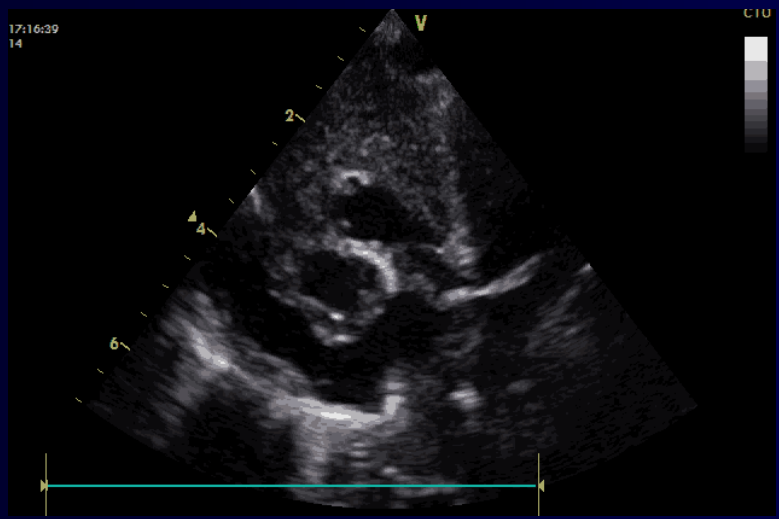
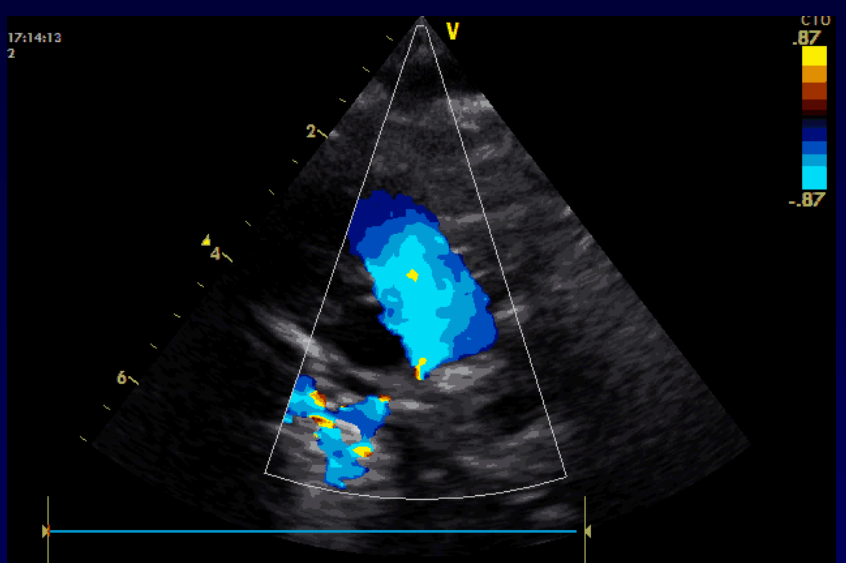
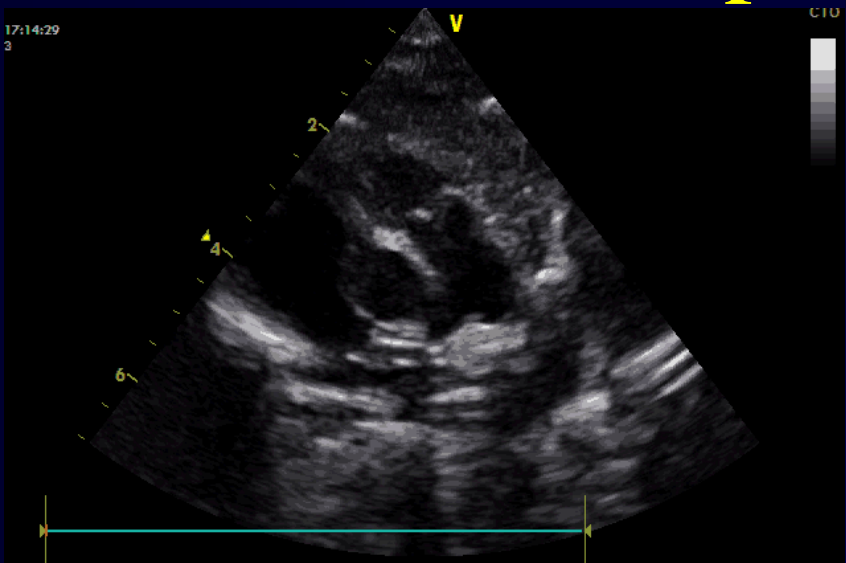
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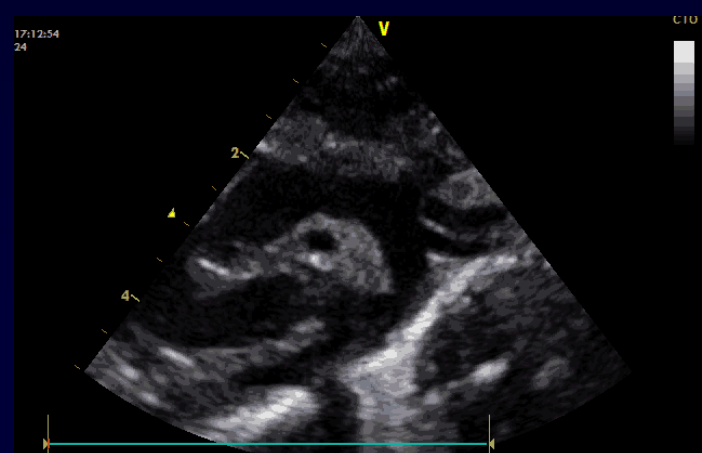


# Studio Valvola Semilunare Aorta

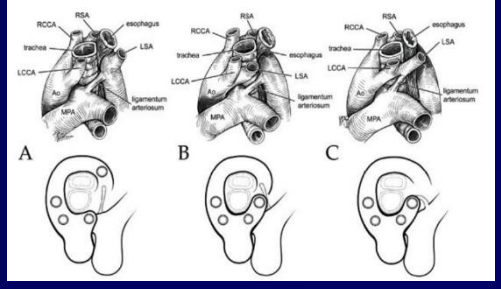
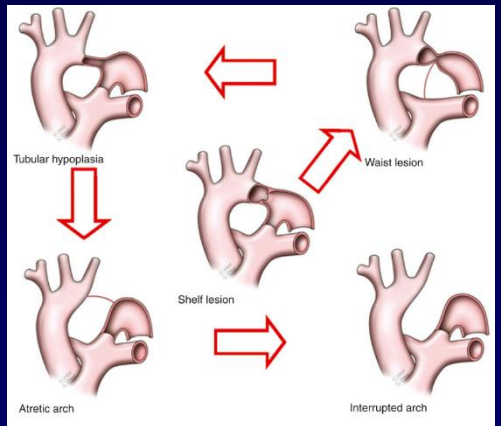
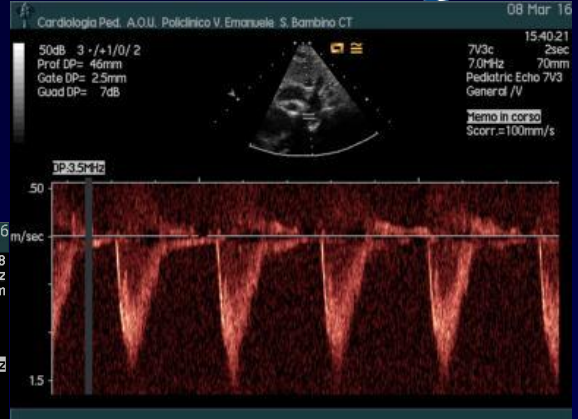


# Studio delle valvole semilunari polmonari

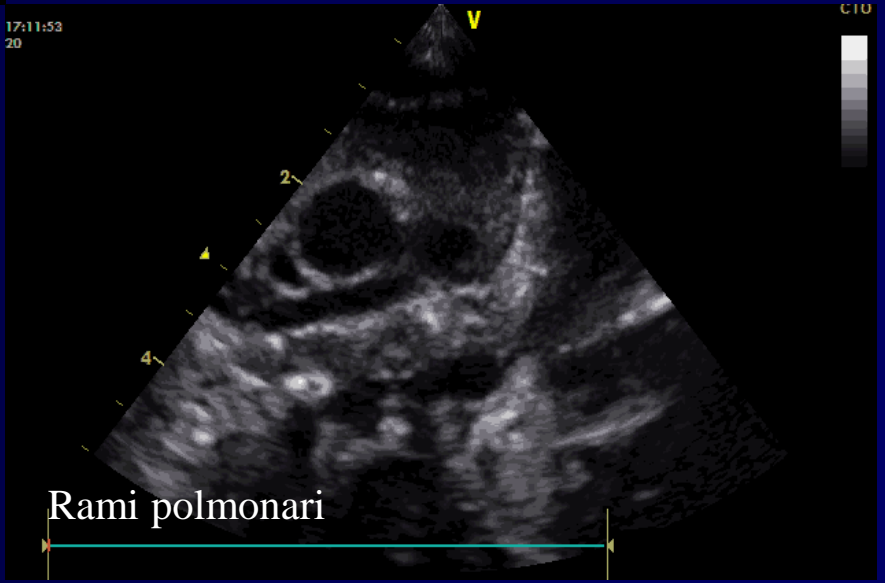
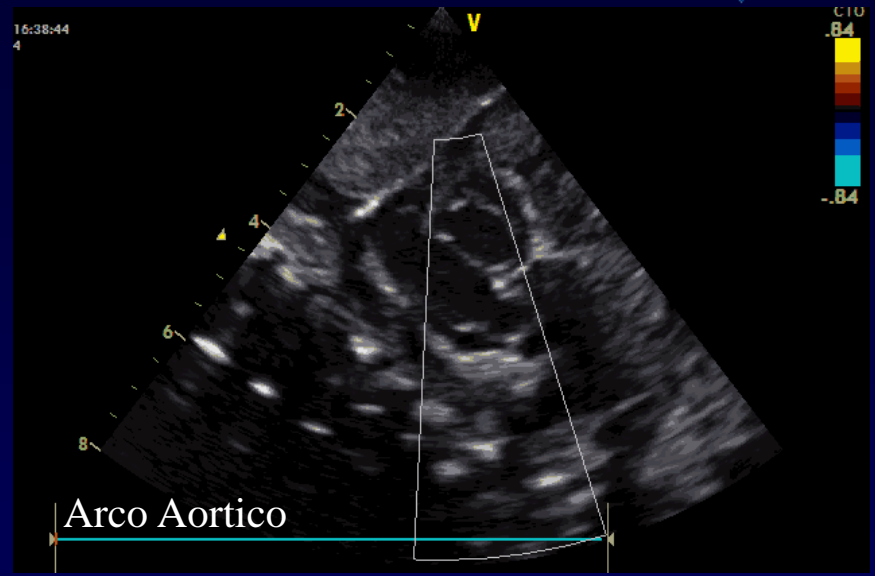
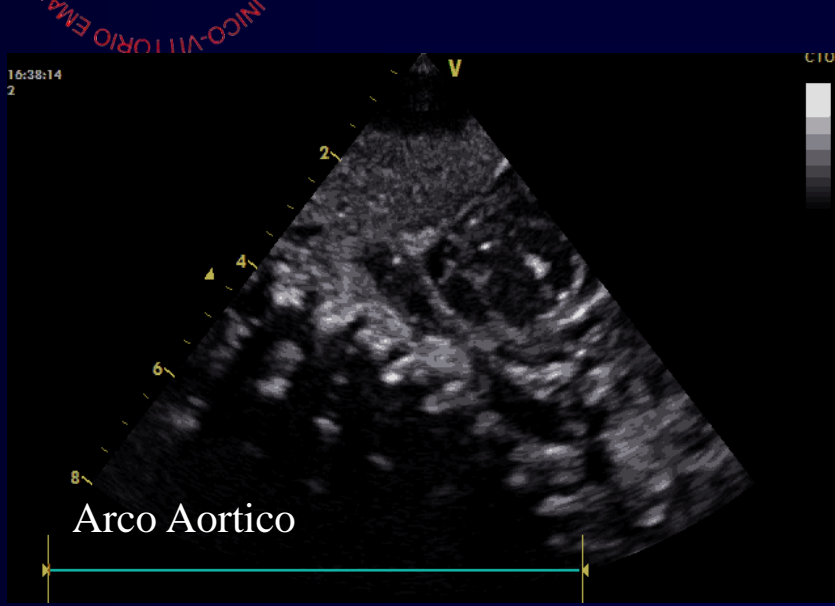




