CONGESTIVE HEART FAILURE
**DEFINITION OF CCF**

**Congestive Cardiac Failure (CCF)**

is a clinical syndrome of varied etiology in which the heart is unable to pump enough blood to meet the metabolic needs of the body resulting in systemic and pulmonary vascular congestion.
## CAUSES – CONGENITAL HEART DISEASES

### Shunt lesions
- Ventricular Septal Defects
- Patent Ductus Arteriosus
- Endocardial Cushion Defect
- Atrial Septal Defect
- Arterio – Venous Malformations

### Obstructive lesions

#### A - Outflow Obstructions
- Aortic Atresia
- Aortic Stenosis
- Pulmonary Atresia
- Pulmonary Stenosis
- Coarctation of Aorta

#### B - Inflow Obstructions
- Mitral Stenosis
- Cor Triatriatum
- Tricuspid Stenosis / Atresia
CONGENITAL COMPLEX STRUCTURAL HEART DISEASES

• Hypoplastic left heart syndrome
• Transposition of Great Arteries
• Single Ventricle without PS
• Truncus Arteriosus
• Aorta - Pulmonary Window
• Total Anomalous Pulmonary Venous Drainage
ACQUIRED HEART DISEASES

• Acute Hypertension
• Arrhythmias – Supra Ventricular Tachycardia, Complete Heart Block
• Acute Rheumatic Carditis and Chronic Rheumatic Valvular heart diseases
• Kawasaki disease
• Infective Myocarditis: Viral, Bacterial, Parasitic
• Toxic Myocarditis: Scorpion venom, Drugs
• Dilated Cardiomyopathy
• Metabolic & Endocrinal abnormalities
• Nutritional: Beri Beri, Anemias
• Secondary to Pulmonary Causes: Cor Pulmonale
## CAUSES AND TIME OF ONSET OF CCF

<table>
<thead>
<tr>
<th>Age</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 24 hrs and beyond</td>
<td>Non Cardiac: NN Asphyxia, Hypoglycemia, Anemia, Hypervolemia, Polycythemia, Hypocalcemia, Sepsis</td>
</tr>
<tr>
<td>Birth to 72 hrs</td>
<td>Cardiac: Pulmonary, mitral and aortic atresias or critical stenosis, Extreme heart rate variations: Complete Heart Block, Paroxysmal Atrial Tachycardia</td>
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<tr>
<td>4 days to 1 week</td>
<td>Hypoplastic left heart syndromes, transposition and malposition of great arteries with poor mixing</td>
</tr>
<tr>
<td>1 to 4 weeks</td>
<td>Transposition and malposition complexes, endocardial fibroelastosis, coarctation of aorta</td>
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<tr>
<td>1 – 2 months</td>
<td>Transposition and malposition complexes, endocardial cushion defects, VSD, PDA, TAPVC, ALCAPA</td>
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<tr>
<td>2 to 6 months</td>
<td>Transposition and malposition complexes, VSD, PDA, TAPVC, Aortic stenosis, Coarctation of Aorta</td>
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</tbody>
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CLINICAL FEATURES - SYMPTOMS

Infants
• Poor feeding
• Tachypnea $\uparrow$ with feeding
• Poor weight gain
• Cold sweat on the forehead

Older children
• Shortness of breath which increases with activity
• Easy fatigability
• Puffy eyelids
• Swollen feet
Interaction of various beneficial and harmful hormonal and neurotransmitter pathways resulting in Heart failure.
Compensatory responses to impaired cardiac function

• Tachycardia
• Gallop rhythm
• Weak thready pulse
• Increased sympathetic discharges – growth failure, perspiration, Cold wet skin
• Cardiomegaly – X-ray will be useful
SIGNS II
SYSTEMIC VENOUS CONGESTION
(RIGHT HEART FAILURE)

• Hepatomegaly
  (absence of Hepatomegaly does not rule out CCF)
• Ankle edema
• Puffy Eye lids
• Distended neck veins
SIGNS III
PULMONARY VENOUS CONGESTION
(LEFT SIDED FAILURE)

• Tachypnea

• Dyspnea on Exertion

• Orthopnea

• Wheezing and pulmonary crackles
INVESTIGATIONS

• X-ray
  – Cardiomegaly will be present
  – Absence of cardiomegaly rule out CCF

• ECG – Limited usefulness in cardiac failure management

• Echocardiography
  – Used to confirm, to find the cause and monitor treatment of CCF
  – Enlarged chamber
  – Impaired left ventricular function - ↓ Ejection fraction
CCF - PRINCIPLES OF TREATMENT

• Specific treatment of the cause of CHF
• Correction of precipitating factors like Anemia, Infections, etc.
• Oxygen to improve delivery to tissues
• Nutritional Support to maintain growth
• Anticoagulants to prevent intracardiac thrombus formation
CCF - PRINCIPLES OF TREATMENT PRINCIPLES OF PHARMACOLOGICAL TREATMENT

• Preload reduction using Diuretics to control excessive salt and water retention

• Inotropes to improve cardiac contractility - Digoxin , - Dopamine, Dobutamine, Epinephrine and Milrinone in severe cardiac failure.

