Paediatrics Cardiology
Part-1

Marrow ss
Paediatrics

2025

Dr. Jay Relan is a distinguished Paediatric Cardiologist renowned for his clinical expertise and teaching experience. He earned his MBBS from

BASICS OF PAEDIATRIC CARDIOLOGY

1 

History & Physical Examination: I
4.8 61 Min video NEW

2 

History & Physical Examination: II
4.7 42 Min video NEW

CARDIAC DIAGNOSTICS AND INTERVENTIONS

3 

Paediatric ECG - Normal And Abnormal
4.5 51 Min video

4 

Echocardiography Basics
4.5 77 Min video NEW

5 

Echocardiography Sequential Segmental Analysis
4.5 54 Min video

6 

Catheterisation Study: Basics And Interpretation
4.5 83 Min video NEW

FETAL CARDIOLOGY

7 

Fetal Cardiology
4.3 52 Min video

CONGENITAL HEART DISEASES

8 

CHD Introduction & Approach: I
4.6 66 Min video

9 

CHD Introduction & Approach: II
4.7 30 Min video

10 

Cyanotic CHD With Increased Pulmonary Blood Flow
4.4 66 Min video

11 

Cyanotic CHD with Decreased Pulmonary Blood Flow : I
4.7 47 Min video

12 

Cyanotic CHD with Decreased Pulmonary Blood Flow : II
4.6 33 Min video

13 

Cyanotic CHD: Single Ventricle Physiology
4.5 68 Min video

14 

Complications Of Cyanotic CHD's
4.6 27 Min video

15  Acyanotic CHD: Left to Right Shunts
4.5 80 Min video

16  Acyanotic Congenital Heart Diseases: Regurgitant Lesions & Others
4.5 65 Min video

17  Acyanotic Congenital Heart Diseases: Obstructive Lesions
4.4 74 Min video

18  Non Infectious Cardio Vascular Diseases
4.7 58 Min video

SPECIAL TOPICS IN PAEDIATRIC CARDIOLOGY

19  Cardiac Tumours
4.7 33 Min video

20  Paediatric Hypertension
4.5 51 Min video

21  Pulmonary Hypertension
4.5 72 Min video

VALVULAR HEART DISEASES

22  Infective Endocarditis
4.4 48 Min video

23  Rheumatic Fever & Rheumatic Heart Disease
4.7 51 Min video

MYOCARDIAL & PERICARDIAL DISORDERS

24  Myocarditis & Pericarditis
4.7 49 Min video

25  Cardiomyopathies
4.4 65 Min video

CARDIAC ARRHYTHMIAS

26  Paediatric Arrhythmias : I
4.4 46 Min video

27  Paediatric Arrhythmias : II
4.3 39 Min video

28  Cardiac Channelopathies & Sudden Cardiac Death
4.2 61 Min video

HEART FAILURE

29  Heart Failure
4.5 62 Min video

30  Advanced Treatment of Heart Failure
4.3 55 Min video

HISTORY & PHYSICAL EXAMINATION : I

History

00:01:24

Overview :

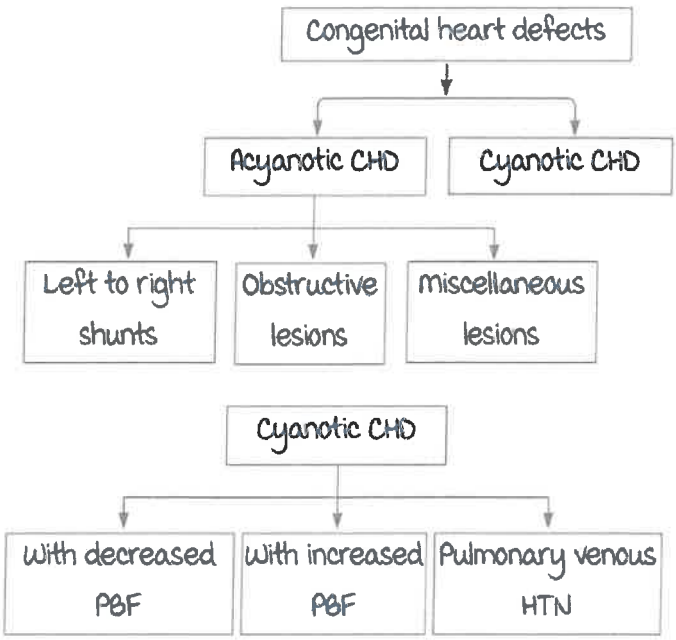
Aim of history :