# Aorta Arco

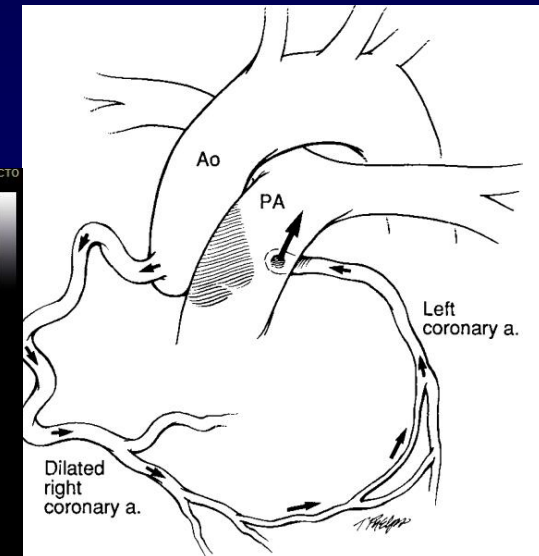
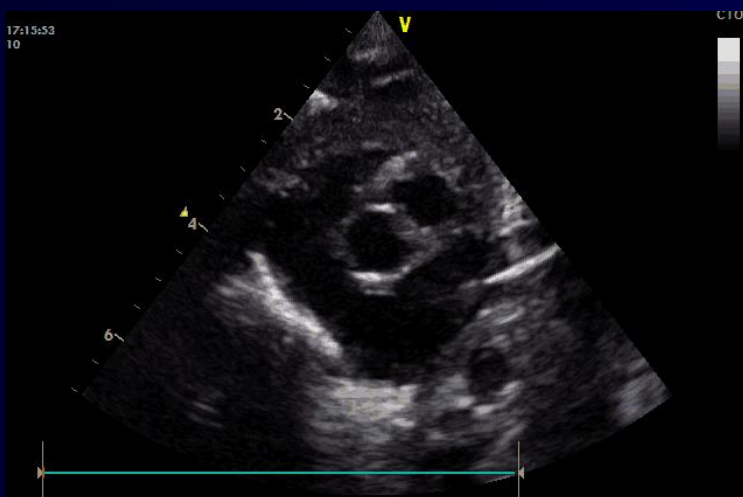
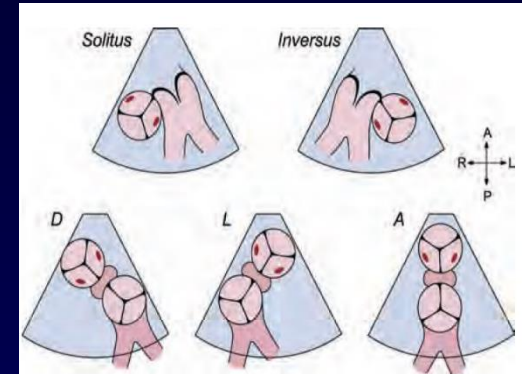
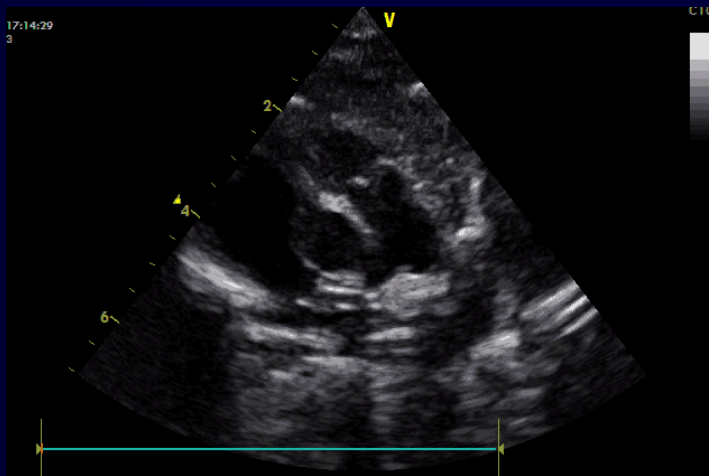


# Sottocostale



Parasternale asse  
corto cranializzata

# Studio origine delle arterie coronarie





# Elenco di ciò che è possibile vedere nelle singole proiezioni

## Structures viewed from subxiphoid (subcostal) views

Inferior vena cava  
 Hepatic veins  
 Abdominal aorta  
 Diaphragm  
 Superior vena cava  
 Left atrium  
 Right atrium  
 Atrial septum  
 Coronary sinus  
 Pulmonary veins  
 Mitral valve  
 Tricuspid valve  
 Left ventricle  
 Right ventricle  
 Ventricular septum  
 Left ventricular papillary muscles  
 Aortic valve  
 Pulmonary valve  
 Ascending aorta  
 Coronary arteries  
 Main and branch pulmonary arteries  
 Pericardium

## Structures viewed from apical views

Inferior vena cava  
 Left atrium  
 Right atrium  
 Atrial septum  
 Coronary sinus  
 Selected pulmonary veins  
 Mitral valve  
 Tricuspid valve  
 Left ventricle  
 Right ventricle  
 Ventricular septum  
 Left ventricular papillary muscles  
 Aortic valve  
 Pulmonary valve  
 Ascending aorta  
 Main and branch pulmonary arteries

## Structures viewed from left parasternal views

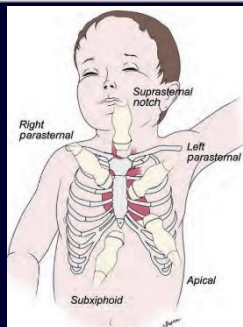
Inferior vena cava  
 Superior vena cava  
 Left atrium  
 Right atrium  
 Atrial septum  
 Coronary sinus  
 Pulmonary veins  
 Mitral valve  
 Tricuspid valve  
 Left ventricle  
 Right ventricle  
 Ventricular septum  
 Left ventricular papillary muscles  
 Aortic valve  
 Pulmonary valve  
 Ascending aorta  
 Coronary arteries  
 Main and branch pulmonary arteries  
 Pericardium

## Structures viewed from suprasternal notch views

Superior vena cava  
 Left atrium  
 Pulmonary veins  
 Ascending aorta  
 Superior thoracic aorta  
 Main and branch pulmonary arteries  
 Aortic arch  
 Proximal brachiocephalic arteries  
 Left innominate vein

## Structures viewed from right parasternal views

Inferior vena cava  
 Superior vena cava  
 Right atrium  
 Atrial septum  
 Right pulmonary veins  
 Ascending aorta  
 Right pulmonary artery



**A = appropriata; M= potrebbe essere appropriata;  
R= raramente appropriata**

**ECG Findings**

9.	PACs in the prenatal or neonatal period	R (3)
10.	PACs after the neonatal period	R (3)
11.	Supraventricular tachycardia	A (7)
12.	PVCs in the prenatal or neonatal period	M (6)
13.	PVCs after the neonatal period	M (6)
14.	Ventricular tachycardia	A (9)
15.	Sinus bradycardia	R (2)
16.	Sinus arrhythmia	R (1)

**TABLE 6 Prior Test Results**

Indication	Appropriate Use Rating
49. Known channelopathy	M (4)
50. Genotype positive for cardiomyopathy	A (9)
51. Abnormal chest X-ray findings suggestive of cardiovascular disease	A (9)
52. Abnormal ECG without symptoms	A (7)
53. Desaturation based on pulse oximetry	A (9)
54. Previously normal echocardiogram with no change in cardiovascular status or family history	R (1)
55. Previously normal echocardiogram with a change in cardiovascular status and/or a new family history suggestive of heritable heart disease	A (7)
56. Elevated anti-streptolysin O titers without suspicion for rheumatic fever	R (3)
57. Chromosomal abnormality known to be associated with cardiovascular disease	A (9)
58. Chromosomal abnormality with undefined risk for cardiovascular disease	M (5)
59. Positive blood cultures suggestive of infective endocarditis	A (9)
60. Abnormal cardiac biomarkers	A (9)
61. Abnormal barium swallow or bronchoscopy suggesting vascular ring	A (7)

**TABLE 8 Family History of Cardiovascular Disease in Patients Without Signs or Symptoms and Without Confirmed Cardiac Diagnosis**

