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CHAPTER 1

Data Interpretation

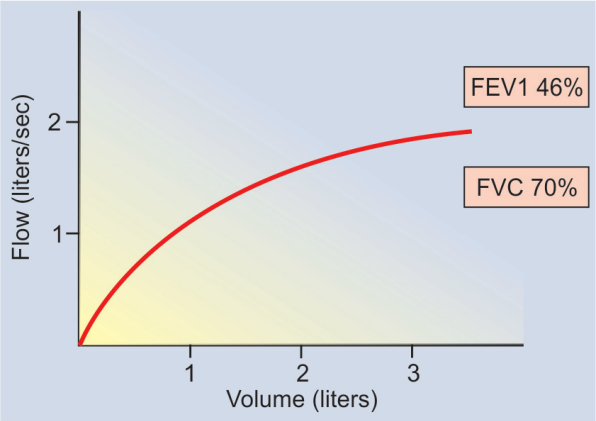
EXERCISES

Q.1. You are sitting in respiratory OPD of your hospital , 8 years old child Rajeev came with his lung function report.

	Predicted	*Measured*	
FVC	2.07	1.31	(63%) of best
FEV1	1.85	1.08	(51%) of best
PEF	275	210	

1. Which type of pulmonary function this result reflecting?
2. What may be the possible causes (write 2)?
3. What type of pulmonary function result you will get in a child with cystic fibrosis?

Q.2. A 7 years old girl Rajni reviewed in respiratory clinic. Here is her flow volume graph.



1. Which type of pattern this graph is reflecting and what is most common diagnosis?
2. What genetic mutation she may have?
3. Which drugs for nebulisation you will prescribe if she had recurrent culture positive pneumonia?

Q.3 . You are sitting in respiratory OPD of your hospital , 14 years old child Rahul came with his lung function report.

	Predicted	*Measured*	
FVC	4.07	3.6	(84%) of best
FEV1	3.90	2.24	(56%) of best
PEF	490	260	(54%) of best
FEF (25–75%)	4.07	1.68	(42%) of best

1. Which type of pulmonary function this result reflecting and what is most common diagnosis?
2. What may the other possible causes (write 2 other than most common)?
3. What is best lung function parameter measurement is best for this child in future?

Q.4. A 2 years old non-cyanotic child came to you with her cardiac catheter result.

	Saturation (%)	*Pressure (mm Hg)*
SA	79	
RA	88	
RV	86	
PA	86	
LA	96	–/6
LV	96	
A	96	

1. Is this catheter report is normal? if not, what is possible diagnosis?
2. What is normal saturation in RA and RV?
3. What pressure will you expect in RA in this child?

Q.5. A 5 years old child came to you with her cardiac catheter result. He was born as a preterm baby.

	Saturation (%)
RA	50
RV	50
PA	50
LA	80
LV	80
A	86

1. What is possible system affected—lung or heart?
2. What is possible diagnosis?

Q.6 A 4 years old child came to you with her cardiac catheter result.

	Saturation (%)	*Pressure (mm Hg)*
RA	74	–/4
RV	74	70/30
PA	74	22/12
LA	96	
LV	96	

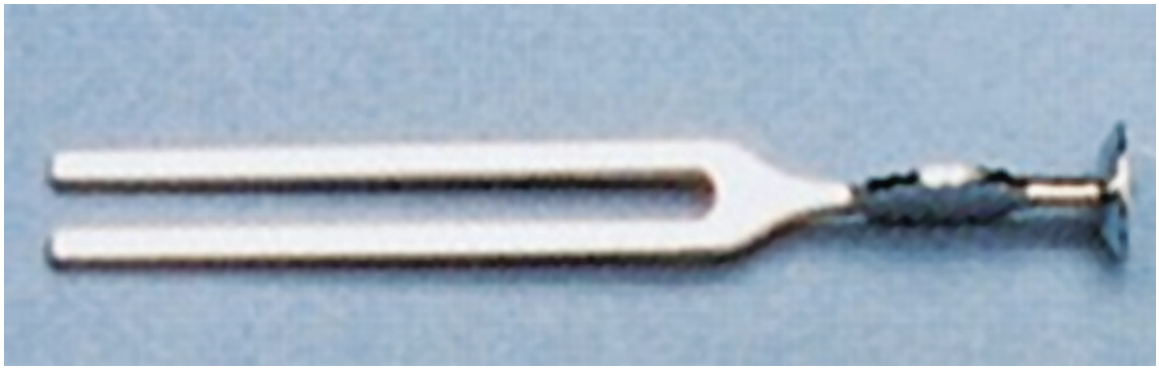
1. What is diagnosis of this catheter report?
2. Write 2 ECG changes.

Q.7. You are asked to see a 7 years old boy who has been suffering from headache. His blood pressure is 160/96 mm Hg. You also noticed murmur on examination.

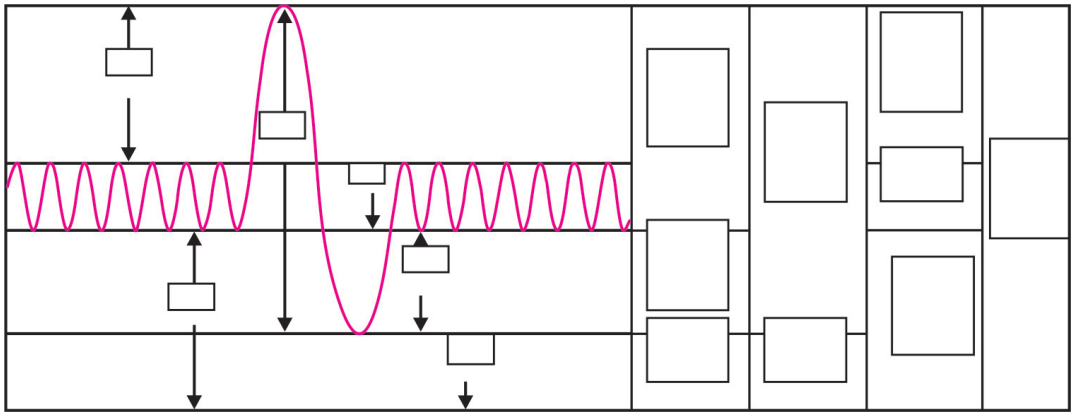
1. What is possible diagnosis in this child?
2. Draw most appropriate pressure and saturation in blocked heart chambers.

	Saturation (%)	*Pressure (mm Hg)*
LA	96	–/10
LV	—	—
Ascending aorta	—	—
Descending aorta	—	—

Q. 8. Test hearing in the 13 years old boy, describing at each step the procedure. (You are provided with tuning fork of frequencies 128 Hz, 256 Hz, 512 Hz.)



Q.9. Mark the lung volumes and capacities



Q.10. Theme: Interpretation of amino acids

A. Phenylketonuria
B. Tyrosinaemia
C. Non-ketotic hyperglycinaemia
D. Ornithine transcarbamylase deficiency (OTC deficiency)
E. Maple syrup urine disease (MSUD)

For each of the following amino acid results, select from the list above the most likely diagnosis.

1.

Amino acid	*Value (µmol/L)*	*Normal range (µmol/L)*
Serine	129	51–230
Glutamine	453	300–760
Glycine	222	80–300
Leucine	1137	55–60
Isoleucine	457	25–150
Valine	826	90–550
Arginine	104	20–180
Phenylalanine	76	30–100
Tyrosine	60	20–150

2.

Amino acid	*Value (µmol/L)*	*Normal range (µmol/L)*
Serine	124	51–230
Glutamine	4122	300–760
Glycine	301	80–300
Leucine	230	55–60
Isoleucine	75	25–150
Valine	300	90–550
Arginine	70	20–180
Phenylalanine	50	30–100
Tyrosine	280	20–150

3.

Amino acid	*Value (µmol/L)*	*Normal range (µmol/L)*
Serine	190	51–230
Glutamine	340	300–760
Glycine	310	80–300
Leucine	120	55–60
Isoleucine	65	25–150
Valine	200	90–550
Arginine	30	20–180
Phenylalanine	1500	30–100
Tyrosine	50	20–150

Q.11. A 6 years old girl Ritu was found to have a poor cortisol response when hypoglycaemic. On the basis of the results of further investigations shown below, what is the most likely diagnosis?

Synachthen test			
Time (min)	0	30	60
Cortisol (nmol/l)	101	94	89
Very-long-chain fatty acids			
C24/C22 ratio	1.54	(NR < 0.96)	
C26/C22 ratio	0.056	(NR < 0.022)	

1. What is possible diagnosis: Addision disease or adrenoleukodystrophy?
2. What is this test results showing?
3. What is genetic inheritance of this disease?

Q.12. Theme: Hepatitis B

	ALT	*HBV/DNA*	*cAb*	*HBsAg*	*Anti-HBsAg*	*eAg*	*eAb*
A	↑	Detectable	IgM	+	–	+	–
B	↑	Detectable	IgM	+	–	–	–
C	↑	Detectable	IgG	+	–	+	–
D	N	High	IgG	+	–	+	–
E	N	Undetectable	IgG	–	+	–	+
F	N	Undetectable	IgG	+	–	–	+

cAb, core antibody; eAb, envelope antibody, eAg, envelope antigen; HBV.

For each of the serologies above, select the correct diagnosis from the following:

1. Chronic hepatitis B infection, non-replicative phase
2. Acute hepatitis B infection with pre-core mutant
3. Chronic hepatitis B infection, immune clearance phase
4. Immune tolerant

Q.13. Theme: Blood and coagulation values

	Hb (g/dl)	*Platelets lacks*	*Total WCC/mm³*	*Neutrophils (%)*	*INR*	*APTT (s)*
A	10.5	0.44	10,000	30	1.1	30
B	12.2	3.2	6,000	50	1.1	32
C	6.2	0.4	15,000	60	1.15	31
D	7.1	0.2	2,200	5	1.15	33
E	18.5	1.5	18,000	60	1.3	55
F	10.1	1.9	5,500	5	0.9	32
G	10.6	0.3	14,000	60	2.5	80

For each patient below, select the appropriate haematological parameters listed above.

1. A 2 years old girl with haemolytic uraemic syndrome
2. A 3 years old boy with Wiskott-Aldrich syndrome
3. A normal 1 day old newborn baby.

Q.14. A 3 years old child present with UTI. On urine culture report you found multiple sensitive antibiotics against *E. coli*. Compare the MIC (minimum inhibitory concentration) report of finally chosen two antibiotics among all and select the best one as per report given below:

***In vitro* efficacy of amoxicillin** (predicts ampicillin)

(A)

Sensitive (MIC)			Intermediate	Resistant
(2)	4	8	16	32
Tested concentrations of amoxicillin (μg/ml)				Breakpoint

***In vitro* efficacy of cefovecin**

(B)

Sensitive (MIC)	Intermediate	Resistant
2	4	8
Tested concentrations of cefovecin (μg/ml)		Breakpoint

1. What is MIC?
2. What antibiotic you will choose among these two and why?
3. What is eagle effect while using antibiotics?

ANSWERS

Ans. 1. 1. Restrictive type
2. Kyphoscoliosis, muscular dystrophy
3. Mix type in cystic fibrosis

**Both FCV and FEV1 are markedly reduced in restrictive type of pattern.

** FCV near normal but FEV1 are markedly reduced in obstructive type of pattern. (Asthma)

** FCV is low but FEV1 much markedly reduced in mix type of pattern. (cystic fibrosis)

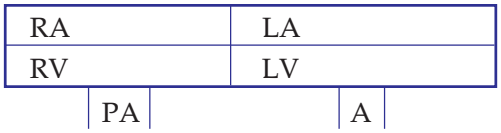
Ans. 2. 1. Mix type, cystic fibrosis
2. Delta 508 mutation for CFTR gene
3. Colistin

Ans. 3. 1. Obstructive, most common—Asthma
2. Pneumonia, bronchiolitis
3. FEF(25–75%)—best to measurement of small airway disease
Peak flow is best for large airway disease follow-up

Ans. 4. 1. ASD
2. 80, 81
3. –/6 (normal is –/4)

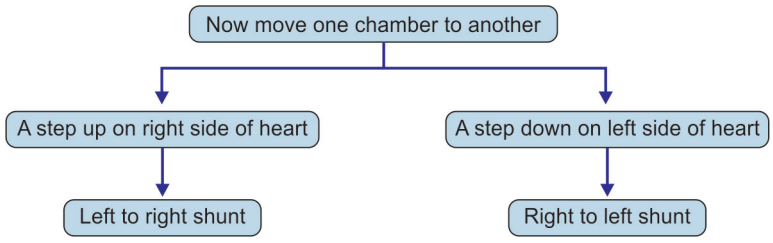
HOW TO SOLVE CARDIAC CATHETER QUESTIONS

1. Made a schematic heart



*RA: Right atrium, LA: Left atrium, RV: Right ventricle, LV: Left ventricle, PA: Pulmonary artery, A: Aorta.

2. Mark the saturation in heart areas
   - Are the saturations on left greater than 90% (Yes): Normal
   - Are the saturations on right less than 80%(Yes): Normal



3. Now mark the pressure in heart chambers
   - all right sides should be less than left-normal
   - if there is equality at any level-(mixing) cardiac shunt
   - if pressure fall across a valve-valve stenosis

Examples:

1. *Saturation*

80%	96%
81%	95%

80% 96%
Normal

80%	96%
79%	95%

96% 80%
TGA

81%	96%
88%	96%

VSD

87%	96%
87%	96%

ASD

2. *Pressures (mm Hg)*

–/4	–/7
20/4	100/10

20/10 (PA) 100/70(A)
Normal

–/7	–/7
20/4	100/10

20/10 (PA) 100/70(A)
ASD

–/4	–/7
60/30	100/10

20/10 (PA) 100/70(A)
Pulmonary stenosis

Ans. 5. 1. Lung 2. BPD

Ans. 6. 1. Pulmonary stenosis
2. Right ventricular hypertrophy—upright T wave in V1
Tall R wave in V1
Right axis deviation

Ans. 7. 1. Coarctation of aorta (COA)
2.

	Saturation%	*Pressure (mm Hg)*
LA	96	–/10
LV	96	150/70
Ascending aorta	96	150/70
Descending aorta	96	70/30

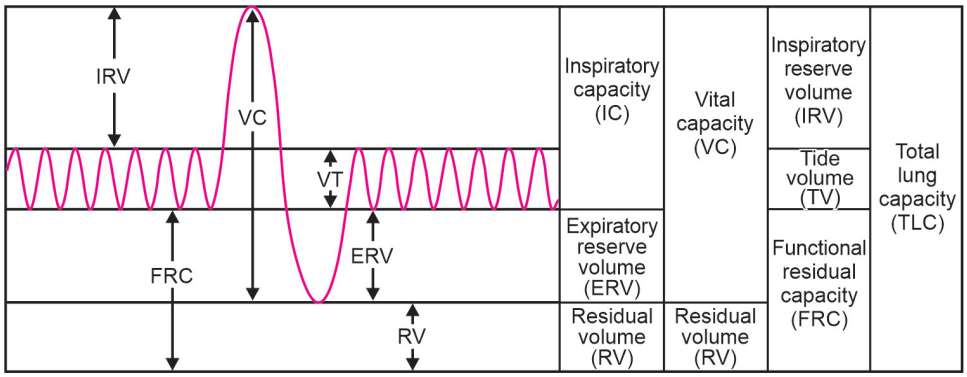
**Acyanotic lesion-COA. So there is no drop in saturation.

Ans. 8. 1. Wish and introduce yourself.
2. Get permission of parent and explain what you're going to do.
3. Select the appropriate tuning fork. (512 or 256 Hz)
4. Rinne test: Strike the tuning fork and hold it near the external ear canal (air conduction) and then against the mastoid process (bone conduction). Ask the patient which sound was louder. In subjects with normal hearing and those with sensorineural loss air conduction is better than bone conduction (Rinne positive.) In conductive deafness bone conduction is louder (Rinne negative).
5. Weber test: Base of the vibrating tuning fork is placed on the vertex or forehead in the midline. Ask the patient whether the sound is heard in the midline or whether

it is lateralized. The normal response is to hear the sound in the midline; this is also true if hearing is symmetrically reduced. However, if there is normal hearing on one side and a pure sensorineural loss on the other the tuning fork will be louder in the normal ear. Conversely, if there is a purely conductive hearing loss the sound will be louder on the side with the conductive deficit.

6. Thank the child.

Ans. 9.



**One block is always volume >1 is always a capacity.

Ans. 10. 1. *Maple syrup urine disease:* The branch-chain amino acids, leucine, isoleucine and valine, share a common enzyme at the start of their catabolic pathway. Deficiency of branched-chain oxo acid dehydrogenase results in increases in all three amino acids.

2. *Ornithine transcarbamylase deficiency:* This amino acid profile suggests a defect of the urea cycle. Ammonia is 'mopped up' by glutamate with a resultant increase in glutamine, which is then transported to the liver for conversion to urea.
3. *Phenylketonuria:* This is the basis of the newborn screening test for PKU phenylalanine hydroxylase converts phenylalanine to tyrosine, and therefore the ratio of phenylalanine to tyrosine is increased. Classic PKU is defined as a phenylalanine level greater than 1000 µmol/L.

Ans. 11. 1. Adrenoleukodystrophy

2. The Synacthen test shows a flat response, with no increase in cortisol. the VLCFAs (very long chain fatty acids) are increased, consistent with adrenoleukodystrophy.
3. X-linked

Ans. 12. 1. F, 2. B, 3. C, 4. D

The following phases of hepatitis B virus infection are recognised:

Host HBV status	*ALT*	*HBV DNA*	*cAb*	*sAg*	*sAb*	*eAg**	*eAb*
A. Acute	↑	Detectable	IgM then IgG	+	–	+	–
B. *Chronic*							
1. Immune tolerance	N	High	IgG	+	–	+	–
2. Immune clearance	↑	Detectable	IgG	+	–	+	–
3. Non-replicative	N	Undetectable	IgG	+	–	–	+
C. Resolved	N	Undetectable	IgG	–	+	–	+

***eAg absent in pre-core mutant.** ↑, increased; ALT, alanine aminotransferase; cAb, core antibody; eAb, envelope antibody; eAg, envelope antigen; HBV, hepatitis B virus; N, normal; sAb, surface antibody; sAg, surface antigen.

Clues to remembering:

Hep Bc IgM +ve	Acute infection
Hep Bc IgG +ve with HBsAg +ve	Chronic infection
Presence of HBeAg	Infective and therefore absent in non-replicative and resolved states (except when there is a pre-core mutant)
Abnormal liver function tests	Only occurs during acute infection and clearance of virus

HBeAg, hepatitis B envelope antigen; HBsAg, hepatitis B surface antigen; Hep Bc, hepatitis B virus core antigen.

Ans. 13. 1. C, 2. A, 3. E

Ans. 14. 1. *In vitro* lowest concetration of an antibiotic agent which completely prevents visible growth of an organism (mg/l or µg/ml).

2. Resistant value of amoxicilline is four times dilution (32) away from MIC value (2) and two times dilution (4) away from MIC value (2) of cefovecin. So in this case amoxicilline is the best choice.
3. Paradoxical reduced killing activity at antibiotics concentrations above its MIC or OBC (supra MIC). (If you use very high dose of antibiotics, it may be less effective than usual dose).

CHAPTER 2

COVID in Children

Applicable to children with confirmed COVID-19 infection.
Based on currently available evidence.

SEVERITY CLASSIFICATION

Mild disease	*Moderate disease*
Sore throat, rhinorrhea, cough No fast breathingy	**Pneumonia** **Fast breathing** (age based)* ≥60/min for <2 months ≥50/min for 2–12 months ≥40/min for 1–5 years ≥30/min for >5 years **No signs of severe pneumonia**
Severe disease	*Critical disease*
Severe pneumonia Pneumonia with any of these: Cyanosis (SpO_2 <90%) Increased respiratory efforts (grunting, severe retraction) Lethargy, somnolence, seizure	ARDS Septic shock MODS Acute thrombosis MIS-C

TREATMENT

Mild Disease

- Supportive care; monitoring at home
- Adequate hydration and feeding
- Paracetamol 10–15 mg/kg/dose for fever
- Explain danger signs
- To report to health facility, if any worsening.

Home isolation 10 days after symptom onset and no fever for 3 days.
(This is followed by further 7 days of home isolation and self monitoring).

- **Documentation of negative RT-PCR/CBNAAT no longer recommended.**

INDICATION FOR ADMISSION

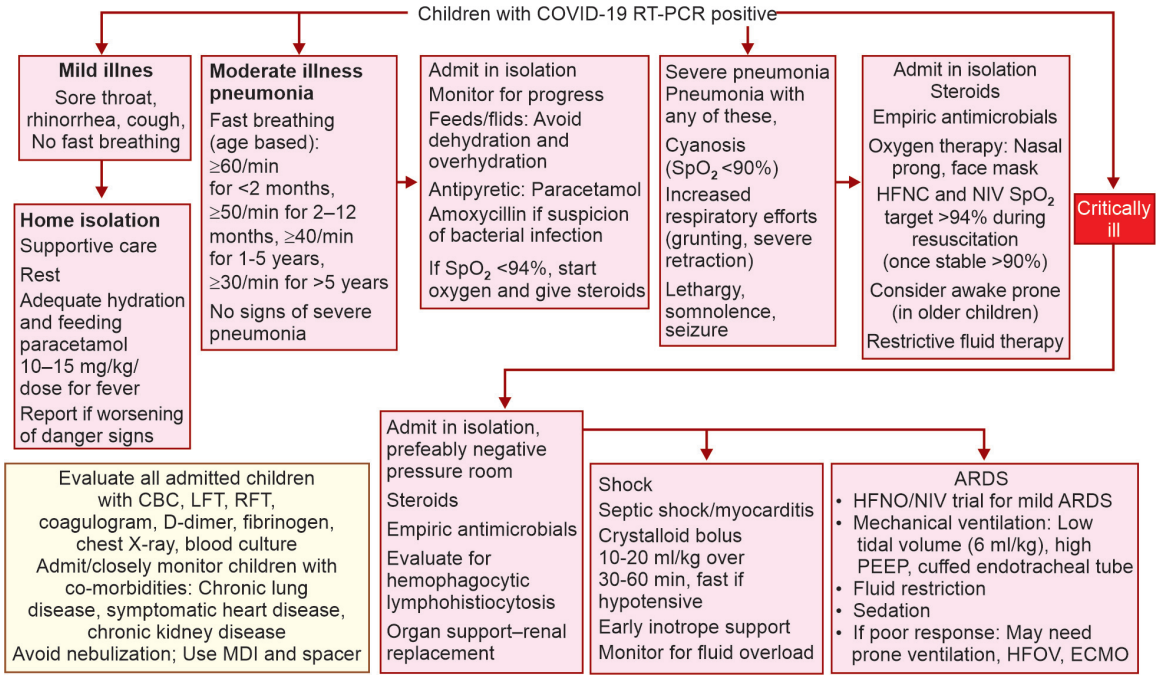
Respiratory distress

- SpO_2 <94% on room air
- Shock/poor peripheral perfusion
- Poor oral intake, especially in infants and young children
- Lethargic, especially in infants and young children
- Seizures/encephalopathy
- Children with high risk for severe disease with mild symptoms:
  - congenital or acquired heart disease,
  - chronic lung, liver, kidney or neurological disease,
  - immunosuppressive drugs,
  - congenital or acquired immunodeficiency.

Indication for PICU Admission

Moderate-to-severe ARDS requiring mechanical ventilation

- Shock requiring vasopressor support
- Worsening mental status
- Multi-organ dysfunction syndrome
- MIS-C.



COVID DRUGS IN CHILDREN

Prednisolone; 1 mg/kg/day, up to 40 mg/day for 5–14 days (depending on clinical response) (or equivalent dose of dexamethasone, methylprednisolone, or hydrocortisone).

***Recommended for severe and critical COVID-19 improved survival.**

- Anticoagulants (LMWH) are not recommended for prophylaxis in any disease severity. It should be used only for established thrombosis.
- Favipiravir, remdesivir, tocilizumab, hydroxychloroquine, chloroquine, ivermectin, azithromycin and lopinavir/ritonavir are not recommended for routine use in COVID-19 in children with any disease severity.
- None of the drugs including ivermectin, hydroxychloroquine have any role prophylaxis.

DISCHARGE CRITERIA

After 10 days of symptom onset, AND

- Clinical resolution of symptoms, AND
- SpO_2 >95%, off oxygen for 3 days
- Followed by home isolation and self-monitoring for 7 days.

MIS-C

DIAGNOSTIC CRITERIA

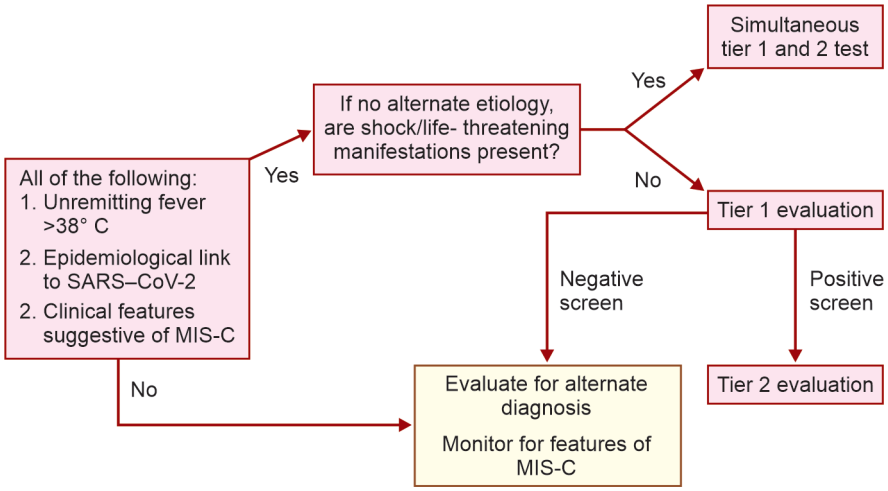
- Children and adolescents 0–19 years of age with fever >3 days.
  AND two of the following:
- Rash or bilateral non-purulent conjunctivitis or muco-cutaneous inflammation signs (oral, hands or feet).
- Hypotension or shock.
- Features of myocardial dysfunction, pericarditis, valvulitis, or coronary abnormalities (including ECHO findings or elevated troponin/NT-proBNP),
- Evidence of coagulopathy (by PT, PTT, elevated D-dimers).
- Acute gastrointestinal problems (diarrhoea, vomiting, or abdominal pain). AND
- Elevated markers of inflammation such as ESR, C-reactive protein, or procalcitonin. AND
- No other obvious microbial cause of inflammation, including bacterial sepsis, staphylococcal or streptococcal shock syndromes. AND
- Evidence of COVID-19 (RT-PCR, antigen test or serology positive), or likely contact with patients with COVID-19.

EVALUATION OF MIS-C

Screening Evaluation

Tier 1 Evaluation (Screening)

- CBC
- Complete metabolic profile (LFT/RFT/blood gas/glucose)
- CRP and/or ESR
- SARS-CoV-2 Serology and/or PCR.



Tier 2 Evaluation (Complete)

Cardiac

- ECG
- Echocardiogram
- BNP, Trop T: Inflammatory markers
- Procalcitonin
- PT, PTT, D-dimer, Fibrinogen
- LDH
- Triglyceride
- Cytokine panel: Blood smear; SARS-CoV-2 serology.

TREATMENT OF MIS-C

MIS-C with shock or life-threatening disease	*MIS-C: Not immediately life-threatening*
Steroid (Methylprednisolone 1–2 mg/kg/day) + IVIg (2 g/kg over 24–48 hours) + antimicrobials simultaneously evaluate for tropical infections	Rule out tropical infection first Steroid (Methylprednisolone 1–2 mg/kg/day): First line OR IVIg: alternative/first line, as per availability

Antiplatelet and Anticoagulants

Aspirin	*Enoxaparin*
• 3–5 mg/kg/day; max 81 mg/day • Indications • Thrombocytosis • Coronary aneurysm (Z-score ≥2.5).	• Target factor Xa level 0.5–1 • Indications? Coronary aneurysm (Z-score >10) • Thrombosis • LVEF <35%

FOLLOW-UP

Echo repeated at 7–14 days and 4–6 weeks

- Repeat at 1 year if initial echo is abnormal.

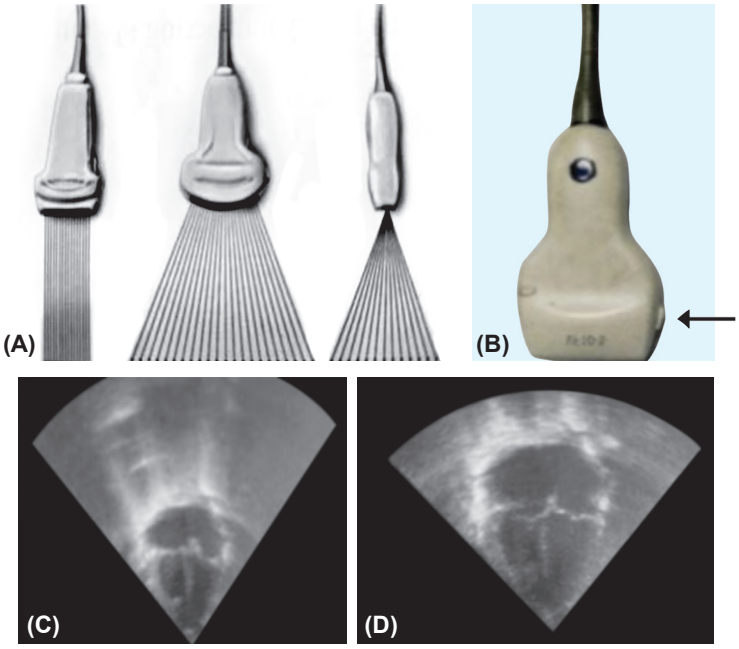
CHAPTER 3

Point-of-care Ultrasound

Point-of-care ultrasound (POCUS) is the new stethoscope in care of babies in NICU and PICU. It contains USG brain in neonates, ECHO and USG of lungs and abdomen. Now this is part of curriculum in MD and DM training and also in examination.

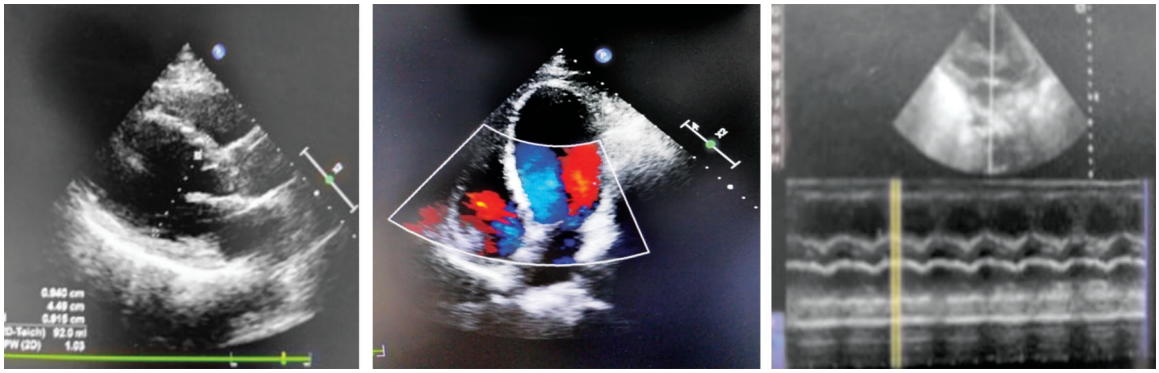
EXERCISES

Q.1. You are posted in ECHO room to learn about neonatal ECHO. Kindly answer the following questions about ECHO machine:



1. What are name of 3 probes in Fig. A?
2. What is this arrow marked name in Fig. B?
3. In Fig. C and D, which depth is appropriate when you are doing ECHO, how much depth is consider best?

Q.2. What are the modalities in given three images and write one use of each.

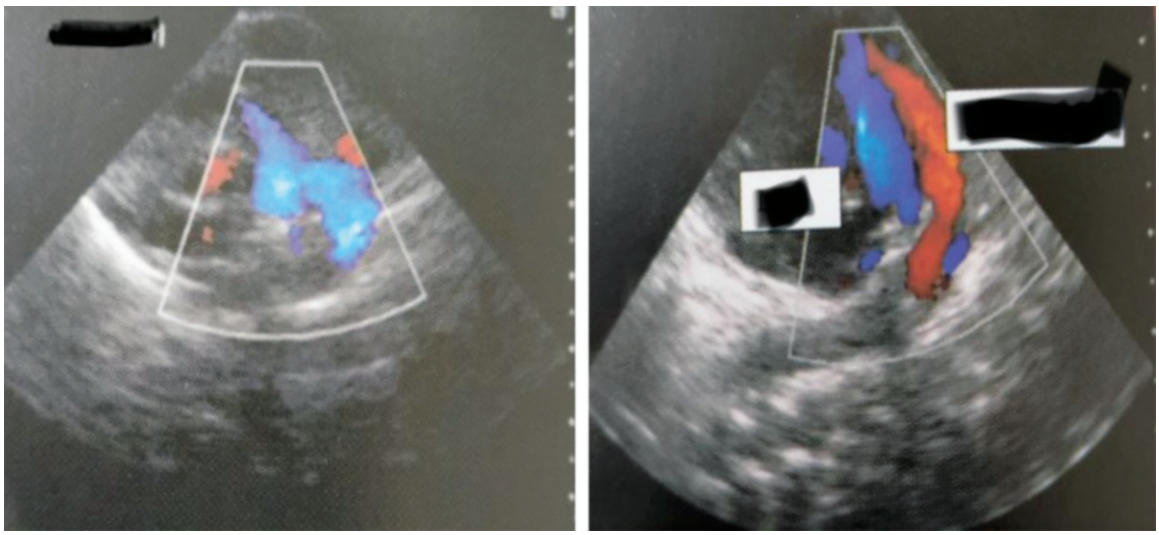


(A) (B) (C)

Q.3. A preterm neonate 26 weeks at day 3 became sick in form of tachycardia, desaturation, feed intolerance. You Observed baby has bounding pulses and oxygen need increased in last 12 hours. Your unit in-charge advised ECHO screening in all preterm babies around day 3. Kindly answer the following questions:

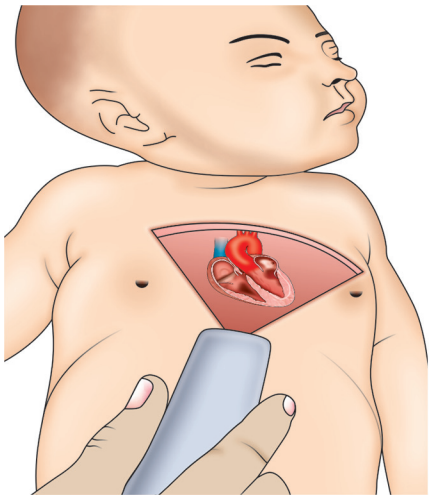
1. What is possible diagnosis?
2. Why ECHO screening important in preterm babies at day 3?
3. What are importance of anterior cerebral artery Doppler in cases of PDA in neonate?