• Afterload reduction using Angiotensin Converting Enzyme Inhibitors - ACEIs ( Captopril, Enalapril, Lisinopril ) and/ or Angiotensin II receptor blockers ( Losartan ) and vasodilators like Nitroprusside, Nitroglycerin or Nesiritide

• Beta blockers ( Carvedilol, Metoprolol ) - Drugs acting on compensatory neuro hormonal changes that lead to progressive worsening of cardiac status -
• Salt restricted diet
• Water restriction - In the presence of poor renal perfusion
• Calories
  – Infants needs 100 – 120 K Cal / kg/ day and sodium 2 – 3 meq/kg/day
• Iron supplementation
DIGOXIN

• Weak inotrope
• Slows ventricular rate especially in AF
• Decreases sympathetic drive
• Pharmacological properties
  – Sodium pump inhibition – Na / ATPase which promotes calcium influx with increased intra cellular calcium and increased contractility
  – Autonomic & Renin – Angiotensin system
    – Parasympathetic activation
    – Sympathetic inhibition
    – Inhibition of renin release
DIGOXIN – CONT.

• Indicated only in Chronic Congestive Cardiac Failure with dilated left ventricle with impaired systolic function
• Definitive indication – Chronic CHF with AF
• In CHF with sinus rhythm, there is symptomatic rather than mortality benefit

• Dose: TDD
  – Preterm – 10 – 20 mcg/kg P.O
  – Term – 20 – 30 mcg/kg P.O
  – 1 – 5 years – 30 -40 mcg/kg P.O
  – 5 – 10 – 20 – 30 mcg/kg P.O
  – Adults – 10 – 15 mcg/kg P.O
  – IV is 80% of P.O dose
DIGOXIN – CONT

• Ideal serum therapeutic level-1-2 ng /ml
• Risk of toxicity is high with levels more than 2ng / ml
• Reduced dosage in renal dysfunction
CONTRA INDICATIONS TO DIGOXIN USE

Absolute

– HOCM (unless AF with severe myocardial failure)
– WPW syndrome with AF
– Significant AV nodal block
– Diastolic dysfunction

Relative

– Low output states – Valvular stenosis
– High output states – Chronic cor pulmonale and thyrotoxicosis
– Hypokalemia
– Myxedema
– Renal failure
– Co-therapy with drugs altering digoxin levels
– Severe myocarditis
DIURETICS

• Control Pulmonary and Peripheral signs and symptoms of congestion
• Thiazides for mild HF and loop diuretic for severe HF
• Addition of aldosterone antagonist - Spironolactone, in sequential nephron block encountered in severe HF

DOSE

• Furosemide: 1mg / Kg / dose
• Chlorthiazide: 5 – 20 mg / kg / dose every 12 -24hr oral , IV
• Hydrochlorothiazide: 1 – 1.5mg/kg/dose every 12 – 24 hrs. oral
• Spironolactone: oral 1-2 mg/kg/day
ACE INHIBITORS - ACEIs

• These drugs improve survival besides giving symptomatic relief.

• ACEIs: Almost always used for all children with CHF and its dose is titrated upwards to the maximum recommended doses

• Hypotension may occur with first dose when used, especially in those receiving high dose of diuretics, and it should be carefully watched for.

• **Dose:** Captopril 0.1 to 0.5mg / kg / dose PO every 8-12 hrly up to 4mg / kg / day

• Enalapril 0.1mg / kg / dose PO every 12-24 hrly up to 0.5mg / kg / day
BETA BLOCKERS

• Increasingly recognized as an integral part of CHF therapy in children as its use has been shown to be associated with slowing of left ventricular dilatation and left ventricular dysfunction and reduced mortality
• Their use is recommended only after stabilization of acute heart failure
• Carvedilol, Metoprolol & Bisoprolol are still being under evaluation in childhood Heart Failure
BETA BLOCKERS

- CARVEDILOL – 0.08 mg / kg / dose 12th hrly if tolerated increase by 0.08 mg / kg /dose every 1 – 2 wks to a maximum of 0.5 – 0.75 mg / kg / dose 12th hrly.
- METAPROLOL – 1- 2 mg / kg / day PO in 2 divided doses
PHOSPHODIESTERASE INHIBITION
– MILRINONE