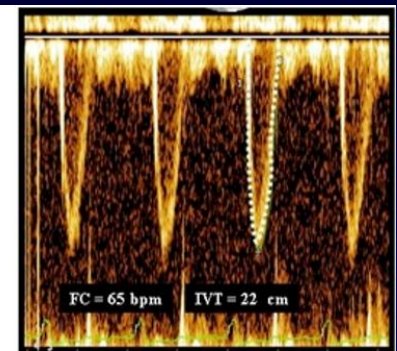
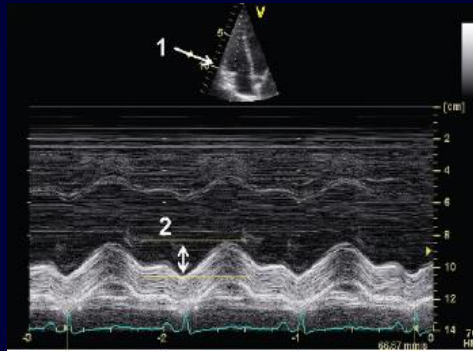
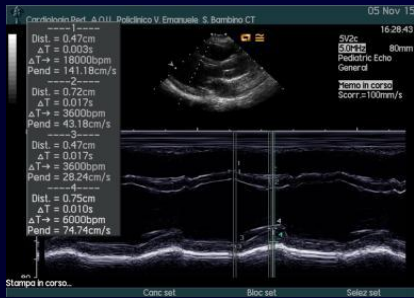
Indication	Appropriate Use Rating
89. Unexplained sudden death before the age of 50 years	M (6)
90. Premature coronary artery disease before the age of 50 years	R (2)
91. Channelopathy	R (3)
92. Hypertrophic cardiomyopathy	A (9)
93. Non-ischemic dilated cardiomyopathy	A (9)
94. Other cardiomyopathies	A (8)
95. Unspecified cardiovascular disease	R (3)
96. Disease at high risk for cardiovascular involvement, including but not limited to diabetes, systemic hypertension, obesity, stroke, and peripheral vascular disease	R (2)
97. Genetic disorder at high risk for cardiovascular involvement	A (7)
98. Marfan or Loeys Dietz syndrome	A (7)
99. Connective tissue disorder other than Marfan or Loeys Dietz syndrome	M (6)
100. Congenital left-sided heart lesion, including but not limited to mitral stenosis, left ventricular outflow tract obstruction, bicuspid aortic valve, aortic coarctation, and/or hypoplastic left heart syndrome	M (6)
101. Congenital heart disease other than the congenital left-sided heart lesions	M (5)
102. Idiopathic pulmonary arterial hypertension	M (5)
103. Heritable pulmonary arterial hypertension	A (8)
104. Pulmonary arterial hypertension other than idiopathic and heritable	R (3)
105. Consanguinity	R (3)

**TABLE 9 Outpatient Neonates Without Post-Natal Cardiology Evaluation**

Indication	Appropriate Use Rating
106. Suspected cardiovascular abnormality on fetal echocardiogram	A (9)
107. Isolated echogenic focus on fetal ultrasound	R (2)
108. Maternal infection during pregnancy or delivery with potential fetal/neonatal cardiac sequelae	A (7)
109. Maternal diabetes with no prior fetal echocardiogram	M (6)
110. Maternal diabetes with a normal fetal echocardiogram	M (4)
111. Maternal phenylketonuria	A (7)
112. Maternal autoimmune disorder	M (5)
113. Maternal teratogen exposure	M (6)

**ACC/AAP/AHA/ASE/HRS/  
SCAI/SCCT/SCMR/SOPE  
2014 Appropriate Use Criteria for  
Initial Transthoracic Echocardiography  
in Outpatient Pediatric Cardiology**

# 2° Indicazione: indice di funzione



## M- Mode

- diametri e spessori parietali delle cavità cardiache
- TAPSE 22<sub>±</sub>4 mm
- MAPSE 12<sub>±</sub>2 mm

## B-Mode

- diametri
- Aree
- Volumi
- Frazione di Eiezione

## Doppler

- Gittata cardiaca
- Indice di contrattilità isovolumetrica DP/DT
- Tei-index

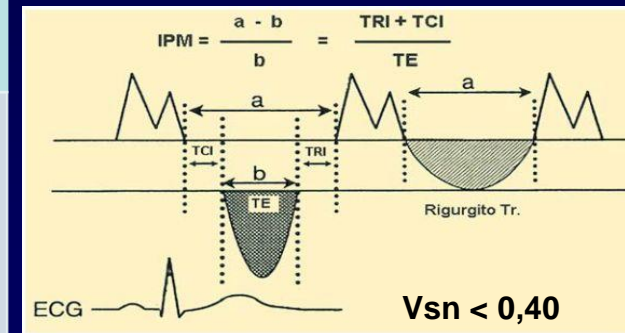
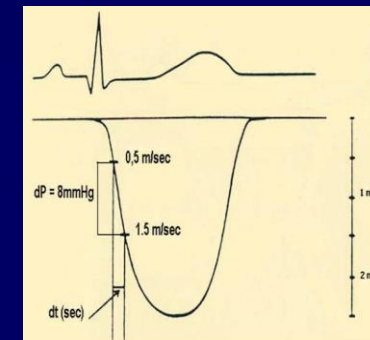


Tabella VI. Legenda: MAPSE: mitral annular plane excursion, DTI: Doppler tissue imaging, S<sub>m</sub>: velocità dell'onda sistolica.

Parametro	Essenziale	Utile	Superfluo	Scopo di ricerca
Gittata sistolica		✓		
Portata cardiaca		✓		
Frazione di eiezione	✓			
Frazione di accorciamento			✓	
Frazione di accorciamento delle aree			✓	
MAPSE		✓		
DTI S <sub>m</sub>		✓		✓
Distanza E-tangente setto			✓	
Indice di Tei				✓
Strain imaging		✓		✓
Eco stress		✓		✓

Vsn 1400-1800  
 mmHg/sec  
 (dipendente da  
 pre e postcarico)



# funzione diastolica ventricolo sn



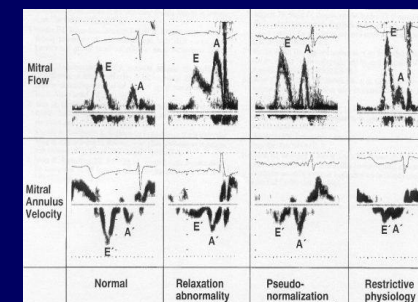
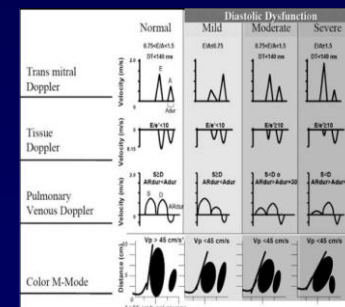
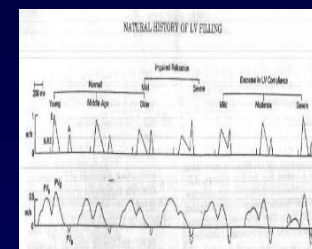
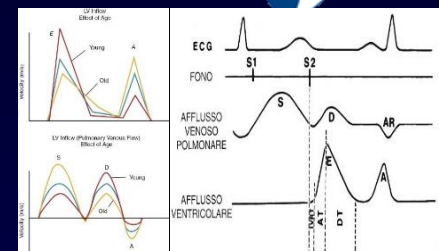
TABLE 3.1 Normal Diastolic Doppler Data in Children

	Age (y)		
	3-8 (n = 75)	9-12 (n = 72)	13-17 (n = 76)
<b>Mitral valve</b>			
E velocity (cm/s)	92 (14)	86 (15)	88 (14)
A velocity (cm/s)	42 (11)	41 (9)	39 (8)
A duration (ms)	136 (22)	142 (21)	141 (22)
E to A velocity ratio	2.4 (0.7)	2.2 (0.6)	2.3 (0.6)
Deceleration time (ms)	145 (18)	157 (19)	172 (22)
LV IVRT (ms)	62 (10)	67 (10)	74 (13)
<b>Pulmonary vein</b>			
Systolic velocity (cm/s)	46 (9)	45 (9)	41 (10)
Diastolic velocity (cm/s)	59 (8)	54 (9)	59 (11)
Atrial reversal velocity (cm/s)	21 (4)	21 (5)	21 (7)
Atrial reversal duration (ms)	130 (20)	125 (20)	140 (28)
<b>Difference data</b>			
PVAR duration - MV A duration (ms)	-8 (26)	-17 (24)	-6 (33)

Values in parentheses represent 1 SD.

A, atrial filling wave; E, early filling wave; IVRT, isovolumic relaxation time; LV, left ventricle; MV, mitral valve; PVAR, pulmonary vein atrial reversal.

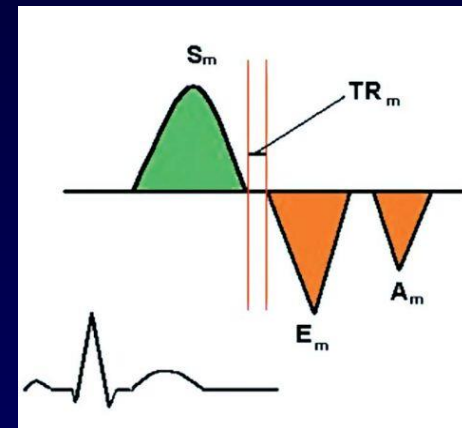
Modified from O'Leary PW, et al. Diastolic ventricular function in children: a Doppler echocardiographic study establishing normal values and predictors of increased ventricular end-diastolic pressure. *Mayo Clin Proc* 1998;73:616-628 and reproduced with permission.



