



## Standard Treatment Workflow (STW) PEDIATRIC HEART FAILURE

### ICD-10-I50.9

#### DEFINITION

Clinical and pathophysiological syndrome that results from inability of the heart to function adequately to meet the metabolic demands of the body

#### CLINICAL SPECTRUM

- Acute decompensated HF
- Chronic compensated HF
- Acute exacerbation of chronic HF

#### MODIFIED ROSS CLASSIFICATION OF HEART FAILURE

- Class I: No symptoms/limitations
- Class II: Mild tachypnea/sweating during feeds in infants/ dyspnoea on exertion in older children but no growth failure
- Class III: Significant tachypnea or sweating during feeds/ marked dyspnoea on exertion/prolonged feeding time with growth failure
- Class IV: Symptoms (tachypnoea, retractions, grunting and sweating) even at rest with growth failure

**HEART FAILURE OFTEN HAS A TREATABLE CAUSE IN MOST CHILDREN. IDENTIFYING AND TREATING THE CAUSE IS THEREFORE THE MOST IMPORTANT PRIORITY**

Category	Specific Conditions	Category	Specific Conditions
Shunt lesions	VSD, PDA, AP window, AVCD, TGA, Truncus, TAPVC	Inflammatory	Myocarditis and other immunoinflammatory conditions
Obstructive lesions	Critical AS, PS, coarctation/aortic interruption	Abnormal rate/rhythm	Tachycardiomyopathy, bradycardia, AV dyssynchrony
Regurgitant lesions	Congenital- AV canal defect, Ebsteins anomaly Acquired- RHD, IE, post-operative	Ischemic	Anomalous coronary artery from pulmonary artery, Coronary artery occlusion from other causes
Primary Myocardial dysfunction	Dilated cardiomyopathy, Inborn errors of metabolism, muscular dystrophy, drug induced	Post- cardiac surgery	Variety of causes (cardiopulmonary bypass, Myocardial preservation etc.)
		Abnormal homeostasis	Hypoxia, hypocalcemia, hypoglycemia, sepsis, hypothermia

First Week	7-30 Days	3-6 Months	6 Months - 1 Years	1-10 Years
<ul style="list-style-type: none"> <li>• Duct dependent systemic circulation               <ul style="list-style-type: none"> <li>◦ HLHS</li> <li>◦ Critical AS</li> <li>◦ Critical Co A</li> <li>◦ Interrupted arch</li> </ul> </li> <li>• Severe Tricuspid regurgitation</li> <li>• Vein of Galen malformation</li> <li>• Fetal/Neonatal myocarditis</li> <li>• Congenital MR</li> </ul>	<ul style="list-style-type: none"> <li>• VSD with Coarctation</li> <li>• Large AP window</li> <li>• Persistent truncus arteriosus</li> <li>• Single ventricle physiology with no PS</li> <li>• TGA-VSD/PDA</li> <li>• Large VSD or PDA especially in preterm infants</li> <li>• All cases listed for the first week</li> </ul>	<ul style="list-style-type: none"> <li>• Large post tricuspid L-R shunts               <ul style="list-style-type: none"> <li>◦ VSD</li> <li>◦ PDA</li> <li>◦ AV canal defects</li> </ul> </li> <li>• ALCAPA</li> <li>• Myocarditis/DCM</li> <li>• All examples listed for the 7-30 days category</li> </ul>	<ul style="list-style-type: none"> <li>• Large post tricuspid L-R shunts               <ul style="list-style-type: none"> <li>◦ VSD</li> <li>◦ PDA</li> <li>◦ AV canal defect</li> </ul> </li> <li>• Myocarditis/DCM</li> <li>• ALCAPA</li> </ul>	<ul style="list-style-type: none"> <li>• Heart valve disease (RHD)</li> <li>• Myocarditis/DCM</li> <li>• Aortoarteritis</li> <li>• Palliated CHD</li> <li>• Post KD coronary arteriopathy</li> <li>• Idiopathic PAH</li> </ul>

#### SYMPTOMS

Neonate	Infant	Older children
<ul style="list-style-type: none"> <li>• Lethargy</li> <li>• Fast breathing</li> <li>• Poor suck</li> <li>• Reduced urine output</li> <li>• Cold extremities</li> </ul>	<ul style="list-style-type: none"> <li>• Rapid and labored breathing</li> <li>• Excessive sweating</li> <li>• Feeding difficulties (suck-rest-suck cycles)</li> <li>• Poor growth</li> <li>• Frequent chest infections</li> </ul>	<ul style="list-style-type: none"> <li>• Breathlessness</li> <li>• Effort intolerance</li> <li>• Growth retardation</li> <li>• Puffiness of face, extremities</li> <li>• Abdominal distension</li> </ul>