- To reach a syndromic diagnosis & make D/D.
- Anticipate findings on examination.
- Narrow down the differential diagnosis.

Importance of history :

- Details of the perinatal period : Cyanosis, respiratory distress or prematurity.
  - Time of symptom can aid in diagnosis.
  - Born with cyanosis : Transposition of great arteries with intact ventricular septum.
- Timing of initial symptoms could aid in diagnosis.

Congenital heart disease history :



- Left to right shunts : Increased pulmonary blood flow. Child has feeding difficulty, poor weight gain and recurrent pneumonia.
- In cyanotic CHD with increased PBF, symptoms will be similar with addition of cyanosis.

----- Active space -----

- In obstructive lesions : Easy fatiguability, exertional dyspnea.
- Cyanotic CHD with decreased PBF (m/c TOF) : Cyanosis at rest or exaggerated when child cries.
- Cyanotic CHD with pulmonary venous HTN : Includes obstructed total anomalous pulmonary venous connection (TAPVC), Hypoplastic left heart syndrome (HLHS).

Common symptoms :

Infants	Older children
• Feeding difficulties (Feeding diaphoresis, suck-rest suck cycle) • Fast breathing/difficulty in breathing with chest retractions • Recurrent LRTIs • Poor weight gain • Cyanosis/cyanotic spells • Edema	• Palpitations • Dyspnea on exertion, orthopnea, paroxysmal nocturnal dyspnea • Exercise intolerance/easy fatiguability • Cyanosis, squatting episodes • Chest pain • Syncope • Edema/facial puffiness

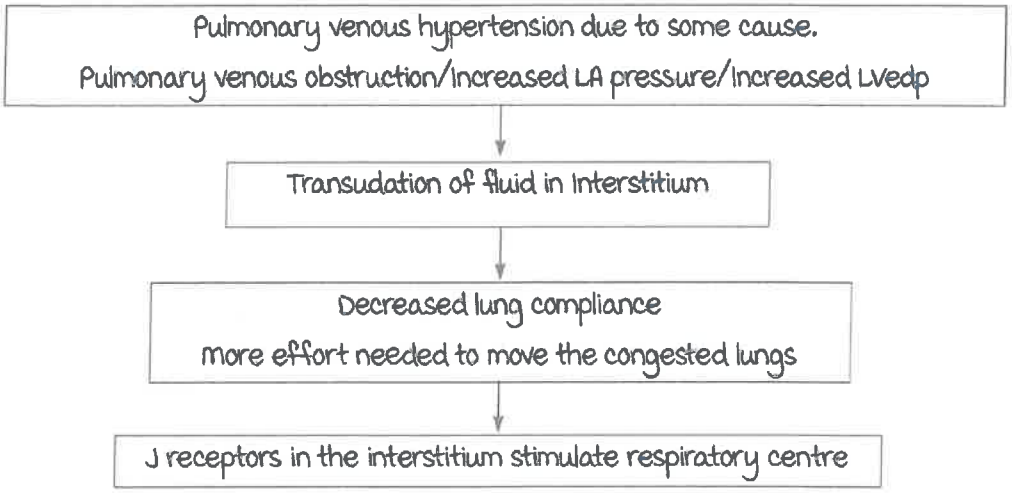
Tachypnea & dyspnea :

- Tachypnea (Fast breathing) :
  - >60/min : 0-2 months.
  - >50/min : 2-12 months.
  - >40/min : 1-5 years.
- Dyspnea : Difficulty in breathing or unpleasant awareness of one's own breathing.
  - Interstitial edema (Pulmonary venous hypertension/increased PBF).
  - Hypoxia.