# Funzione Diastolica Doppler Tissutale

TABLE 3.2 Pulsed-Wave Doppler Tissue Velocities and Time Intervals in Healthy Children by Age Group

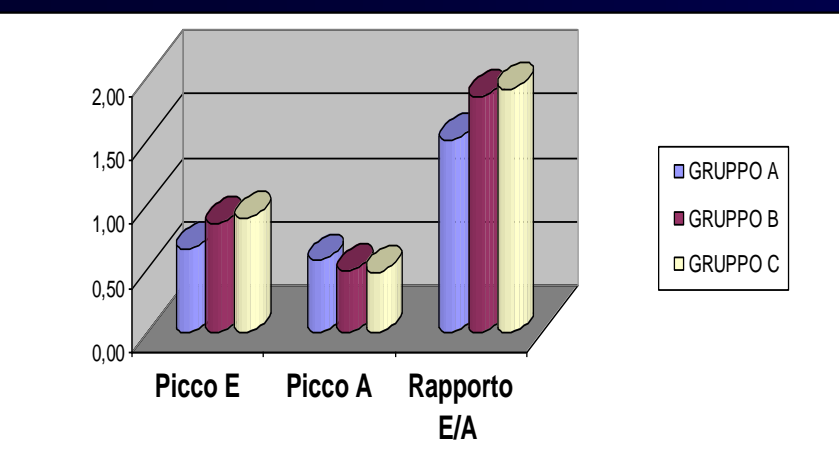
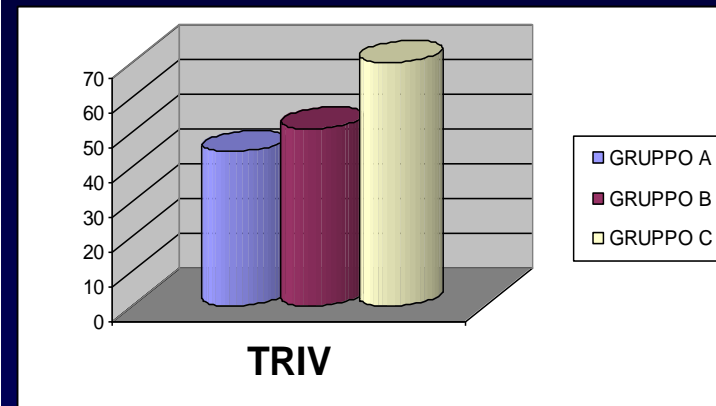
Age group	N	E'-wave velocity	A'-wave velocity	S'-wave velocity	ICT	IRT	E/E ratio
<b>Mitral annular</b>							
<1y	63	9.7 ± 3.3 (8.8 – 10.5)	5.7 ± 1.8 (5.3 – 6.2)	5.7 ± 1.6 (5.3 – 6.1)	77.4 ± 18.4 (72.7 – 82.0)	57.0 ± 14.8 (53.1 – 60.8)	8.8 ± 2.7 (8.1 – 9.5)
1-5y	68	15.1 ± 3.41 (14.3 – 15.4)	6.5 ± 1.9 (6.1 – 7.0)	7.7 ± 2.11 (7.2 – 8.2)	76.9 ± 15.9 (72.8 – 80.9)	62.1 ± 13.2 (58.9 – 65.4)	6.5 ± 2.01 (6.0 – 7.0)
6-9y	55	17.2 ± 3.71 (16.2 – 18.3)	6.7 ± 1.9 (6.2 – 7.3)	9.5 ± 2.11 (8.9 – 10.1)	77.9 ± 18.9 (72.4 – 83.4)	62.9 ± 11.9 (59.5 – 66.3)	5.8 ± 1.9 (5.3 – 6.4)
10-13y	58	19.6 ± 3.41 (18.7 – 20.5)	6.4 ± 1.8 (5.9 – 6.9)	10.8 ± 2.9* (10.0 – 11.5)	79.6 ± 16.2 (74.4 – 80.9)	62.6 ± 12.4 (59.4 – 65.9)	4.9 ± 1.3 (4.6 – 5.2)
14-18y	81	20.6 ± 3.8 (19.7 – 21.4)	6.7 ± 1.6 (6.3 – 7.1)	12.3 ± 2.91 (11.6 – 12.9)	78.9 ± 15.4 (75.4 – 82.3)	69.5 ± 15.5* (66.1 – 73.0)	4.7 ± 1.3 (4.4 – 5.0)
Total	325	16.5 ± 5.3 (16.0 – 17.1)	6.4 ± 1.9 (6.2 – 6.6)	9.3 ± 3.4 (8.9 – 9.7)	77.5 ± 16.7 (75.7 – 79.5)	63.2 ± 14.4 (61.7 – 64.9)	6.1 ± 2.4 (5.9 – 6.4)
<b>Septal</b>							
<1y	63	8.1 ± 2.5 (7.5 – 8.7)	6.1 ± 1.5 (5.7 – 6.4)	5.4 ± 1.2 (5.1 – 5.7)	77.5 ± 17.5 (73.0 – 82.0)	53.0 ± 11.7 (50.0 – 56.0)	10.3 ± 2.7 (9.7 – 11.0)
1-5y	68	11.8 ± 2.01 (11.3 – 12.3)	6.0 ± 1.3 (5.7 – 6.4)	7.1 ± 1.51 (6.8 – 7.5)	80.1 ± 15.5 (76.3 – 83.9)	59.8 ± 12.0 (56.9 – 62.7)	8.1 ± 1.81 (7.7 – 8.5)
6-9y	55	13.4 ± 1.91 (12.8 – 13.9)	5.9 ± 1.3 (5.5 – 6.3)	8.0 ± 1.3 (7.6 – 8.4)	82.8 ± 15.3 (78.4 – 87.2)	65.6 ± 10.7 (62.5 – 68.7)	7.2 ± 1.6 (6.8 – 7.7)
10-13y	58	14.5 ± 2.6 (13.8 – 15.2)	6.1 ± 2.3 (5.6 – 6.7)	8.2 ± 1.3 (7.9 – 8.5)	87.9 ± 16.4* (83.6 – 92.2)	72.5 ± 12.3 (69.3 – 75.8)	6.6 ± 1.4 (6.3 – 7.0)
14-18y	81	14.9 ± 2.4 (14.3 – 15.4)	6.2 ± 1.5 (5.9 – 6.6)	9.0 ± 1.5 (8.7 – 9.3)	88.4 ± 15.6 (84.9 – 91.9)	77.5 ± 14.5 (74.3 – 80.8)	6.4 ± 1.5 (6.1 – 6.8)
Total	325	12.6 ± 3.4 (12.2 – 13.0)	6.1 ± 1.6 (5.9 – 6.3)	7.6 ± 1.9 (7.4 – 7.8)	83.5 ± 16.5 (81.7 – 85.4)	66.1 ± 15.3 (64.4 – 67.9)	7.7 ± 2.3 (7.5 – 8.0)
<b>Tricuspid annular</b>							
<1y	63	13.8 ± 8.2 (11.7 – 15.9)	9.8 ± 2.4 (9.1 – 10.5)	10.2 ± 5.5 (8.8 – 11.7)	68.7 ± 18.2 (63.9 – 73.5)	52.0 ± 12.9 (48.5 – 55.4)	4.4 ± 2.3 (3.8 – 5.0)
1-5y	68	17.1 ± 4.01 (16.1 – 18.1)	10.9 ± 2.7 (10.2 – 11.6)	13.2 ± 2.01 (12.7 – 13.7)	77.7 ± 15.0 (73.9 – 81.5)	59.0 ± 13.9 (55.4 – 62.5)	3.8 ± 1.1 (3.5 – 4.1)
6-9y	55	16.5 ± 3.0 (15.7 – 17.4)	9.8 ± 2.7 (9.0 – 10.6)	13.4 ± 2.0 (12.8 – 14.0)	91.8 ± 21.51 (85.5 – 98.0)	58.5 ± 17.5 (53.4 – 63.6)	3.6 ± 0.8 (3.4 – 3.9)
10-13y	58	16.5 ± 3.1 (15.7 – 17.4)	10.3 ± 3.4 (9.3 – 11.2)	13.9 ± 2.4 (13.2 – 14.5)	98.1 ± 21.7 (92.2 – 103.9)	61.7 ± 19.9 (56.4 – 67.1)	3.5 ± 1.4 (3.2 – 3.9)
14-18y	81	16.7 ± 2.8 (16.0 – 17.3)	10.1 ± 2.6 (9.5 – 10.7)	14.2 ± 2.3 (13.7 – 14.7)	101.9 ± 20.4 (97.2 – 106.6)	63.9 ± 18.9 (58.5 – 67.3)	3.7 ± 1.0 (3.5 – 3.9)
Total	325	16.1 ± 4.7 (15.6 – 16.7)	10.2 ± 2.8 (9.9 – 10.5)	13.0 ± 3.4 (12.6 – 13.4)	88.2 ± 23.1 (85.6 – 90.8)	59.0 ± 17.2 (57.0 – 60.9)	3.8 ± 1.4 (3.6 – 4.0)



# Risultati



	<b>Gruppo A 30-60 giorni</b>	<b>Gruppo B 1-3 anni</b>	<b>Gruppo C 6-12 anni</b>
<b>TRVI ms</b>	44.3 ± 8.3	51 ± 7.8	70 ± 10
<b>Picco E ms</b>	0.65 ± 0.12	0.85 ± 0.14	0.89 ± 0.16
<b>Picco A ms</b>	0.56 ± 0.08	0.48 ± 0.13	0.47 ± 0.12
<b>Rapporto E/A</b>	1.5 ± 0.42	1.84 ± 0.5	1.9 ± 0.42
<b>DT ms</b>	86 ± 26	116 ± 30	122 ± 26
<b>Vp cm/s</b>	>50	>50	>50
<b>Em cm/s</b>	>8.5	>8.5	>8.5
<b>E/Em</b>	<8	<8	<8
<b>Tempo A/Tempo AR</b>	0.32 ± 0.09	0.25 ± 0.8	0.25 ± 0.8



<b>Flusso Polmonare</b>	<b>Gruppo A</b>	<b>Gruppo B</b>	<b>Gruppo C</b>
<b>Picco S cm/s</b>	44 ± 8	43 ± 7	40 ± 6
<b>Picco D cm/s</b>	41 ± 8	47 ± 8	51 ± 8
<b>VTI S cm</b>	8.96 ± 1.86	10.14 ± 1.82	10.4 ± 1.85
<b>VTI D cm</b>	5.14 ± 1.69	7.14 ± 1.95	9.84 ± 2.19
<b>Picco A cm/s</b>	21 ± 2.8	22.5 ± 4.2	23.7 ± 3.6