#### SIGNS

- Tachypnea and labored respiratory efforts with intercostal and subcostal recession (RR>60/min in less than 1 year old and >50/min in 1-2 year old)
- Tachycardia (HR>160/min in less than 1 year old, >140/min between 1-2 year old)
- Hepatomegaly
- Auscultation-Crackles at lung bases (limited sensitivity and specificity)
- S3 gallop, murmurs
- Raised JVP (not useful in infants)
- Peripheral edema

#### RED FLAGS

- Reduced peripheral perfusion
- Reduced urine output
- Elevated lactate levels
- Altered sensorium

### INVESTIGATIONS

#### HEART FAILURE MIMICS

- Sepsis
- Respiratory distress syndrome
- Inborn errors of metabolism
- Bronchiolitis (infants)

#### ESSENTIAL INVESTIGATIONS

##### Chest x-ray

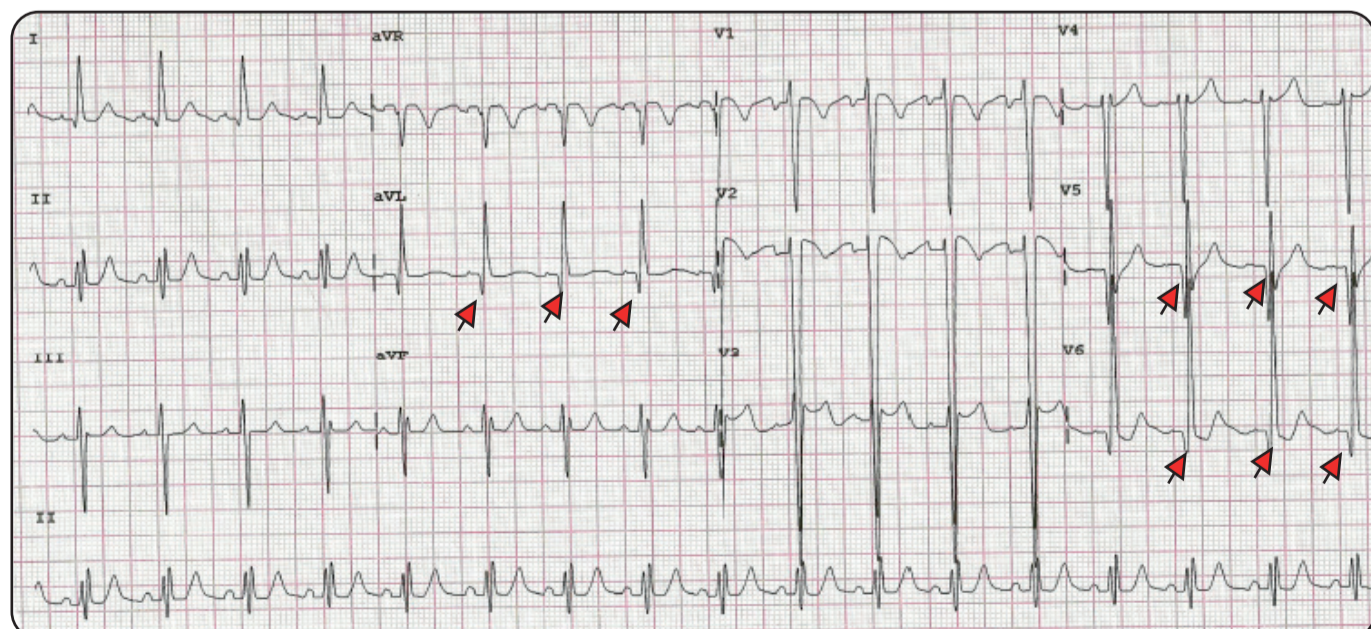
Information on cardiac silhouette, pulmonary vasculature, pulmonary artery dilatation and associated skeletal abnormalities

##### ECG

Diagnosis of treatable causes of heart failure such as persistent tachyarrhythmia, ALCAPA and, hypocalcemia. Other specific causes such as Pompe's disease, specific forms of cardiac muscle involvement in muscular dystrophy have ECG manifestations