Dyspnea mechanism :

- Interstitial edema occurs when there is imbalance of starling forces (Hydrostatic pressure inside blood vessel vs pressure outside in the interstitium).
- When there is increased pulmonary blood flow with high pressure causing increased hydrostatic pressure in capillaries there will be extravasation.
  - Common causes include : VSD, PDA, Truncus arteriosus.

- If the pulmonary blood flow is normal, there is pulmonary venous HTN causing extravasation due to :
  - Obstruction of pulmonary veins.
  - Increased left atrial pressure in MS.
  - Increased left ventricular end diastolic pressure.
- Cyanotic CHD :
  - Hypoxia (Directly & indirectly) → Acidosis → Stimulate respiratory centre.



Orthopnea & paroxysmal nocturnal dyspnea :

- Orthopnea :
  - Dyspnea occurring within minutes of lying down.
  - Increased systemic venous return.
  - Reduced diaphragm movement, since liver pushes the diaphragm upwards when lying down.
  - Advised to sleep propped up, given diuretics to decongest lung.
- Paroxysmal nocturnal dyspnea :
  - Occurs after 2-3 hours of sleep; relieved in sitting position.
- Mechanisms :
  - Decreased responsiveness of respiratory centre in brain.
  - REM sleep → Catecholamine surge → Sudden increase in HR.
  - Respiratory centre lags behind → Acute dyspnea perceived.

----- Active space -----

NYHA grading of dyspnea :

In older children.

Class	Description
I	At risk or diagnosed heart disease; asymptomatic
II	Dyspnea at ordinary levels of exertion; comfortable at rest
III	Dyspnea at less-than-ordinary levels of exertion; comfortable at rest
IV	Inability to exert without dyspnea (Dyspnea at rest)

Ross classification in children :

In younger children.

Class	Description
I	Asymptomatic
II	Mild tachypnea or diaphoresis with feeding in infants; dyspnea on exertion in older children
III	Marked tachypnea or diaphoresis with feeding in infants; prolonged feeding times with growth failure; marked dyspnea on exertion in older children
IV	Symptoms such as tachypnea, retractions, grunting, or diaphoresis at rest

Feeding difficulty :

- Main symptom of CHF in infants.
- Results from dyspnea & fatigue while sucking.
- Suck-Rest-Suck cycle :
  - Baby starts sucking → Dyspnea, fatigue, forehead sweating → Stops after a small feed → Rests for a few minutes → Restarts sucking as still hungry.
- Feeding diaphoresis (Heightened sympathetic tone).

Pathophysiology of failure to thrive :

- CHF associated feeding difficulty → Decreased calorie intake.
- Increased energy expenditure → Catabolic state (Increased RR).
- Recurrent respiratory infection (Increased demand & less intake).
- Other recurrent infections due to low immunity.

- Systemic venous congestion → Portal venous congestion → Anorexia → Decreased absorption from gastrointestinal tract.
- Part of syndrome. Eg : DiGeorge/Rubella syndrome.

----- Active space -----

Pathophysiology of recurrent pneumonias :

- Interstitial edema & pulmonary venodilation → Compression of bronchioles & retention of secretions.
- Dilated LPA (Large post tricuspid shunts) → Compression of left bronchus → Retention of secretions & impaired clearance.
- Anastomotic channels between pulmonary & bronchial veins open up → Bronchial mucosal congestion → Good nidus for infection.
- Bronchial mucosal congestion & goblet cell hypertrophy → Impaired muco-ciliary clearance.
- Poor immunity due to poor weight gain → Recurrent infections.