# Indice di funzione sistolica

## Vdx

**Table 1** Classification table for TAPSE values

Age	n	TAPSE (cm)					BSA (m <sup>2</sup> )			Indexed TAPSE mean/BSA mean
		Mean	Bounds for z-score ranges			Mean	Minimum	Maximum		
			±2 SD (95%)	±3 SD (99%)						
0-30 d	41	0.91	0.68	1.15	0.56	1.26	0.22	0.14	0.28	4.13
1-3 mo	45	1.14	0.85	1.42	0.71	1.56	0.29	0.12	0.54	3.93
4-6 mo	20	1.31	1.01	1.65	0.86	1.77	0.34	0.26	0.41	3.85
7-12 mo	22	1.44	1.13	1.77	0.97	1.91	0.40	0.31	0.47	3.6
1 y	25	1.55	1.25	1.88	1.10	2.00	0.47	0.3	0.69	3.29
2 y	39	1.65	1.36	1.94	1.22	2.09	0.53	0.4	0.62	3.11
3 y	27	1.74	1.48	2.02	1.35	2.14	0.63	0.52	0.77	2.76
4 y	47	1.82	1.56	2.07	1.43	2.20	0.70	0.6	0.91	2.6
5 y	29	1.87	1.60	2.13	1.47	2.26	0.77	0.63	0.99	2.42
6 y	41	1.90	1.62	2.18	1.48	2.33	0.82	0.46	1.06	2.31
7 y	32	1.94	1.64	2.25	1.49	2.39	0.94	0.75	1.17	2.06
8 y	23	1.97	1.67	2.28	1.52	2.43	0.97	0.79	1.39	2.03
9 y	20	2.01	1.73	2.30	1.58	2.44	1.00	0.8	1.32	2.01
10 y	27	2.05	1.79	2.31	1.65	2.46	1.15	0.82	1.54	1.78
11 y	25	2.10	1.83	2.36	1.69	2.50	1.28	1.06	1.55	1.64
12 y	18	2.14	1.84	2.43	1.68	2.60	1.39	1.08	1.67	1.53
13 y	20	2.20	1.85	2.54	1.68	2.71	1.48	1.03	1.87	1.48
14 y	35	2.26	1.87	2.65	1.68	2.84	1.55	1.11	1.93	1.45
15 y	25	2.33	1.93	2.75	1.74	2.92	1.59	1.32	1.96	1.46
16 y	34	2.39	1.98	2.78	1.78	3.01	1.66	1.3	2.04	1.43
17 y	27	2.45	2.04	2.88	1.83	3.06	1.77	1.43	2.06	1.38
18 y	21	2.47	2.05	2.91	1.84	3.10	1.79	1.34	2.25	1.37

For each age group, the SD of TAPSE was taken to construct ranges of the mean  $\pm$  2 SDs and the mean  $\pm$  3 SDs. These ranges represented the expectable normal intervals of deviation for certainty levels of 95% and 99%. Furthermore, the mean, minimum, and maximum of BSA were calculated for the age groups. An index was calculated of mean TAPSE for age divided by mean BSA for each age group.

**Table 1** Patient demographics Journal of the American Society of Echocardiography May 2012

Variable	Controls (n = 44)	Patients with PHT (n = 41)	P
Age (y)	7.7 ± 4.1	7.9 ± 5.6	.82
Height (cm)	126.1 ± 23.7	117.6 ± 34.2	.20
Weight (kg)	31.1 ± 16.5	26 ± 17.5	.14
Heart rate (beats/min)	97 ± 28	105 ± 23	.43

**Table 2** Conventional echocardiographic measures

Variable	Controls (n = 44)	Patients with PHT (n = 41)	P
RA area	9.6 ± 2.5	12.4 ± 6.2	.02
LA diameter	9.2 ± 2.8	7.6 ± 3.7	.044
TV diameter	2.15 ± 0.48	2.57 ± 0.75	.005
PV diameter	1.85 ± 0.36	2.06 ± 0.65	.10
Right PA	1.1 ± 0.3	1.3 ± 0.5	.002
Left PA	1.1 ± 0.3	1.4 ± 0.5	.002
RVIDd (cm)	1.83 ± 0.72	2.73 ± 1.29	.0002
RVIDs (cm)	1.5 ± 0.52	3.6 ± 6.5	.002
TR velocity (m/sec)	2 ± 0.4	4.5 ± 1	<.0001
PA acceleration (msec)	119.7 ± 31.8	65.3 ± 22.7	<.0001
MV diameter	2.10 ± 0.45	1.83 ± 0.59	.03
LVEId	1 ± 0	1.6 ± 0.5	<.0001
LVEIs	1.1 ± 0.1	2.1 ± 0.8	<.0001
TAPSE (cm)	1.9 ± 0.2	1.4 ± 0.3	<.0001
EF (%)	58.7 ± 12.6	66.3 ± 16.6	.10

LA, Left atrial; LVEId, LVEI in diastole; LVEIs, LVEI in systole; MV, mitral valve; PA, pulmonary artery; PV, pulmonary valve; RA, right atrial; RVIDd, diastolic RV inner diameter; RVIDs, systolic RV inner diameter; TV, tricuspid valve.  
Data are expressed as mean ± SD.

Tabella I. Valori normali indicizzati per BSA calcolati all'ecocardiogramma. Le misure dei diametri ventricolari sinistro destro sono relativi alla sezione parasternale asse lungo in telediastole. I diametri delle valvole aorta o polmonaresono misurati a livello dell'anulus. Tutti i valori sono espressi in millimetri

BSA	Polmonare		Aorta		Ventricolo sn		Ventricolo dx	
	Media	Dev St	Media	Dev St	Media	Dev St	Media	Dev St
25	8.40	1.10	7.20	1.00	20.00	3.60	8.70	4.50
30	9.30	1.15	8.10	1.00	22.90	4.90	8.70	4.50
35	10.10	1.20	8.80	1.00	23.60	4.60	8.80	4.50
40	10.70	1.15	9.50	1.00	26.00	5.00	8.90	4.50
45	11.30	1.15	10.10	1.00	27.10	5.05	9.00	4.50
50	11.90	1.20	10.60	1.00	29.00	5.60	9.30	4.50
60	12.80	1.20	11.40	1.05	31.60	5.60	9.60	4.40
70	13.50	1.15	12.20	1.00	33.90	6.50	10.10	4.40
80	14.20	1.20	12.80	1.00	35.80	6.20	10.50	4.70
90	14.80	1.15	13.40	1.00	37.10	6.10	11.00	4.60
100	15.30	1.15	13.90	1.00	38.50	6.80	11.20	4.80
120	16.20	1.20	14.80	1.00	41.70	6.20	12.4	4.80
140	17.00	1.15	15.60	1.00	43.30	6.00	14.00	5.00
160	17.60	1.15	16.20	1.00	45.8	6.05	16.00	5.05
180	18.20	1.15	16.80	1.00	47.00	8.00	16.70	5.50
200	18.7	1.15	17.30	1.00	53.40	8.00	17.50	6.00





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## Early Human Development

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Best Practice Guideline article

### Functional echocardiography; from physiology to treatment

Koert de Waal <sup>a,\*</sup>, Martin Kluckow <sup>b</sup>

#### 2. In what clinical situations can fECHO be used?

In the neonatal intensive care there are several clinical situations where additional information gathered with fECHO could assist in clinical management. In this paper we will discuss the following situations:

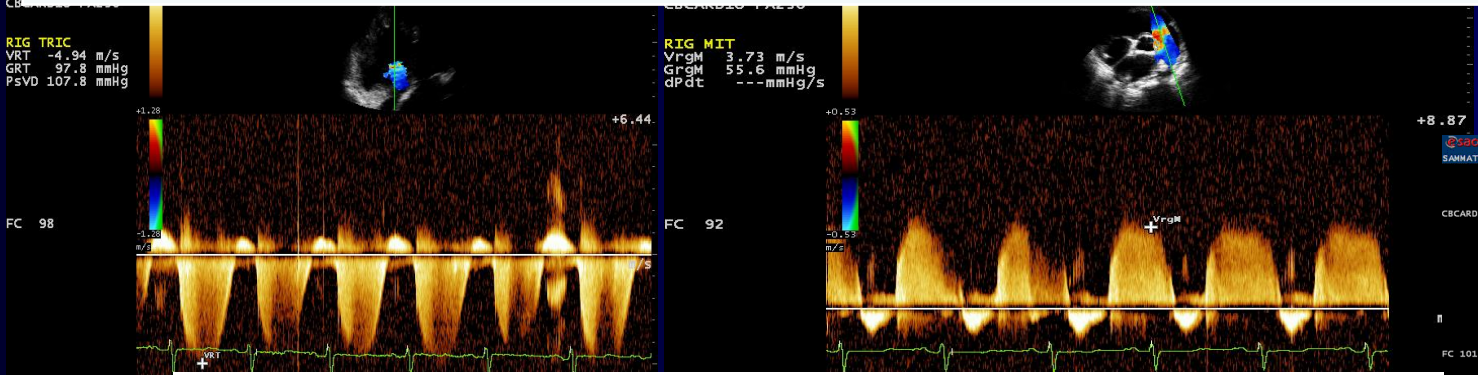
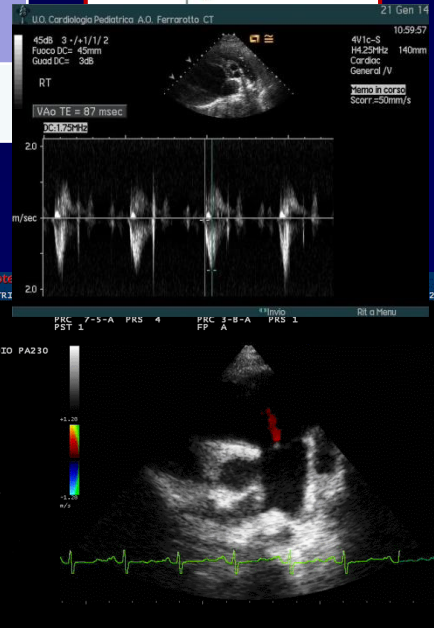
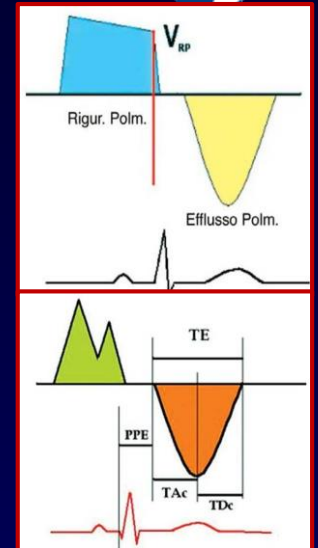
1. The very low birth weight infant (VLBW) with hypotension during the first 24 h of life.
2. Assessment and monitoring of the ductus arteriosus.
3. Assessment and response to treatment of infants with pulmonary hypertension.
4. The infant with perinatal asphyxia.
5. The infant with sepsis and cardiovascular compromise.