##### Echocardiogram

Critically important to accurate diagnosis and tailoring response to therapy





## Standard Treatment Workflow (STW)

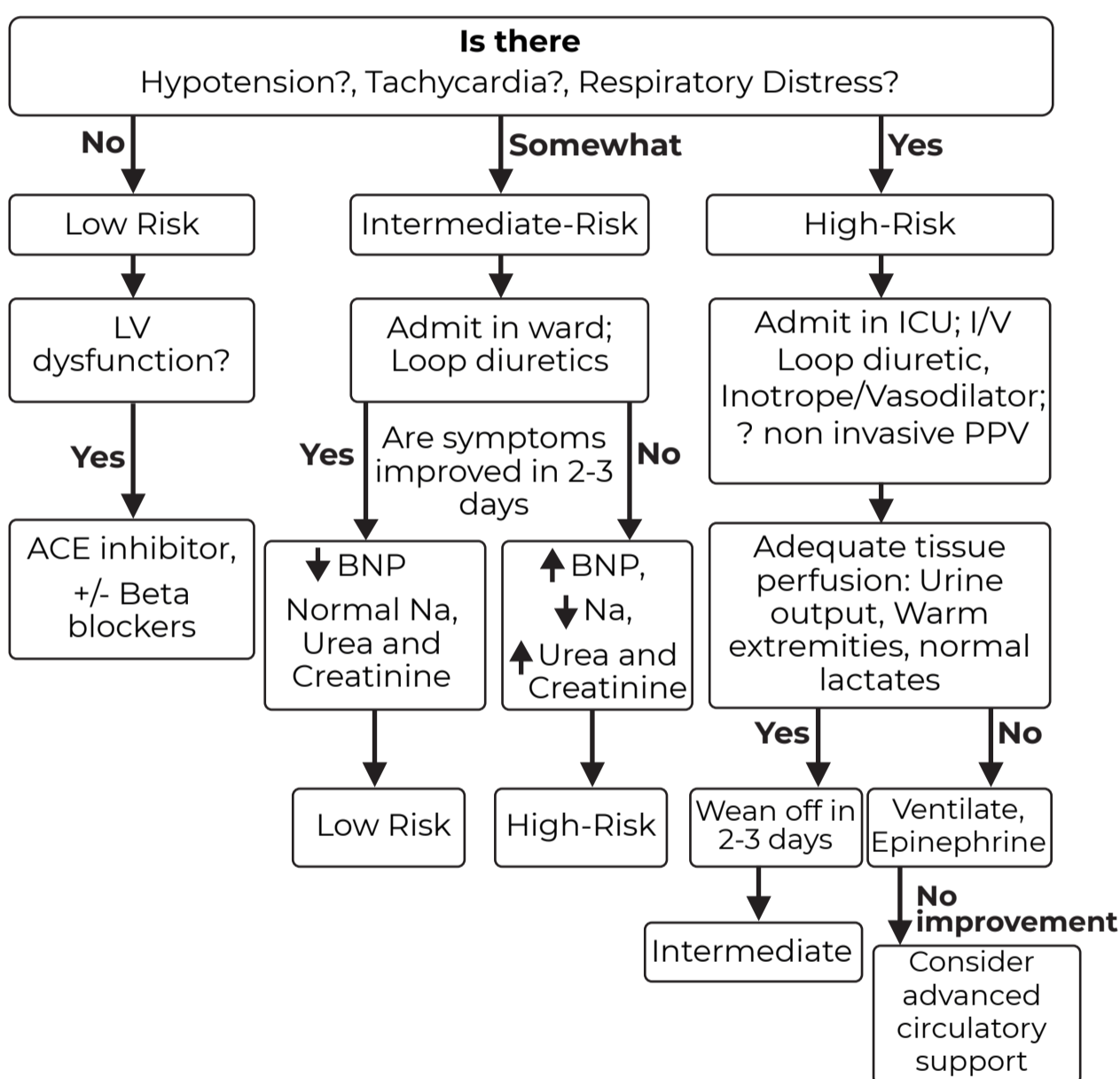
# PEDIATRIC HEART FAILURE

### (Continued)

Essential blood tests to be performed in all	Utility
Complete blood count; CRP	Identifying Sepsis, Anemia
Electrolytes and urea, creatinine	Elevated urea, creatinine may indicate decompensated HF or may result from medication side effects. Electrolyte imbalance is a common association of HF and diuretic use. Hypocalcemia can cause ventricular dysfunction leading to HF
Liver function test	Elevated bilirubin, liver enzymes and prolonged prothrombin time points towards congestive hepatopathy. Hypoalbuminemia points to chronic HF and poor nutrition
Optional tests to be decided based on clinical situation	
Arterial blood gas with lactate	Lactic acidosis- as a marker of tissue perfusion and helps monitor response to treatment; It is also elevated in specific inborn errors of metabolism
Thyroid function test	Thyroid hormone imbalance could be a primary cause or may lead to worsening of symptoms
Brain Natriuretic Peptide (BNP)	It helps differentiate HF from respiratory disease. Useful in monitoring response to therapy
Cardiac enzymes (troponin I, T, CKMB) and Viral Panel	In suspected cases of myocarditis

### Management Goals

- Correct the underlying cause
- Reduce associated morbidity and mortality
- Improve functional status and quality of life



### General Measures

- **Fluid restriction**
  - In acute HF with lung congestion, peripheral edema despite diuretics and in presence of hyponatremia
- **Rest and restriction of activity**
  - Activity as tolerated for older children with chronic compensated HF
- **Correction of Anaemia**
  - Hematinics; Blood transfusion only for severe anemia (Hb < 7gm/dl)
- **Nutrition**
  - NG feeds for infants in acute severe HF.
  - In infants calorie intake of 120-150kcal/kg/day with a fluid intake of 100 ml/kg/day. (thickening of feeds or by adding coconut oil/medium chain triglyceride). In older children increase protein content of diet while optimizing the fat and carbohydrate intake. Supplement Ca and Vit D3;