Note :

Recurrent infections only include lower respiratory tract infections not URTI.

Edema/facial puffiness :

- Due to systemic venous congestion.
- Reflected as puffy eyelids & sacral edema in younger children, ankle edema in older children.
- Causes :
  - CHF.
  - Severe TR.
  - RV dysfunction due to any cause.

} Right sided heart failure

Exertional fatigue :

- Inadequate skeletal muscle perfusion during exercise.
- Inability to increase CO during exercise.
- Due to reduced CO.
- Causes :
  - Fixed obstruction of RVOT : PAH or PS.
  - Fixed obstruction of LVOT : Aortic stenosis/coarctation.

----- Active space -----

Palpitation :

- Unpleasant awareness of one's own heart beat (Rapid or forceful).
- Exertional/at rest/paroxysmal.
- Exertional :
  - Volume overloaded heart (Shunts, regurgitant lesions, Ventricular dysfunction), rarely exercise induced arrhythmias.
- Rest : Volume overload (Turned to left side) or arrhythmia.
- Paroxysmal : Unprovoked; usually arrhythmia.
  - Ask regarding onset & offset.
  - May note neck pulsations or cardiac pulsations.
  - May have polyuria just after the episode (Natriuretic peptides).

Syncope :

- Transient LOC and muscle tone d/t inadequate cerebral perfusion.
- Non-cardiac causes :
  - Benign vasovagal syncope (m/c cause in children). It is transient and can be managed by increasing salt and water intake and avoiding sudden position changes.
  - Dehydration.
  - Metabolic abnormalities.
  - Neurological disorders : Seizures, migraine, etc.
- Syncopal duration <1 min : Vasovagal syncope, hyperventilation.
- Longer duration : Convulsive disorders, migraine, cardiac arrhythmias.

Cardiac causes of syncope :

- Classified as exertional or rest.
- Exertional : Inability of heart to increase CO.
- Exercise induces arrhythmia (CPVT/LQTS/HCM).
- Causes : Severe PAH, Severe RVOT obstruction, Severe LVOT obstruction, Severe Ventricular dysfunction.
- At rest : arrhythmia.

Neurological symptoms :

- H/o stroke :
  - Thromboembolism secondary to cyanotic CHD with polycythemia.
  - Infective endocarditis.
  - Paradoxical embolism of venous thrombus through ASD/patent formaen ovale.

- H/o headache :
  - Cerebral hypoxia with cyanotic heart disease.
  - Severe polycythemia.
  - Brain abscess in cyanotic children.
  - Hypertension with or without COA.
- Choreiform movement strongly suggests rheumatic fever.

Chest pain :

- Seldom cardiac in origin in children (m/c : musculoskeletal issue).
- Common causes : Activity related/trauma history/food habits.
- Relation with breathing : Deep breathing worsens the pain → Pericarditis.
- Nature (Eg : Sharp, stabbing, squeezing).
- Radiation (Eg : Neck, left shoulder, left arm).
- Cardiac origin chest pain : Deep, heavy pressure or feeling of choking or squeezing sensation usually triggered by exercise.

Cardiac causes of chest pain :

- Pericarditis.
- Coronary abnormalities : ALCAPA, abnormal course (Intramural course), Kawasaki disease.
- Hypertrophied LV/RV due to any cause : Severe AS/PS/PAH.
- Some patients with MVP : Atypical chest pain.
- Aortic dissection.
- Rupture of sinus of valsalva.
- Myocarditis.

Cyanosis :

- Bluish discolouration of the skin and/or mucus membranes resulting from increased concentration of de-oxygenated haemoglobin to >3g/dL in arterial blood or >5g/dL in cutaneous veins/capillaries.