# Valutazione Pressione in Arteria Polmonare

## Ruolo Ecocardiografia Doppler

Pressione arteriosa <b>sistolica</b> polmonare (PAPs)	Gmax RT (4xV2)+PAD Gmax Vsn-Vdx (DIV) Gmax Ao-AP (dotto)
Pressione <b>telediastolica</b> polmonare	Gmax telediastolico + PAD
Tempo di accelerazione Arteria polmonare	< 90msec PAPmedia 20-25mmHg
PAPmedia	(0.61 × PAPs) + 2
PAPmedia da insufficienza valvola polmonare	Gmax protodiastolico + PAD
PAPmedia in presenza di dotto arterioso pervio	PA media sistolica-Gmed dotto

RT rigurgito tricuspidalico, PAD= pressione atrio destro, Tacc= tempo di accelerazione

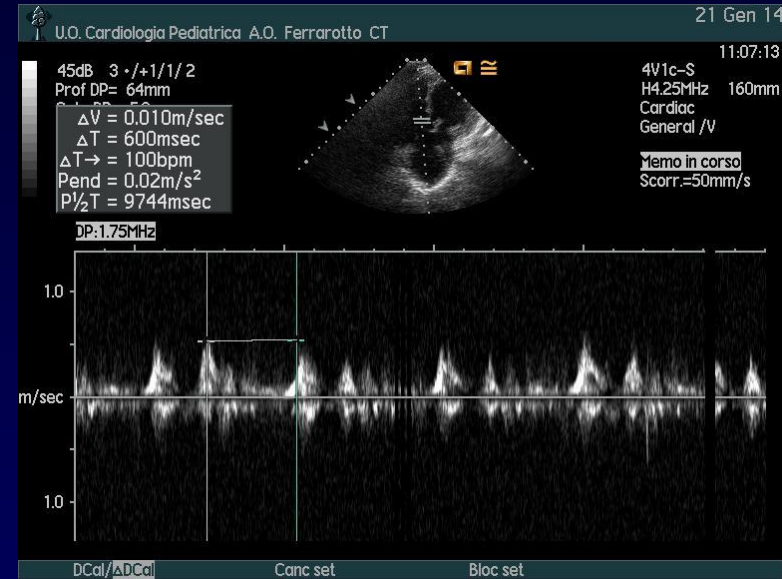


# Ecocardiografia

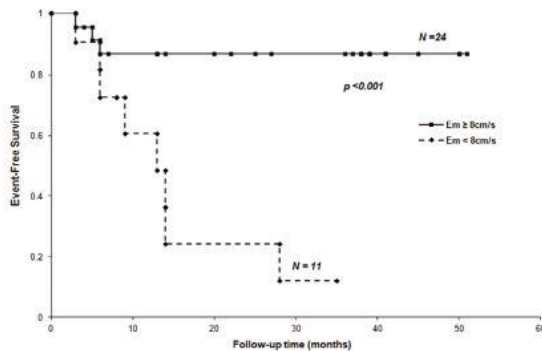
## Stima Pressione atriale destra

VCI in età pediatrica % di collasso	Stima PAD
Collasso > 45%	6 mmHg
35% < collasso < 45%	9 mmHg
Collasso < 35%	16 mmHg

Altro Parametro	PAD
E/Em > 6	> 10 mmHg

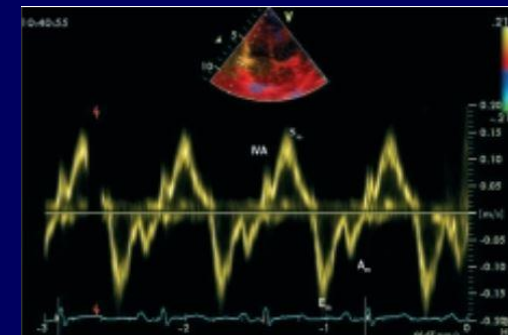
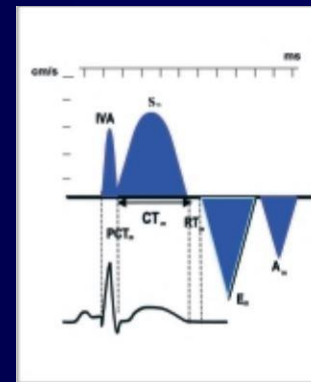


Tricuspid E' velocity by tissue Doppler imaging at baseline and survival rate



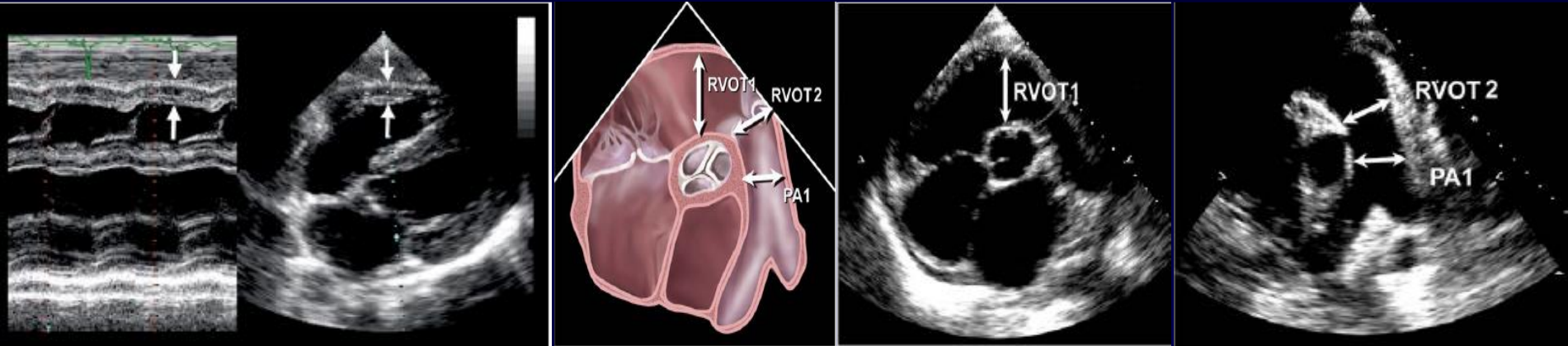
47th Annual Meeting of the Association for European Paediatric and Congenital Cardiology.

**Figure 6.** Event-free survival and tricuspid Em velocity on tissue Doppler imaging at baseline, and survival rate. Cumulative event-free survival was significantly lower when tricuspid Em was 8 cm/s or less (log-rank test,  $P < 0.001$ ).<sup>65</sup>



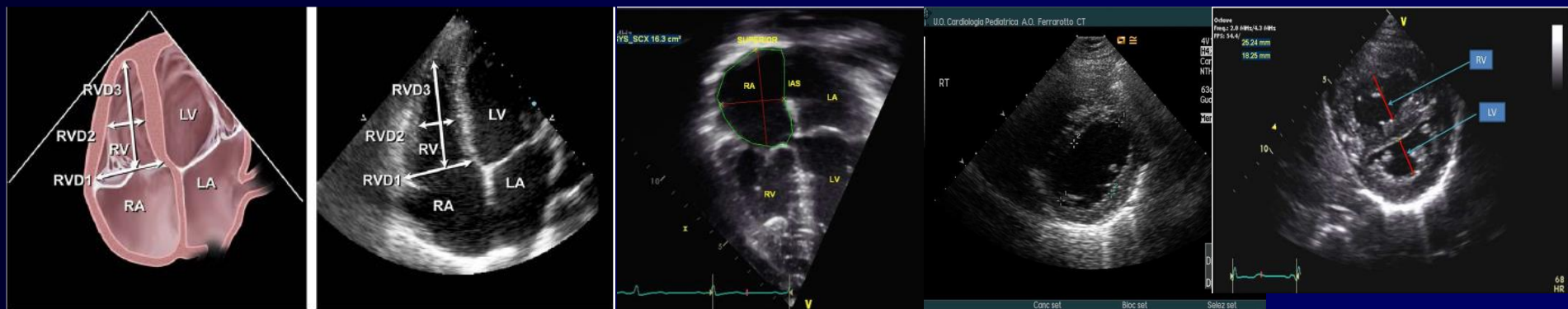


## Echocardiography in pediatric pulmonary hypertension



Sottocostale spessore parietale vdx

Parasternale asse corto



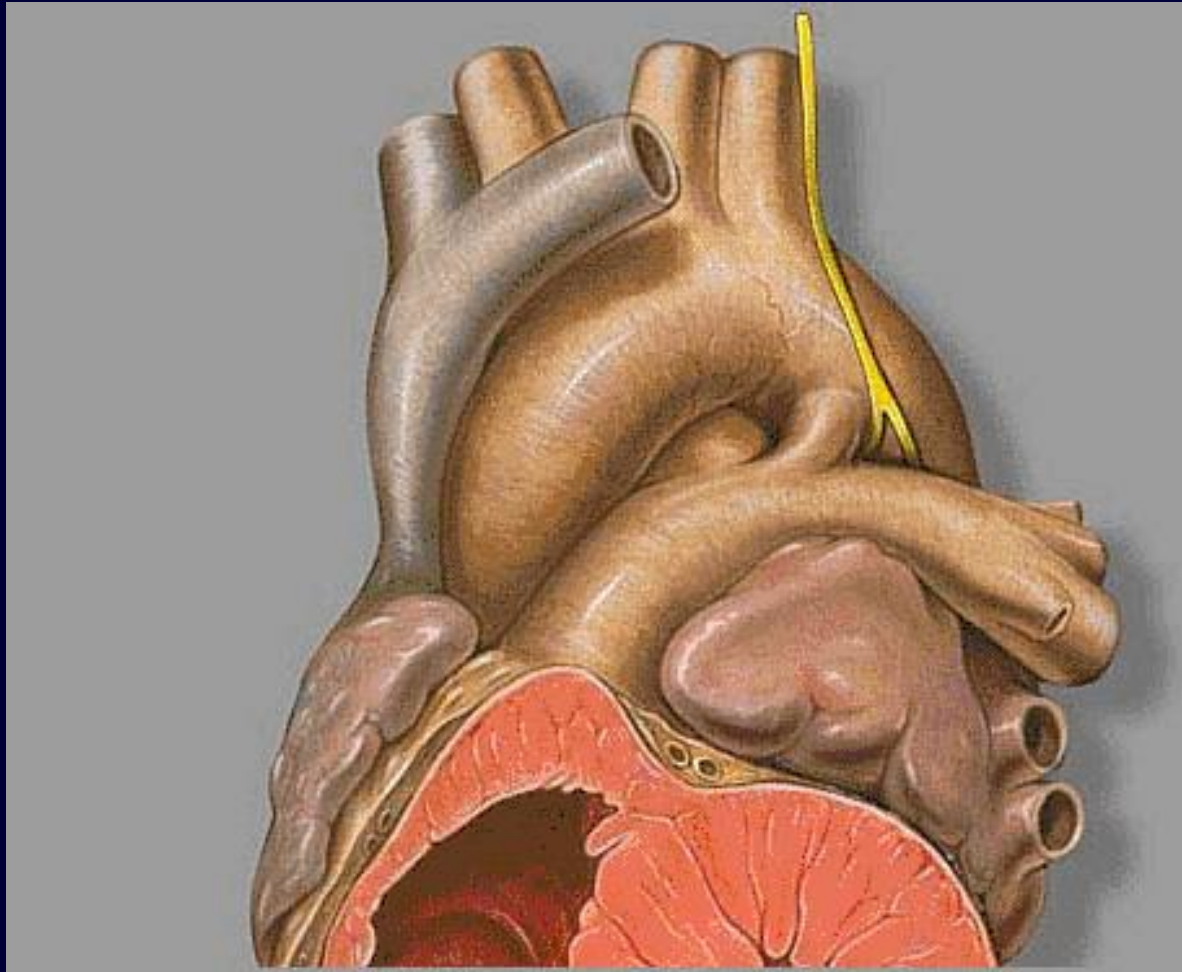
Quattro camere diametro trasverso massimo e medio, diametro longitudinale, area telediastolica