Q.4. In given two images below differential normal image and abnormal duct and what is diagnosis in abnormal duct image? What are three important pathophysiological parameters of abnormal duct?

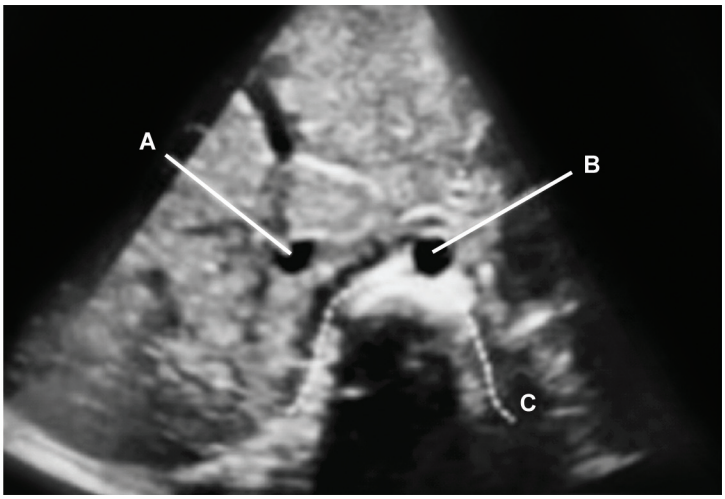


(A) (B)

Q.5. A neonate has issues related to his heart. A screening ECHO was planned by your unit head. While performing the ECHO this is the first image you saw on screen. Observe this image and answer the following question related to this.



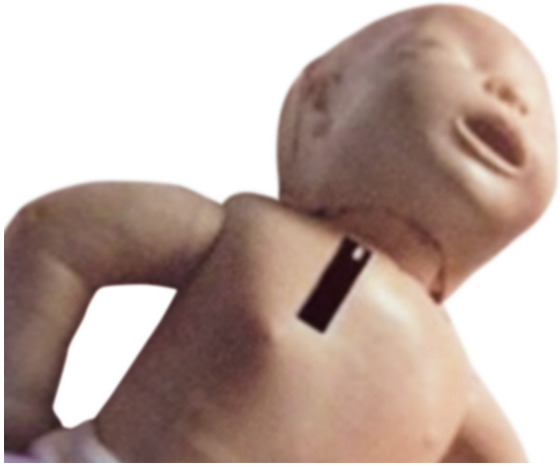
(A)



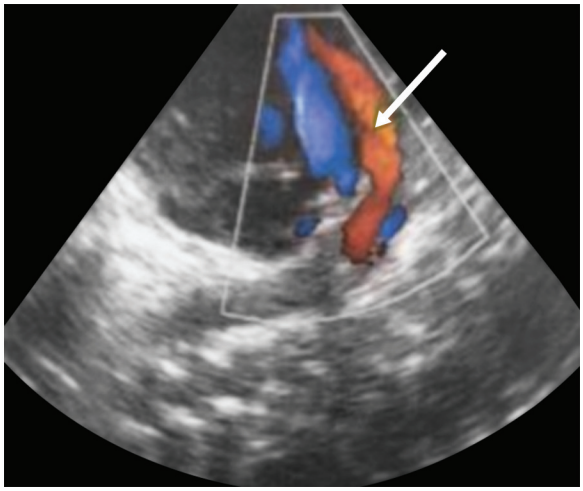
(B)

1. Which is this view (Image A)
2. What are the marked structures in (Image B)
3. What is NEOPOCUS means

Q.6. A 5 days old 26 weeks preterm baby started deteriorating in NICU. Baby has tachycardia, hyperactive precordium, increased pulse pressure. You diagnose this as a hemodynamically significant PDA and called the pediatric cardiologist. See the images below and answere the following questions:



(A)

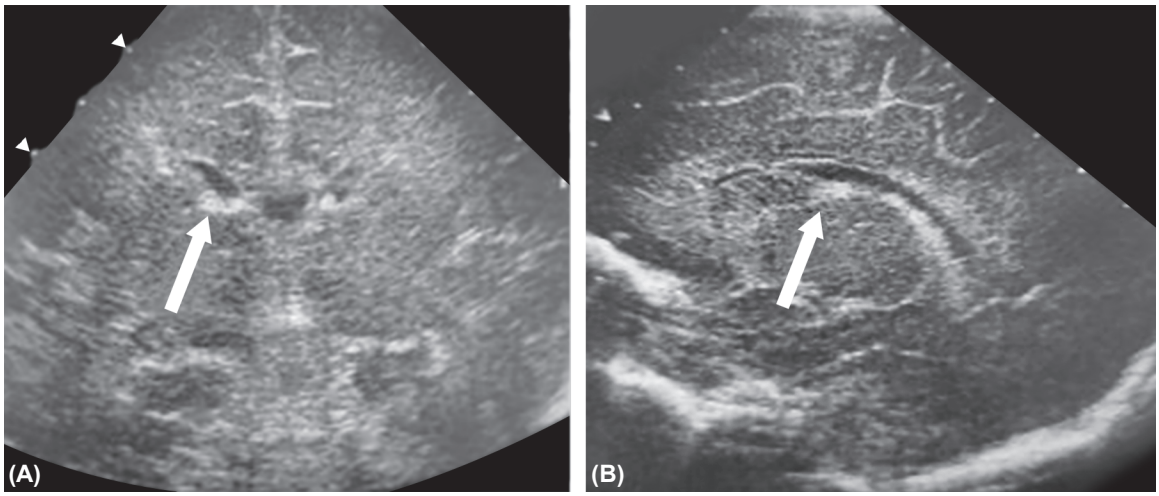


(B)

1. What is this view to diagnosed PDA in neonate (Image A)
2. What does the arrow marker show in image B
3. Make the most important "triple leg view" line diagram indicating vessels.

Q.7. A 25-week premature at day 3 of life has features of IVH clinically. As per protocol a USG brain was planned bedside. See the images below and answer the following questions:

1. What are the name of two "views" showing IVH?
2. What is the grade of IVH?
3. What is important structure shown in arrow in both images?
4. Why this area is important for IVH in preterm for long-term outcome?



ANSWERS

Ans. 1. 1. Linear, curved and array probes
2. Probe marker
3. Figure D is of appropriate depth (must be 75% of total screen).

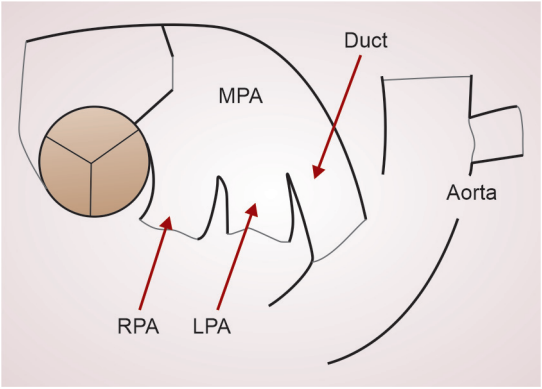
Ans. 2. 1. Grey scale to see structure and orientation
2. Doppler to see blood flow in vessel
3. M MODE: to see motion in form of contractility.

Ans. 3. 1. Hemodynamically significant PDA
2. To see hypoperfusion, assessment and monitoring of PDA, assessment of neonatal shock
3. As a marker of systemic hypoperfusion due to PDA: will see diastolic blood flow pattern.

Ans. 4. Image A: Closed duct (normal); Image B: Large patent duct (abnormal) and three pathophysiological parameters are:
i. Pulmonary over circulation,
ii. Systemic hypoperfusion,
iii. High volume left to right shunt.

Ans. 5. 1. Subcostal view
2. A: IVC, B: Aorta, C: Spine
3. Neonatal point-of-care ultrasound.

Ans. 6. 1. High parasternal view (ductal view)
2. Patent PDA
3. See figure below.



Ans. 7. 1. Image A: Coronal view; Image B: Sagittal view
2. Grade I germinal matrix hemorrhage
3. Germinal matrix hemorrhage at "caudothalamic groove"
4. More chances of mortality and abnormal neurodevelopment outcome.

CHAPTER 4

Blood Gas and Electrophysiology

ABG

Check consistency of any ABG report:

$$\frac{[H^+] \times [HCO_3]}{pCO_2} = 24 \quad \textit{Henderson equation}$$

$$\frac{40 \times 24}{40} = 24$$

Example, in a patient of DKA
pH: 7.2, pCO_2: 30, HCO_3: 15

$$\frac{60 \times 15}{30} = 30$$

pH	Subtract from	$[H^+]$
6.8		160
6.9		130
7.0	100	100
7.1	90	80
7.2	80	60
7.3		50
7.4		40
7.5		30
7.6	85	25
7.7	90	20
7.8	95	15

EFFECT OF ALBUMIN

- **1 g/dl decrease** in serum **albumin** results in a **2.5 mEq/L decrease** in the **anion gap (AG)**.
- A **50%** reduction in the **albumin** conc. will result in a **75%** reduction in the **AG**.
- A **very low or negative** anion gap may be due to **hypoproteinemia** and **lithium toxicity**.

INTERPRETATION OF THE ANION GAP (AG)

High AG Metabolic Acidosis [*Mnemonic*: **MUD PILES**]

- *M*ethanol, metformin, midaz
- *U*remia
- *D*iabetic ketoacidosis
- *P*araldehyde, phenformin, propylene glycol, PCM
- *I*nfection (Increased lactic acid), iron, isoniazid
- *E*thylene glycol, ethanol
- *S*alicylates

Normal AG Metabolic Acidosis

[*Mnemonic*: **I Enjoy DARU]**

- **Isotonic saline infusion**
- Early renal insufficiency
- Diarrhea (N urinary anion gap)
- **Renal tubular acidosis** (high urinary anion gap)
- **Acetazolamide**
- Ureteroenterostomy

CAUSES OF METABOLIC ALKALOSIS

- **Infantile hypertrophic pyloric stenosis**
- Prolonged vomiting
- Duodenal atresia
- Diuretics (thiazides, frusemide)
- **Conn's syndrome**
- Bartter and Gitelman syndrome

CAUSES OF RESPIRATORY

Acidosis	*Alkalosis (Mnemonic: SUT-CODA)*
• **Pneumonia, pulmonary edema**	• **Theophylline**, aminophylline
• Anesthetic drugs (propofol)	• Salicylates overdose
• **Morphine, alcohol**	• **CO poisoning**
• Bronchial asthma	• Duodenal atresia
• **GBS**, SMA	• Hyperventilation syndrome
• Poliomyelitis, myasthenia gravis	• Severe anemia
• Hypoventilation syndrome	• **High altitude,** CHF
• **Pickwickian syndrome**	• Urea cycle defect
• Head trauma, brain tumor	
• **Organophosphorus poisoning**	

Note: Pneumonia, pulmonary edema, asthma and pneumothorax can cause respiratory alkalosis also (Ref.: Nelson)

DELTA-RATIO (May 2013 Questions)

- In the presence of a **high AG metabolic acidosis**, it is possible to detect another metabolic acid–base disorder (a normal AG metabolic acidosis or a metabolic alkalosis) by comparing the **AG excess** (the difference between the measured and normal AG) to the **HCO_3 deficit** (the difference between the measured and normal HCO_3 concentration in plasma).
- The ratio (**AG excess/HCO_3 deficit**) is shown below using 12 mEq/L as the normal AG and 24 mEq/L as the normal plasma HCO_3 concentration.

$$\textbf{Delta-ratio} = \frac{\textbf{AG excess}}{\textbf{HCO}_3\ \textbf{deficit}} = \frac{\textbf{[Measured AG} - \textbf{12]}}{\textbf{[24} - \textbf{measured HCO}_3\textbf{]}}$$

- Normal = 1
- In the presence of a high AG metabolic acidosis, a "gap-gap" (AG excess/HCO_3 deficit) ratio of **less than 1** indicates the coexistence of a **normal AG metabolic acidosis.**
- In the presence of a high AG metabolic acidosis, a gap-gap (AG excess/HCO_3 deficit) ratio of **greater than 1** indicates the coexistence of a **metabolic alkalosis.**

Compensation: Always in Same Direction and Increase or Decrease

1. **Metabolic acidosis**
   Ideal pCO_2 level = HCO_3 (1.5) + 8 ± 2
2. **Metabolic alkalosis**
   Ideal pCO_2 level = 40 + 0.7 (HCO_3 level – normal HCO_3 level)
3. **Respiratory acidosis**
   Ideal HCO_3 level = with each 10 increase of pCO_2 – there is HCO_3 increase with 1 (in acute), 3 (chronic)
4. **Respiratory alkalosis**
   Ideal HCO_3 level = with each 10 decrease of pCO_2 – HCO_3 decrease with 2 (acute), 4 (chronic)

Arterial blood gas analysis

ABG parameter			ABG result	Calculation and interpretation		
pH	>7.45	Alkalemia		pH	pCO_2	Interpretation
	7.36–44	Normal		↓	↓	Metabolic acidosis
	<7.35	Acidemia		↑	↑	Metabolic alkalosis
pCO_2	>45	High		↑	↓	Respiratory alkalosis
	35–45	Normal		↓	↑	Respiratory acidosis
	<35	Low		Corrected standard AG for albumin		
HCO_3	>26	High		Albumin + 1.5 a phosphate 4		
	24+/–2	Normal		Anion gap calculation		
AG	<22	Low		$\{[Na^+] – [Cl + HCO_2]\} – 12+/–4$		
	> 16	High		Corrected Na^+ for AG in hyperglycemia		
	12+/–4	Normal		Corrected $Na^+ – Na^+ \frac{Glucose – S}{3}$		
Glucose	<8	Low		Gap: Gap calculation for metabolic acidosis		
	>10	High		<0.4	Low or normal AG metabolic acidosis	
	<2	Low		0.4–0.8	Normal + high AG metabolic acidosis	
Gap:Gap	$\frac{\Delta AG}{\Delta HCO_3}$	$\frac{AG – 12}{24 – HCO_3}$		0.8–2.0	Pure high metabolic acidosis	
Lactate	<1.9	Normal		>2.0	Metabolic acidosis with metabolic alkalosis, respiratory acidosis	
	>2.0	High				
pO_2	80–100	Normal		$pAO_2 – [713 \times FiO_2] – [pCO_2 \times 1.25]$		
	<60	Hypoxia		A-a gradient = $pAO_2 – paO_2 – \frac{Age – 4}{4}$		

Compensation rules for				
Expected pCO_2	Metabolic acidosis		Metabolic alkalosis	
	1.5 × [HCO_3] + 3 (+/–2)		0.7 × [HCO_3] + 20 (+/–5)	
Expected HCO_3	Respiratory acidosis		Respiratory alkalosis	
	Acute	Chronic	Acute	Chronic
	$24 + \frac{pCO_2 – 40}{10} X_2$	$24 + \frac{pCO_2 – 40}{10} X_4$	$24 – \frac{40 – pCO_2}{10} X_2$	$24 – \frac{40 – pCO_2}{10} X_5$

For every 10 mm change in pCO_2 → There is

- 0.08 change in pH—acute
- 0.03 change in pH—chronic

Which are unmeasured cations and anions?

- Cations: Magnesium and gamma globulins
- Anions: Albumin, sulphate, phosphate, organic acids

In Venous Sample than Arterial

pO_2	<40 mm Hg
pH	0.03 lower
pCO_2	6 mm Hg higher
$[HCO_3–]$	2–4 mEq higher

ACID–BASE STATUS

Step 1. In high AG acidosis: Calculation of osmolal gap.
Calculated osmolality = 2[Na] + [glucose]/18 + [BUN]/2.8

Step 2. In normal AG acidosis
Urinary anionic gap: UAG = [Na + K] – [Cl]

- Negative UAG = > ammonia excretion is normal (GI cause or iatrogenic)
- Positive UAG (>20–30 mEq/L) = > ↓ NH_3 excretion (RTA—I, II, IV).

Step 3. Look at urine pH: >6.0 → distal (type I) RTA
Look at urine pH: <5.5 → proximal (type II) RTA/(type IV) RTA

Step 4. Look at serum K^+
Hypokalemia → proximal (type II) RTA/hyperkalemia → aldosterone deficiency (type IV) RTA

Step 5. In metabolic acidosis look at urinary electrolytes.
Normal AG acidosis = RTA

- If urine pH <5.5, give IV $NaHCO_3$ till urine alkalinise
  - If urine pH >6.0 before normalization of $S.HCO_3$ → proximal RTA
  - If urine pH remains acidic → diarrhea
- If urine pH >6.0, give IV $NaHCO_3$ and check urine pH.
  - If urine pH remains unchanged despite $NaHCO_3$ → distal RTA

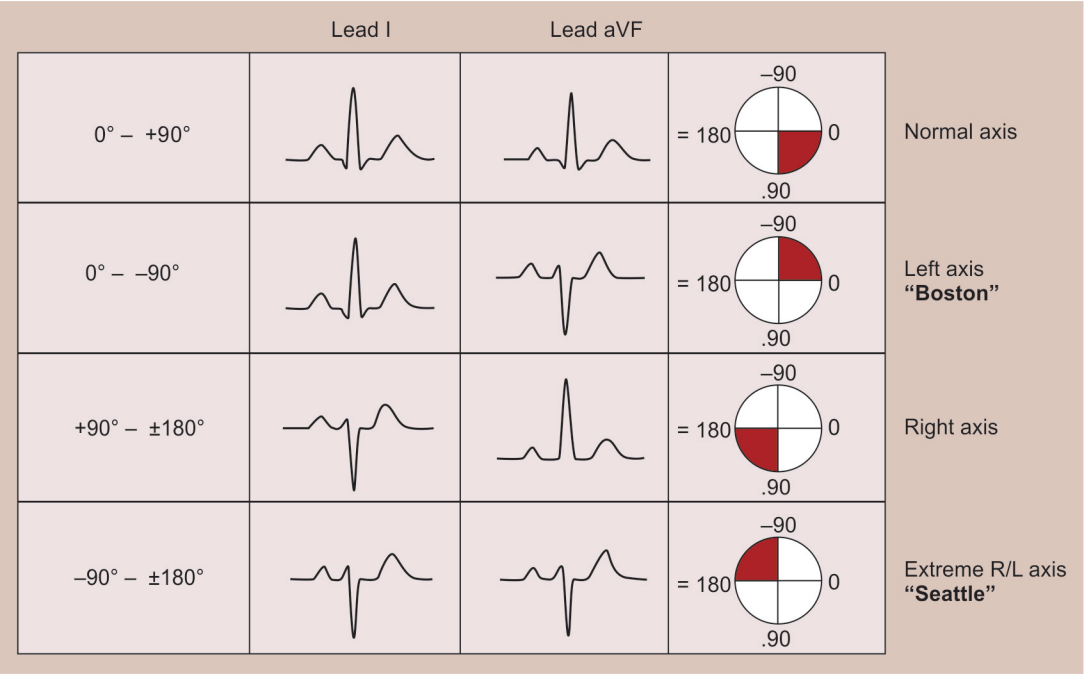
Step 6. Metabolic alkalosis:

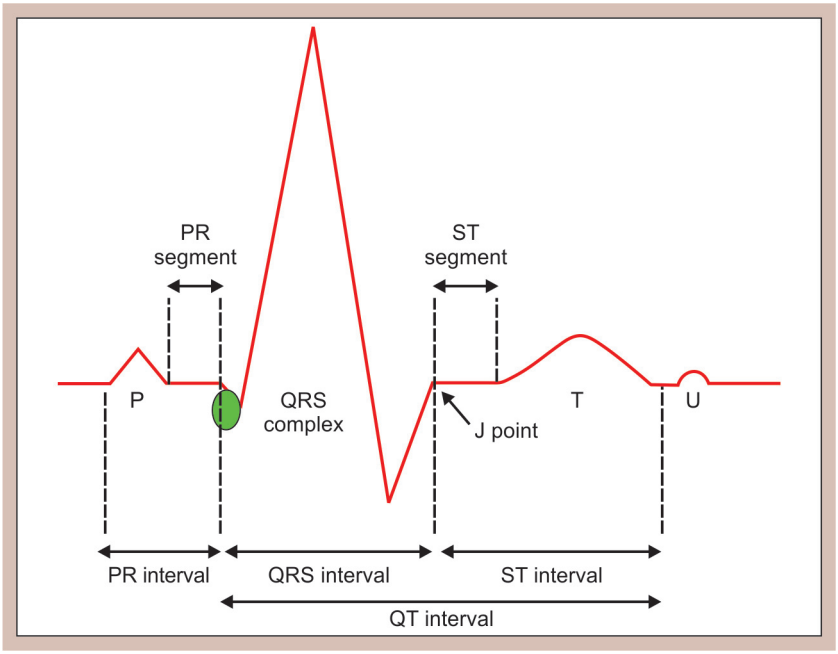
- Urinary Cl → >20 mEq/L → saline resistant
- Urinary Cl → <10 mEq/L → saline responsive

ECG (*10 Marks Question)

ECG is very wide subject but if you mug up material in text and question. 95% will be covered.

AXIS = Always see lead 1 and AVF



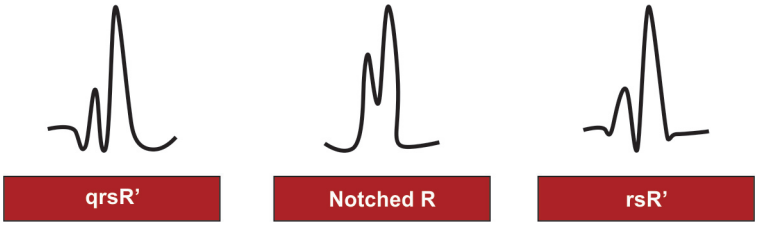


Interval/segment

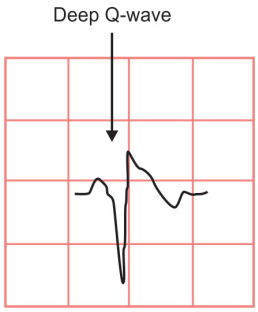
*Interval are always longer than segment

COMMON QRS MORPHOLOGIES–TERMINOLOGIES (*Asked Once)

- Capital letter describes deflection that is at least one half the amplitude of major deflection.
- Lower case letters—minor deflections.



Q-WAVE



- Produced by ventricular septum depolarization.
- Always present in V5, V6 absent in V1.
- If present in V1: L-TGA, single ventricle.
- Absent in V6: Single vent, LBBB, L-TGA.
- Deep Q-wave in V5–V6-**ALCAPA**** (***Repeated OSCE Q.*).**

QT Abnormalities (Must Know) = 0.44 second (N Q–T interval)

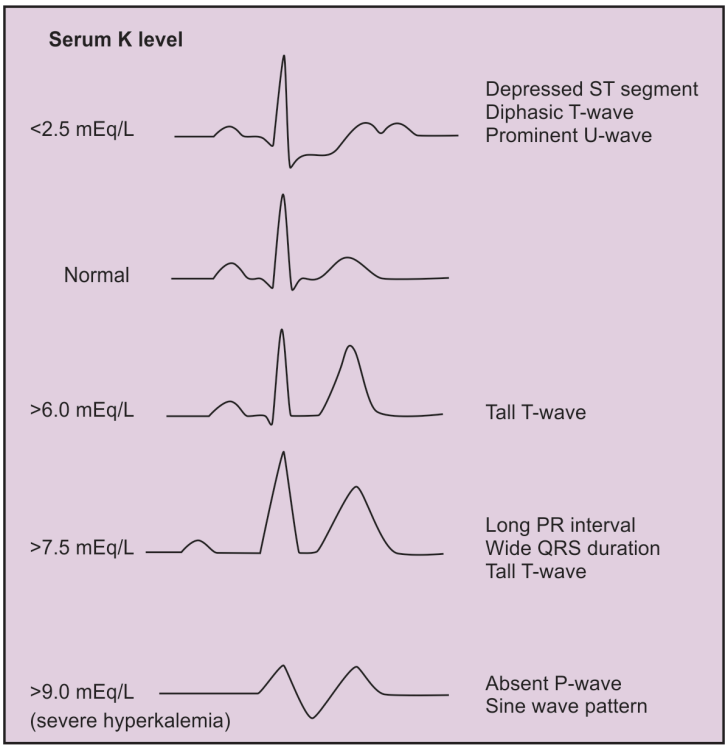
- *Short QT*
  - **Digoxin toxicity**
  - **Hypercalcemia**
- *Long QT—congenital causes*
  - **Jervell-Lange-Nielsen**—AR, deafness
  - **Romano-ward**—AD, normal hearing
- *Long QT—acquired causes*
  - Metabolic
    - **Hypocalcemia, hypothermia**
    - **Hypomagnesemia**
    - Malnutrition (anorexia)
  - Drugs
    - Ia and III antiarrhythmics
    - Phenothiazines
    - **TCA**, quinidine, procainamide
  - CNS trauma
  - Myocardial
    - Ischemia
    - Myocarditis

Bazett's Formula**

$$QTc = \frac{QT}{\sqrt{RR}}$$

Electrolyte Disturbances

1. **Hypokalemia:** Prominent **U-wave** with apparent prolongation of QTc is seen
   - Flate or disphasic T-wave
   - Depressed ST segment
2. **Hyperkalemia:** Tented T-wave
   - Prolonged of QRS uration and PR interval
   - Disappearance of P-wave
   - Sine wave pattern (due to ventricular fibrillation) is seen in severe hyperkalemia (*see* below)



ECG findings of hypokalemia and hyperkalemia

PROLONGED PR INTERVAL

Prolonged PR: Defined as

- <1 year = >0.12 sec (lower limit 0.08 sec)
- 1–3 years = >0.16 sec (lower limit 0.08 sec)
- Up to 16 = >0.18 sec (lower limit 0.10 sec)

PR Interval (0.12–0.20 sec) (also called 1° heart block)

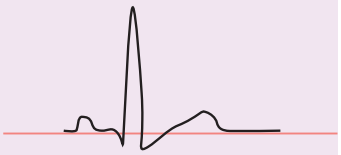
Prolonged PR	*Short PR*	*Variable PR*
Myocarditis—**rheumatic,** viral, diphtheric Toxicity—**digitalis,** quinidine **Hyperkalemia,** ischemia, Left atrial hypertrophy	**Wolff-Parkinson-White (WPW)** syndrome LGL syndrome **Glycogen storage** disease	Wandering atrial pacemaker **Mobitz Type 1, 2nd** degree block

QRS Duration (Ventricular Conduction Disturbances)

- Abnormal—**>0.08 sec** specially in children
  - Bundle branch block—right and left
  - Intraventricular block
  - Preexcitation syndrome (WPW syndrome)
  - Arrhythmia of ventricular origin

DIGITALIS EFFECT AND TOXICITY ** (Very Important)

Effect	*Toxicity*
• **Sagging of ST segment**	• **Prolonged PR interval**
• Decreased T-wave amplitude	• Profound sinus bradycardia or SA block
• **Shortening of QTc (earliest sign)**	• Supraventricular arrhythmia
• **Slowing of HR****	• Ventricular bigeminy (earliest)



T-wave Abnormalities

Tall T-wave is seen in

Hyperkalemia, LVH

Flat T-wave is seen in

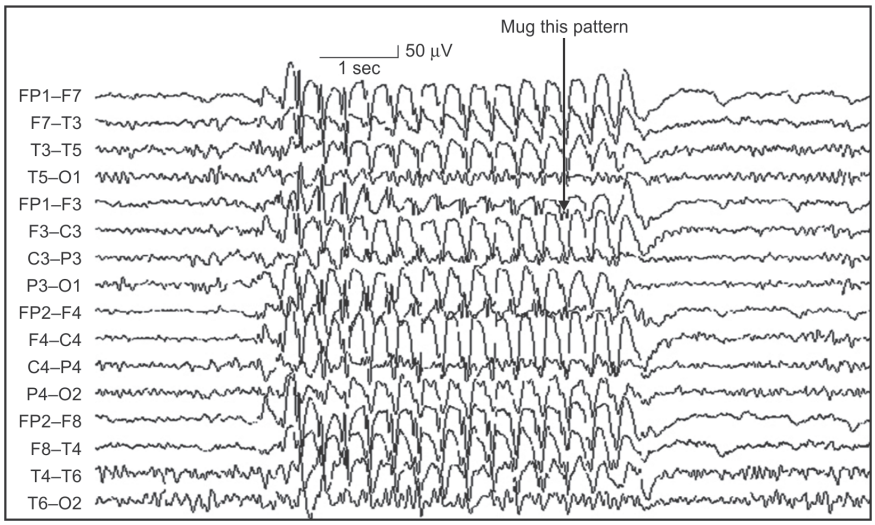
- Normal newborn
- **Hypokalemia**
- **Digitalis effect**
- **Hypothyroidism**
- Hypo- and hyperglycemia

EEG EXERCISES

- Just know the fix pattern of diseases with EEG. Questions usually come with case scenario.
- Questions given in chapter are more than sufficient to get the full marks.

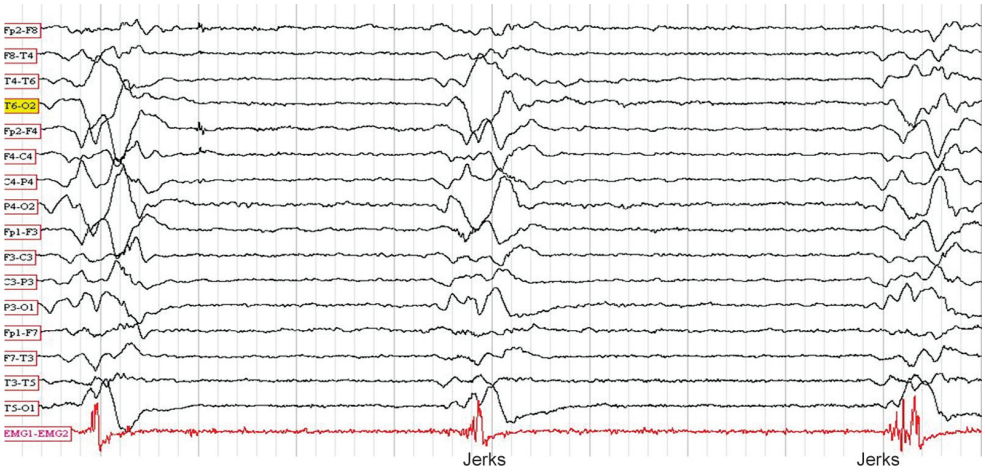
Q.1. EEG of a six-year-old child:

1. What does this EEG show?
2. What is the drug of choice (write two drugs)?
3. Prognosis.
4. One OPD procedure to confirm diagnosis.



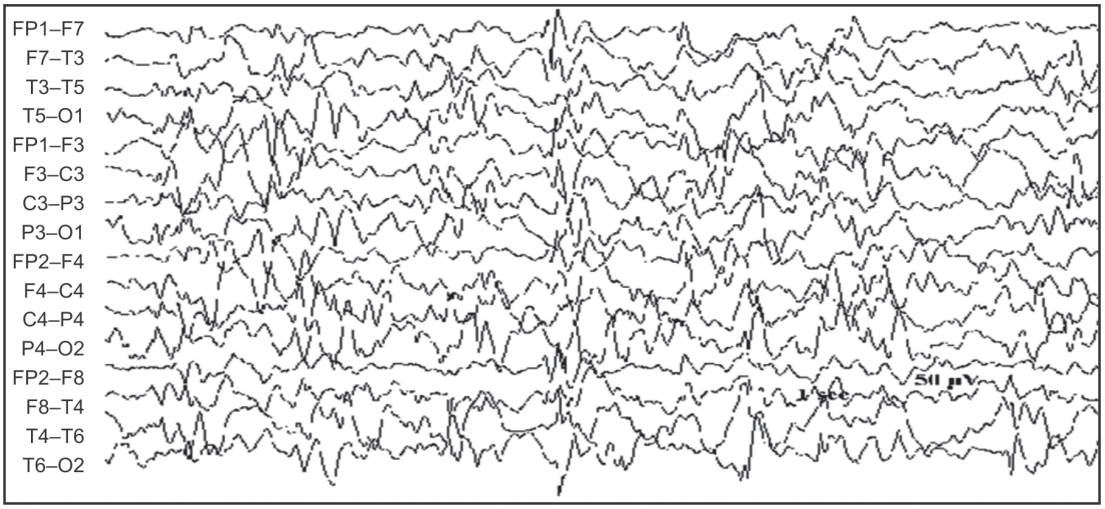
Q.2. A 10-year-old child came with history of loss of school performance and abnormal body movement from last 3 months, the child now have loss of interest in surrounding. Past history suggests febrile illness with rash around 1 year age:

1. Diagnosis of clinical condition and EEG pattern.
2. Staging of disease.
3. Diagnosis modality of disease.
4. Treatment option with recent change in prevention strategy (2014 change).



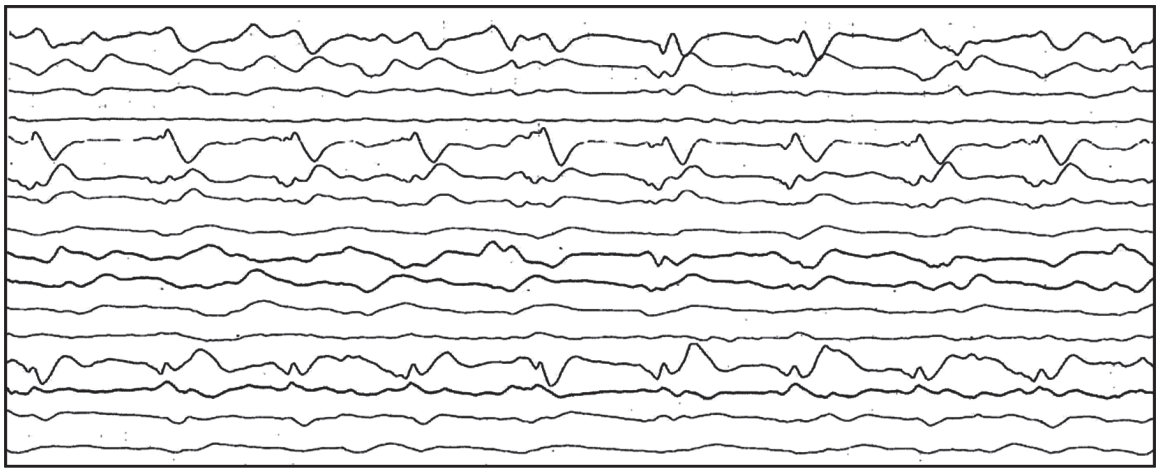
Q.3.* A 9-month-old male child admitted with complains of abnormal movement of head and hand, more than 100 time per day, baby do this when just awake from sleep. Baby now unable to sit without support as 2 months back, EEG was done:

1. What is diagnosis of EEG pattern?
2. What are types of disease and causes?
3. What is treatment options with name?
4. What is prognosis?