• **Dose:** 50 -75mcg/kg as slow IV infusion to be followed by 0.375 – 0.750 mcg/kg/min up to 48 hrs maximum dose is 1.13mg/kg

• **Adverse drug effects:**
  – Ventricular arrhythmia.
  – Contraindicated in tight aortic stenosis, HOCM.
  – Reduce dose in renal failure.
• Sodium Nitroprusside, Nitroglycerine, iondilators

• Indication:
  – Increased ventricular filling pressure
  – Increased systemic vascular resistance

• Normal blood pressure or hypertension

• Systolic BP
  – Neonate >50 mmHg
  – 1 mo to 12 mo >60mmHg
  – 1 to 12 yrs > 70 + (Age x 2 )
SODIUM NITROPRUSSIDE

• Rapidly acting vasodilator of arterioles and veins by its direct action on vascular smooth muscle; also reduces pulmonary vascular resistance.

• **Dose:** 0.5 – 10 mcg/kg/min but infusion at maximal rate should never last > 10 minutes

• **Adverse drug effects:**
  – Cyanide toxicity
  – Hypotension
  – In renal failure - Thiocyanide accumulates
- IV infusion – 1-10 mcg/kg/min

- Use polyethylene lined syringe and tubing (NOT PVC)
INDICATIONS FOR SHORT TERM USE OF INOTROPIC AGENTS IN CARDIAC FAILURE

• Presence of low cardiac output and poor peripheral perfusion
• Low blood pressure
• Signs of end organ dysfunction and
• Severe Left Ventricular Systolic and diastolic dysfunction
DOPAMINE

• **Dose** - < 2.5 mcg / kg / min - Increase blood flow to cerebral coronary renal and splanchnic vascular bed through DA1 postsynaptic receptor.
  – 2.5-5 mcg / kg / min - Inotropic effect through β receptor
  – 5-10 mcg / kg / min - Both α and β effects occur.
  – >10 mcg / kg / min - Arterial tone progressively increases.

• **Indications**
  – Cardiogenic shock with Hypotension
DOPAMINE

• Adverse drug reactions
  – Tachyarrhythmia's
  – Gangrene of digital extremity
  – Increase in Pulmonary vascular resistance particularly in hypoxemic pulmonary hypertension
DOBUTAMINE

• Primarily β 1 agonist
• Indications:
  – Cardiogenic shock with normal or high blood pressure
  – If inadequate response - Dopamine may be added.
• Dose: 2.5 – 20 mcg / kg / min.
• Complication:
  – Tachyarrhythmia's
EPINEPHRINE

• Indications
  – Inadequate Cardiac output
  – Hypotension
  – Symptomatic bradycardia
  – Pulseless cardiac arrest
  – Septic shock.
• Rarely used as first line agent
• Useful in patients with left ventricular dysfunction that remains refractory to dopamine or dobutamine
• Once stabilized it is withdrawn as early as possible.
• It increases Systolic BP, HR and reduces Diastolic BP
• **Dose**—0.05-0.1mcg/kg/min upto max 0.3 mcg/kg/min.
PREPARATION OF VASOACTIVE DRUGS

• Epinephrine / Norepinephrine:
  \[ 0.6 \times \text{body wt (kg)} = \text{mg to be added to sufficient diluent to create a total volume of 100ml.} \]

• Dopamine, Dobutamine, Sodium nitroprusside:
  \[ 6 \times \text{body wt. (kg)} = \text{mg to be added to sufficient diluent to create total volume of 100ml.} \]
  \[ 1\text{ml/hr. delivers} - 1.0 \text{mcg/kg/min} \]
DEVICE – BASED THERAPIES FOR CHRONIC CONGESTIVE FAILURE
INTRA- AORTIC BALLOON COUNTER PULSATION

• Provides circulatory assistance by decreasing LV after load, during systole and augmenting aortic perfusion pressure during diastole
• Done by repetitive catheter mounted pneumatic inflation and deflation of a catheter balloon placed within thoracic aorta by percutaneous femoral arterial technique
HEART FAILURE TREATMENT – CONT
DEVISE – BASED THERAPIES FOR CHRONIC
CONGESTIVE FAILURE

• Cardiac resynchronization therapy using biventricular pacemakers – Limited role in Pediatric cardiac practice

• Implantable cardioverter defibrillator
HEART FAILURE TREATMENT – CONT
DEVISE – BASED THERAPIES FOR CHRONIC
CONGESTIVE FAILURE

• Long term mechanical support by:

  Mechanical Ventricular Assist Device
  – LV Assist Device
  – Total artificial heart

• Acute temporary mechanical support by:
  Extra Corporal Membranous Oxygenation
Thank You