  - Dietary restriction of sodium is generally not recommended in children unless there is severe edema unresponsive to diuretic therapy
- **Supplementary oxygen**
  - May be necessary when there is respiratory distress but must be used with caution in L-R shunts and avoided in neonates with duct dependent lesions

### Inotropes should be physiologically appropriate:

- Avoid vasodilators in presence of fixed outflow obstruction (AS); use vasodilators for regurgitant lesions, pump failure and large shunts
- Avoid using very high doses for sustained periods (Preferably adrenaline < 0.1; dopamine or dobutamine < 15 mcg/g/min)

## ABBREVIATIONS

**ACEI:** Angiotensin Converting Enzyme Inhibitor

**ALCAPA:** Anomalous Origin of Left Coronary Artery from Pulmonary Artery

**AP Window:** Aorto-Pulmonary Window

**AS:** Aortic Stenosis

**AVCD:** Atrio-Ventricular Canal Defect

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**CoA:** Coarctation of the Aorta

**CKMB:** Creatine Kinase Myoglobin Binding

**CRP:** C-reactive Protein

**DCM:** Dilated Cardiomyopathy

**HF:** Heart Failure

**HLH:** Hypoplastic Left Heart

**HR:** Heart Rate

**IE:** Infective Endocarditis

**JVP:** Jugular Venous Pressure

**KD:** Kawasaki Disease

**LV:** Left Ventricle

**MR:** Mitral Regurgitation

**NG:** Naso-Gastric

**PAH:** Pulmonary Arterial Hypertension

**TAPVC:** Total Anomalous Pulmonary Venous Connection

**PDA:** Patent Ductus Arteriosus

**PPV:** Positive Pressure Ventilation

**PS:** Pulmonary Stenosis

**RHD:** Rheumatic Heart Disease

**RR:** Respiratory Rate

**TGA:** Transposition of Great Arteries

**VSD:** Ventricular Septal Defect

## REFERENCES

1. Venkatesh S, Kumar RK, Heart Failure in Children. IAP specialty Series on Pediatric Cardiology, 3<sup>rd</sup> edition. Jaypee Brothers Medical Publishers, New Delhi; 2022. pp. 351-76.
2. Hinton RB, Ware SM. Heart Failure in Pediatric Patients With Congenital Heart Disease. Circ Res. 2017 Mar 17;120(6):978-994. doi: 10.1161/CIRCRESAHA.116.308996. PMID: 28302743; PMCID: PMC5391045.

👉 **PEDIATRIC HEART FAILURE IS BEST MANAGED IN CONSULTATION WITH A PEDIATRIC CARDIOLOGIST**