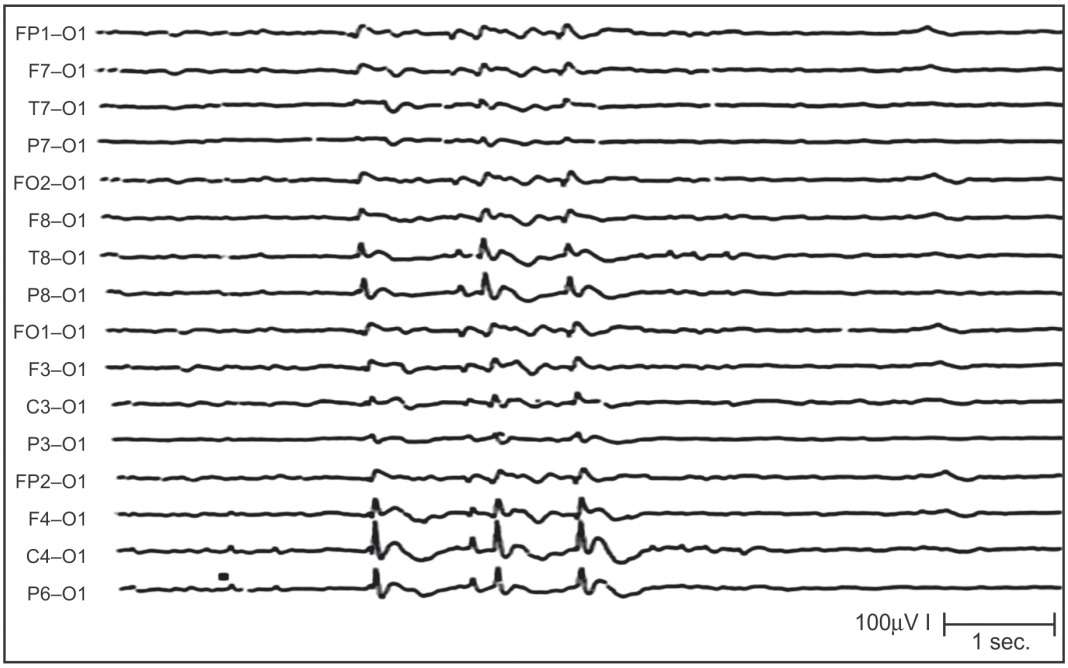
Q.4.* A 3-year-old child admitted with complains of high grade fever with seizure, rash and loss of consciousness from last 2 days, EEG done:

1. Diagnosis of EEG pattern and diagnosis.
2. Site of lesion in MRI brain in this disease.
3. Drug use in treatment with dose.



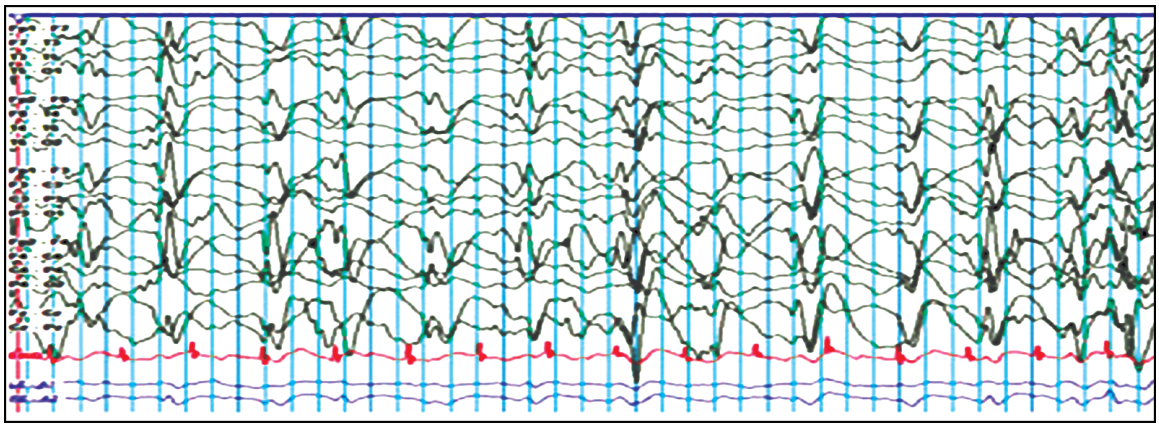
Q.5. 7-year-old boy presents with nocturnal seizure, jerky movements of the lips, eyes wide open, unable to sleep, hypersalivation, EEG done:

1. Diagnosis of condition.
2. Two important clinical features at face.
3. Treatment and prognosis.



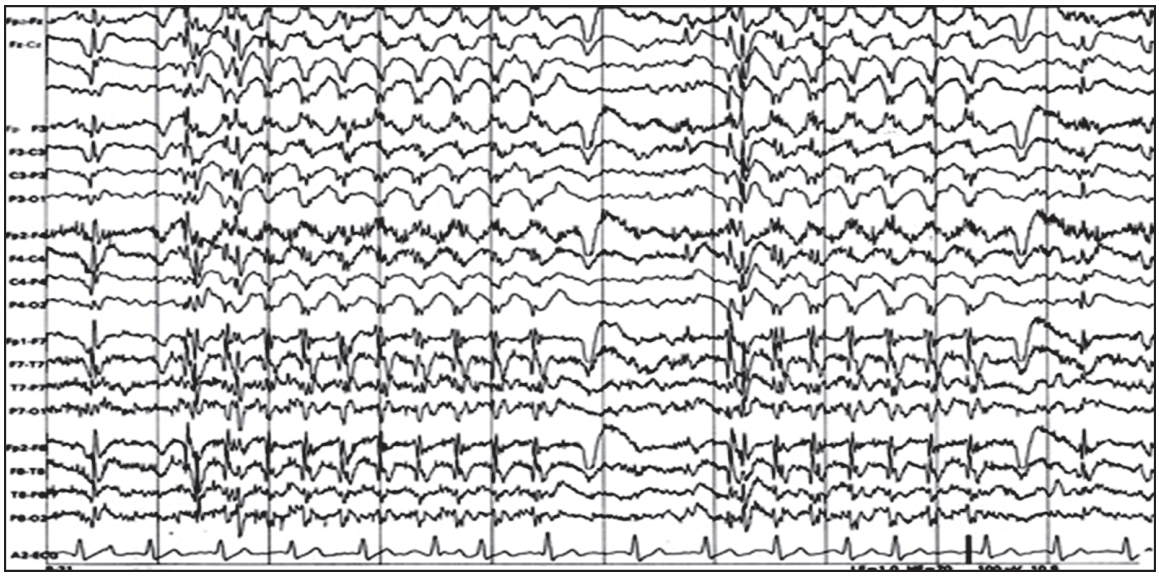
Q.6. 8-year-old boy, history of delayed milestones—walking 2 years, speech 3 years, multiple types of seizures several times a day–2 months, tonic seizures, atonic falls, myoclonic seizures, and regression of milestones:

1. What is EEG pattern and diagnosis of disease?
2. Management options and name of surgery.
3. What is test that is done before giving anesthesia in neurosurgery of a child with seizure?



Q.7.* 4-year-old girl presented with fever and recurrent focal seizures—2 days comes in status epilepticus. Seizures stop after lorazepam and phenytoin. Patient remains comatose >24 hours after all motor seizures have stopped:

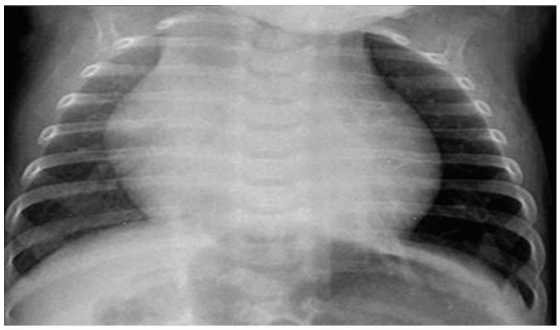
1. Diagnose the EEG pattern.
2. What is best way to diagnose this problem?

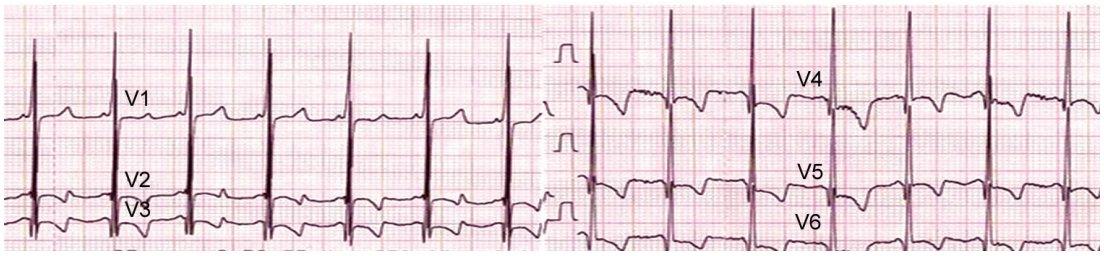


ECG EXERCISES

Q.8.* A 2-month baby presents with hypotonia, X-ray and EEG was done:

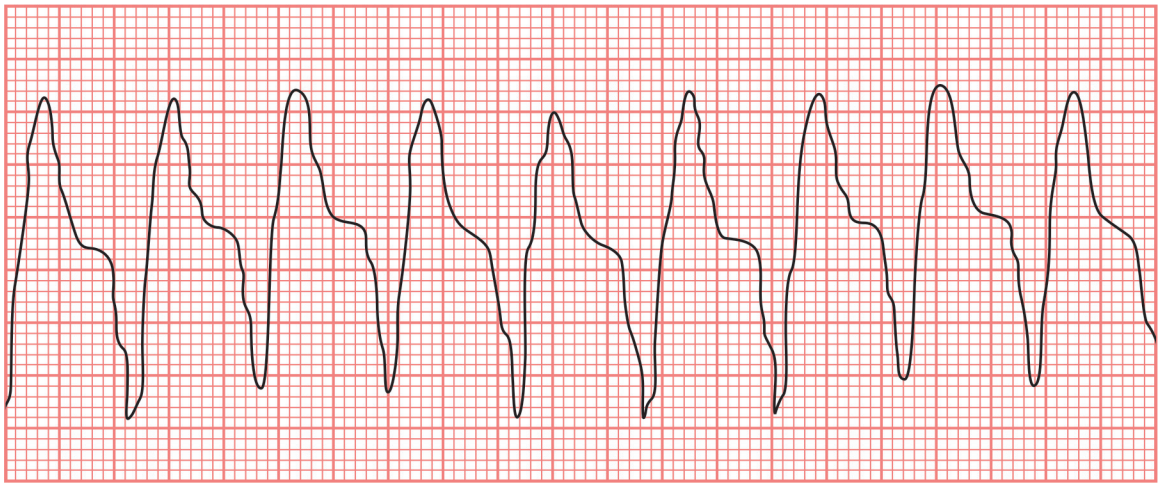
1. What is finding in X-ray and EEG suggest the diagnosis?
2. What are differential diagnosis?
3. What is test for confirm diagnosis?
4. Treatment





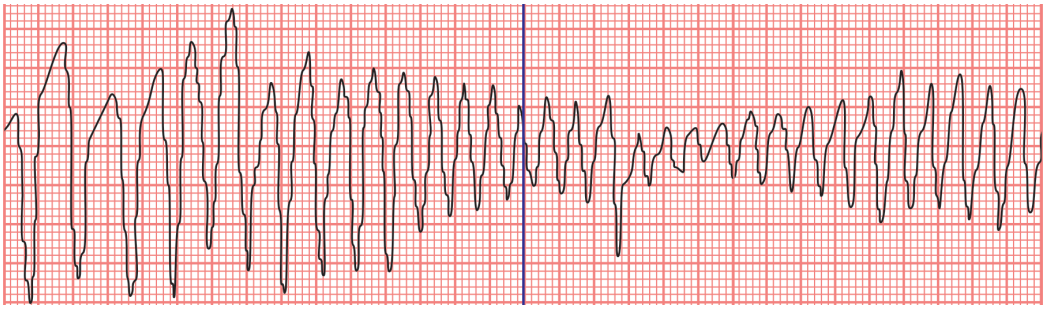
Q.9.*

1. What is the rate?
2. Is the QRS wide or narrow?
3. Causes
4. Treatment

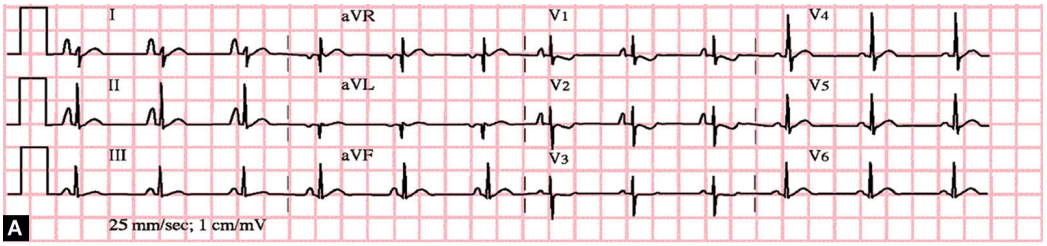


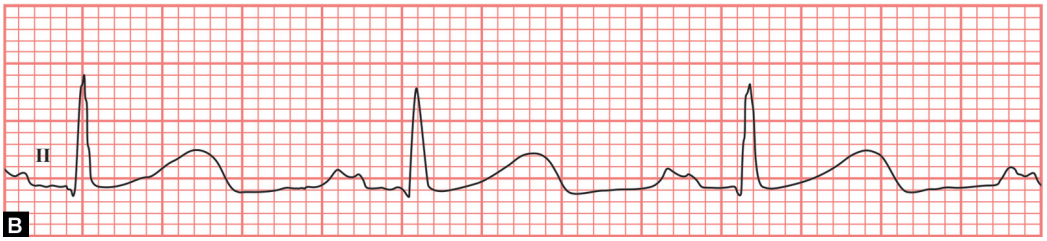
Q.10.

1. Diagnose the condition shown in ECG.
2. Causes leads to this condition including 2 electrolytes.
3. Treatment of disease.

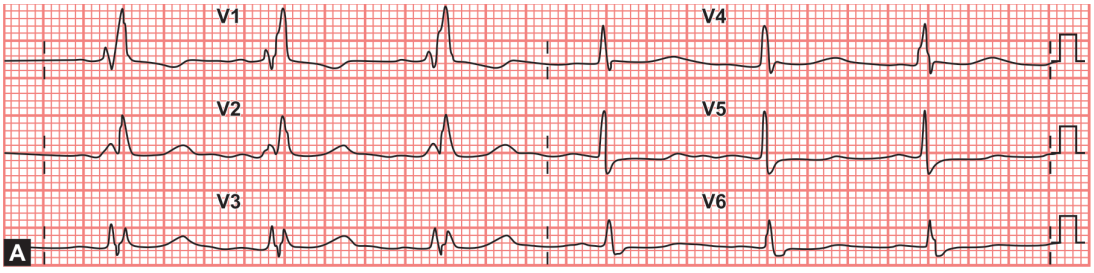


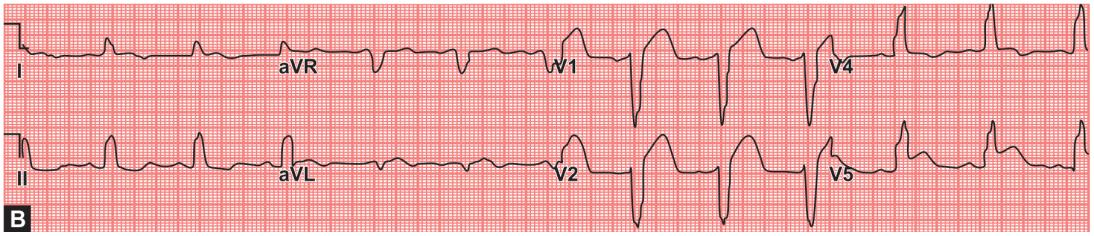
Q.11. Diagnose these 2 ECGs and give one possible cause:





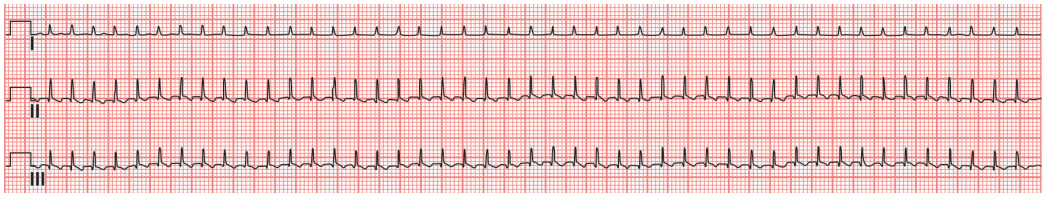
Q.12. Diagnose these 2 ECG conditions:





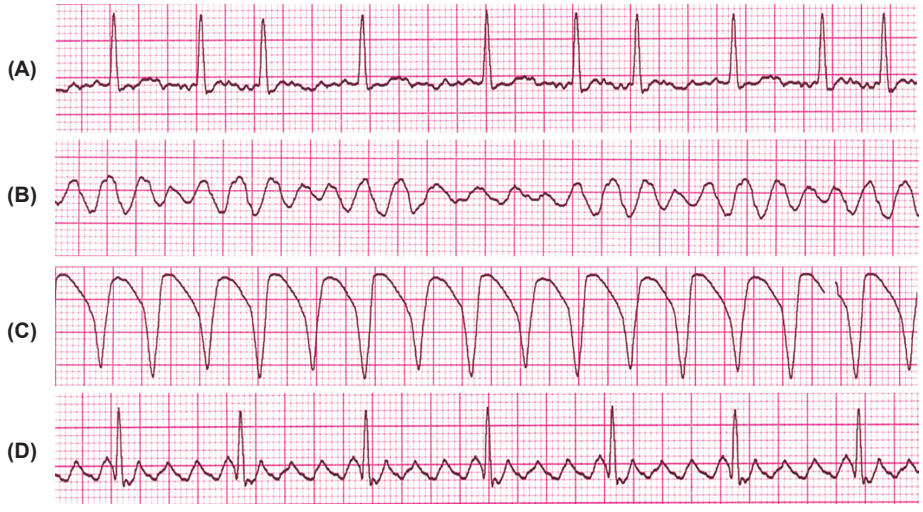
Q.13.* 20-day-old patient presents with fussiness and poor feeding. You are not sure about P-waves as quality is poor. BP: 80/50 mm Hg, CFT: <2 seconds:

1. What is diagnosis and ECG features of this condition?
2. Calculate HR on ECG and what should be the next step in management (other than supportive, paracetamol, comfort)?
3. Repeat ECG showed same pattern. Condition of the baby same. Name one drug which is contraindicated in above situation and name simple non-pharmacological procedure which can be applied to this patient and also define how many attempts can be made if first time the procedure was unsuccessful (mention total number of attempts including the first attempt).
4. After failure of the above attempt what procedure or drug would you like to give?
   Give dose for 4 kg baby and also assume weight of the child 70 kg. Mention the name and dose. Also mention 2 precautions while giving above drug/procedure.
5. Prior to giving any medication patient becomes hypotensive mottled and cold. No IV cannulae in place. His heart rate is 300/min. Next therapeutic step would be.



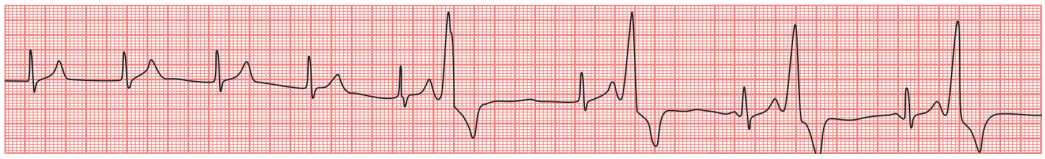
Q.14.* Diagnosis A, B, C, D. And give answer of questions ask below about D:

1. List 4 underlying disorders causing this.
2. What is the treatment of choice for pattern D.
3. List 3 drugs useful in treatment for pattern D.
4. What CNS complication can occur after pattern D.



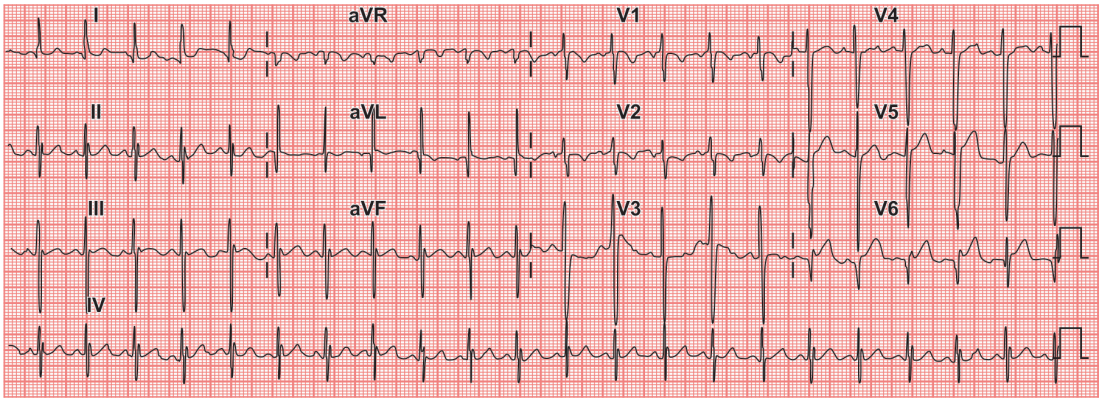
Q.15.*

1. What is the diagnosis of this ECG pattern? Give reason for diagnosis.
2. List 3 indications for investigating further in this arrhythmia.
3. What is the emergency medication for this arrhythmia?

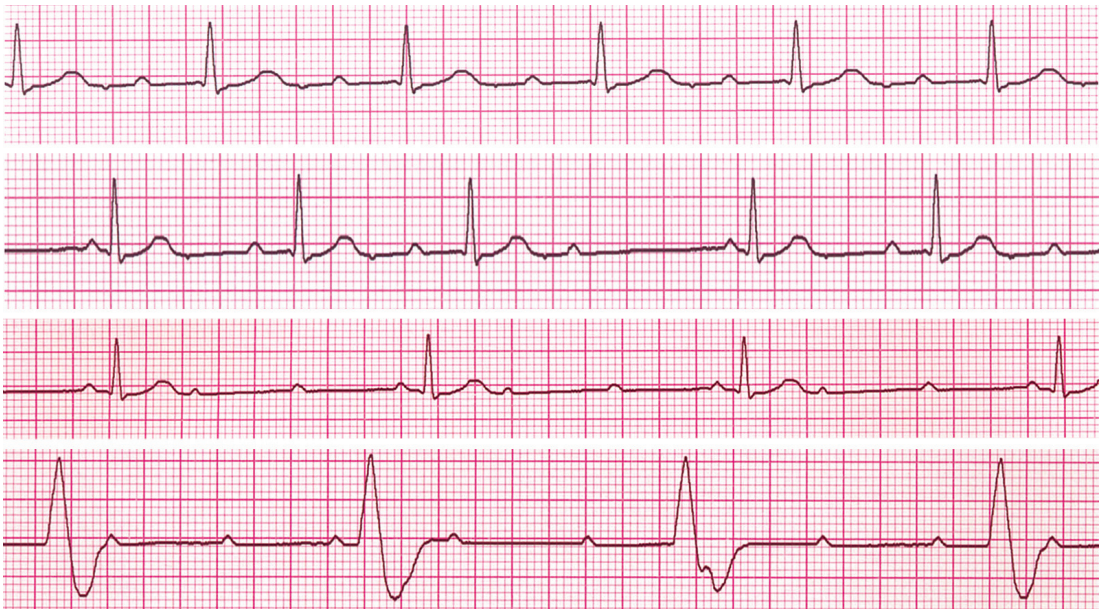


Q.16.* 2-month-old baby with LV dysfunction, mitral regurgitation and cardiomegaly:

1. Identify abnormality in this ECG.
2. What is diagnosis of the condtions and differential diagnosis?

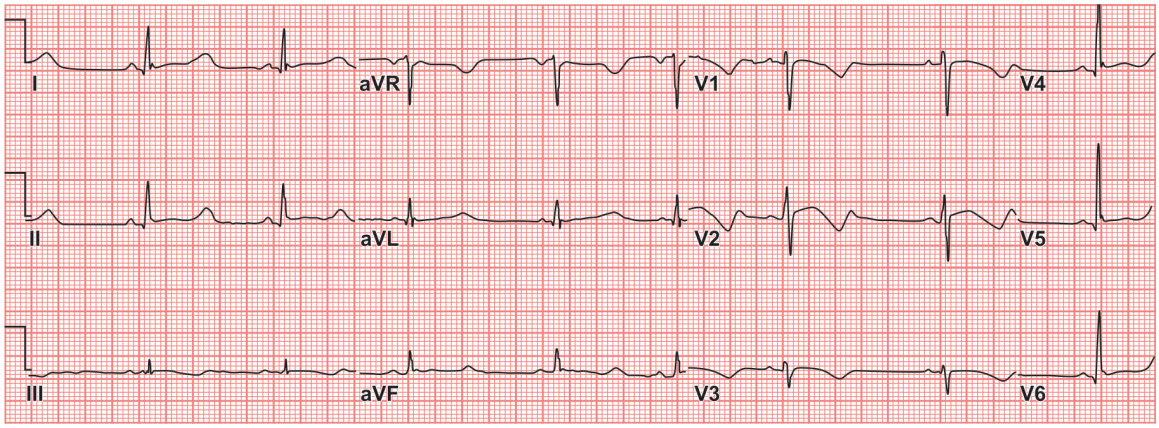


Q.17.* Diagnosis A, B, C, D:



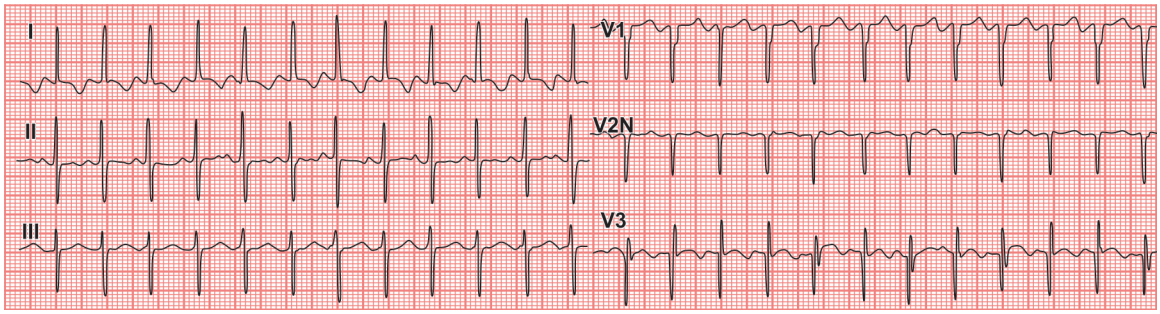
Q.18.

1. Identify the abnormality in the ECG.
2. What electrolyte abnormality can cause this?
3. Why is it important to identify this rhythm disturbance?



Q.19. Two months old baby admitted with recurrent cough, cold, irritability, dyspnea and sweating. EKG done:

1. What is the diagnosis?
2. Name 4 EKG findings that helped you in diagnosis.
3. What is the diagnostic test?
4. Name treatment options of it.



ABG EXERCISES

Q.20.* Identify these acid–base disorder—A, B, C, D. And fill in the blank:

ABG	*A*	*B*	*C*	*D*
pH	7.40	7.29	7.38	7.10
pCO_2	40	30	35	20
HCO_3	24	14	20	6
AG	12	20	26	22
ΔAG				
ΔHCO_3				
$\Delta AG/\Delta HCO_3$				

Q.21.* A child with short stature, come in OPD. ABG report is here. What is your interpretation in view of?

1. Diagnosis of ABG
2. Anion gap (with this albumin level)
3. ΔAG, ΔHCO_3, delta ratio
4. Urinary AG
5. Diagnosis of the possible clinical cause

FiO_2	100%
paO_2	477
$paCO_2$	47
pH	7.23
HCO_3	19
Hb	7.2
S. albumin	2.0
Sr. Na	131
Sr. K	3.4
Sr. Cl	104
Ur. Na	146
Ur. K	27.6
Ur. Cl	146
Ur. pH	6.1

Q.22.* The ABG of a patient on room air given below (new pattern Q).

1. What is wrong?
2. How severe is it?
3. What will you do?

FiO_2	0.21
pO_2	48
pCO_2	40
pH	7.40
HCO_3	24

Q.23.* ABG of a patient on ventilator given below:

1 What is wrong?
2. How are the lungs?
3. Can the patient be weaned?
4. What will you do?

FiO_2	0.80
pO_2	220
pCO_2	34.6
pH	7.48
HCO_3	26

Q.24.* ABG of a patient on ventilator with FiO_2: 40%, TV: 500, RR: 12 is given below:

1. What is wrong?
2. What will you do?

FiO_2	0.40
pO_2	128
pCO_2	60
pH	7.21
HCO_3	24

Q.25.* A baby is admitted to the NICU with persistent pulmonary hypertension (PPHN). He is on ventilator with FiO_2 100%, PIP 35 and PEEP 6 and SpO_2 85% and he has following lab values:

ABG: pH: 7.22, pCO_2: 50, pO_2: 50, Na: 136, K: 4, Cl: 103

1. Calculate alveolar-arterial oxygen gradient. Assume respiratory quotient (RQ) = 0.8
2. What are the indications for extracorporeal membrane oxygenation (ECMO)?

Q.26.* A 5-month-old boy with development delay, ABG report below:

pH: 6.64, pCO_2: 25.8, pO_2: 396.4, Na^+: 140, K^+: 4.3, Cl^-: 95, HCO_3: 5

1. List the abnormalities in ABG.
2. Calculate the anion gap.
3. Two conditions with increased anion gap.
4. Two conditions with decreased anion gap.

Q.27. Interpret the following ABG reports:

1. pH 7.6/$paCO_2$ 25/PaO_2 160/HCO_3 24 (FiO_2–50%)
   Calculate $AaDO_2$ and write the formula
2. pH 7.38/$paCO_2$ 65/paO_2 48/HCO_3 34 (FiO_2–60%)
   a. What is the ABG diagnosis?
   b. What is normal paO_2 level expected if a child is breathing at room air with normal lungs?
3. pH 7.45/$paCO_2$ 40/paO_2 120/HCO_3 28.5/SpO_2 99%/Hg 8 g%
   Calculate oxygen content in given blood gas.

ANSWERS (EEG)

Ans. 1.
1. 3 Hz spike and wave activity in absence seizure—Childhood/Juvenile
2. Valproate, lamotrigine, ethosuxamide
3. Good in childhood, slightly less for juvenile
4. Hyperventilation

Ans. 2.
1. SSPE—burst suppression pattern (Subacute sclerosing panencephalitis)
2. *Three stages:*
   i. Behavioral, mental changes
   ii. Myoclonic jerks, choreoathetosis, language problem
   iii. No independent ambulation, no speech, blind
3. CSF (Marked elevated gamma-globulin level), Typical EEG pattern
4. Ribavarine, interferons, inosiplex, amantadine, in 2014 change of measles vaccine, replaced by MMR at 9 months.

Ans. 3.
1. Infantile spasms with hypsarrhythmia—West syndrome
   EEG—chaotic, high amplitude, multifocal spikes and polyspikes, asynchronous, arrhythmic
2. *Two types:* Cryptogenic and symptomatic
3. Drugs of choice
   - **ACTH-75 u/kg/m^2**
   - Vigabatrin
   - Steroids
4. Poor

Ans. 4.
1. Pleds (Periodic lateralization epileptiform discharge), herpes encephalitis
2. Fronto-temporal area
3. Acyclovir (10 mg/kg/dose, IV, TDS)

Ans. 5.
1. BECTS—benign childhood epilepsy with centro-temporal spikes (Rolandic epilepsy)
2. Oneset 1–14 years, unilateral facial sensorimotor seizures, speech arrest, oropharyngeal manifestations, hypersalivation
3. Prognosis—most remit in 2–4 years, treatment—nil, IF daytime seizure drugs: Carbamazepine

Ans. 6.
1. EEG of Lennox-Gastaut syndrome—background—slow and disorganised, slow generalized spike wave (<2.5 cps), multiple independent spike foci
2. Multiple AET (anti-epileptic drugs), ketogenic diet, IVIG
   Surgery—corpus callosotomy
3. Wada test

Ans. 7.
1. EEG of NCSE (non-convulsive status epilepticus)
   - Spikes, waves, rhythmic activity
   - Focal or partial features, discrete or continuous
   - Cyclic or recurrent patterns
   - May correlate with changes in behaviour and responsiveness
2. Significant improvement in discharges and sensorium on giving IV anti-epileptics, 24 hours EEG monitoring.

ANSWERS (ECG)

Ans. 8. 1. Pompe's disease
- CXR: Cardiomegaly with history of floppy infant
- ECG has **extremely tall QRS complexes**
- Needs to be taken at half calibration
- **Short PR interval**

2. Differential diagnosis SMA, hypotonic CP, Down syndrome, congenital muscular dystrophy
3. Diagnosis: Enzyme assay
4. Treatment: Enzyme replacement (myozyme <8 years age), lumizyme (>8 years age), dose = 20 mg/kg

Ans. 9. 1. Ventricular tachycardia: Rate >120/min
2. QRS >0.08 sec
3. **Causes: Myocarditis, LCAPA, tumour, long QT, drugs, surgery**
4. Treatment:
   Stable—IV amiodarone, IV lignocaine, IV procainamide
   Unstable—DC shock

Ans. 10. 1. Torsade de pointes: Gradual change in amplitude of QRS—rate 150–250/min
2. Prolonged QT interval, **hypokalemia**, **hypomagnesemia**
3. IV magnesium sulphate

Ans. 11. 1. P-pulmonale: P-wave >3 SD, right atrial enlargement
2. P-mitrale: P-wave-notched and wider than 3 SD, left atrial enlargement—MS

Ans. 12. 1. RBBB: Wide QRS >0.12s (3 small divisions), M morphology in V_1, V_3
2. LBBB: Wide QRS >0.12s (>3 small divisions), M morphology in V_5 and W in V_1

Ans. 13. 1. Supraventricular tachycardia. Narrow complex tachycardia
2. HR 300/min 1500/5 (small squares between two r waves), obtain ECG with 50 mm strip speed (with preferable non-crying baby).
3. Verapamil. Ice pad placed over the face. Causes vagal stimulation decreasing the AV conduction (total 2 attempts: 10–15 seconds each)
4. Adenosine max 6 mg/rapid flush/choose proximal vein.
5. Airway/breathing/synchronized cardioversion/sedation and analgesia

Ans. 14. 1. A—Atrial fibrillation
   B—Ventricular fibrillation
   C—Ventricular tachycardia
   D—Atrial flutter
2. Last question is asked about—atrial flutter
   - Synchronised cardioversion
3. Digoxin, β-blockers, or calcium channel blockers
4. **Thromboembolism** and stroke

Ans. 15. 1. Premature ventricular contractions (PVCs) in a bigeminal rhythm.
- 2 or more ventricular premature beats in a row,
- Multiform PVCs, and
- Increased ventricular ectopic activity with exercise

2. Intravenous lidocaine as bolus

Ans. 16.* Frequently asked in exams:
1. Deep Q-waves in I, aVL, ST elevation in V5/V6, this suggests severe myocardial ischemia
2. Diagnosis: ALCAPA
   This condition mimic with intussusception, colic as ALCAPA present as cardiac ischemic pain

Ans. 17. 1. 1st degree AV block
2. 2nd degree AV block, type-I
3. 2nd degree AV block, type-II
4. 3rd degree AV block

Ans. 18. 1. Prolonged QT interval
2. Hypocalcemia
3. As it can degenerate into dangerous rhythm—V Tac/VF and cardiac arrest.