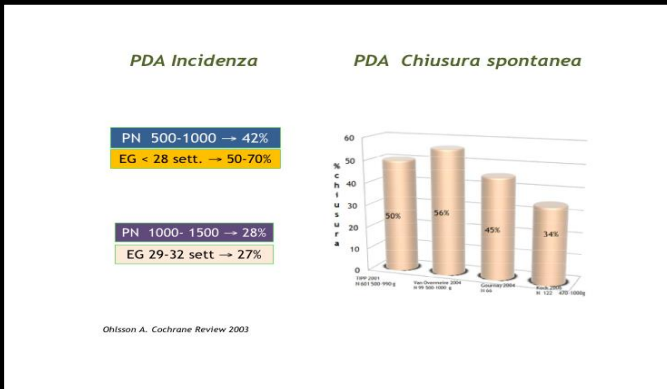
Area, diametro maggiore e minore fine sistole

$D2/D1 > 2$

$RV/LV > 1$   
(fine sistole)

# Dotto di Botallo





### PDA Chiusura spontanea

Rates of spontaneous ductus arteriosus closure (%)

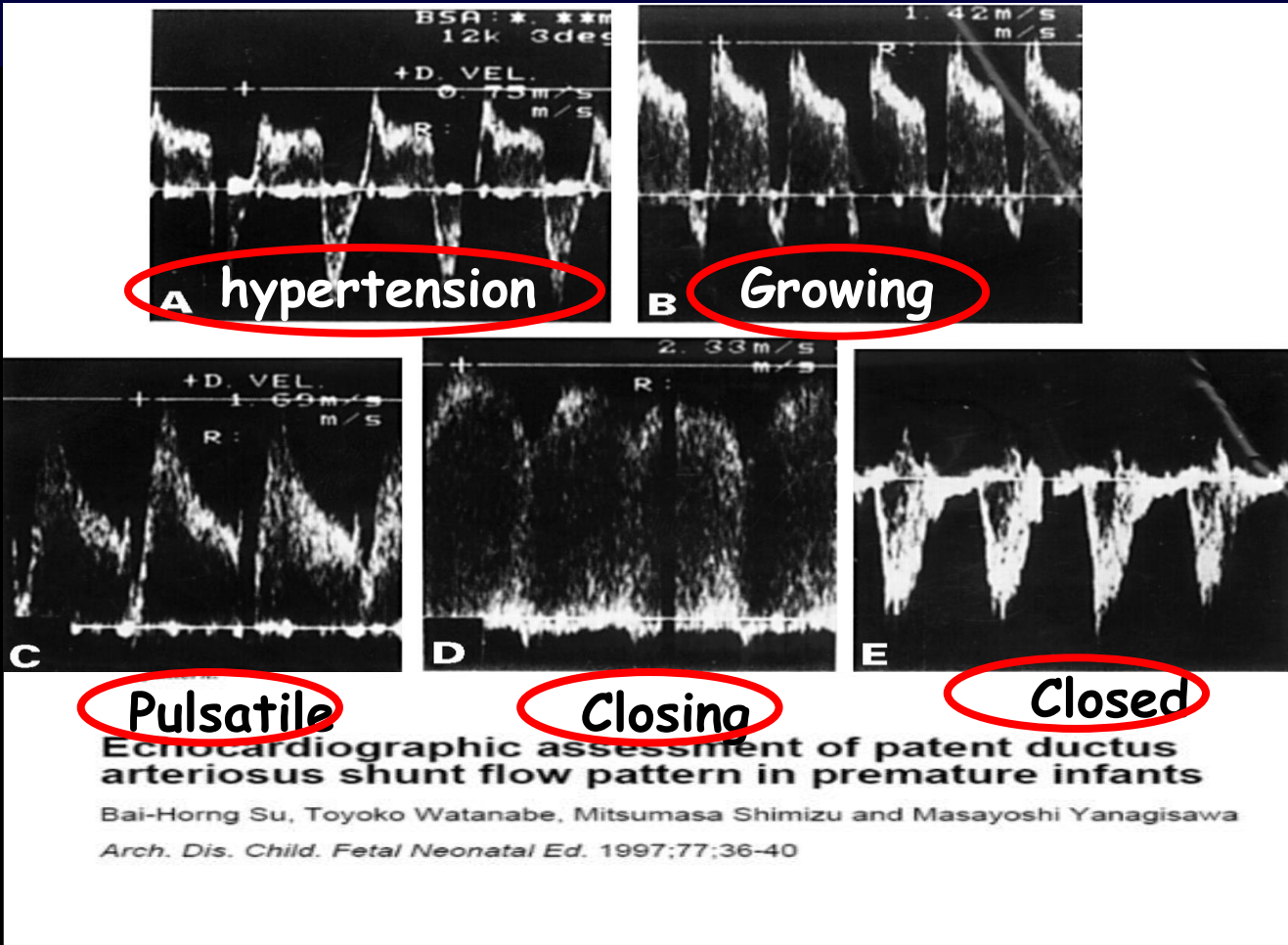
A. Gestation	Closed on day 4	Closed on day 7	Closed at discharge
Full term	100	100	100
>30 weeks	90	98	98
27-28 weeks	22	36	na
25-26 weeks	20	32	na
24 weeks	8	13	na
B. Birthweight			
1000-1500 grams	35	67	94
<1000 grams	21	34	na

## 1. Pattern flussimetrico

NON tutti i dotti devono essere chiusi ma esiste un sottogruppo di bambini nei quali il dotto deve essere necessariamente trattato



**Dotto emodinamicamente significativo**



# Caratteristiche ecografiche predittive negative per chiusura spontanea del dotto e significatività emodinamica:

- 1) **Diametro del colletto del dotto > 1,5mm o 1,4 mm/Kg**  
(sensibilità 94%, specificità 90%)
- 2) **LA/AO > 1,4**  
(sensibilità 92%, specificità 91%)
- 3) **Velocità media di flusso in AP sinistra > 0,42 m/sec**  
**Velocità di flusso di fine diastole > 0,2 m/sec**  
(rispettivamente sensibilità 91%-92%, specificità 92-100%)

- 4) **Pattern di flusso di tipo growing o pulsatile**  
dopo le prime 24-48 ore di vita  
(sensibilità 64-93%, specificità 81-100%)

- 5) **Valutazione dei flussi distali**  
(Reverse flow in:

Aorta discendente,  
cerebrale anteriore,  
mesenterica)

## ORIGINAL ARTICLE

Severity of the ductal shunt: a comparison of different markers

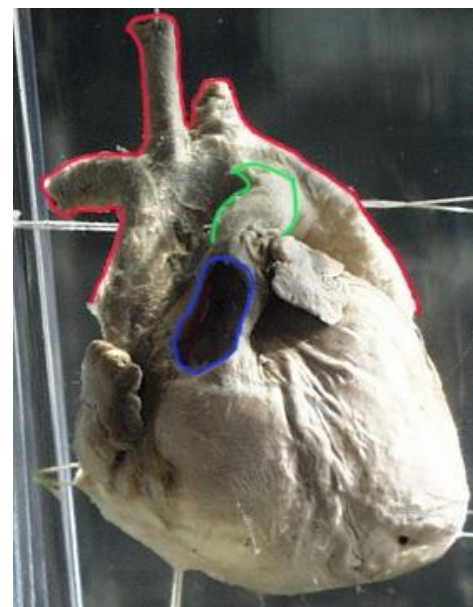
M El Hajjar, G Vaksmann, T Rakza, G Kongolo, L Storme

correlano

$LVO^*/SVC^{\wedge} > 4$  (v.n. 2.4)  
( $Qp/Qs$ ) > 2

Specificità e sensibilità > 90%

<sup>^</sup>flusso sistemico  
<sup>\*</sup>somma tra flusso sistemico e flusso da dotto



**Table 1** Proposed staging system (adapted from McNamara and Hellman, unpublished clinical triaging system for ligation of a patent ductus arteriosus (PDA)) for determining the magnitude of the haemodynamically significant ductus arteriosus (HSDA), which is based on clinical and echocardiographic criteria

Clinical	Echocardiography
C1 Asymptomatic	E1 No evidence of ductal flow on two-dimensional or Doppler interrogation
C2 Mild	E2 Small non-significant ductus arteriosus
Oxygenation difficulty (OI <6)	Transductal diameter <1.5 mm
Occasional (<6) episodes of oxygen desaturation, bradycardia or apnoea	Restrictive continuous transductal flow (DA $V_{max}$ >2.0 m/s)
Need for respiratory support (nCPAP) or mechanical ventilation (MAP <8)	No signs of left heart volume loading (eg, mitral regurgitant jet >2.0 m/s or LA:Ao ratio >1.5:1)
Feeding intolerance (>20% gastric aspirates)	No signs of left heart pressure loading (eg, E/A ratio >1.0 or IVRT >50)
Radiologic evidence of increased pulmonary vascularity	Normal end-organ (eg, superior mesenteric, middle cerebral) arterial diastolic flow
C3 Moderate	E3 Moderate HSDA
Oxygenation difficulty (OI 7–14)	Transductal diameter 1.5–3.0 mm
Frequent (hourly) episodes of oxygen desaturation, bradycardia or apnoea	Unrestrictive pulsatile transductal flow (DA $V_{max}$ <2.0 m/s)
Increasing ventilation requirements (MAP 9–12)	Mild-moderate left heart volume loading (eg, LA:Ao ratio 1.5 to 2:1)
Inability to feed due to marked abdominal distension or emesis	Mild-moderate left heart pressure loading (eg, E/A ratio >1.0 or IVRT 50–60)
Oliguria with mild elevation in plasma creatinine	Decreased or absent diastolic flow in superior mesenteric artery, Middle cerebral artery or renal artery
Systemic hypotension (low mean or diastolic BP) requiring a single cardiotropic agent	
Radiological evidence of cardiomegaly or pulmonary oedema	
Mild metabolic acidosis (pH 7.1–7.25 and/or base deficit –7 to –12.0)	
C4 Severe	E4 Large HSDA
Oxygenation difficulty (OI >15)	Transductal diameter >3.0 mm
High ventilation requirements (MAP >12) or need for high-frequency modes of ventilation	Unrestrictive pulsatile transductal flow
Profound or recurrent pulmonary haemorrhage	Severe left heart volume loading (eg, LA:Ao ratio >2:1, mitral regurgitant jet >2.0 m/s)
“NEC-like” abdominal distension with tenderness or erythema	Severe left heart pressure loading (eg, E/A ratio >1.5 or IVRT >60)
Acute renal failure	Reversal of end-diastolic flow in superior mesenteric artery, middle cerebral artery or renal artery
Haemodynamic instability requiring >1 cardiotropic agent	
Moderate-severe metabolic acidosis (pH <7.1) or base deficit >–12.0	