----- Active space -----

	Central cyanosis	Peripheral cyanosis
Site	Skin, mucous membranes, tongue	Skin (Peripheries)
Causes	Pulmonary cause Cardiac cause (R->L shunt) Hematological cause Neurological cause	Sepsis Shock due to any cause Polycythemia Hypothermia Hypoglycemia Low cardiac output

Cyanosis & cyanotic spell :

- Age of onset.
- Severity of cyanosis : Permanent or paroxysmal nature.
- At rest/during crying or exercise.
- Parts of body involved (Skin ± mucus membranes).
- Time of appearance : Morning after awakening/feeding.
- History of cyanotic spells.
- D/D : Breath holding spell.
  - Breathing fast and deep v/s holding their breath.

Cyanotic spells :

- Typically occurs in TOF physiology.
- Characterized by paroxysm of hyperpnea, irritability or agitation, and prolonged crying, leading to worsening cyanosis.
- Precipitated by crying, urination, injections, immunization.
- May lead to altered sensorium, neurological complication & death.
- H/o squatting : In older children with CCHD with decreased PBF.
- Denotes TOF physiology in older children.
- Increases systemic arterial SpO_a.

Family history :

Hereditary diseases :

- Marfan's syndrome : Aortic aneurysm or aortic or mitral insufficiency.
- Holt-Oram syndrome/Familial ASD syndrome : ASD & limb abnormalities.
- Long-QT syndrome : sudden death d/t VT/VF.
- Bicuspid aortic valve.
- Familial hypercholesterolemia.
- Noonan's syndrome : PS due to a dysplastic pulmonary valve.

Maternal history :

----- Active space -----

Infections	
Rubella	PDA, Peripheral PA stenosis
CMV, Herpes, Coxsackie B, HIV	myocarditis
Medications	
Amphetamines	VSD, PDA, ASD
Phenytoin	PS, AS, COA
ACEi & ARBs	ASD, VSD, PDA
Lithium	Ebstein's anomaly
Retinoic acid	Conotruncal defects
Valproic acid	ASD, VSD, PS, AS
Alcohol intake	VSD, PDA, ASD, TOF
Maternal conditions	
DM	TGA, VSD, PDA
SLE, MCTD	Complete AV block

Other relevant history :

- Past history of admission.
- H/O surgical or transcatheter procedures.
- H/O medication use.
- Development history : Predominantly gross motor milestones affected (Unless associated genetic syndrome).

Examination

00:34:31

Overview :

- General appearance : Respiratory distress/signs of instability/dysmorphism/ nutritional status.
- Anthropometry/growth pattern.
- Head to toe examination.
  - Cyanosis, clubbing, edema.
- Vitals : Pulse (HR), Respiratory rate, SpO2, BP.
  - Jugular venous pressure in older children.
- Cvs examination : Inspection, palpation, percussion, auscultation.
- Rest systemic examination : Respiratory/GI (Hepatomegaly)/CNS.

----- Active space -----

Growth pattern :

- Length or HC affected : Congenital malformations/genetic disorder.
- Pattern of growth disturbance.

i. Conditions with increased pulmonary blood flow/CHF :
   - Predominantly weight affected (Proportional to shunt).

ii. Conditions with decreased pulmonary blood flow :
   - Mild cyanosis : Growth unaffected.
   - Severe cyanosis : Both height & weight affected.

Cyanosis :

- Cyanosis with arterial desaturation → Central cyanosis.
  - Arterial saturation usually ≤85%.
- Cyanosis with normal arterial saturation → Peripheral cyanosis.
- Distribution : Check the tongue, nail beds, and conjunctiva.
- Use of pulse oximetry is confirmatory.
- D/d : Respiratory diseases, CNS disorders.

Preductal v/s post ductal SpO_a :

- Preductal : Right upper arm. Post ductal : Lower limbs.
- Difference of >3% considered significant.
- Differential cyanosis (High in UL, low in LL) :
  - Interrupted aortic arch/severe COA with PDA.
  - PPHN.
  - PDA with Eisenmenger syndrome.
- Reverse differential cyanosis (High in LL, low in UL) :
  - TGA with COA/IAA and PDA.