Ans. 19. 1. ALCAPA
2. Inverted T-wave, V_5–V_6 deep Q-wave, ST elevation, inverted T-wave
3. Cardiac catheterization
4. Medical treatment for CCF, ischemia and surgical excision and ligation

ANSWERS (ABG)

Ans. 20.* VV important. See text written in beginning to understand the answers:

ΔAG	0	+10	+14	+10
ΔHCO_3	0	–10	–4	–18
$\Delta AG/\Delta HCO_3$		1	>1–2 (3.5)	<1

Ans. 21. 1. Respiratory acidosis + metabolic acidosis (Mix acidosis)
2. Expected anionic gap = 8 – 2.5 = 5.5* (see the effect of albumin in beginning)
3. ΔAG = 0 $\Delta HCO_3 = 5$ Delta ratio = 0
   Therefore, metabolic acidosis with normal AG
4. Urinary AG = 146 + 27.6 – 146 = 27.6 → positive
5. Therefore → RTA (Distal, because urine pH > 6)

Ans. 22. 1. Hypoxemia
2. Moderately severe
3. Increase FiO_2

Ans. 23. 1. Hyperoxemia
- Expected $paO_2 = 5 \times 80 = 400$

- paO_2/FiO_2 (old) = paO_2/FiO_2 (new)–mug up this
- paO_2 (new) = 220 × 21/80 = 57.8

2. Therefore, patient would be hypoxic on room air:
3. Not advisable to wean
4. Reduce FiO_2 to 36–40% to get paO_2 of 100

Ans. 24. 1. pO_2 slightly increased but acceptable.
pO_2 high, therefore, increase minute ventilation (RR × TV)
RR × pCO_2 (old) = RR × pCO_2 (new)
12 × 60 = RR × 40
2. RR = 18 (increase RR to 18)

Ans. 25. 1. $pAO_2 = FiO_2 (760 - H_2O) - pCO_2/RQ$
= 1(760 – 47) – 50/0.8
= 713 – 62. 5 = 650
Oxygen gradient = $pAO_2 - paO_2$ = 650 – 50 = 600
2. Reversible respiratory failure
Oxygen gradient >600 for 12 hr 94% mortality or >610 at 8 hr 79% mortality

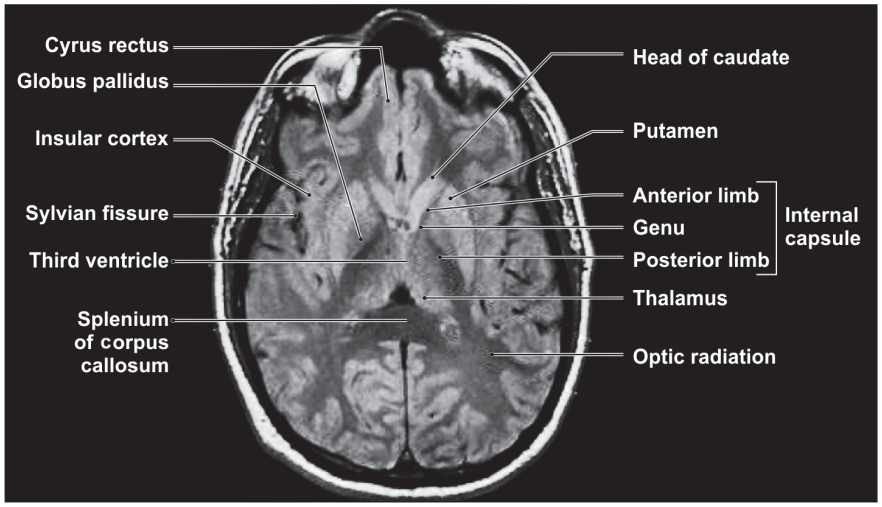
Ans. 26. 1. Mixed metabolic acidosis and hyperoxia
2. 40
3. Diabetic ketoacidosis, uremia, methanol, propylene glycol, IEM, lactic acidosis, ethylene glycol, salicylates
4. Hypoalbuminemia, lithium toxicity

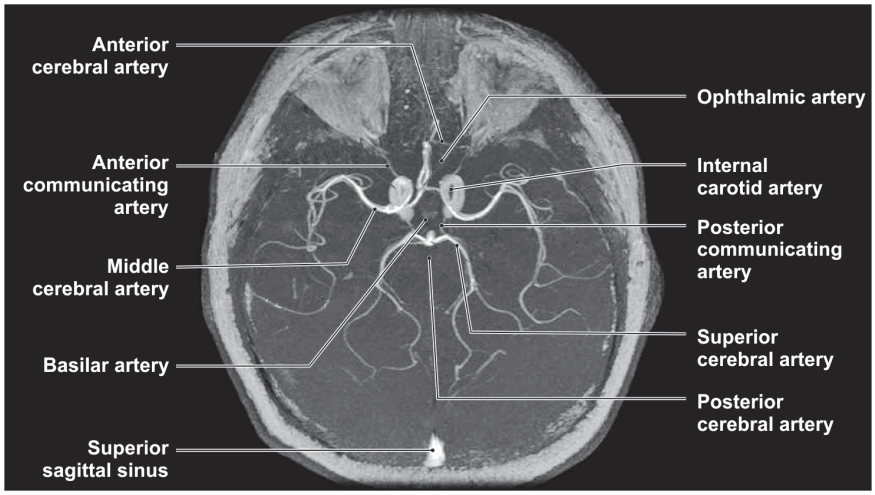
Ans. 27. 1. 165.25
(Formula)
$AaDO_2 = (713 \times FiO_2) - (pCO_2/0.8) - (paO_2)$
2. (a) Respiratory acidosis with metabolic compensation
(b) 80–100 mm Hg
3. 11 ml O_2/dl
Arterial oxygen content = $(Hb \times 1.34 \times SpO_2) + (0.0031 \times paO_2)$

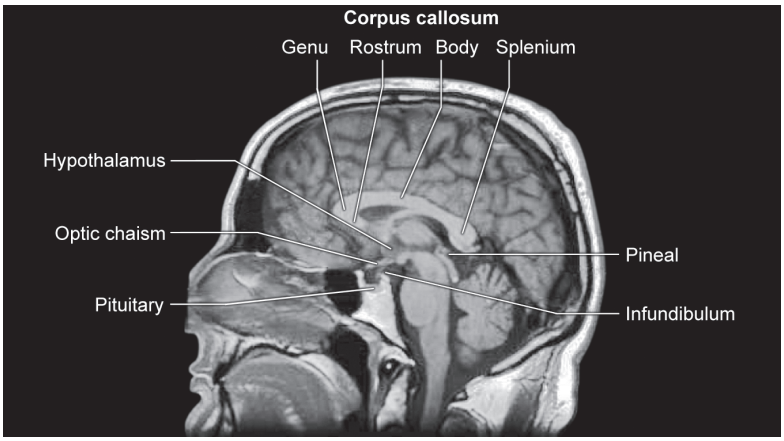
CHAPTER 5

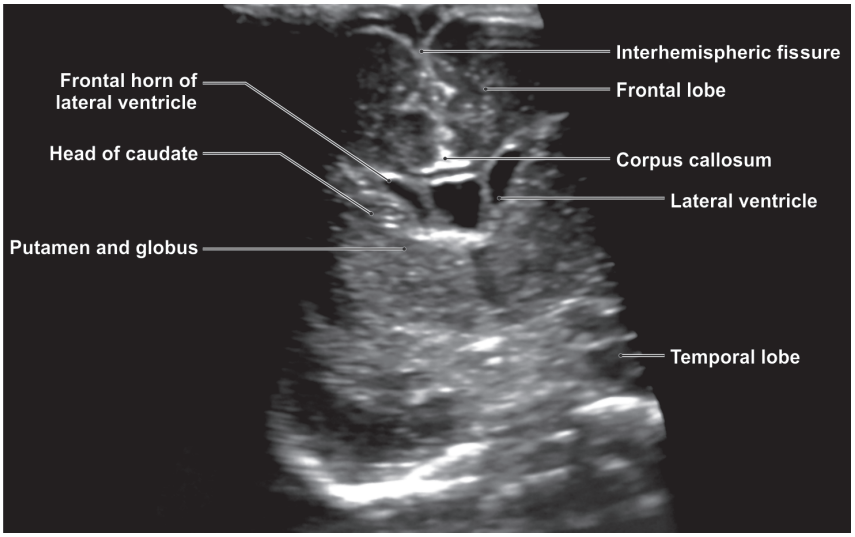
Neuroimaging

NEUROANATOMY

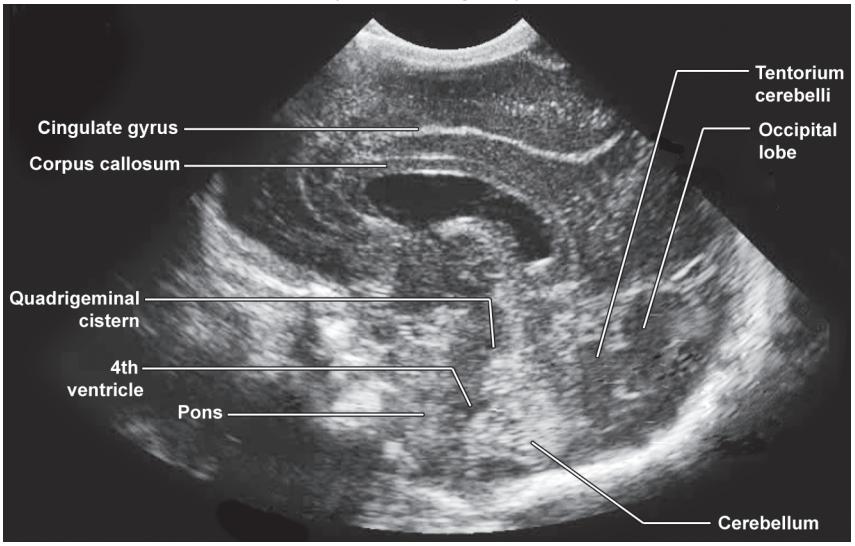








(Neurosonogram)



(Neurosonogram)

DeVries Classification of PVL Grading on Ultrasound

- Grade I PVL: Prolonged periventricular flare present for 7 days or more.
- Grade II PVL: Presence of small-localized **front-parietal cysts.**
- Grade III PVL: Extensive peri-ventricular cystic lesion involving **occipital** and fronto-parietal white matter.
- Grade IV PVL: **Areas of extensive subcortical cystic lesions.**

IVH/GMH GRADING—BY VOLPE USING CRANIAL USG

PVH-IVH Grading	
Grade 1	GMH with no or minimal IVH (<10% of ventricular area on parasagittal view)
Grade 2	IVH (10–50% of ventricular area on parasagittal view)
Grade 3	IVH (>50% of ventricular area on parasagittal view)
IPE	Concomitant periventricular echodensity
PHVD	Mention separately if present

IPE: Intraparenchymal echodensity; PHVD: Post hemorrhagic ventricular dilatation

IVH/GMH GRADING—BY PAPILE USING CT SCAN

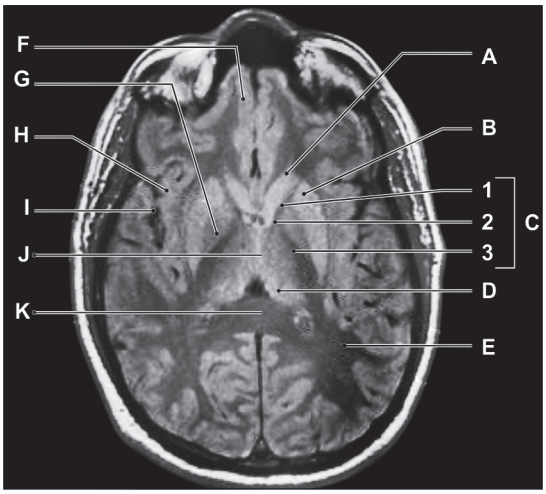
Grade 1	Isolated GMH (no IVH)
Grade 2	IVH without ventricular dilatation
Grade 3	IVH with ventricular dilatation
Grade 4	IVH with parenchymal hemorrhage

Neurocysticercosis		
Stages	*CT*	*MR*
Vesicular	Hypodense lesion with mural nodule, edema/enhancement rare.	T1-weighted (T1W) hypointense T2-weighted (T2W) hyperintense
Colloidal vesicular	Ring enhancing lesion with edema.	Hyperintense on T2W with peripheral enhancement/edema.
Granular nodular	Isodense cyst with hyperdense calcified scolex. Edema/ enhancement +.	Isointense to hypointense on T2W. Target or Bull's eye appearance.
Nodular calcified	Small calcified nodule. No edema/enhancement.	Void on T2W.

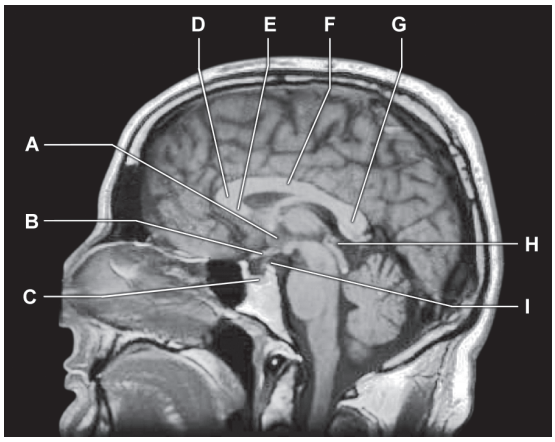
Intraparenchymal Bleed		
Stages	*CT*	*MRI*
Acute (deoxy Hb)	Hyperdense to brain parenchyma.	T1: Hyperintense, T2-Hypointense
Sub-acute (met Hb)	1 to 6 weeks. Isodense with adjacent brain parenchyma. Peripheral enhancement.	T1: Hyperintense, T2: Hypointense
Chronic (hemosiderin)	Hypodense to adjacent parenchyma. Fluid-fluid level s/o rebleed.	T1: Hypointense, T2: More Hypointense

EXERCISES

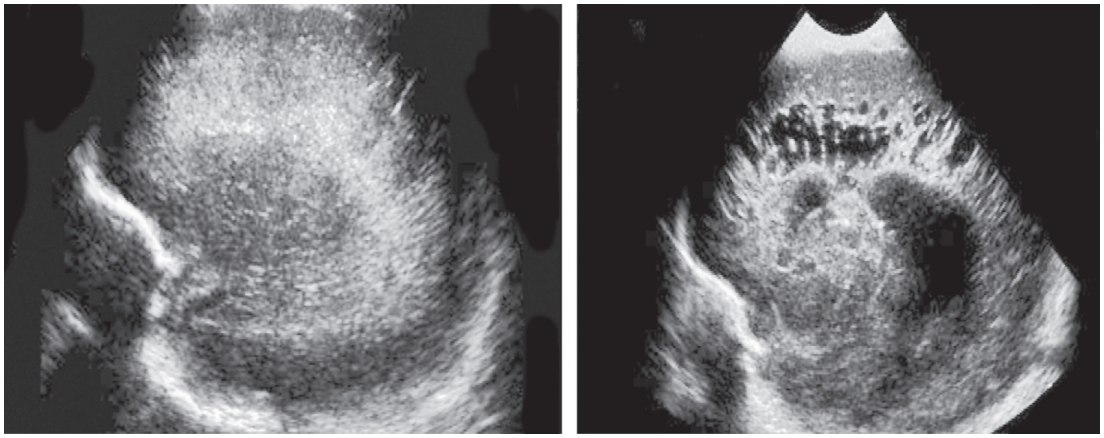
Q.1.* Identify A to K in image given below:



Q.2.* Nov 2014 identify A to I in image given below:

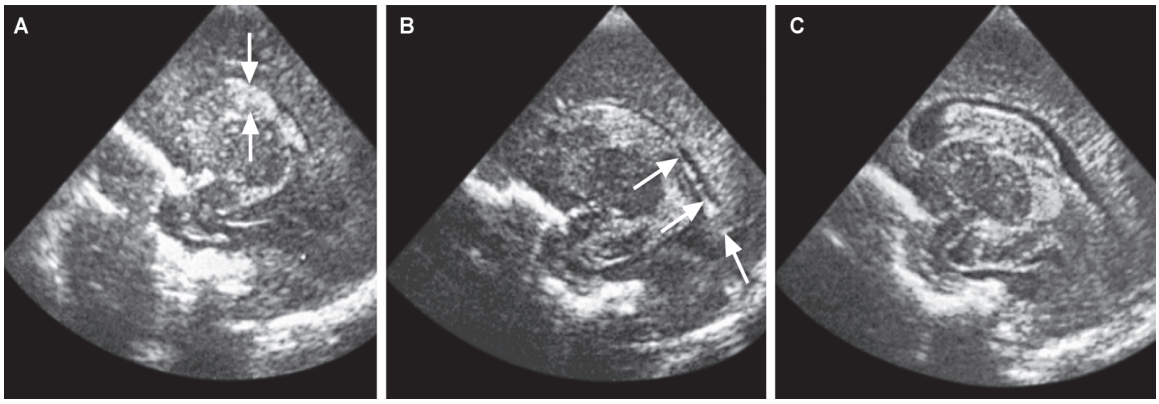


Q.3.* Identify the mode and view and diagnose the condition with grade of image A and B:

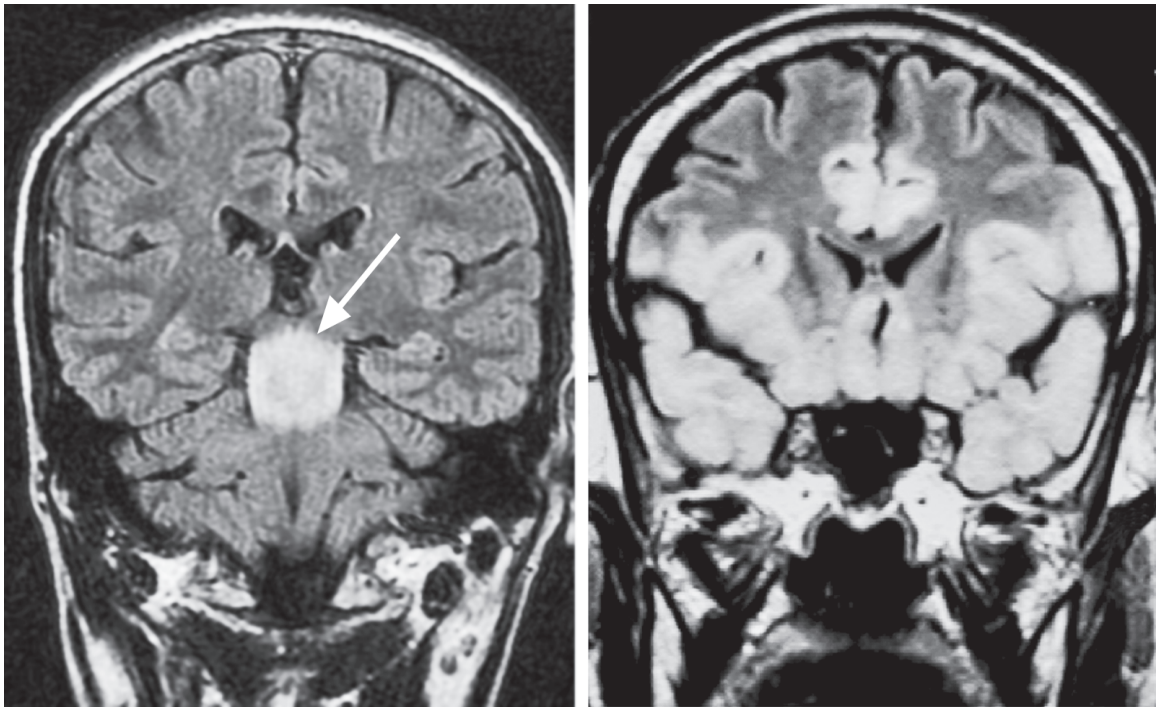


Q.4.* See the image and give answer of following:

1. What are risk factor for this disease
2. CT and USG criteria for grades
3. Preventive modality
4. Possible complication if this happen in a newborn preterm baby
5. Grade these images



Q.5.* Nov 2014
Diagnose these 2 conditions and write treatment

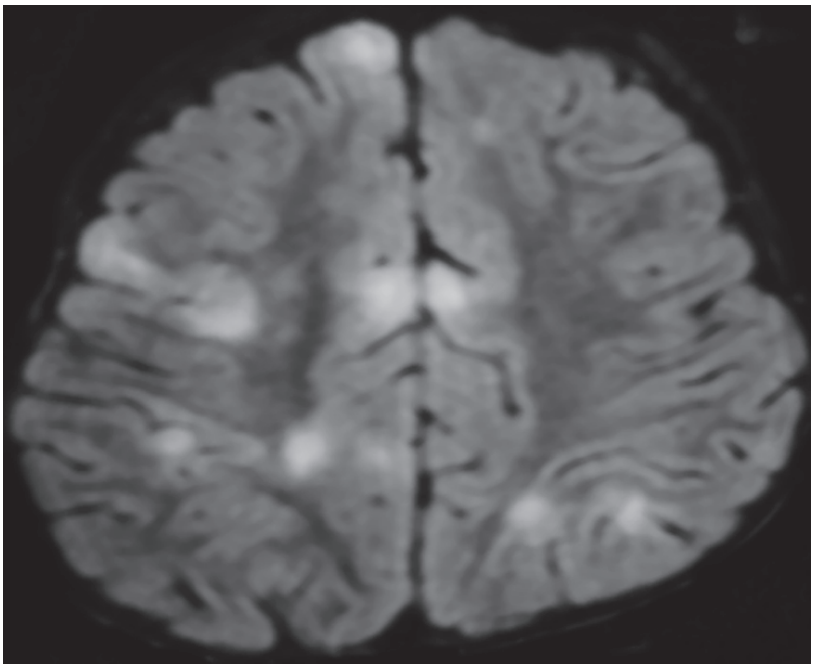


(A) (B)

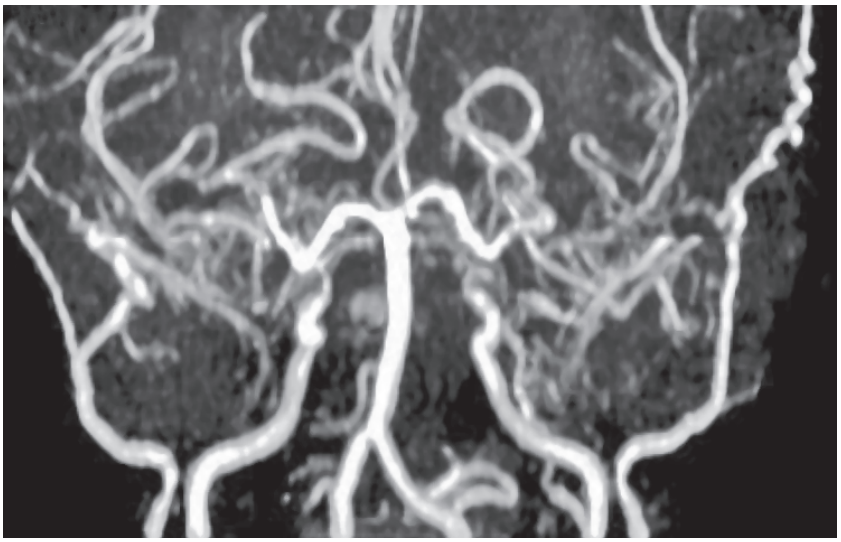
Q.6.* Nov 2014

An 8-year-old child presents with complaints of seizure with multiple cranial nerve palsy and disarthria and dysphasia, past history of viral illness is positive:

1. Identify the condition
2. Treatment and prognosis

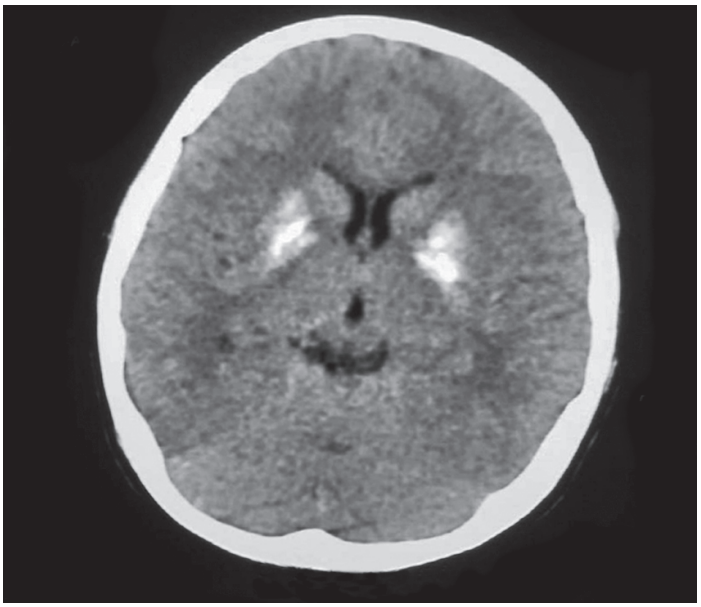


Q.7. 1. Diagnose the condition showing in image given below:
2. Risk factor (4)
3. Clinical presentation
4. Treatment



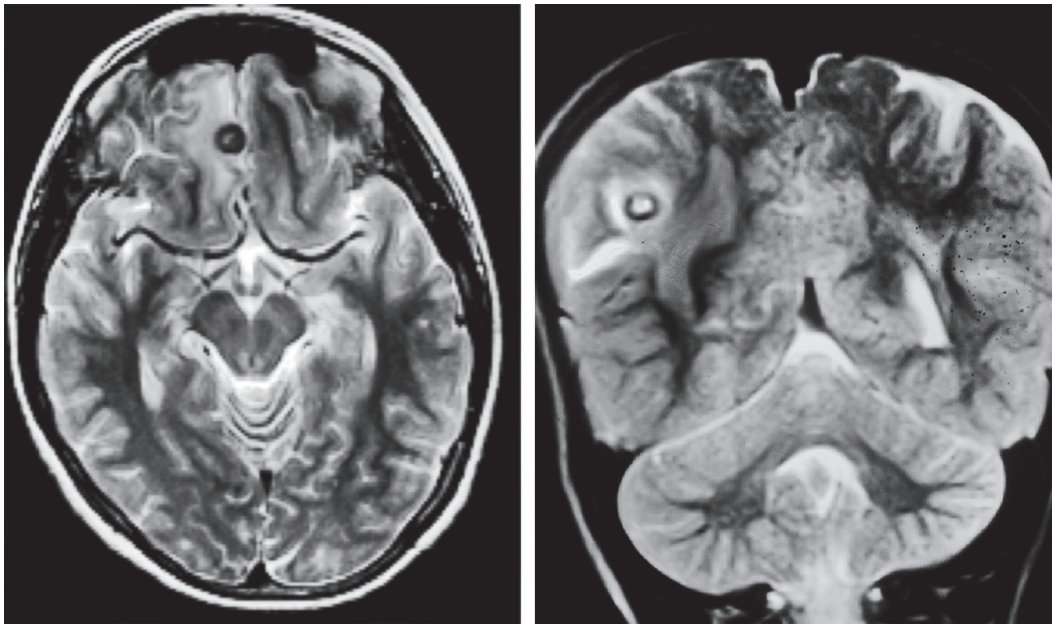
Q.8. CT scan of an 8-year-old child:

1. Diagnose the CT scan given below:
2. Give 4 differential diagnoses of this condition.

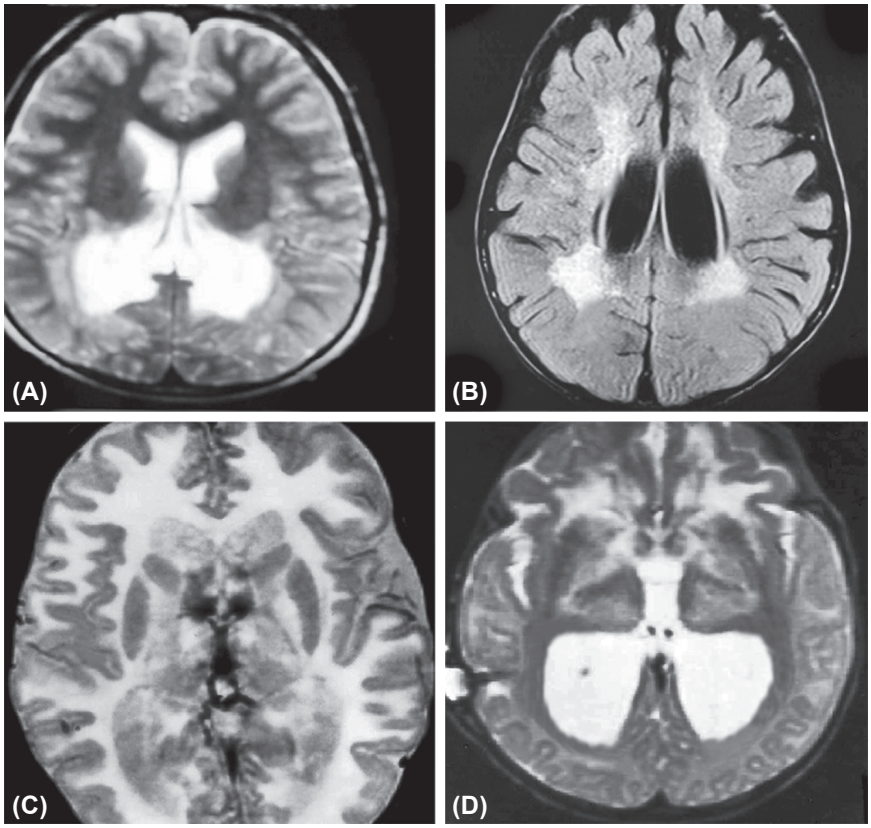


Q.9.

1. What is this imaging modality?
2. What are these two images and how can we differentiate by this imaging in these two conditions?

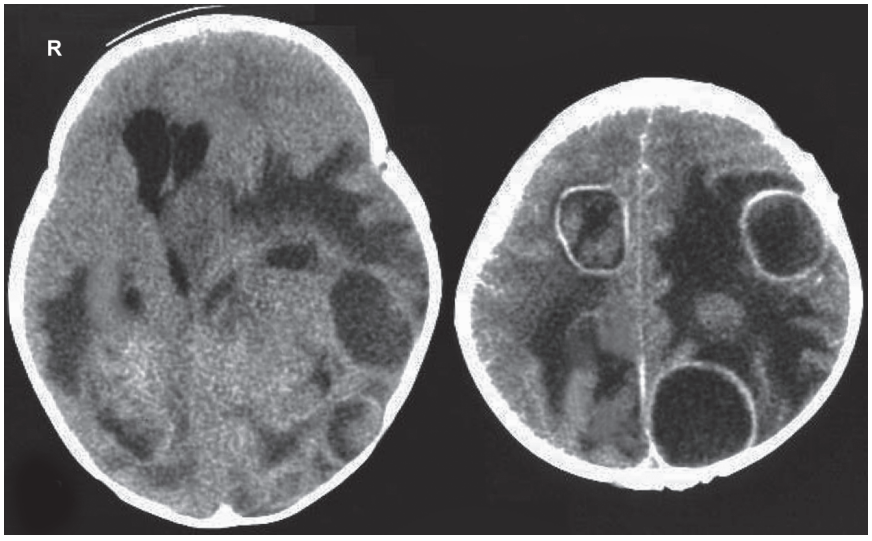


Q.10. Diagnose A, B, C, D:



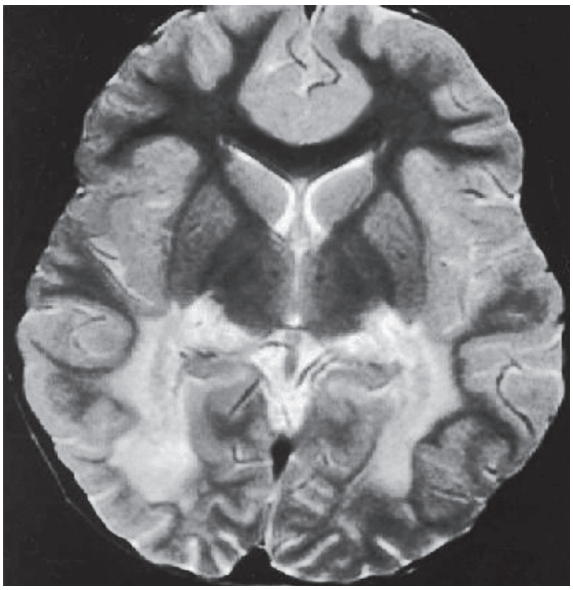
Q.11.* May 2010:

1. Interpret the CT brain.
2. What are the predisposing factors for their conditions (mention at least 5)?
3. What long-term neurological sequelae would you expect in this child?