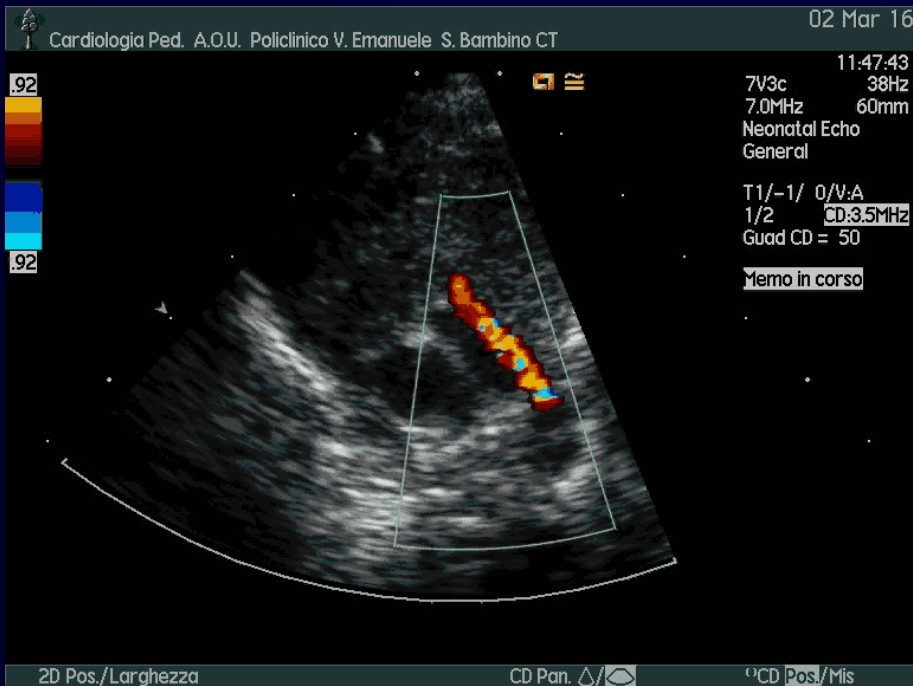
BP, blood pressure; DA  $V_{max}$ , ductus arteriosus peak velocity; E/A, early passive to late atrial contractile phase of transmitral filling ratio; IVRT, isovolumic relaxation time; LA: Ao ratio, left atrium to aortic ratio; MAP, mean airway pressure; nCPAP, nasal continuous positive airway pressure; NEC, necrotising enterocolitis; OI, oxygenation index.

Patients should be assigned both a clinical and echocardiography stage (eg, neonate with severe oxygenation failure, pulmonary haemorrhage and a 3.2 mm unrestrictive left-to-right shunt will be C4-E4 class HSDA).

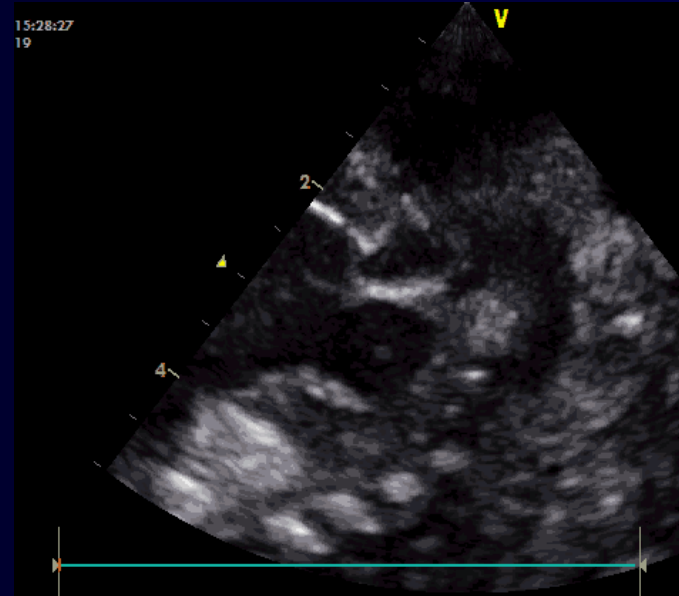
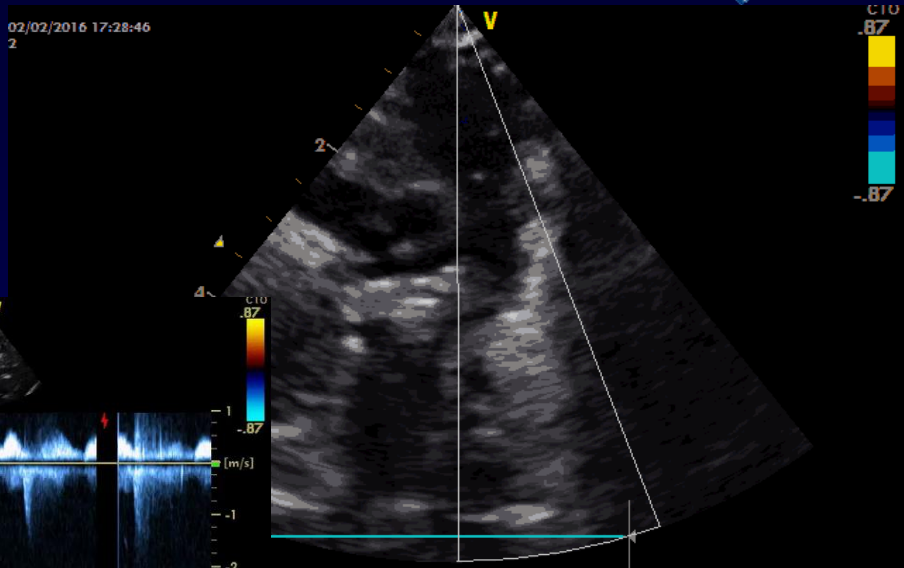
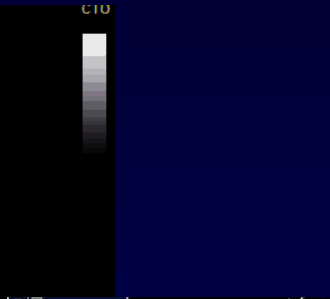
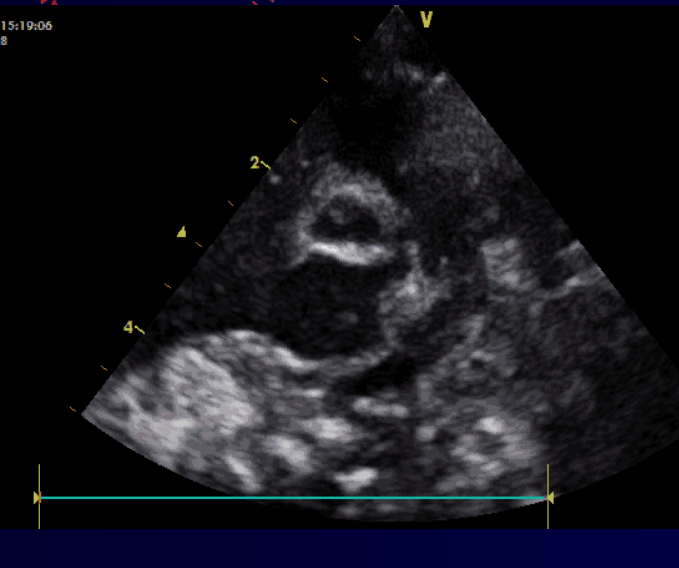
Detailed discussion of the echocardiography parameters is beyond the scope of this perspective.



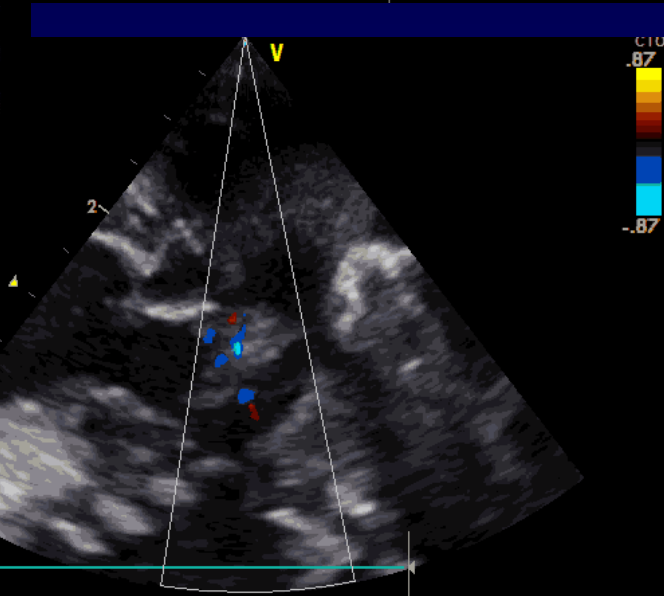
# Dotto di Botallo pervio



# Parasternale asse corto



# Dotto con pressione sistemiche



# Proiezione soprasternale



II EDIZIONE  
**GIORNATE**  
**di CUORE CHIARO** 2016

**“UN CUORE CHE CRESCE”**  
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**FOCUS SULL'ECOCARDIOGRAFIA IN ETÀ PEDIATRICA**  
**Nel neonato: come, quando e perché?**

**GRAZIE!**

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