Pandigital clubbing :

- >6 months arterial desaturation.
- Widening & thickening of ends of fingers & toes.
- Loss of angle between nail & nail bed : Convex fingernails.
- Earliest noticed in thumb.
- Other causes : Lung disease, cirrhosis of the liver, subacute bacteria endocarditis, familial clubbing.

Pandigital clubbing

----- Active space -----

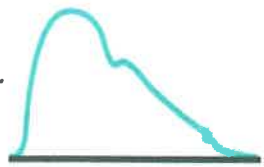
Grade	Description
1	Softening of nail bed
2	Obliteration of Lovibond angle (Angle between nailbed and cuticle)
3	Convex nails
4	Swelling in all directions. Hypertropic

Heart rate & respiratory rate :

- Tachypnea, tachycardia, hepatomegaly.
  - Clinical triad of left-sided heart failure.
- Persistent tachycardia, bradycardia, irregular heartbeat : Suspect arrhythmias.
- Associated dyspnea or retraction.
  - Severe degree of left-sided heart failure.
  - Significant lung pathology.
- Peripheral edema : more common with Right heart failure.
  - Infants : Around the eyes and over the flanks.
  - Older children and teenagers : Periorbital and pedal edema.

Pulse :

- Pressure distension wave due to ejection of blood, propagated along arterial walls & palpable in all superficial arteries.
- Components :
  - Percussion wave : Impulse generated by LV ejection.
  - Tidal wave : Reflectance wave from upper part of the body.
  - Dicrotic wave : Recoil of blood from closed aortic valve and reflectance wave from lower part of body.



Trace of pulse

Characteristics of pulse :

- Rate.
- Rhythm.
  - Regularly irregular : Bigeminy, Trigeminy (Every third beat is a ventricular ectopic).
  - Irregularly irregular : Atrial fibrillation, random occurrence of frequent ectopics.
- Volume.

----- Active space -----

- Character.
- Peripheral pulses : Radioradial & radiofemoral delay.

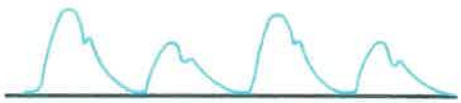
Volume of pulse :

- Amplitude of expansile movement of vessel wall.
- Normal/low/high.
- Pulse pressure : Quantitative measure of pulse volume.
- High volume : Wide pulse pressure (>50% of SBP) with bounding pulses.
  - Aortic runoff : PDA, AR, arteriovenous communication (VOGM). Low pressure due to blood leak.
  - Increased CO due to anemia, anxiety, thyrotoxicosis.
- Low volume : Weak, thready pulse, narrow PP (<25-30mmHg/<25% of SBP).
  - Pericardial tamponade, severe AS, cardiomyopathy, shock.

Abnormal pulse volume :

Pulsus alternans :

- Alternate beats have lower volume.
- Causes : Severe LV failure, ventricular bigeminy.



Pulsus alternans

Pulsus paradoxus :

- Exaggerated inspiratory decline of pulses.
- Difference of systemic blood pressure between inspiration and expiration.
- Diagnosis :
  - By arterial line : Wide swing (>10 mm Hg) in BP.
  - Sphygmomanometry.
- Korotkoff sound-1 is heard for some cycles : A.
- Korotkoff sound-1 heard for all cardiac cycles : B.
- If A - B >10 mm Hg : Pulsus paradoxus present.
- Causes : Cardiac tamponade, constrictive pericarditis (Fluid/fibrotic thickening reduces filling of ventricle), acute asthma (Increased negative intrathoracic pressure).