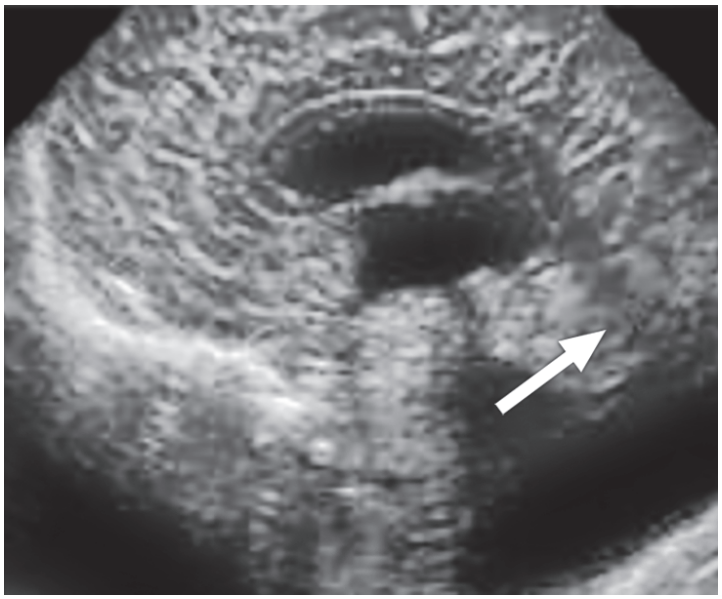
Q.12.* May 2010:

1. Identify the image/level.
2. Give diagnosis.
3. Mention other two diseases form the same group (metabolic).

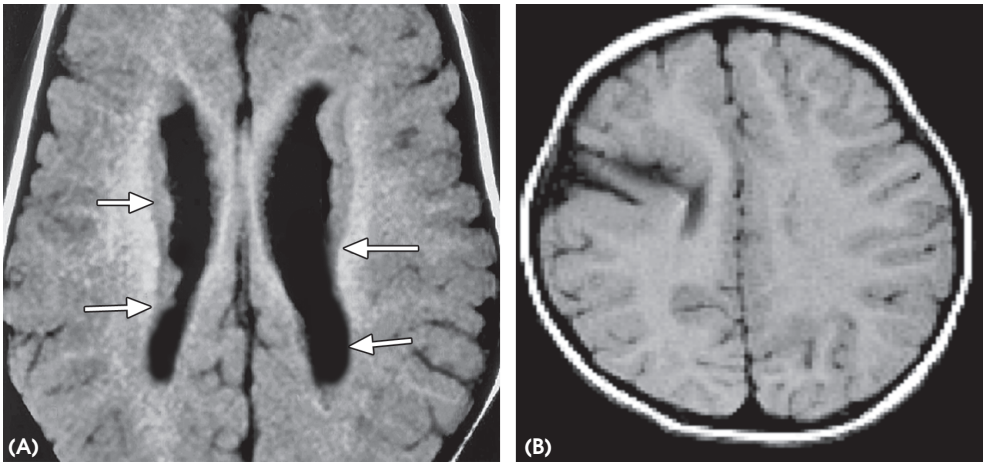


Q.13.* 10-month infant, brought with complaints of rapidly increasing head size and delayed development. He was noticed to have prominent occiput:

1. Mention abnormalities noted on this image.
2. Give your diagnosis.
3. Mention associated anomalies.

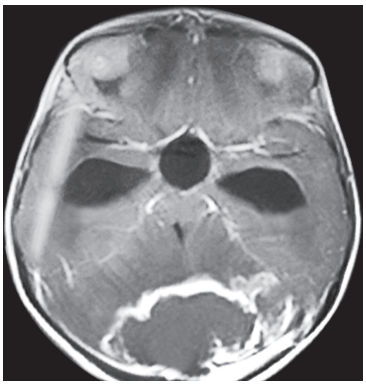


Q.14.* Identify image A and B.



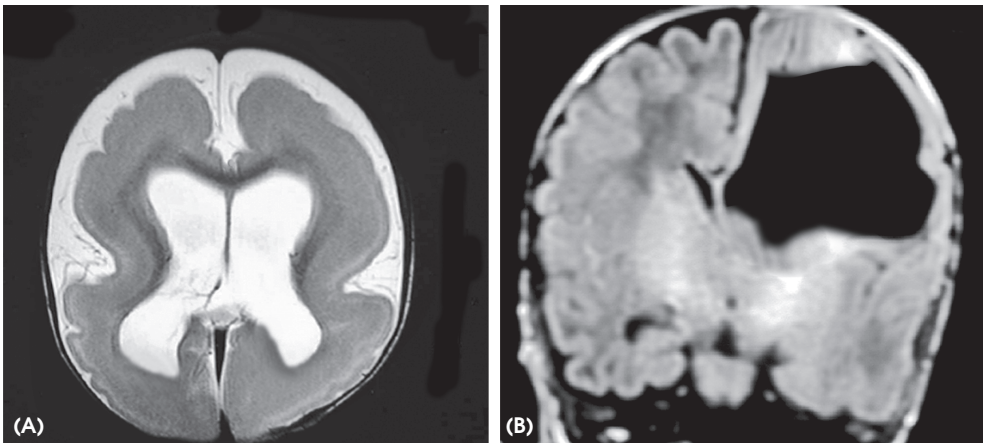
Q.15.* A 10-year-old male child presents with fall during walking and headache since 3 months that is progressively increasing, neuroimaging done that is given below:

1. Diagnose the condition given in image
2. Treatment



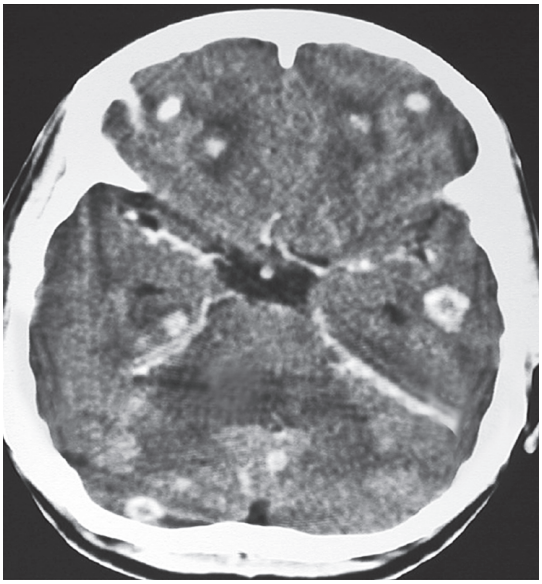
Q.16.*

1. Identify image A and B.
2. Write down one syndrome associated with image A and other associates features.



Q.17.* A 6-year-old male child presents with seizure in school without any fever but history of vomiting presents in today morning:

1. What is diagnosis?
2. Stepwise management with investigation.
3. How prolong you will give antiepileptics?
4. What preventive advice you give to family?



ANSWERS

Ans. 1. *See* the image given in neuroanatomy.

Ans. 2. *See* the image given in neuroanatomy.

Ans. 3. Sagittal section of cranial USG grade 1 and grade 3 PVL.

Ans. 4.
1. Preterm, fast bolus, poor ventilation, HCO_3 bolus
2. *See* text in beginning of chapter (Volpe and papile staging)
3. Antenatal steroid, slow bolus, gentle ventilation, maintain perfusion, gentle handling of baby
4. PHVD, hydrocephalus
5. 1. Grade I IVH: Note the echogenic blood in the germinal matrix (*arrowheads*) just anterior to the anterior tip of the choroid plexus, which (normally) is also echogenic.
   2. Grade II IVH: Note the echogenic blood (*arrowheads*) filling <50% of the ventricular area.
   3. Grade III IVH: Note the large blood clot nearly completely filling and distending the entire lateral ventricle.

Ans. 5.
1. JE—lesion always present in basal ganglia region
   Treatment—maintain BP, sugar, treatment of increase ICT
2. HSV—lesion presents in fronto-temporal area, acyclovir is treatment.

Ans. 6.
1. ADEM (Acute demyelinating encephalomyelitis)
2. 30 mg/kg/day methylprednisolone for 5 days followed by oral prednisolone for 2–4 weeks.
3. Prognosis is good for single episode.

Ans. 7.
1. Moyamoya disease.
2. Idiopathic (mc), Down syndrome, NF-1, Asian race, hypothyroidism.
3. Recurrent episode of hemiplasia.
4. Shunt between temporal artery and middle carotid artery.

Ans. 8.
1. Basal ganglia calcification.
2. Idiopathic, Fahr's disease, hypoparathyroidism, postinflammatory (TB, CID, toxoplasmosis, cysticercosis, congenital HIV).

Ans. 9.
1. T2 MRI
2. a. Tuberculomas (hypointense on T2W image)
   b. Neurocysticercosis (hyperintense on T2W image)

Ans. 10. A. ALD B. MLD
C. Canavan disease D. Alexander disease

Ans. 11.
1. Multiple cerebral abscesses.
2. CHD with R-L shunt (usually TOF), soft tissue infections of the scalp/sinusitis/orbital cellulites/immunodeficiency/VP shunt infection/penetrating head injury to the skull.
3. Hemiparesis/seizure/hydrocephalus/cranial nerve palsies/behaviour and leaning problems.

Ans. 12. 1. MRI: T2W image at level of internal capsule and basal ganglia.
2. Occipital white matter most involved adrenoleukodystrophy.
3. Differential diagnosis: Refsum/Zellweger/acetyl CoA deficiency peroxisomal disorders.

Ans. 13. 1. Cystic 4th ventricle + dilated horns + dilated third ventricle.
2. Dandy-Walker malformation.
3. Hydrocephalous + agenesis of corpus callosum + agenesis of cerebellar vermis + winged cerebellum.

Ans. 14. a. Heterotropia b. Schizencephaly

Ans. 15. Meduloblastoma, surgical

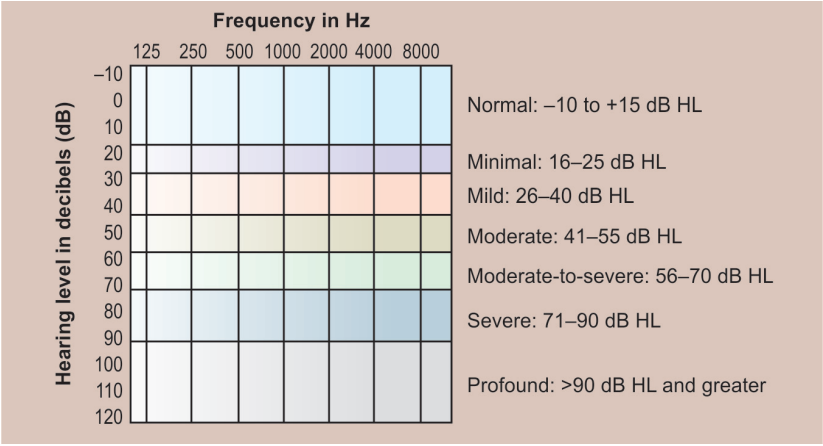
Ans. 16. 1. a. A—lissencephaly b. Porencephalic cyst
2. Miller Dicker syndrome, microophthalmia, optic neuritis

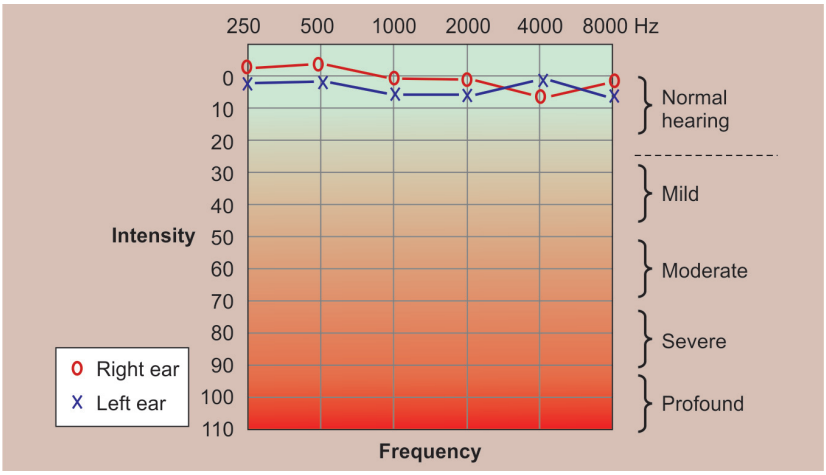
Ans. 17. 1. Multiple NCC
2. Manage if sign of increase ICP, start AED, do fundas examination, then start steroid for 7 days, after starting 2 days of steroid start Albendazole for 7–21 days.
3. At least 2 years or 6 months seizure free period whichever is later.
4. Do not use meal without proper cooking.

CHAPTER 6

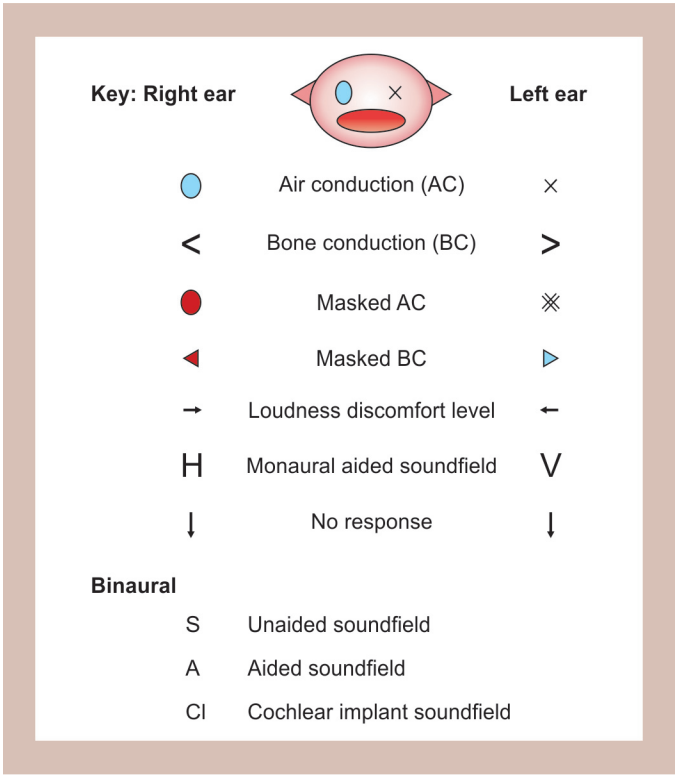
Audiometry, Capnogram and Spirometry

AUDIOMETRY

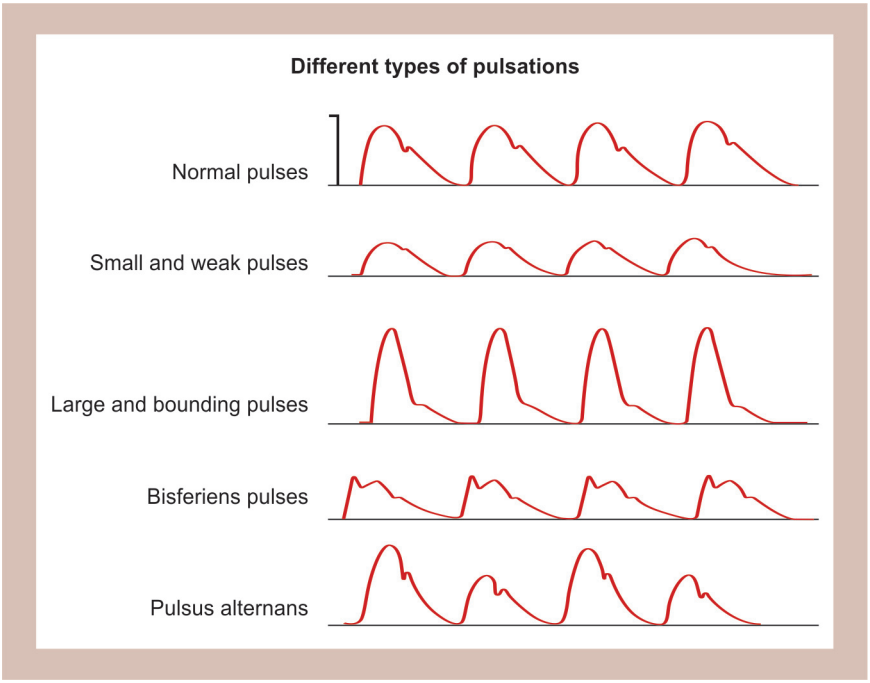


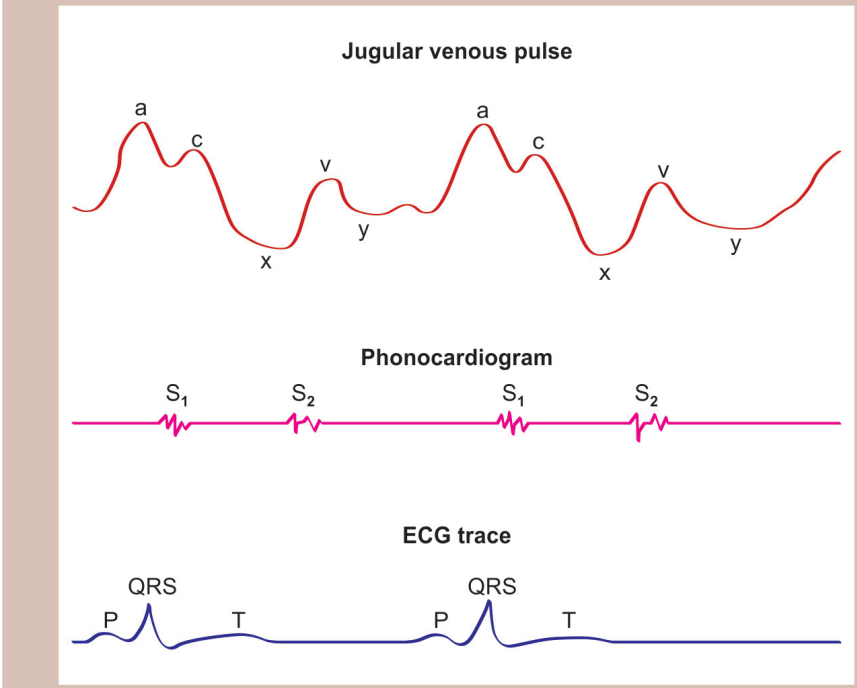


Note: **Please read each and every word that is very important.

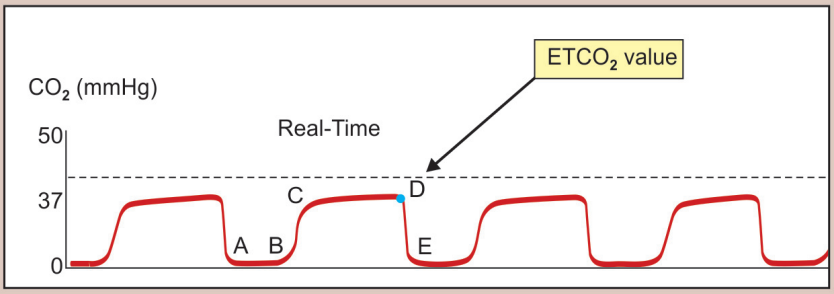

Key: Right ear
Left ear
Air conduction (AC)
Bone conduction (BC)
Masked AC
Masked BC
Loudness discomfort level
Monaural aided soundfield
No response
Binaural
S Unaided soundfield
A Aided soundfield
CI Cochlear implant soundfield

PULSE


Different types of pulsations
Normal pulses
Small and weak pulses
Large and bounding pulses
Bisferiens pulses
Pulsus alternans

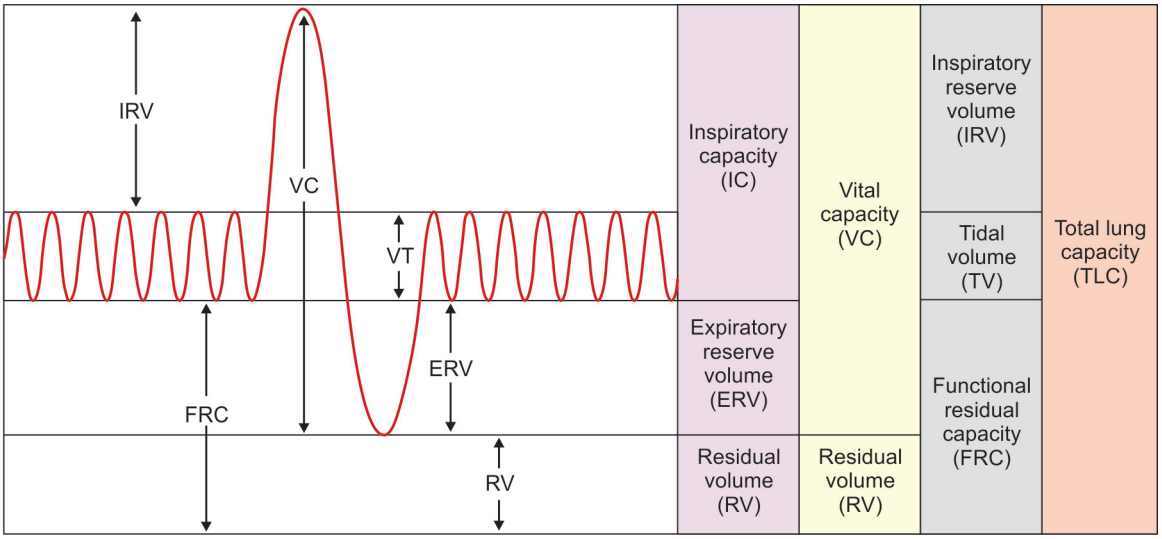


CAPNOGRAM

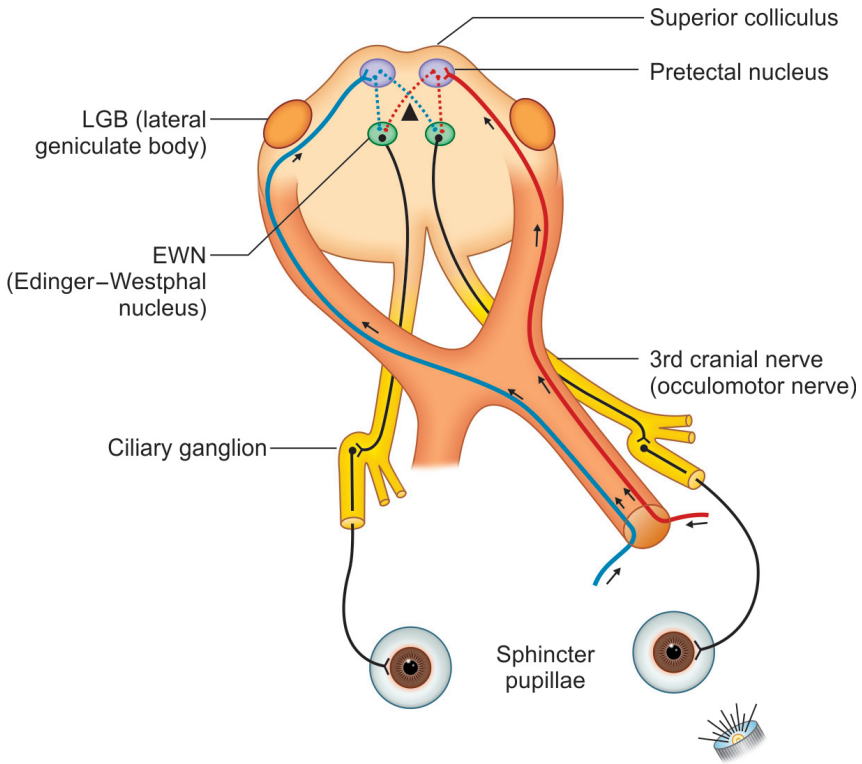


▪ A – B	Baseline
▪ B – C	Expiratory upstroke
▪ C – D	Expiratory plateau
▪ D	$ETCO_2$ value
▪ D – E	Inspiration begins

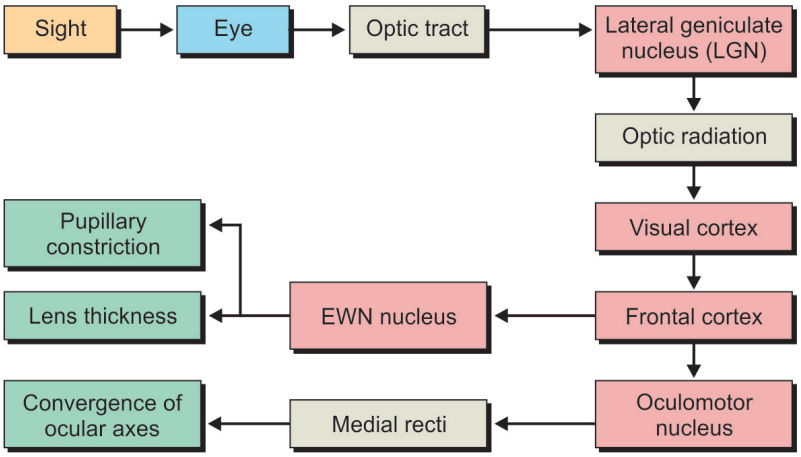
SPIROMETER TRACE



LIGHT REFLEX

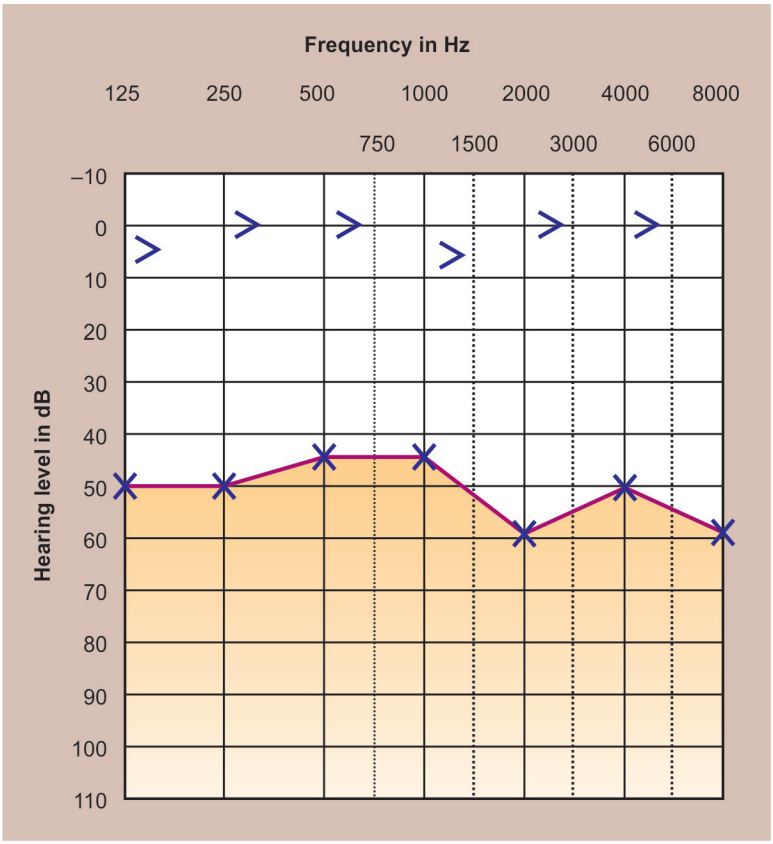


ACCOMMODATION REFLEX

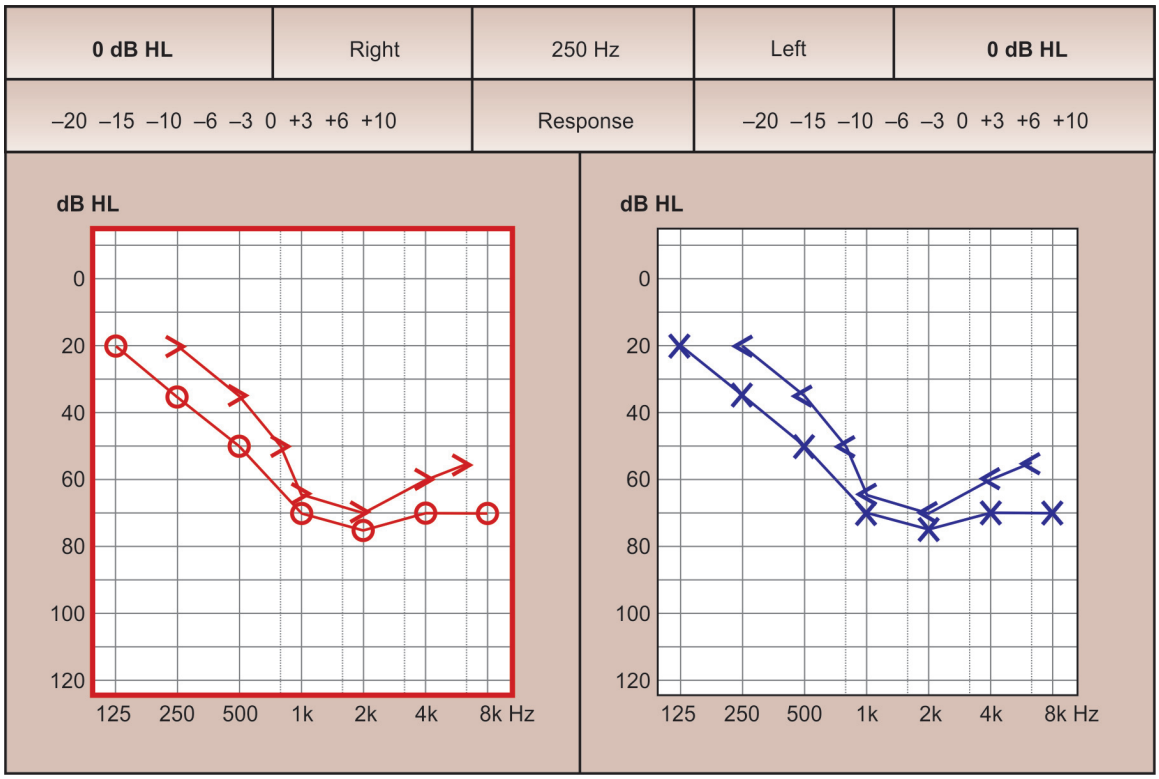


EXERCISES

Q.1.* Identify images A and B:



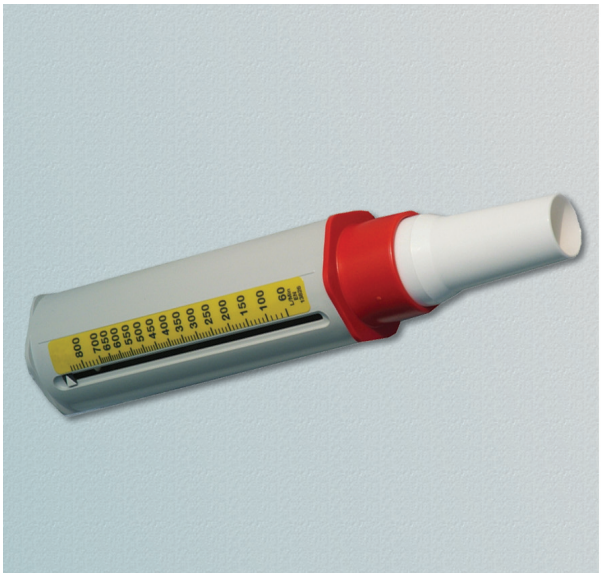
(A)

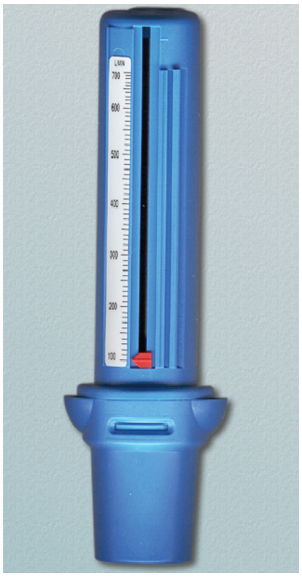


(B)

Q.2.*

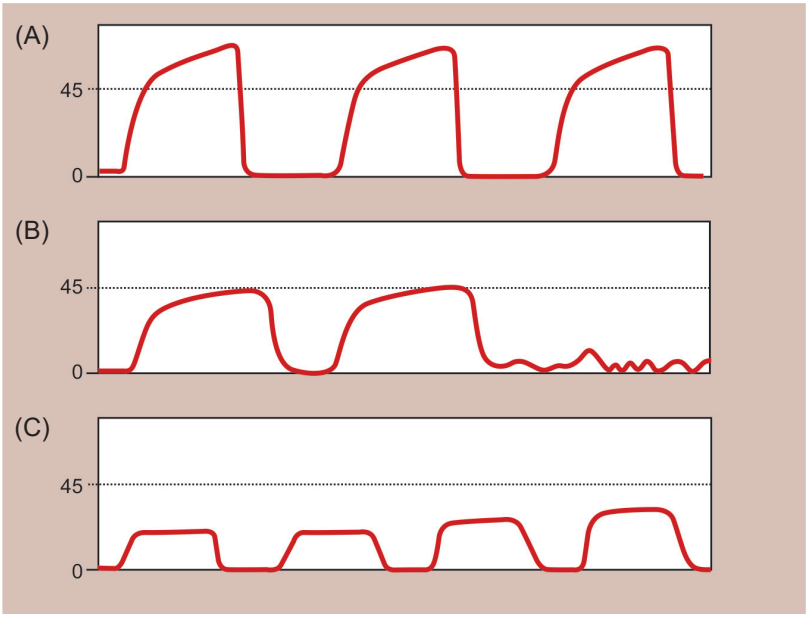
1. Identify the instrument.
2. Which illness is it used in?
3. What are the three settings?



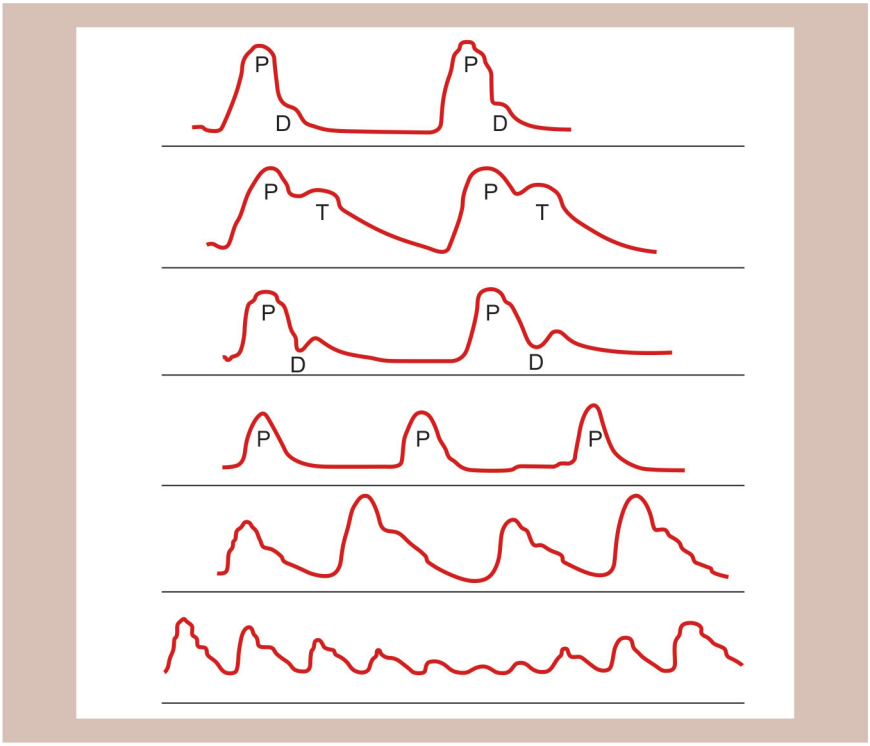


Q.3.*

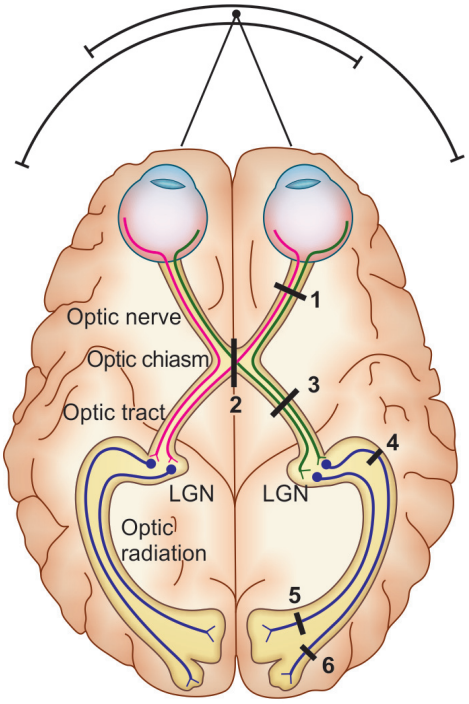
1. What are these graphical techniques?
2. What are interpretation for images A, B, C?