Pulse character :

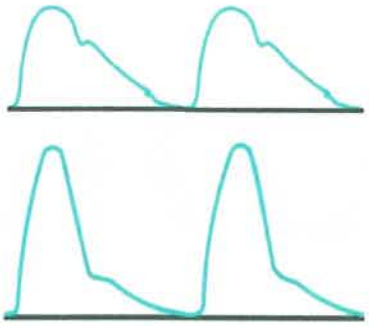
- Character is distinctive feature of pulse
- Abnormalities :
  - Collapsing pulse.
  - Bisferiens pulse.

- Dicrotic pulse.
- Pulsus parvus.
- Pulsus parvus et tardus.

----- Active space -----

Collapsing pulse :

- Increased CO or aortic runoff.
- High volume pulse; rapid upstroke, ill sustained peak & rapid downstroke .
- Appreciated with distal palm, elevating the arm.



Collapsing pulse

Mechanism :

- Rapid upstroke : Due to increased SV.
- Rapid downstroke due to :
  a. Diastolic run off into the LV.
  b. Decreased SVR as a result of reflex vasodilatation.

Causes of collapsing pulse :

Hyperkinetic conditions	Arterial leak
Fever	Severe Chronic AR
Anemia	Patent ductus arteriosus
Thyrotoxicosis	Aorto-pulmonary window

Bisferiens pulse :

- Double beating pulse.
- Both Percussion & Tidal wave are palpable.
- Causes :
  - Chronic severe AR : Volume of LV before systole is so high that both components are palpable.
  - AS + AR : Because of AS second component becomes more prominent and due to AR first component becomes prominent.
  - HOCM : First component due to ejection of LV and second component when the dynamic obstruction in outflow tract is relieved.

Dicrotic pulse :

- Dicrotic wave palpable.
- Double beating pulse.

----- Active space -----

- Abnormal arterial tone : Toxic fevers (Dengue, typhoid, etc.).

Note :

In Dicrotic pulse : 1 component in systole and other in diastole.

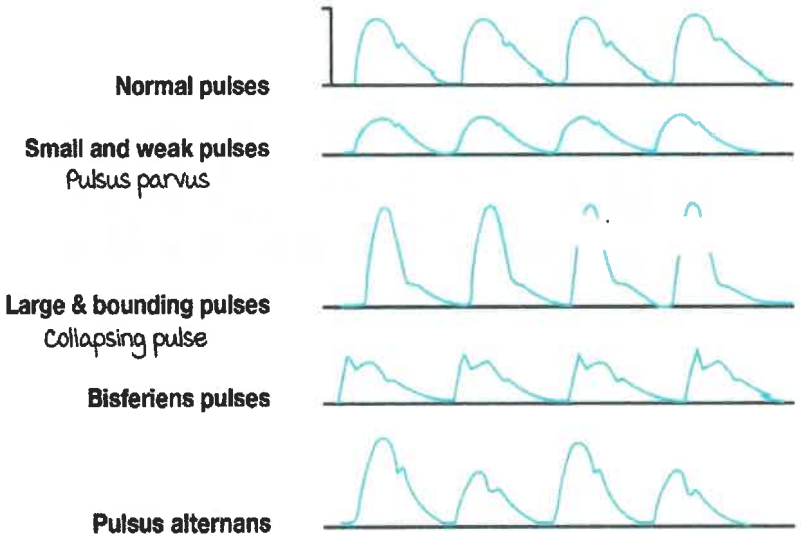
In Bisferiens : Both components in systole.

Pulsus parvus :

- Low amplitude pulse.
- In conditions with decreased stroke volume.

Pulsus parvus et tardus :

- Slow rising, late peaking pulse.
- Seen in severe aortic stenosis.



Peripheral pulses :

- Palpate both radials & both femorals.
- Asymmetry of UL pulses :
  - Pre-subclavian COA (R > L).
  - Takayasu arteritis (Left subclavian artery m/c affected).
  - COA with ARSA (R < L or Both reduced).
  - Supravalvar AS : Right UL pulses > Left UL pulses.
  - Coanda effect (Blood jet directly goes to the right innominate artery).
- Radiofemoral delay : Older patients with COA, Takayasu arteritis.
  - In patients with adequate collateralisation : Femoral appears along with radial or after radial.

HISTORY & PHYSICAL EXAMINATION : II

----- Active space -----

General examination 00:00:07

BP measurement methods :

Gold standard technique : Invasive intra-arterial measurement.

Indirect methods :

i. Auscultation technique (Not practical in neonates).
   - Systolic BP : Appearance of the 1st Korotkoff sound.
   - Diastolic BP : Fifth phase of Korotkoff sounds.

ii. Oscillometric devices (m/c) :
   - Best for measuring mean arterial pressure (MAP).

Procedure :

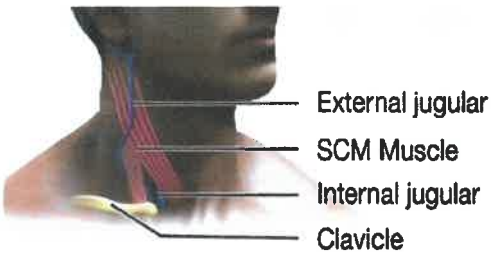
- Seated position in right upper arm, quiet period for at least 5 min.
- Cuff size :
  - Bladder length covers 80–100% of upper arm circumference.
  - Width at least 40% of arm circumference.
- Cuff too small : Falsely high readings.
- Cuff too large : Slightly decreased BP.
- HTN : BP >95th percentile.

Jugular venous pressure :

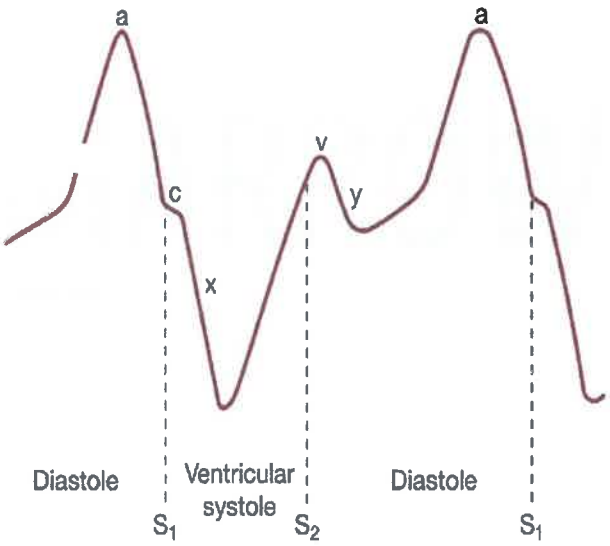
- In cooperative older children & adults.
- Gives information about central venous pressure & RA pressure.
- IJV is used since there is no valve between IJV and heart.
- Procedure : Patient is lied down at 45° and the highest point of pulsation in the left side of neck is noted → Vertical angle of the pulse is noted using a scale from the sternal angle.
- Normally JVP should not be seen >3 cm from the sternal angle.

JVP position

----- Active space -----



JVP anatomy



Normal JVP waveforms

a wave	Right atrial contraction
c wave	RV contraction causing closed TV to bulge towards RA (Isovolumetric contraction)
x descent	RV pulling TV downward during ventricular systole
v wave	Venous filling of RA when TV is closed (During systole)
y descent	Rapid emptying of RA following opening of TV

Abnormalities of JVP :

Waveform	Cardiac condition
Absent a wave	Atrial fibrillation, sinus tachycardia
Flutter waves	Atrial flutter
Prominent a waves	First-degree atrioventricular block
Large a waves	TS, RA myxoma, PAH, PS
Cannon a waves	Atrioventricular dissociation, VT, JET
Absent x descent	Tricuspid regurgitation
Prominent x descent	Conditions causing enlarged a waves