Q.4.* Identify these pulse waveform types with one example.

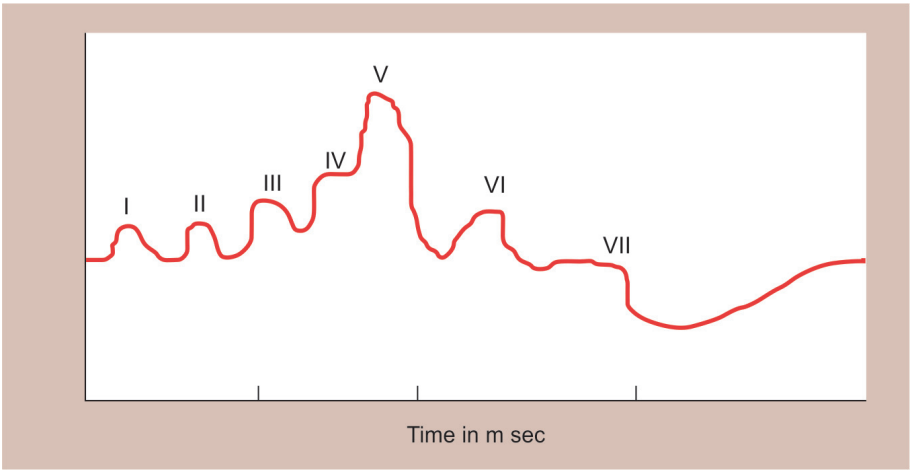


Q.5.* Give the type of vision loss according to lesion at site 1–6. (2012 Question):



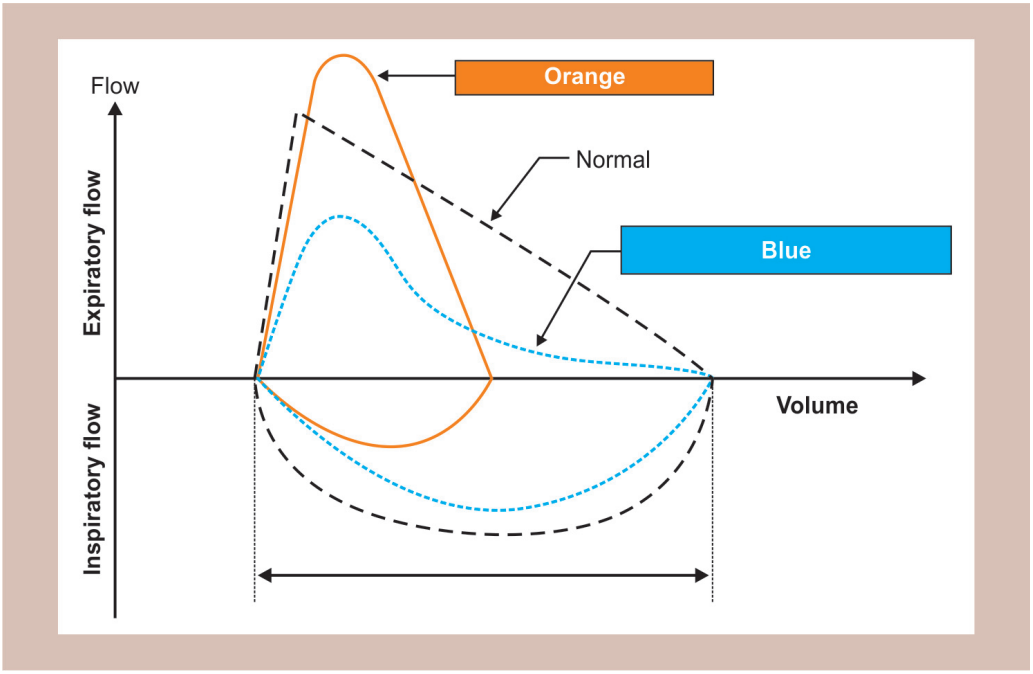
Q.6.*

1. What is this test?
2. Identify level I–VII.



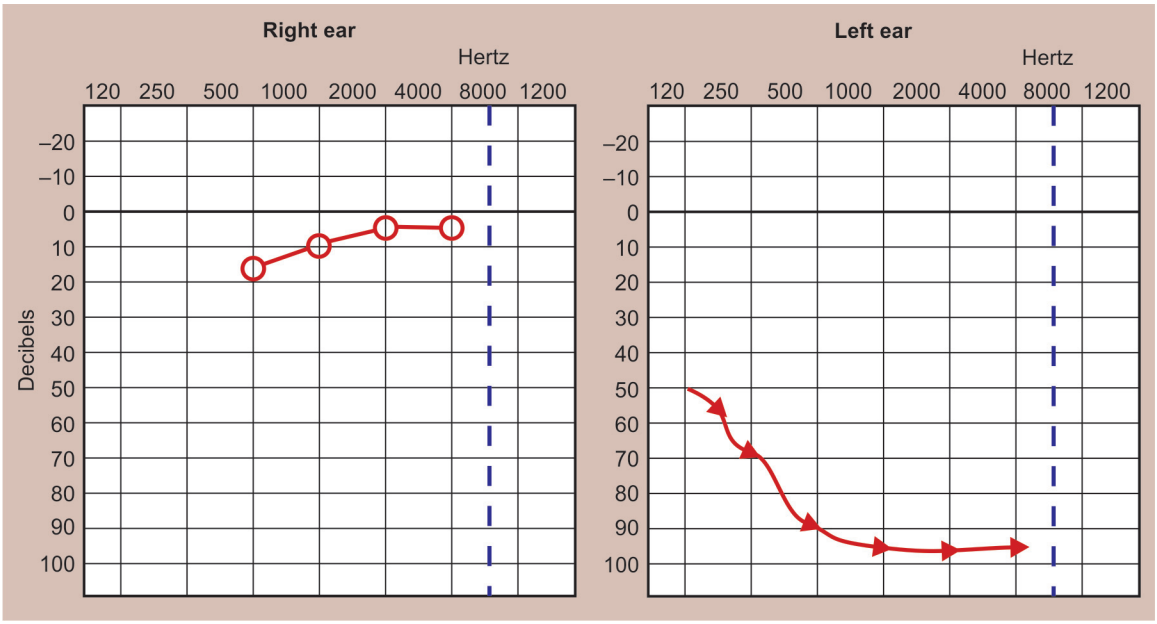
Q.7.*

1. Identify the graphical picture and give its use.
2. Give one example of red and green flow.



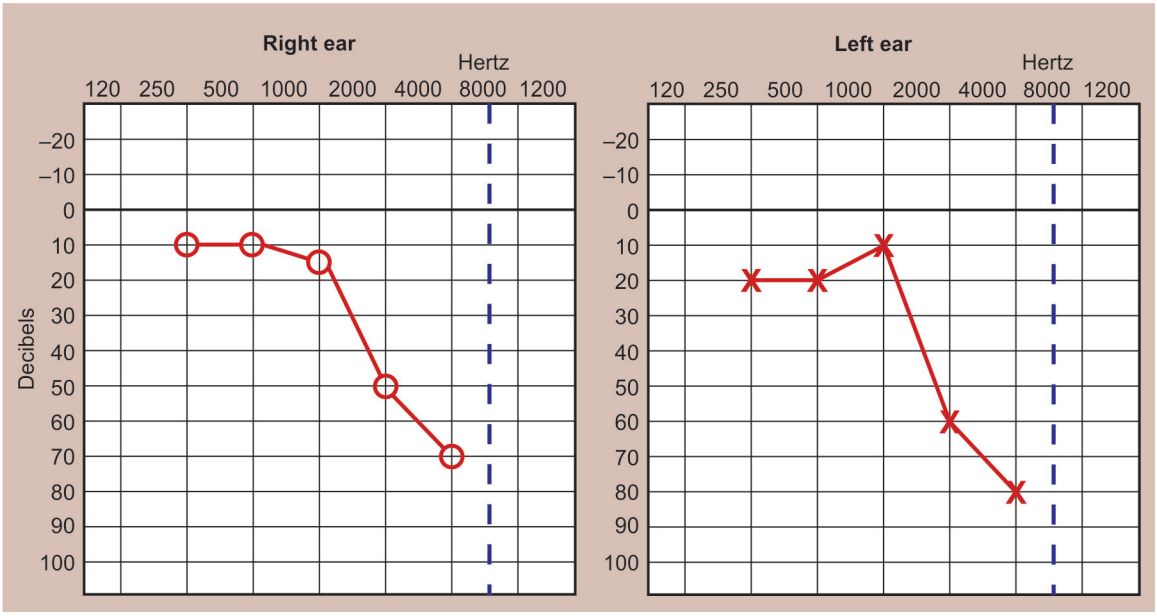
Q.8. Audiogram from a 7-year-old boy Ronit. His mother was worried by his hearing. He has passed his routine audiometry screen at 5 years and there was no family history of deafness. On examination, no abnormalities were found.

1. Diagnose the given audiometry.
2. Write down the causes.



Q.9. This is the audiogram of a 4-year-old girl child who was referred because of severe speech delay:

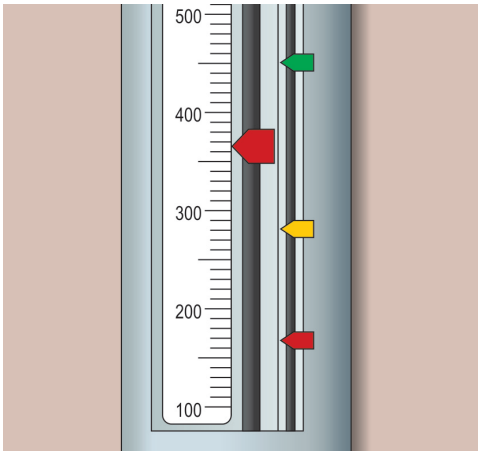
1. What does this audiogram show?
2. What is the cause of her speech delay?



ANSWERS

Ans. 1. 1. Conducting hearing loss—left ear
2. Sensorineural hearing loss—B/L

Ans. 2. 1. Peak flow meter
2. Bronchial asthma
3. Green zone >80% peak expiratory flow
   - Yellow zone 50–80% PEF
   - Red zone <50% PEF



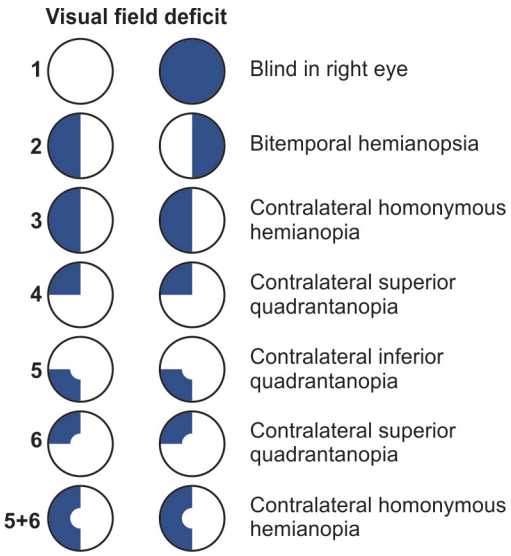
Ans. 3. 1. Capnograph
2. a. Shark fin pattern—asthma
   b. Obstruction of ET
   c. During CRP

Ans. 4. 1. Collapsing pulse: AR, PDA, artriovenous fistula
2. Pulses bisferiens: AS, AR
3. Dicrotic pulse: Typhoid fever
4. Small volume collapsing pulse: MR
5. Pulses alterans: AS
6. Pulses paradox: Severe asthma, SVC obstruction

Ans. 5. (*See* figure)

Ans. 6. 1. Bera
2. Level (Pneumonic: ***C. coli***)
   a. Cochlear nerves—waves I and II
   b. Cochlear nucleus—wave III
   c. Superior olivary complex—wave IV
   d. Nulclei of lateral lemniscus—wave V
   e. Inferior colliculus—waves VI and VII

Ans. 7. 1. Flow volume curve, it is useful in differentiating type of respiratory failure
2. Red—restrictive pattern
   Green—obstructive pattern



Ans. 8. 1. Profound sensorineural deafness affecting the left ear
2. Mumps infection after 5 years of age
   - SN deafness due to viral infection
   - Progressive herediatary deafness
   - Acoustin neuroma

Ans. 9. 1. Bilateral partial sensorineural deafness
2. Deafness

CHAPTER 7

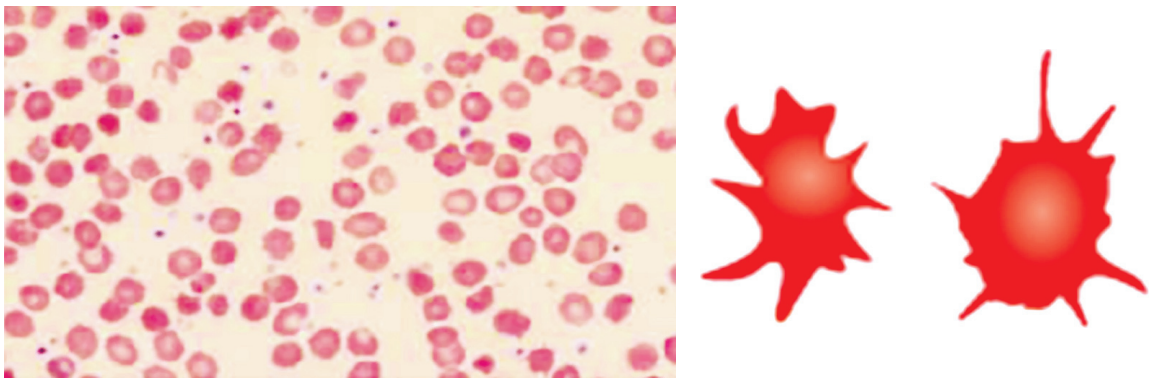
Blood Film

Acanthocytes* (Spur Cells)

Acanthocytes are red cells lacking central pallor with **thom-like projections** of variable sizes located **at irregular intervals**.

Seen in:

1. Hereditary acanthocytosis
2. Hereditary abetalipoproteinemia
3. Post-splenectomy
4. Liver disease
5. Anorexia nervosa



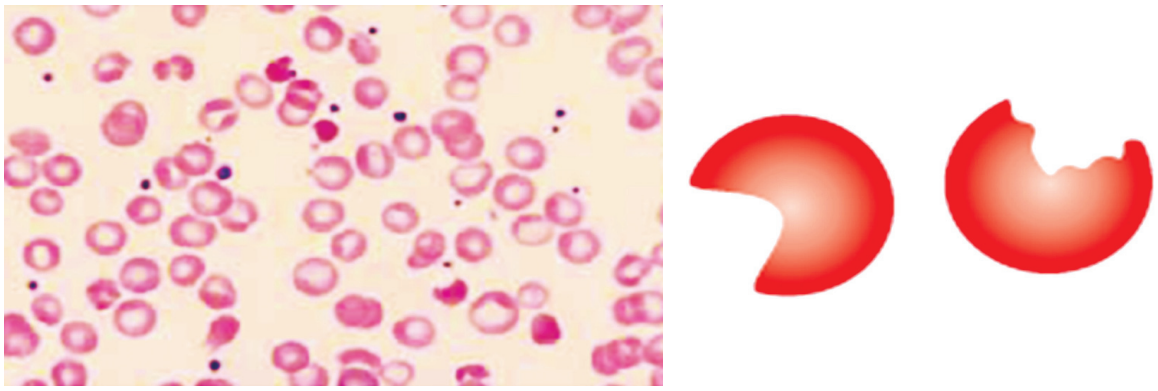
Acanthocytes (spur cells)

Bite Cells

Bite cells are red cell from which **denatured hemoglobin has been removed by the spleen.** The **"bite"** appears as half a circle removed from the edge of the red blood cell.

Seen in:

1. Glucose 6 phosphate dehydrogenase (G6PD) deficiency
2. Congenital Heinz body anemia (congenital bite cell anemia)



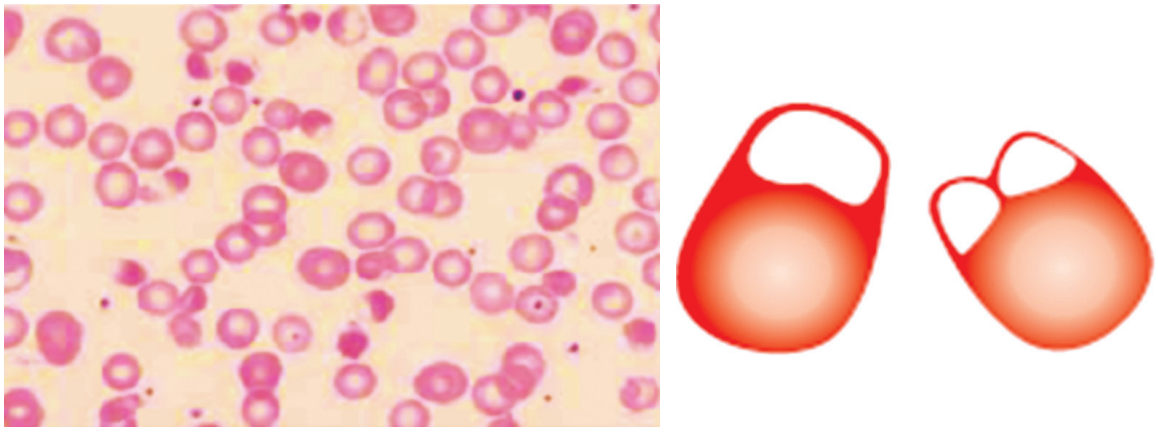
Bite cells

Blister Cells

Blister cells are RBC in which there is a large vacuole or clear zone on one side of the erythrocytes.

Seen in:

1. Glucose 6 phosphate deficiency (G6PD)
2. Sickle cell disease



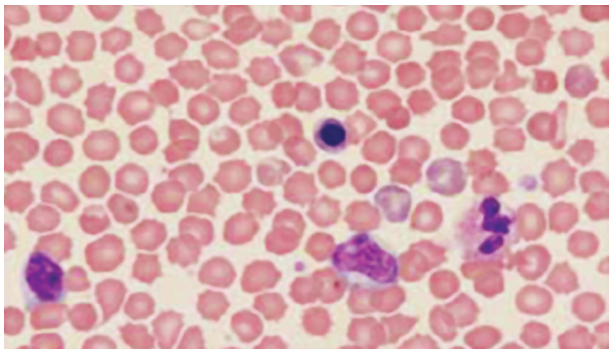
Blister cells

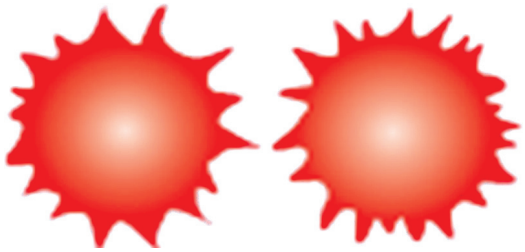
Echinocytes (Burr Cells, *Crenated Cells)

Echinocytes are normochromic red cells with **blunt short projections**, which are **evenly distributed** over the surface of the red blood cell.

Seen in:

1. Renal disease (MC)
2. Liver disease
3. Pyruvate kinase deficiency





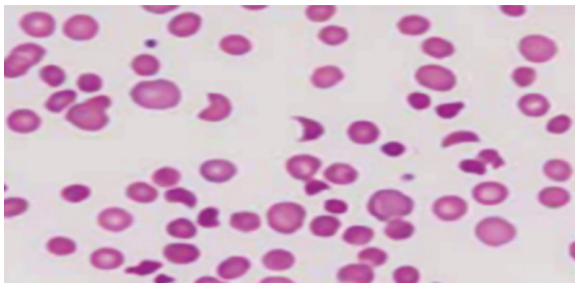
Echinocytes (Burr cells)

Fragmented Red Cells (Schistocytes, Helmet Cells)

Fragmented red cells are red cells that are injured torn due to **microangiopathic process** in which fibrin strands are generated and are responsible for injury to the red cells.

Seen in:

1. Hemolytic uremic syndrome (HUS)
2. Thrombotic thrombocytopenic purpura (TTP)
3. Disseminated intravascular coagulation (DIC)
4. Microangiopathic hemolytic anemia



Fragmented red cells
(schistocytes, helmet cells, keratocytes)

Fragmented red cells

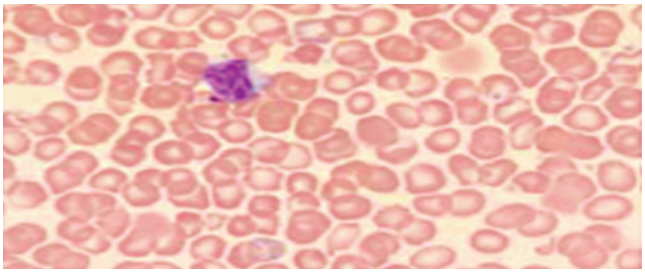
Macrocytes

Macrocytes are large red cells with a high mean corpuscular volume (MCV), usually greater than 100%. There hemoglobin concentration is normal.

Seen in:

1. Normal newborn
2. Folate deficiency

3. B_{12} deficiency
4. Down syndrome
5. Drug—anticonvulsants, sulpha, chemotherapeutic agents
6. Hypothyroidism
7. Liver disease



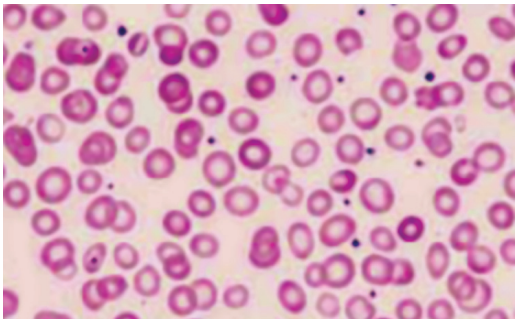
Macrocytes

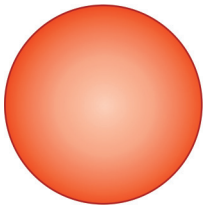
Microcytes

Microcytes are smaller than normal red cells with a MCV less than 75 fl in children less than 5 years of age and less than 80 fL in children over 5 years of age. Microcytosis is usually associated with hypochromia.

Seen in:

1. Iron deficiency anemia
2. Lead poisoning
3. Thalassemias
4. Sideroblastic anemia
5. Anemia of chronic diseases





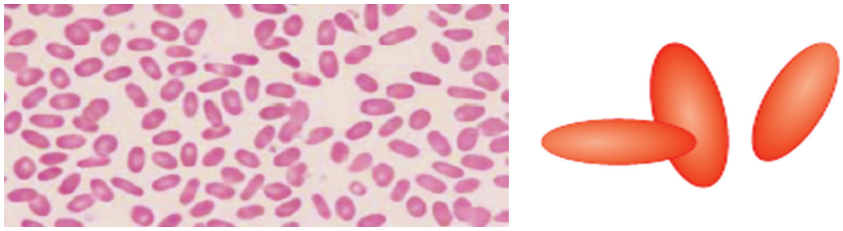
Microcytes

Ovalocytes (Elliptocytes)

Ovalocytes and elliptocytes are red cells that are elongated with blunt ends and parallel sides.

Seen in:

1. Hereditary elliptocytosis (>25%)
2. Myelodysplasia
3. Renal and liver diseases



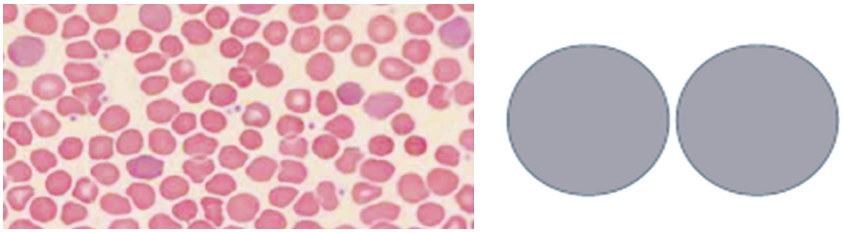
Ovalocytes (elliptocytes)

Polychromatophilic Red Cells (Reticulocytes)

A polychromatophilic red cells is a non-nucleated red cell precursor slightly larger than the mature red cell (8–10 microns in diameter). It contains RNA in addition to the hemoglobin and stains gray blue or pale purple with Wright-Giemsa stain.

Seen in:

1. Hemolytic anemias
2. Blood loss anemias
3. Recovering anemia



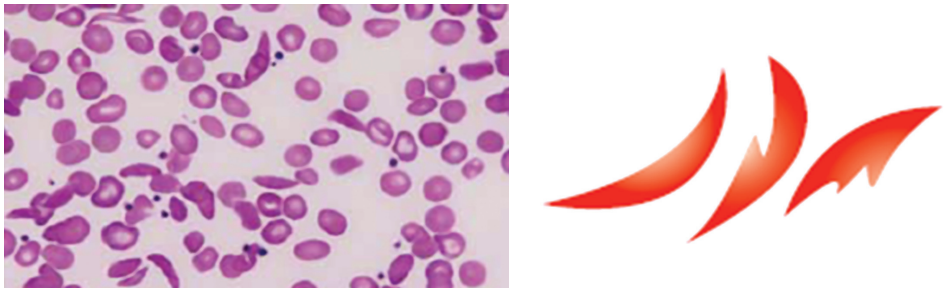
Polychromatophilic red cells

Sickle Cells (Drepanocytes)

Sickle cells are red cells with two pointed ends which are in the shape of a crescent or sickle. This is due to the polymerization of deoxygenated hemoglobin S causing changes to the red blood cell making more rigid.

Seen in:

1. Sickle cell anemia
2. S beta thalassemia
3. Hemoglobin SD



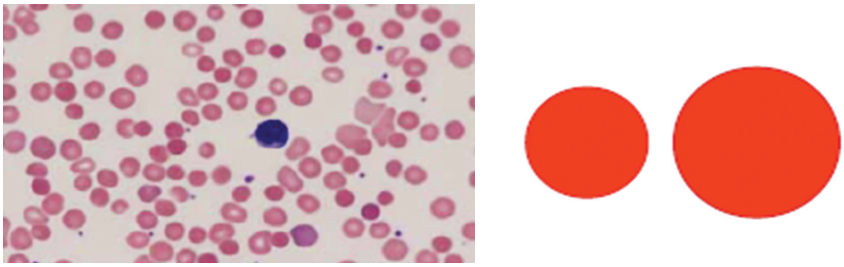
Sickle cells (drepanocytes)

Spherocytes

Spherocytes are dense, staining spherical red cells with normal or slightly **reduced MCV without any central pallor.**

Spherocytes are commonly found in

1. Hereditary spherocytosis
2. ABO incompatibility
3. Severe burns
4. DIC and HUS
5. Autoimmune hemolytic anemia (warm antibody type)
6. Infections (e.g. EBV, CMV, *E. coli*, sepsis/urosepsis)



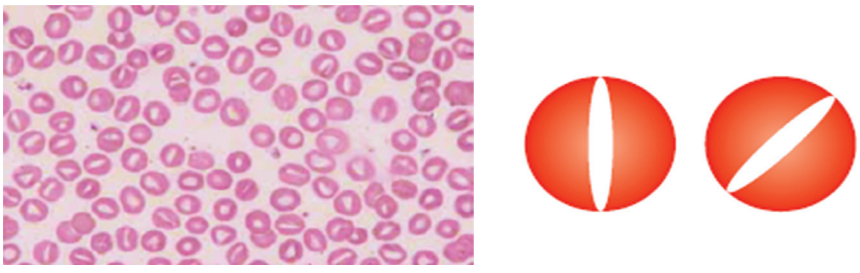
Spherocytes

Stomatocytes

Stomatocytes are red cells with a central clear opening appearing like a mouth, hence the name *stoma*, meaning *mouth*.

Seen in:

1. Hereditary stomatocytosis
2. Liver disease



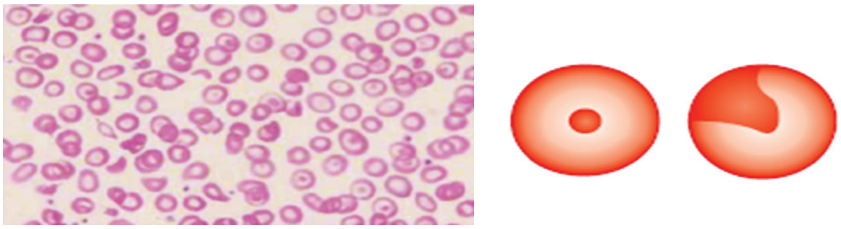
Stomatocytes

**Target Cells (Codocytes)—Repeated Question in Exam

Target cells have a central hemoglobinized area within the surrounding area of pallor. These morphological features give these red cells the appearance of a bull's eye.

Seen in:

1. Thalassemias
2. Iron deficiency anemia
3. Liver disease
4. Hemoglobin C, E
5. Sickle cell disease



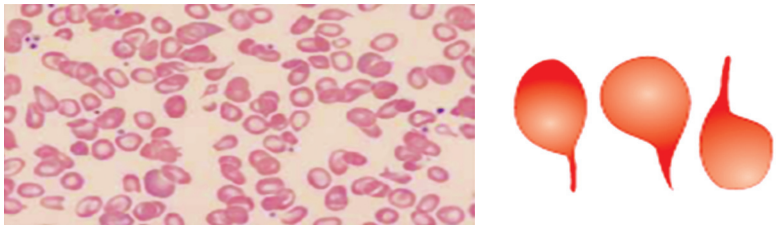
Target cells (codocytes)

Teardrop Cells (Dacrocytes) (*Very Important)

Red cells in the shape of a teardrop or a pear with single short or long, blunted or rounded end are teardrop cells.

Seen in:

1. Osteopetrosis
2. Iron deficiency anemia
3. Pernicious anemia
4. Myelofibrosis
5. Anemia of renal disease



Teardrop cells (dacrocytes)

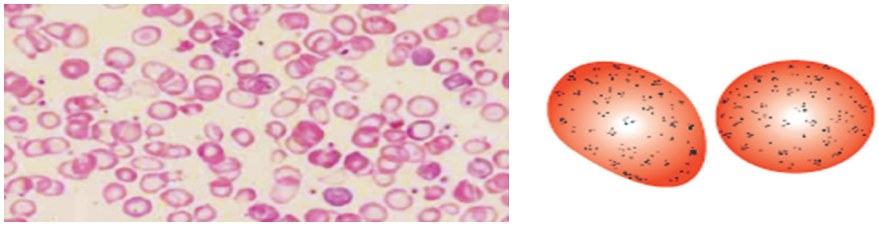
Basophilic Stippling (*Very Important)

Basophilic stippling is a collection of fine or coarse granules in the red cells stippling is seen result of accumulation of abnormal aggregates of ribosomes and polyribosomes.

***This slide can be asked with X-ray, knee of led poisoning—asked an exam.**

Seen in:

1. *Lead poisoning
2. Iron deficiency anemia
3. Refractory anemia
4. Thalassemia



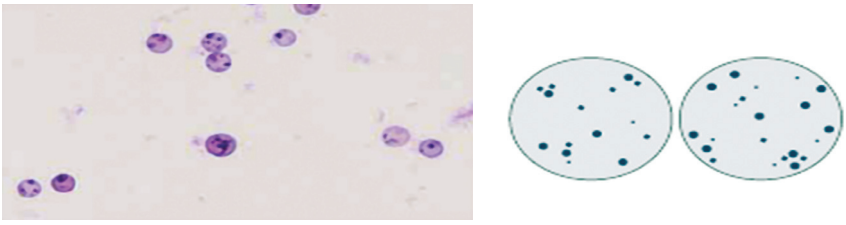
Basophilic stippling

Heinz Bodies

Heinz bodies are multiple **blue-purple inclusions** attached to the inner surface of the red cell membrane. They are not visible in Wright-Giemsa-stained blood films, but are visible in supravitally stained smears.

Seen in:

1. G6PD deficiency
2. Congenital Heinz body (bite cell) anemias



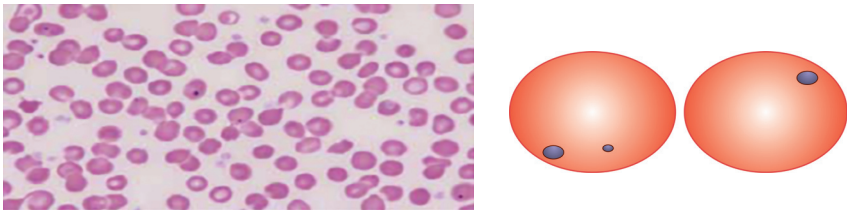
Heinz bodies

Howell-Jolly Bodies

Howell-Jolly bodies are small round bodies composed of DNA, about 1 µm in diameter, usually single and in the periphery of a red cell. The spleen is responsible for the removal of nuclear material in the red cells, so in absence of a functional spleen, nuclear material is removed ineffectively.

Seen in:

1. Post-splenectomy
2. Functional asplenia in **sickle cell disease**

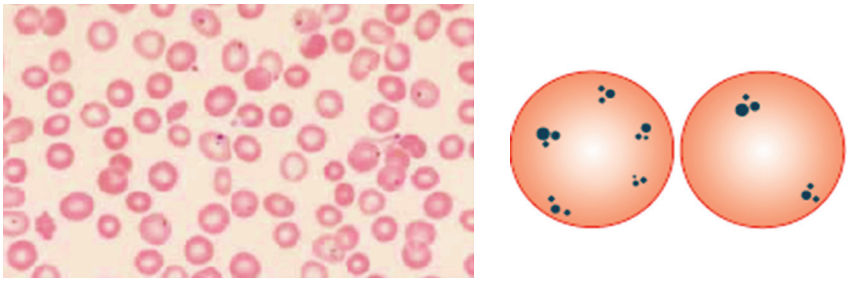


Howell-Jolly bodies

Pappenheimer Bodies

Pappenheimer bodies are small dark inclusions 2 to 5 per red cell appearing either singly or in pairs. They are smaller than Howell-Jolly bodies.

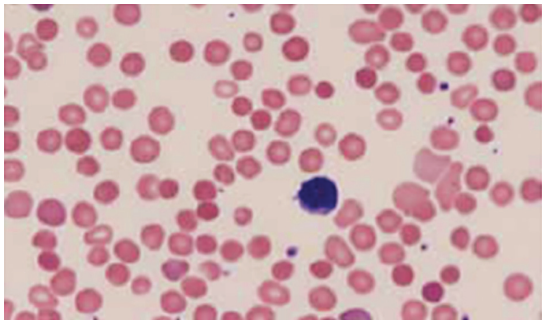
Pappenheimer bodies are seen **in iron overload** in patient of thalassemia



Pappenheimer bodies

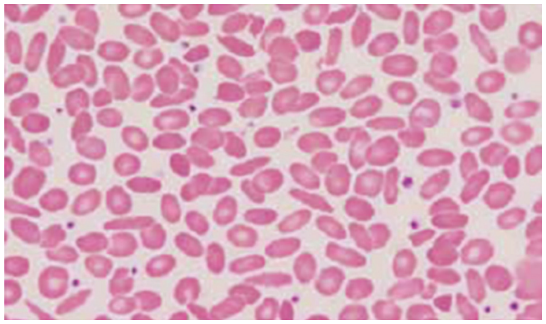
Membrane Defects

1. **Hereditary spherocytosis (HS)** is the **commonest hereditary hemolytic anemia,** inherited as an **autosomal dominant** disorder. The hallmark of HS erythrocytes is **increased red cell fragility** secondary to **loss of membrane surface area,** which is also responsible for spherocytic red cells. The increased fragility is caused by a quantitative defect in the membrane proteins, **ankyrin, spectrin** and others.



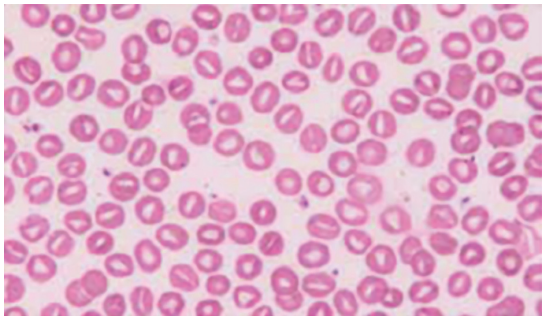
Hereditary spherocytosis

2. **Hereditary elliptocytosis (HE)** is due to a structural defect of the erythrocyte membrane protein, **spectrin.** It is common in individuals **of African.**



Hereditary elliptocytosis

3. **Hereditary stomatocytosis (HSt) is a mild autosomal dominant hemolytic anemia.** There is an inherited abnormality in erythrocyte cation permeability, leading to abnormal erythrocyte **hydration.** The most common defect in the red cell membrane protein, **stomain.**

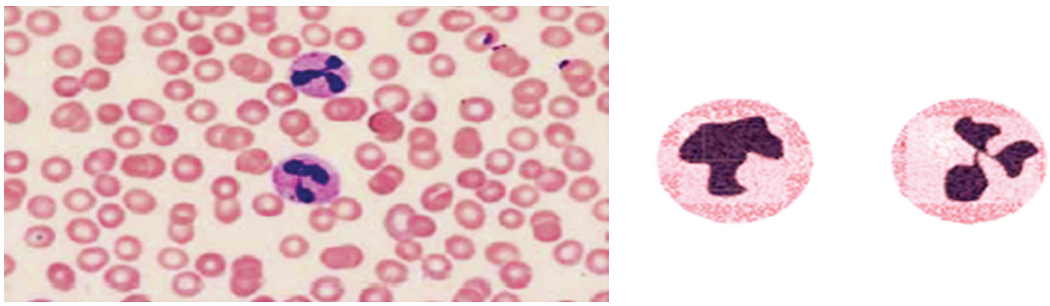


Hereditary stomatocytosis

White Blood Cells (Leukocytes)

Neutrophil and Segmented

The segmented neutrophil is the predominant white blood cell in the peripheral blood. It is 10 to 15 µm in diameter with **pale pink cytoplasm** and specific fine granules. The nucleus is lobulated **(between 2 and 5 lobes)** and the lobes are connected by a thin filament.



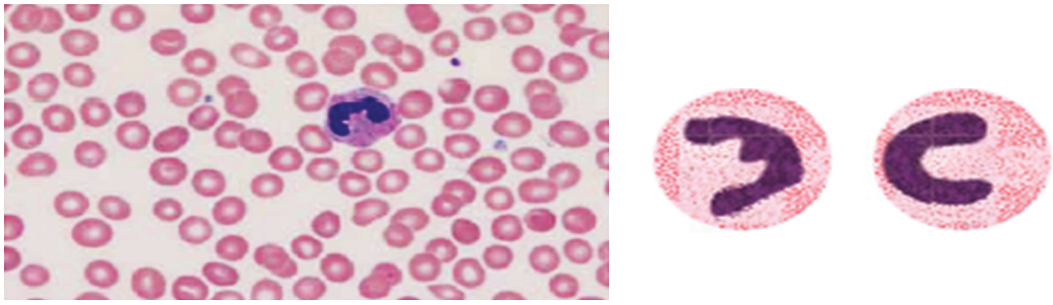
Neutrophil and segmented

Band Neutrophil

The band is round to oval in shape and 10 to 18 µm in diameter. The nucleus can be band like, **sausage-shaped, S-, C- or U-shaped** and may be twisted and folded on itself. Increased numbers of bands appear in the blood in a number of physiologic and pathologic states.

**Bands seen in* (very important)

- Severe infections
  - **Sepsis/bacteremia:** More than 20% is positive marker of sepsis in neonate.
- **Inflammation**



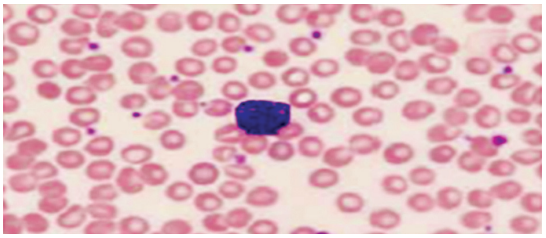
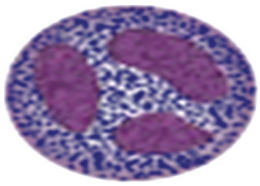
Band neutrophil

Basophil

In the normal physiological state there are (0–1%) to basophils in the peripheral blood. The granules in the **Wright-Giemsa-stained preparation are blue-black.**

Basophils are increased in the blood in

1. Myeloproliferative disorders (e.g. chronic myelogenous leukemia)
2. Hypersensitivity states
3. Xeroderma pigmentosum

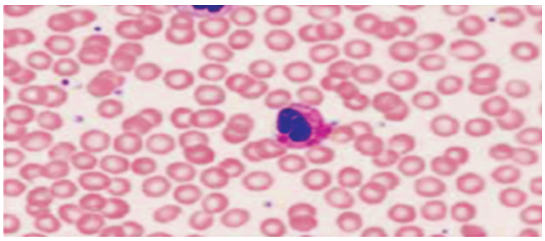
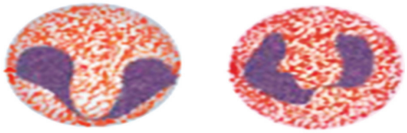
Basophil

Eosinophil

Eosinophils are size of a neutrophil (10–15 µm) with abundant cytoplasm field with many large, coarse, **orange-red granules**. About 80% of segmented eosinophils will have the classic two-lobe appearance.

Eosinophils are increased in the following conditions

1. Allergies
2. Parasitic infestations
3. Infections
4. Myeloproliferative diseases
5. Hypereosinophilic syndrome
6. Drug-associated

Eosinophil (band and segmented)

Döhle Bodies

Single or multiple, pale blue, spindle-shaped inclusions located on the rim of the cytoplasm of neutrophils.

Seen in:

- Infection
- Thermal injury
- Trauma

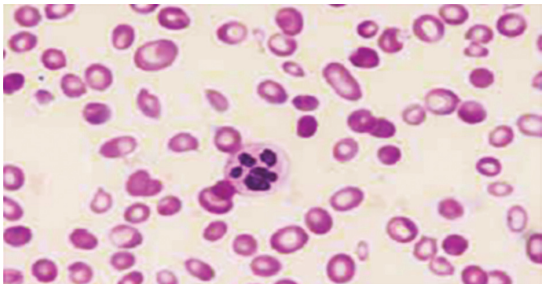
Döhle bodies

Hypersegmented Neutrophils (Very Important)

Large hypersegmented neutrophils are a result of megaloblastic hematopoiesis. In megaloblastic myelopoiesis, eosinophils and basophils are large and also hypersegmented. To be considered hypersegmented, neutrophils should have 6 or more lobes.

Seen in:

1. Vitamin B_{12} deficiency
2. Folate deficiency
3. Effects of chemotherapeutic agents (e.g. 6-mercaptopurine or methotrexate)



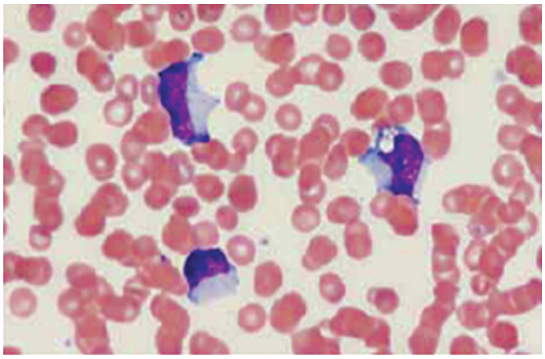
Hypersegmented neutrophils

Lymphocytes and Large Granular (Atypical Lymphocytes) (Very Important)

These atypical-appearing lymphocytes are large with abundant cytoplasm—containing areas having azurophilic granules. The nucleus has clumped chromatin and no visible nucleoli.

Large granular lymphocytes are commonly found with viral infections (infectious mononucleosis).

Large lymphocyte



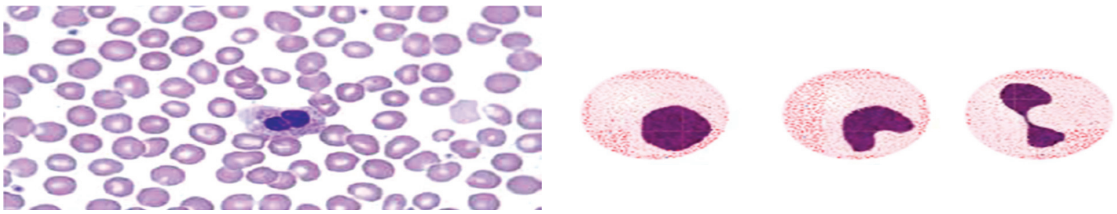
Infectious mononucleosis

Pelger-Huët Cell Anomaly

Neutrophils with bilobed nuclei in the pince- or dumbbell conformation (two round lobes connected by a distinct thin filament) are designated as Pelger-Huët cells.

Seen in:

1. Myelodysplastic syndrome
2. Myeloid malignancies

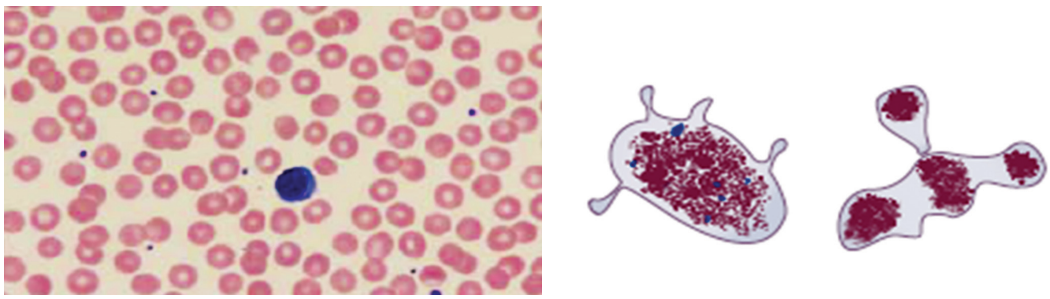


Pelger-Huët cell

Normal Platelets (Thrombocytes)

Platelets are small non-nucleated cells derived from the cytoplasmic fragments of megakaryocytes and are variable in size. Normal-sized platelets are **1.5 to 3 µm in diameter** and have the purple-red granules aggregated at the center or dispersed throughout the cytoplasm.

1. Normal platelets: 1.5 to 3 µm
2. Large platelets: 4 to 7 µm
3. Giant platelets: >7 µm
4. Small (micro) platelets: **<1.5 µm**

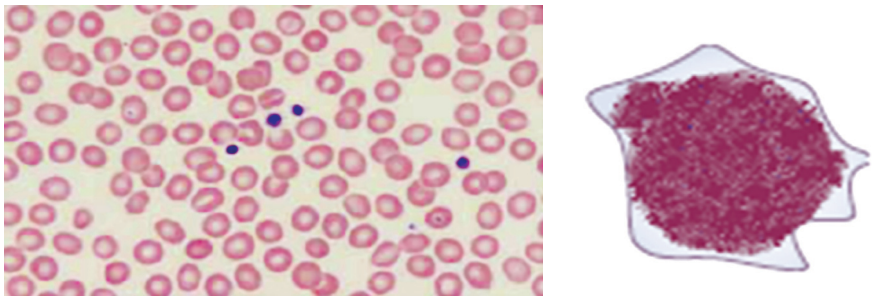


Platelets (normal)

Large Platelets

Large platelets are usually 4 to 7 µm in diameter. Large platelets are commonly seen in:

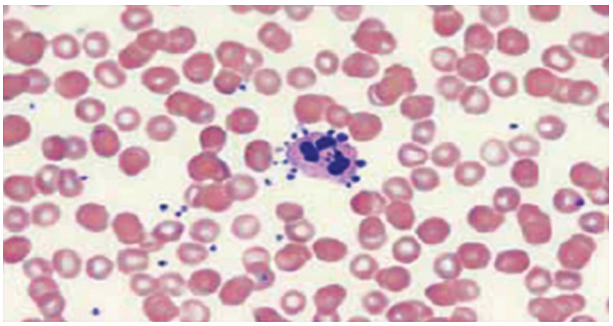
1. Reactive thrombocytosis
2. Myeloproliferative disorder/leukemoid reaction
3. Autoimmune thrombocytopenia



Large platelets

Platelet Satellitism (Very Important)

Platelets sometimes clump and adhere to neutrophils and more rarely to monocytes forming "platelet rosettes", which is known as *platelet satellitism*. Platelet satellitism is a cause of spurious thrombocytopenia because the cellular aggregates are counted as leukocytes rather than platelets.



Platelet satellitism

Quantitative Disorders of Platelets

- Thrombocytopenia
- Thrombocytosis

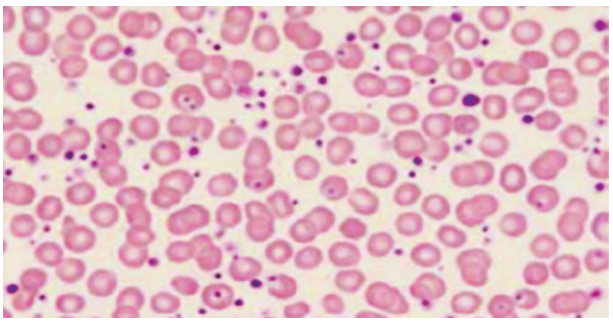
Common Causes of Thrombocytopenia

- Decreased production
  - Aplastic anemia
  - Acute leukemia
  - Viral infections
    - Parvovirus

Thrombocytosis

Causes may include:

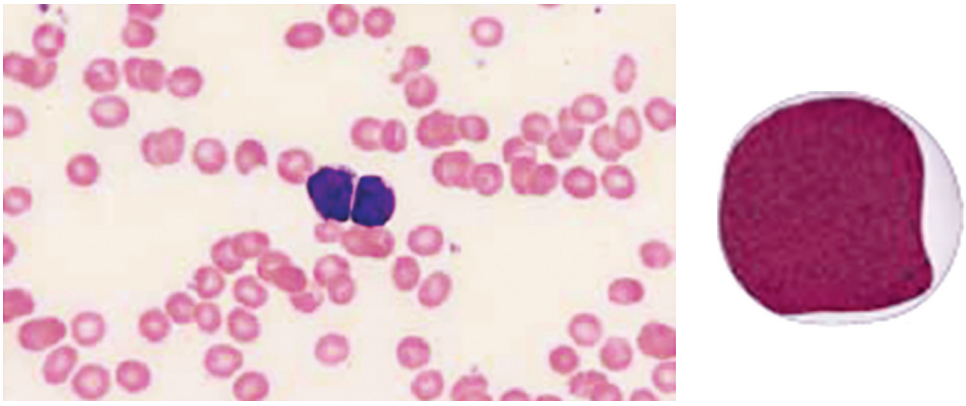
- Reactive thrombocytosis
  - Post infection
  - Inflammation
  - Chronic diseases
- Essential thrombocythemia



Thrombocytosis

L1 Lymphoblastic Leukemia

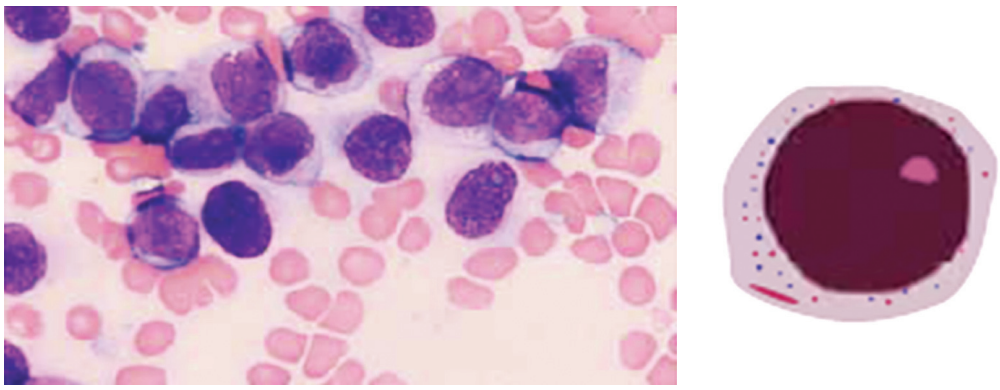
These cells are relatively small (1½ times a normal lymphocyte) with coarse chromatin and scanty cytoplasm. The chromatin is evenly dispersed and nucleoli are usually not visible. The cells are characterized by a uniform cell population.



L1 Lymphoblast

M1 Myeloblastic Leukemia

This cell has agranular cytoplasm with maturing cells, promyelocytes onward or monocytes less than 10%. Cytochemical stains and flow cytometry are necessary in their **identification. Auer rods may be present.**

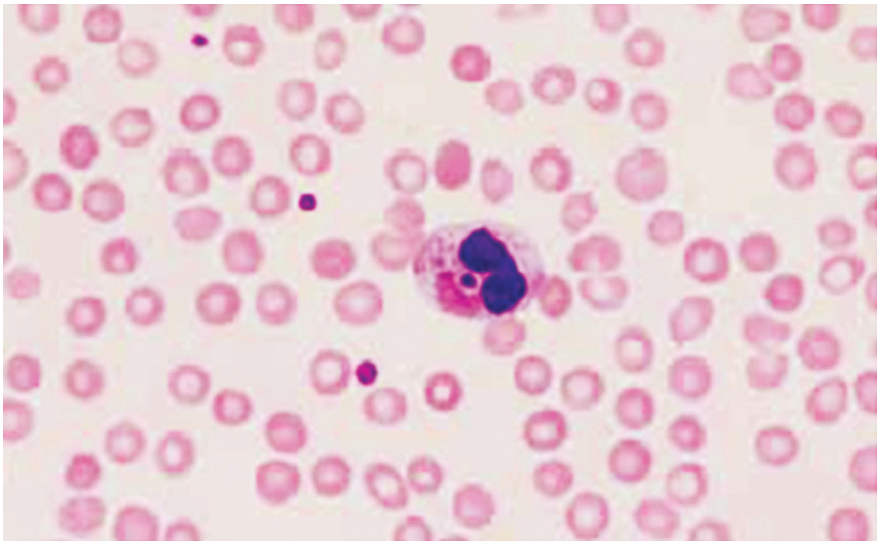


M1 Myeloblastic

Chédiak-Higashi Syndrome

Chédiak-Higashi syndrome is a rare **autosomal recessive** disorder associated with partial **oculocutaneous albinism** and **impaired neutrophil function,** leading to increased **susceptibility to bacterial infection.** This disorder is characterized by the presence of large lysosomal granules in granulocytes, lymphocytes and monocytes in the blood.

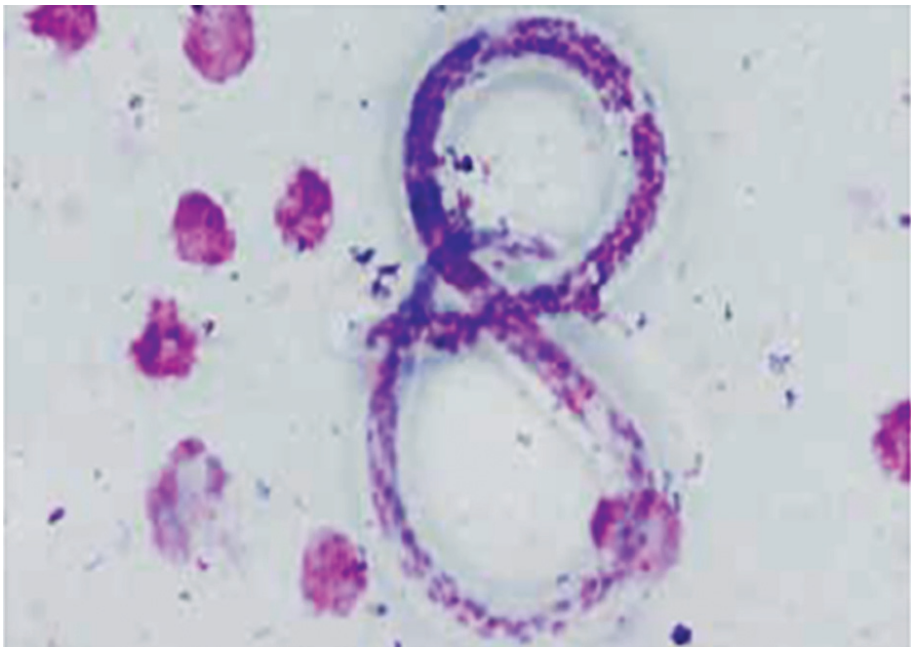
***This slide can be asked with a child with albinism and immunodeficiency.**



Chédiak–Higashi syndrome

Filaria

Filariae are transmitted by insect bites (usually mosquitoes); they reside in the lymphatic system, subcutaneous tissue or within body cavities. The microfilariae make their way to the bloodstream and vary in size from 160 to 315 μm in length and 3 to 10 μm in width.

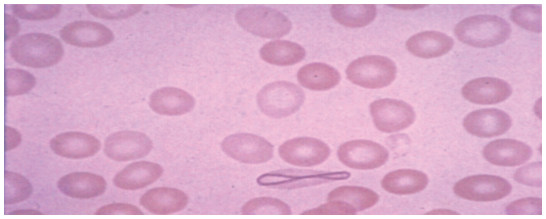


Filaria

EXERCISES

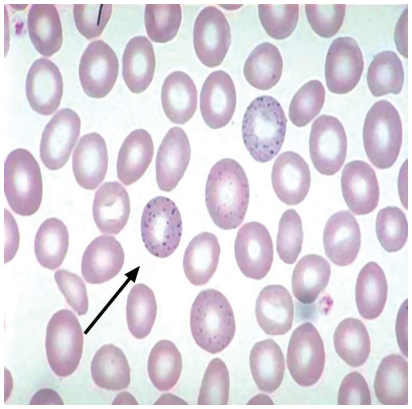
Q.1.* A six-year-old child investigated for increasing pallor, peripheral blood examination was done that is shown below:

1. Name the intracellular inclusion seen in this blood film.
2. Name the conditions in which it is seen (Write 3 at least).



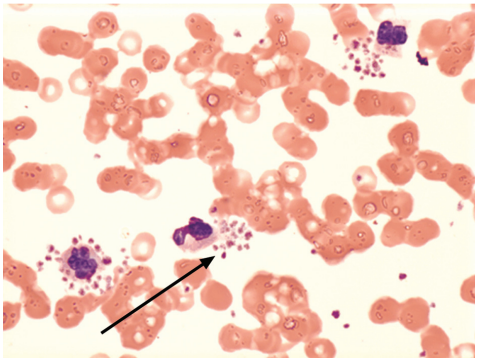
Q.2.* (2014 Exam):

1. Identify the abnormality pointed in the given PBF (Peripheral blood film).
2. Give 2 differential diagnosis.
3. Describe porter index.



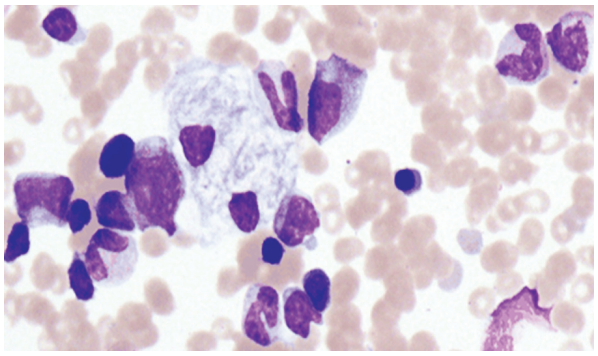
Q.3.* PBF of an 8-year-old child was investigated and pathologist inform you about the satellitism of platelets in PBF:

1. Describe platelet satellitism.
2. What is its clinical significance?
3. Next step in evaluation in these patients.



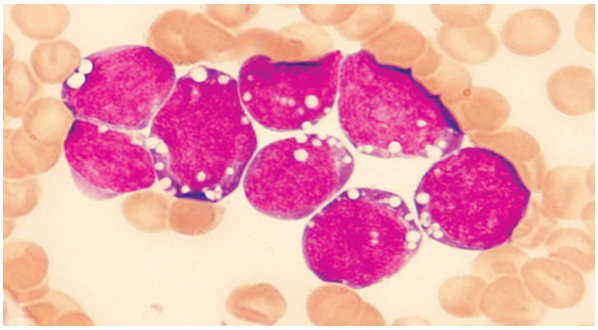
Q.4. Bone marrow aspirate of an 18-month-old child with a history of hypertonicity, aspiration pneumonia and hepatosplenomegaly: See the film and answer the following questions:

1. Describe the findings and write the diagnosis.
2. Give 2 clinical differential diagnosis.
3. Management



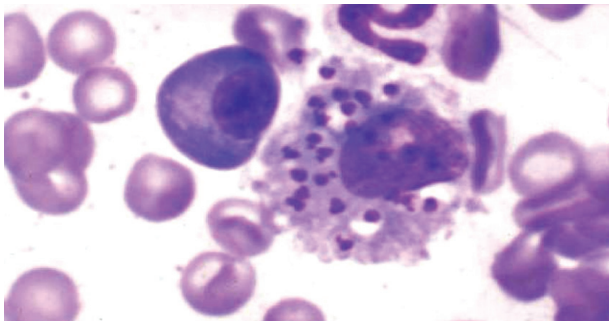
Q.5. A 4-year-old male child presents with fever, hepatosplenomegaly, lymphadenopathy and petechial rash over body, bone marrow was done:

1. What is this cell and type of malignancy?
2. Write down 4 prognostic factors (favorable).

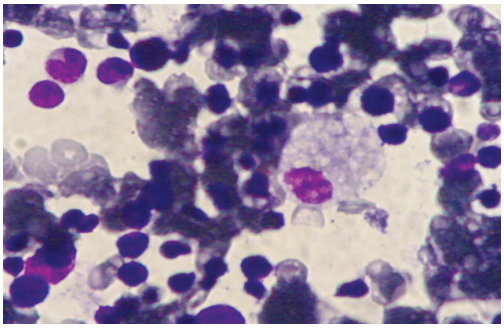


Q.6.* A 10-year-old male boy from Bihar, presents with complaints of prolong fever, weight loss and hepatosplenomegaly. Bone marrow was done in film below:

1. Identify the bone marrow abnormality and write the possible diagnosis.
2. What are diagnose test for this disease?
3 . Write treatment with two new drugs.



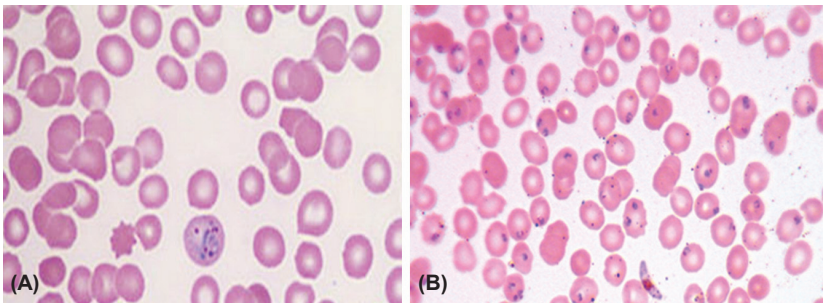
Q.7.* A 7-month-old male child was brought from Abbottabad with complaints of loose stools and fever off and on for the last 6 months. On examination, he had hepatomegaly 10 cm, splenomegaly 5 cm, delayed milestones, and fundoscopy showed cherry-red spots:



1. What is diagnosis of this bone marrow and clinical scenario?
2. Write the inheritance of this disease.
3. Enzyme defect responsible for this.

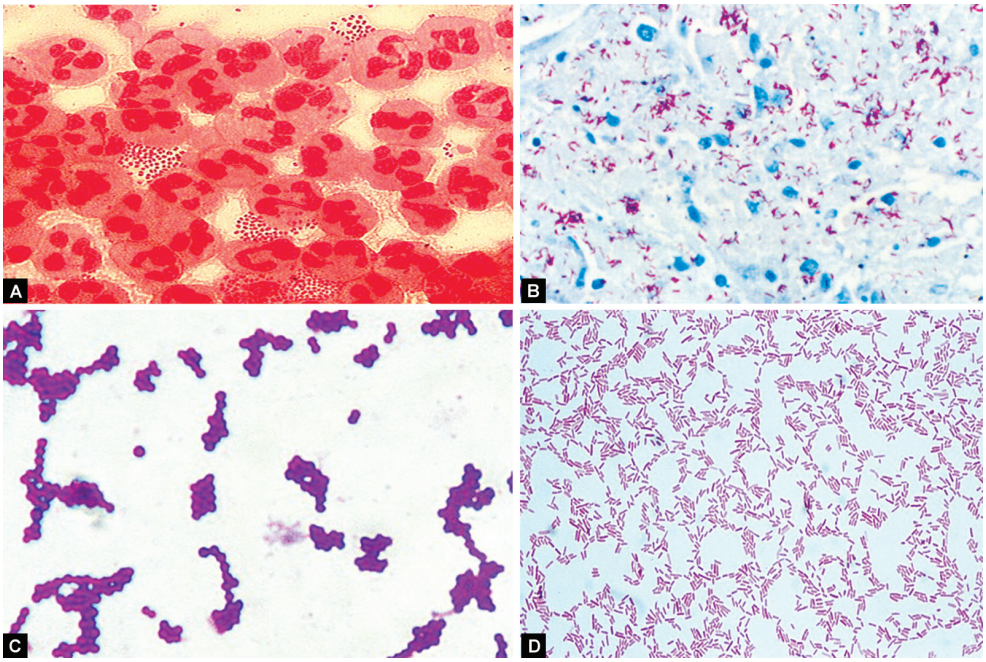
Q.8.*

1. Identify the slide A and B.
2. Write down the treatment for both A and B.

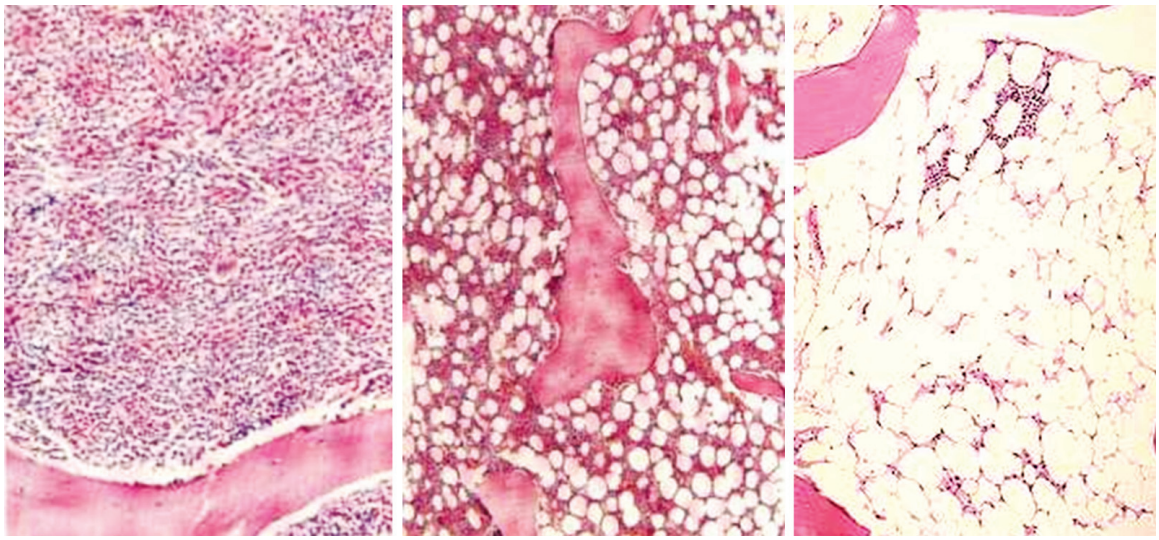


Q.9.*

1. Identify slide A, B, C and D.
2. Write down steps for gram and acid fast staining.



Q.10.* Comment on these 3 bone marrow examination slides on basis of cellularity and give 2 examples of type 1 and 3.



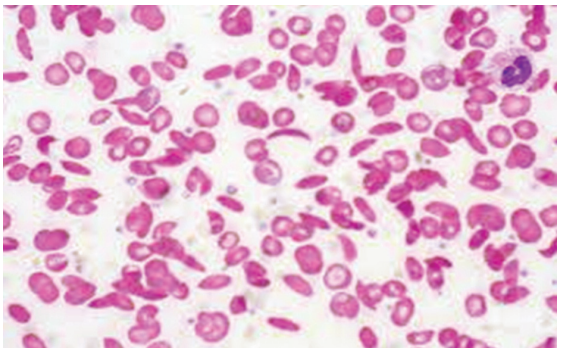
Q.11.* Exam 2014:

Match

1. Spur cell	A. Renal disease
2. Burr cell	B. Thalassemia
3. Target cell	C. Pernicious anemia
4. Cabot ring	D. G6PD deficiency
5. Bite cell	E. Myelofibrosis
6. Teardrop cell	F. Liver disease

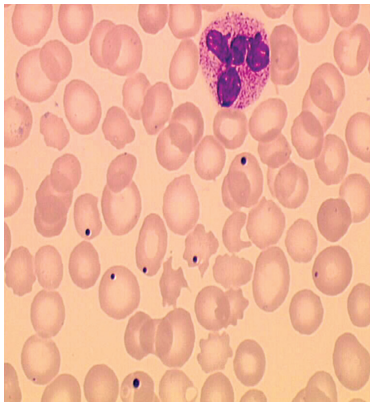
Q.12* Peripheral smear:

1. What is the diagnosis?
2. What is the drug of choice for the prevention of painful episodes?
3. What are measures for the primary prevention of stroke in these children?
4. What are the antibiotics of choice in acute chest syndrome?
5. What type of renal malignancy is common in this condition?



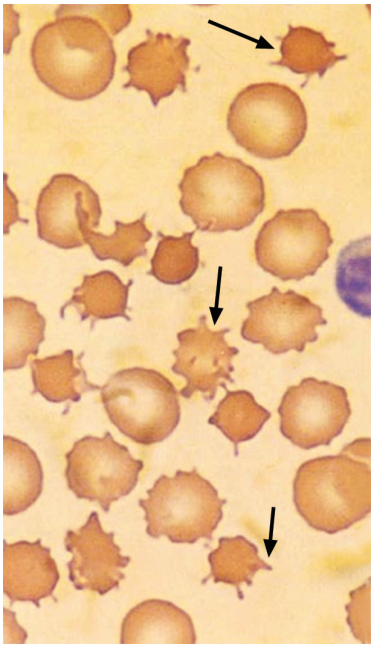
Q.13.* 1-year-old child with high fever and convulsions:

1. What does the smear show?
2. What association will you suspect in clinical examination with this blood film.
3. What is the likely cause of the symptoms?
4. Which organism is responsible?
5. How could you have prevented this infection?

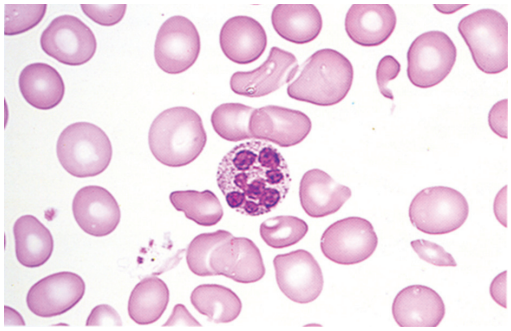


Q.14.* Exam 2013, 2014:

1. Describe the cells seen.
2. Name one condition each from following category in which these cells are seen:
   - Neurological
   - Metabolic
   - Hepatic
   - Endocrinal



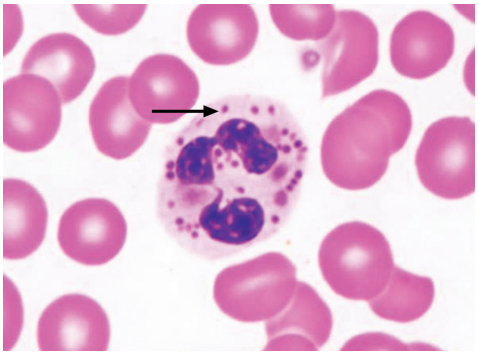
Q.15.* A 10-year-old girl presents with fatigue and tingling sensation from last one month, on examination pallor was presents with murmur, all other examination was normal, PBF is given below:



1. Describe this peripheral smear.
2. Diagnosis the condition and give 6 differential diagnoses of macrocyte.
3. Define this abnormality of neutrophil and write down 4 causes of it.

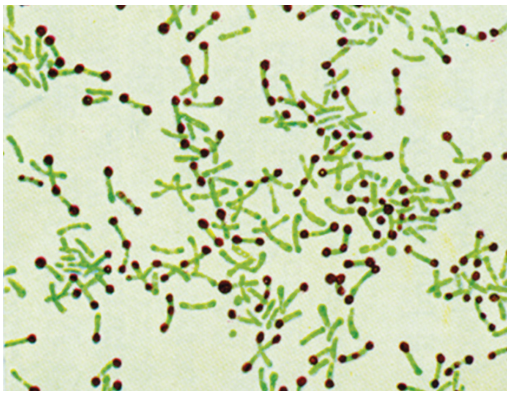
Q.16.*

1. Identify cell and write condition it is seen in.
2. What are clinical features of this condition?



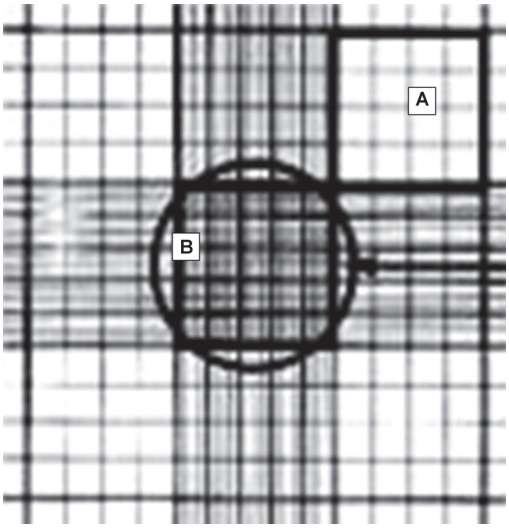
Q.17.

- An 8-year-old boy presented with pain in throat with difficulty in respiration 1 day. Throat examination showed palatal weakness with white patch on tonsil.
  1. Name two common complications in this situation.
  2. What is the name of stain in the slide?
  3. Write differential diagnosis of white patch on tonsil.



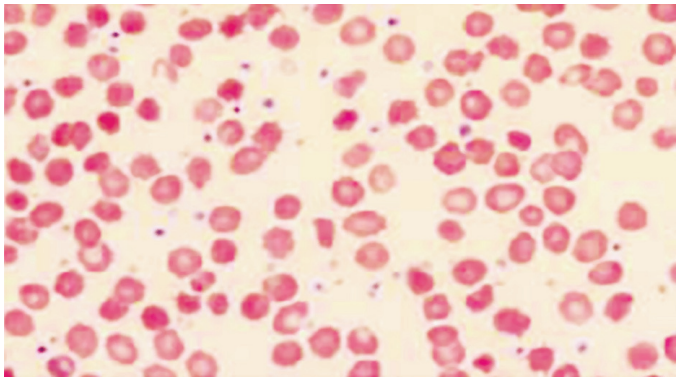
Q.18.

1. Name the spot.
2. What are these chambers used for A and B (blood cells)?
3. If doing CSF cytology for WBCs, which chambers are used for this purpose?



Q.19.

1. Identify the abnormality in RBC.
2. This child has chronic diarrhea with foul smelling stool. What is the possible diagnosis?
3. Which vitamin deficiency in these children is associated with neurological symptom?
4. Which lipid abnormalities are characteristics?
5. What is the fundus finding?
6. What is the mode of inheritance?



ANSWERS

Ans. 1. 1. Cabot ring
2. Lead poisoning
Pernicious anemia (vit B_{12} deficiency)
Hemolytic anemias

Ans. 2. 1. Basophilic stippling ** **this question can be asked along with X-ray knee of lead poisoning.**
2. • Thalassemia, vit B_{12} deficiency
• Lead poisoning
3. The desferal therapeutic index or porter index is defined as mean daily dose of desferrioxamine in mg/kg, divided by serum ferritin. This is useful in thalassemia patient.
• This is calculated every 6 months in paitents receiving desferrioxamine.
• Porter index should not **exceed 0.025 in order to minimize sensorineural hearing loss.**

Ans. 3. 1. Platelet satellitism: Platelet clustering around neutrophils in the presence of EDTA
2. Pseudothrombocytopenia
3. Repeat platelet count in citrate sample

Ans. 4. 1. Two macrophages are shown which have a fibrillar, crumpled appearing cytoplasm and eccentric nuclei, consistent with Gaucher cells. This seen in Gaucher disease.
2. Niemann-Pick, MPS (Mucopolysaccharidosis)
3. Enzyme replacement (60 µ/kg/m^2): Cerezyme (imiglucerase for injection) is indicated for long-term enzyme replacement therapy.

Ans. 5. 1. Blast cell: L_3 type—Burkitt's lymphoma
2. Age (>1 year, <10 years)
Hyperdiploidy
T 4:11 to 12:21
Low TLC at the time of diagnosis

Ans. 6. 1. LD bodies in bone merrow—kala azar
2. Diagnosis—bone merrow, NNN media culture (Novy McNeal-Nicolle Media)
3. Sodium stibogluconate—20 mg/kg/day for 1 month and amphotercin B 1 mg/kg/day for 1 month
New drug—pentamidine and amofostine

Ans. 7. 1. **The foamy appearing cell** with a small nucleus is a macrophage containing lysosomes filled with sphingolipid. The patient has Niemann-Pick disease
2. **AR disease**
3. Absence of **lysosomal sphingomyelinase.**

Ans. 8. 1. Trophozoites forms **Schuffner** stippling—*Plasmodium vivax*
2. *Plasmodium falciparum* with >80% infected RBC.
Treatment A—Chloroquine for 3 days with 14 days primaquine
B—Artesunate for 3 or 7 days with single day primaquine

Ans. 9. 1. A = Gm – cocci B = AF bacilli C = Gm + cocci D = Gm – bacilli
2. Gram staining

Ziehl-Neelsen technique
- Heat and dry. Fix the smear.
- Add strong carbol fuchsin
- Heat approximately for 5 mins. Do not boil.
- Decolorise the smear with 20% sulfuric acid
- Wash with water
- Counterstain with methylene blue

Steps of gram staining:
- Heat fixation of smear
- Apply crystal violet stain (primary stain)
- Flood with gram iodine for 10 sec
- Decolorise the smear with 95% ethyle alcohol
- Wash with water immediately
- Counter stain with basic fuschin/safranin for 15 sec

Ans. 10. 1. Hypercellular—megaloblastic anemia
2. Normal
3. Hypocellular BM—aplastic anemia

Ans. 11. 1. F, 2. A, 3. B, 4. C, 5. D, 6. E

Ans. 12. 1. **Sickle cell anemia.**
2. **Hydroxyurea.**
3. **Transcranial Doppler—blood velocity of ICA**
   Time averaged mean maximum blood flow (TAMM) is more than 200 cm/sec to maintain Hb S levels less than 30%
4. Third generation cephalosporin.
5. Renal medullary carcinoma.

Ans. 13. 1. Howell-Jolly bodies (nuclear fragments of condensed DNA)
2. Absence of spleen
3. Bacterial meningitis
4. *Streptococcus pneumoniae*
5. Pneumococcal conjugate vaccine

Ans. 14. 1. Acanthocytosis (spur)
2. Conditions

a. Neurological	Neuroacanthocytosis
b. Metabolic	Abetalipoproteinemia
c. Hepatic	Severe liver dysfunction
d. Endocranial	Hypothyroidism

Ans. 15. (Must know)
1. Macrocyte, hypersegmented neutrophil
2. Megaloblastic anemia

Macrocyte
Vit B_{12} deficiency, hypothyroidism, orotic aciduria, and aplastic anemia
Chronic liver disease, Diamond-Blackfan syndrome

3. Presence of one or more netrophil with 6 lobe or 5 or more cell with 5 lobe among 100 segmented nutrophils
   Causes—vitamin B_{12} deficiency, IDA, uremia, hydroxycarbamide treatment

Ans. 16. 1. Chédiak-Higashi cells in Chédiak-Higashi syndrome
2. Partial oculocutaneous albinism and recurrent infection

Ans. 17. 1. **Diphtheria**
2. Complications:
   - Myocarditis
   - Neuroparalysis
   - Both leading to hypoxia
   - Upper airway obstruction
3. Albert stain
4. Differential diagnosis:
   - Strep. throat
   - Exudative tonsillitis
   - Infectious mononucleosis

Ans. 18. 1. **Neubauer chamber**
2. A—WBC and B for RBCs and platelets
3. All 9 corners

Ans. 19. 1. Acanthocytosis
2. Abetalipoproteinemia
3. Vitamin E
4. Cholesterol
   - TGL
   - Absent B lipoproteins
5. Retinitis pigmentosa
6. Autosomal recessive

CHAPTER 8

Growth Monitoring

5 MARKS FIX ALWAYS**

Recommended X-ray for Bone Age

<1 year—knee, ankle

>1–12 years = left hand wrist

***Why left hand: Because available data is in left hand X-ray and right hand in children is more prone for injury.**

Bone Age

At birth baby have 5–6 ossification center at knee and ankle joint that's why we do knee X-ray or ankle at birth to know bone age.

Ossification centers for the distal femur, proximal tibia, calcaneus, talus—present at term birth (Fig. 8.1).

The rate of skeletal maturation is rapid in girls than boys

- 1–6 years there is different of 6 months.
- 6–12 years difference is one year.
- 12–18 years, it is 2 years.

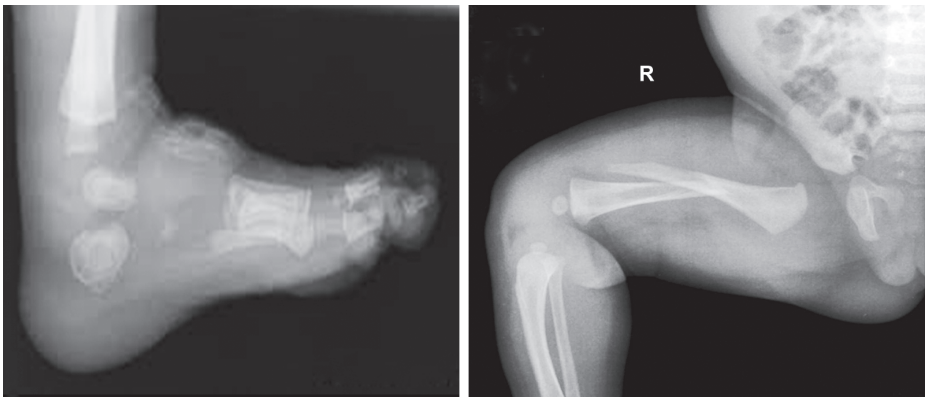
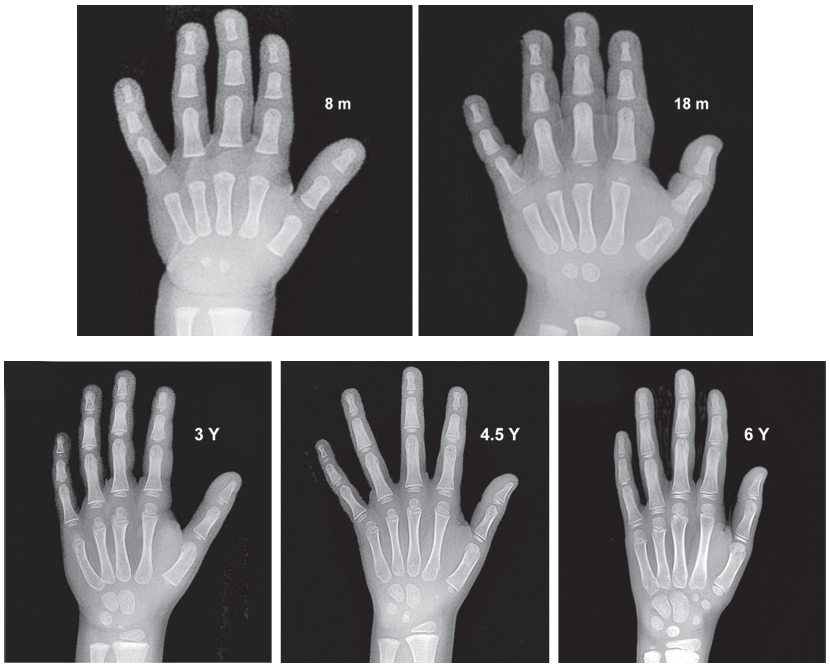


Fig. 5.1: Bone age at birth

Center of Ossification

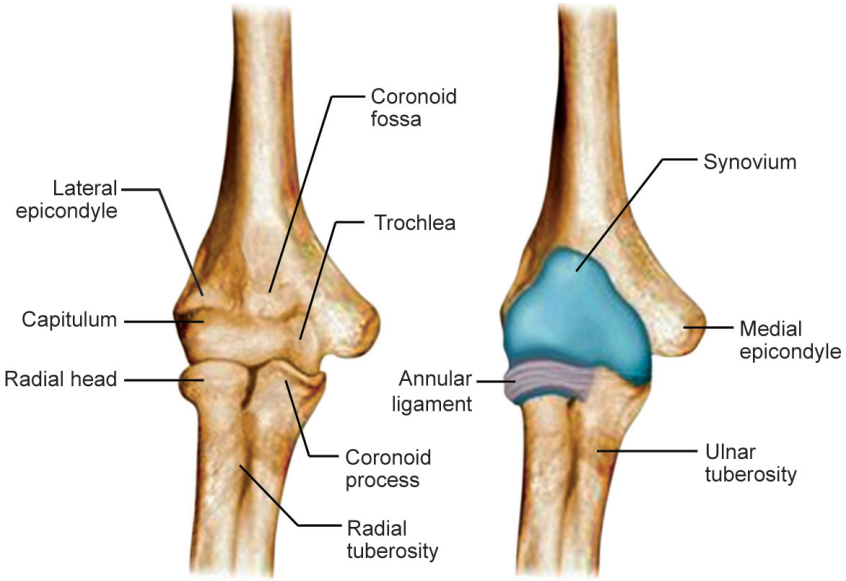
1. Capitate and hamate: 6 months
2. Appearance of ossification centers of radial epiphysis and proximal phalanx—1½ years

No. of carple bone – 1 = age of child



What is CRITOE? X-ray elbow.

- **CRITOE: C**apitulum: 1 year, **R**adial head: 3 years, **I**nternal epicondyle: 5 years, **T**rochlea: 7 years, **O**lecranon: 9 years, **E**xternal epicondyle: 11 years



Types of growth-charts

CDC (NCHS) chart 2–18 years

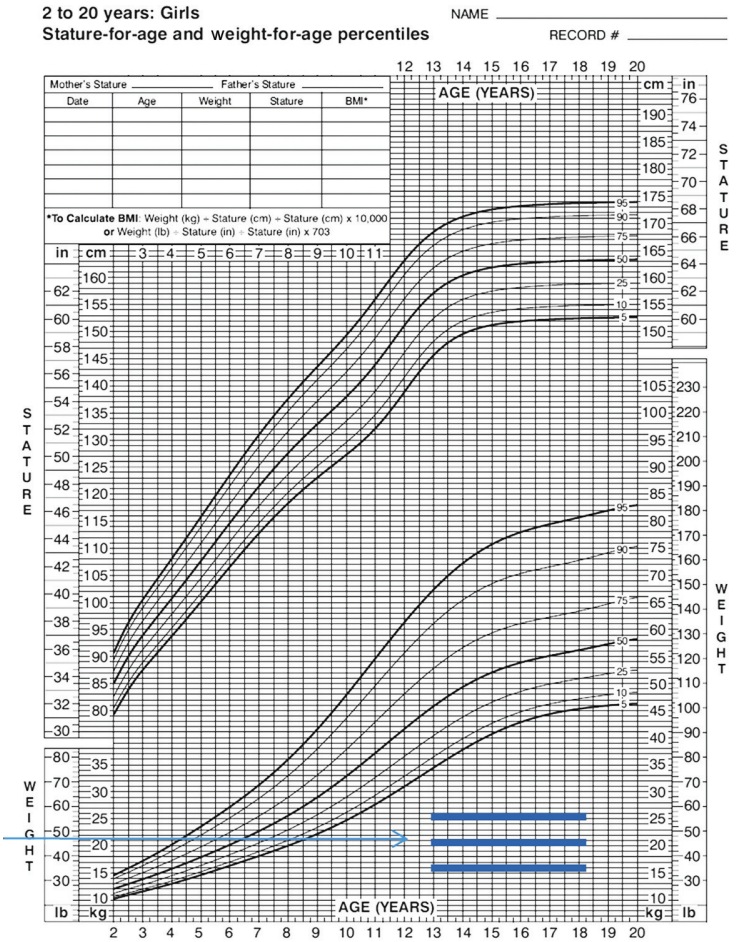
Weight + height 7 centile lines

95th/90/75/50/25/10/5th

3 SD extra band (0.4% percentile or centile)

Parameters to be plotted:

1. Name
2. Date
3. Age
4. Weight
5. Height
6. BMI
7. Mother and father (height)
8. Mid-parental height (MPH)
9. Tanner stage (in centile) (may be shown)



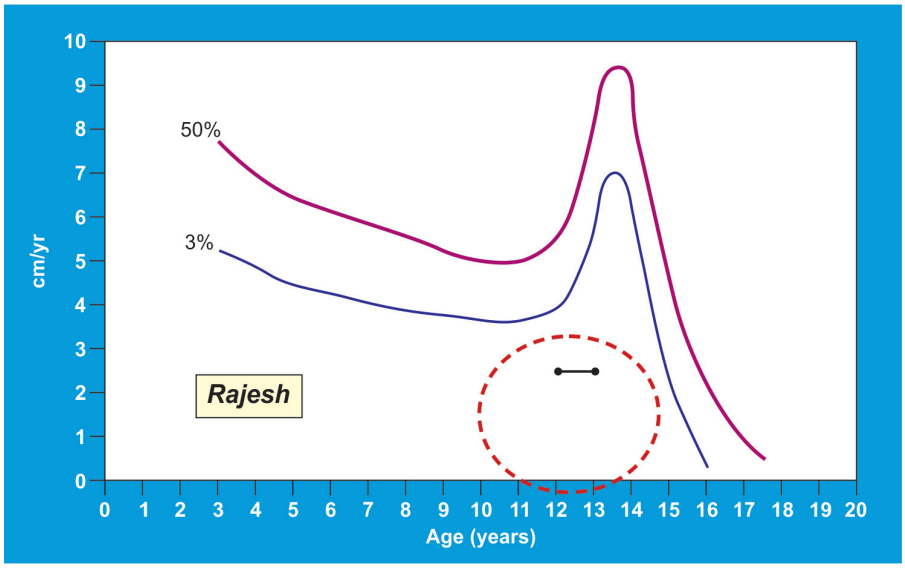
Velocity charts

2 reading at 6 monthly of 1 year apart

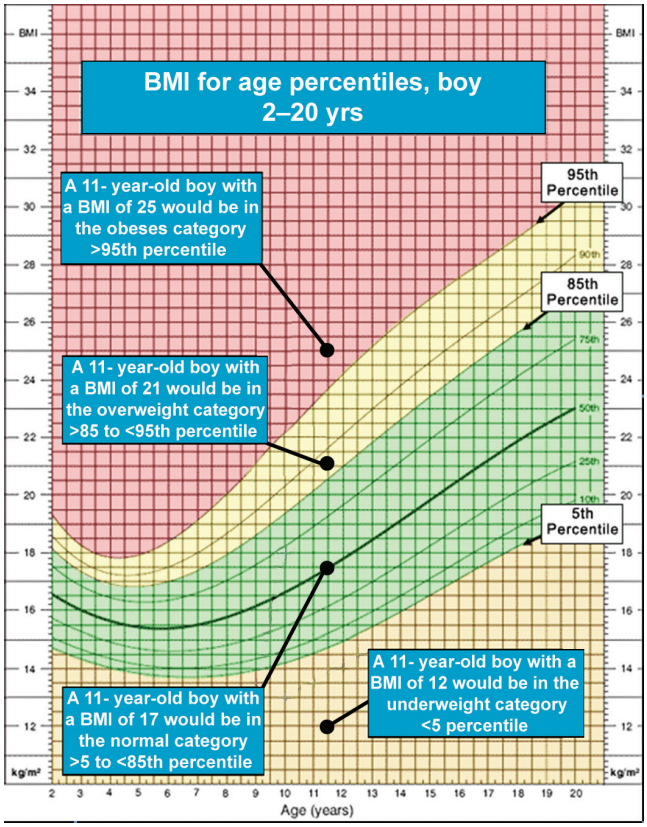
(X-axis): Age in year, **(Y-axis):** Rate = increase in **cm/year**

Lowest growth velocity: Pre-adolescence

Annual velocity: **<25 centile: Insufficient growth**
>75 centile: Crossing height centile upwards

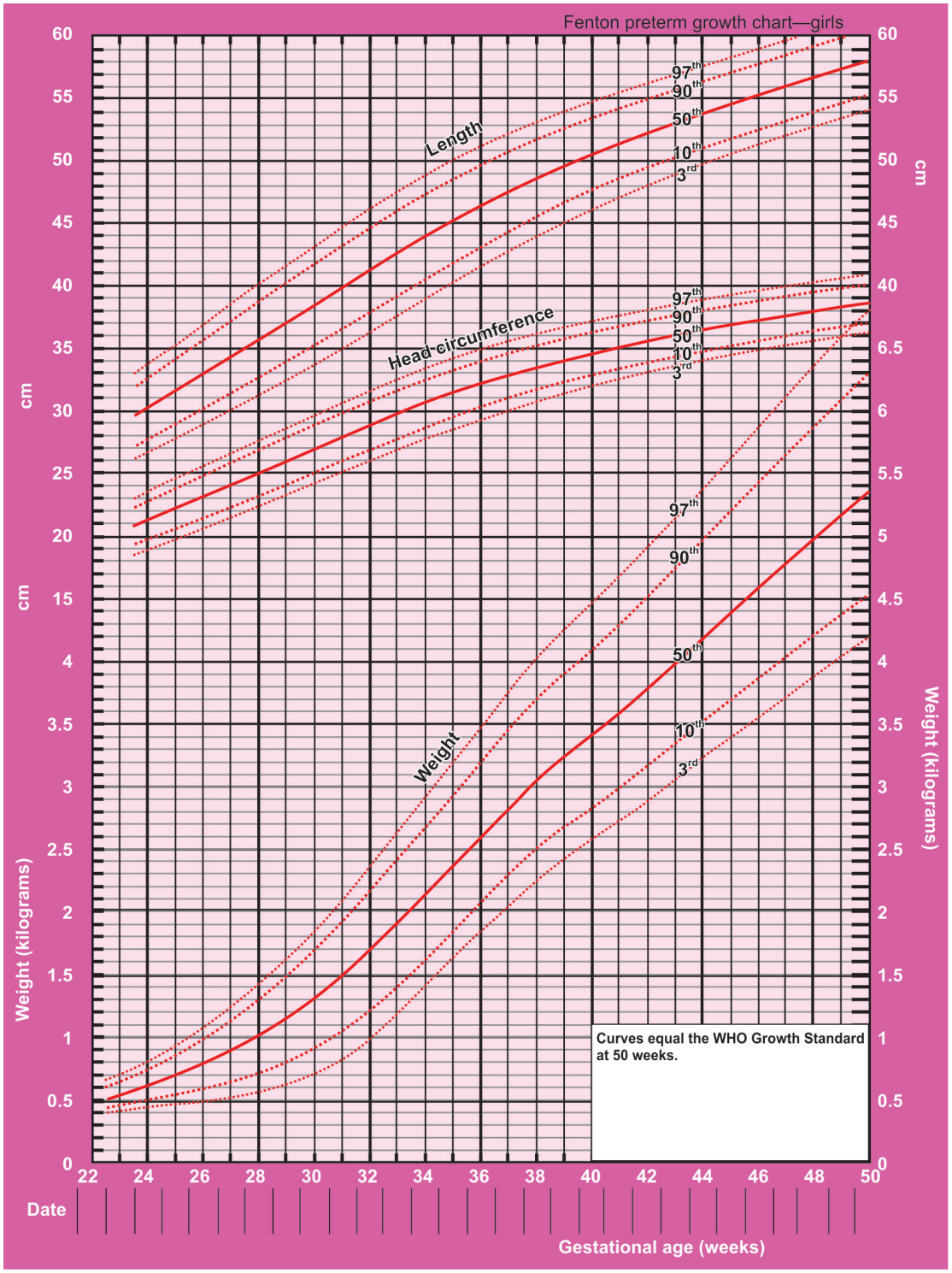


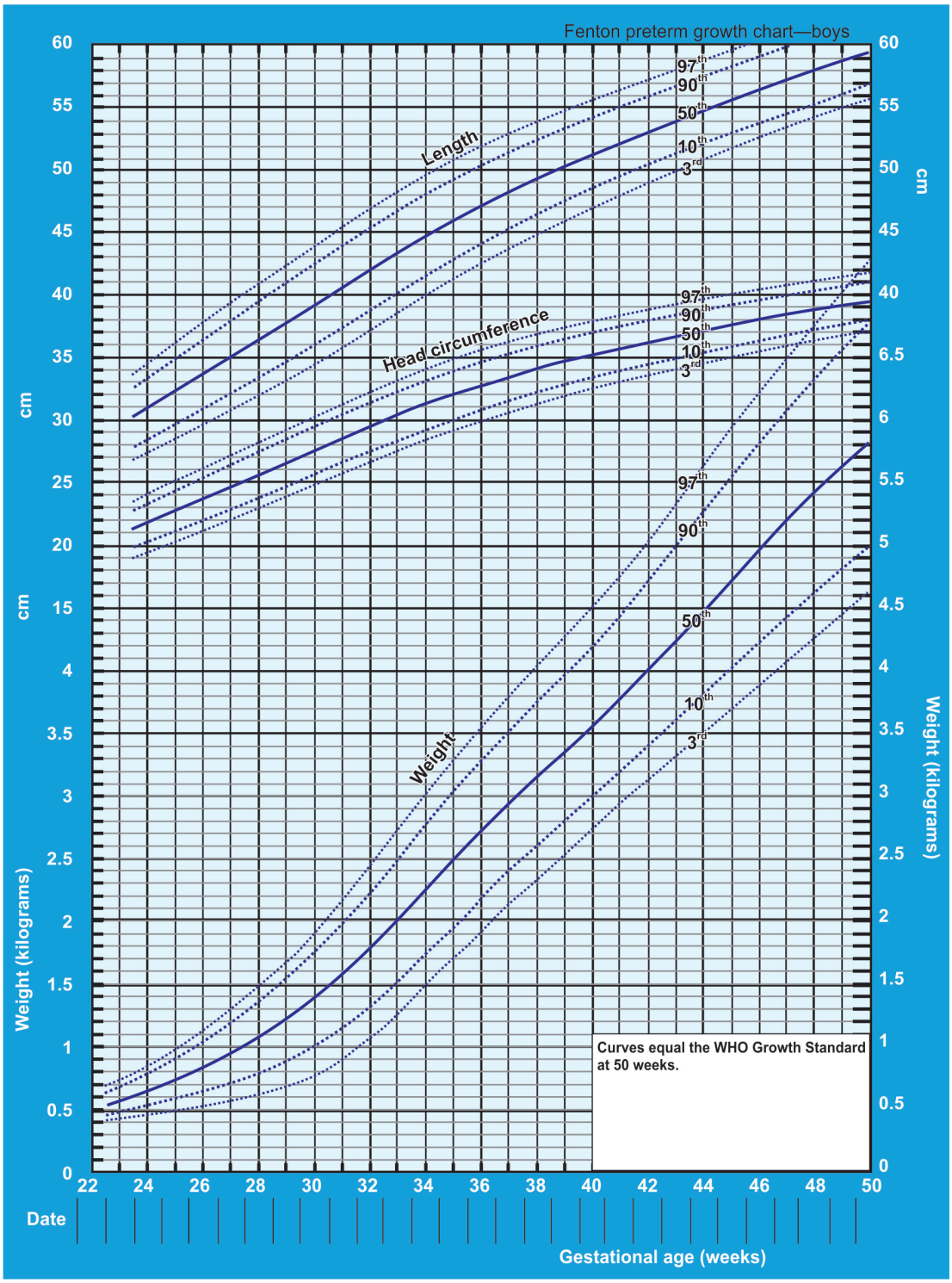
11-year-old boy: BMI
<5th percentile = undernutrition
between 5th and 85th = normal range
between 85th and 95th = overweight
between 95th and above 95th = obese



Preterm Growth Charts

Fenton intrautrine growth chart for preterm babies from 22 to 50 weeks.




Fenton preterm growth chart—boys
Length
Head circumference
Weight
97th
90th
50th
10th
3rd
cm
Weight (kilograms)
Curves equal the WHO Growth Standard at 50 weeks.
Date
Gestational age (weeks)

MPH/TMH/Target Range/Target Centile *(Very Important)

Mid-parental height (MPH) *or* **target mean height (TMH)**

$$\text{For boy} = \frac{\textbf{Father + (Mother + 13)}}{\textbf{2}} \qquad \text{For girl} = \frac{\textbf{Mother + (Father – 13)}}{\textbf{2}}$$

Mark this at 18 years (IAP)

1. **Target range**
   - Boys: MPH ± 8 cm IAP
   - Girls: MPH ± 8 cm IAP
   - Chart these range at "18 year"= **Target Range**
2. **Target centile**
   - Trace the corresponding centile lines to current age.
   - This is the **target centile**. It corresponds to 3rd and 97th centile for this child (growth potential).

When is it abnormal? When to refer for further studies?

1. Less than 3rd/more than 97th
2. Crossing two major centiles (downwards or upwards)
3. Child outside target centile.
4. **0–3 years**
   - (0–6 months) weight loss/no gain since birth
   - (6–12) no gain
   - Abnormal genitalia

3–9 years
- <5 cm/year
- >7 cm/year
- BMI (6 years onward) >85 centile
- **Puberty (early)**
  <8 years girls
  <9 years boys

9–18 years
BMI >85 centile
Puberty (delayed)
>14 breast develop
>15 menarche
>16 male puberty

Percentile Versus Deviation

- **Percentile:** Allows you to compare an attribute in a population on relative terms.
  - Example: 10th percentile value means 10% of sample/population are less and 90% are more than the given value.
- **Standard deviation:** It is a measure of central tendency.
  - It informs how much from the mean the given reading is deviating.
- Normal range: ± 2 SD = 3rd to 97th centile
- ± 3 SD = 0.2 centile on either side (total 0.4)

HOW TO SOLVE GROWTH CHART Q** VERY IMPORTANT

A. Short Stature

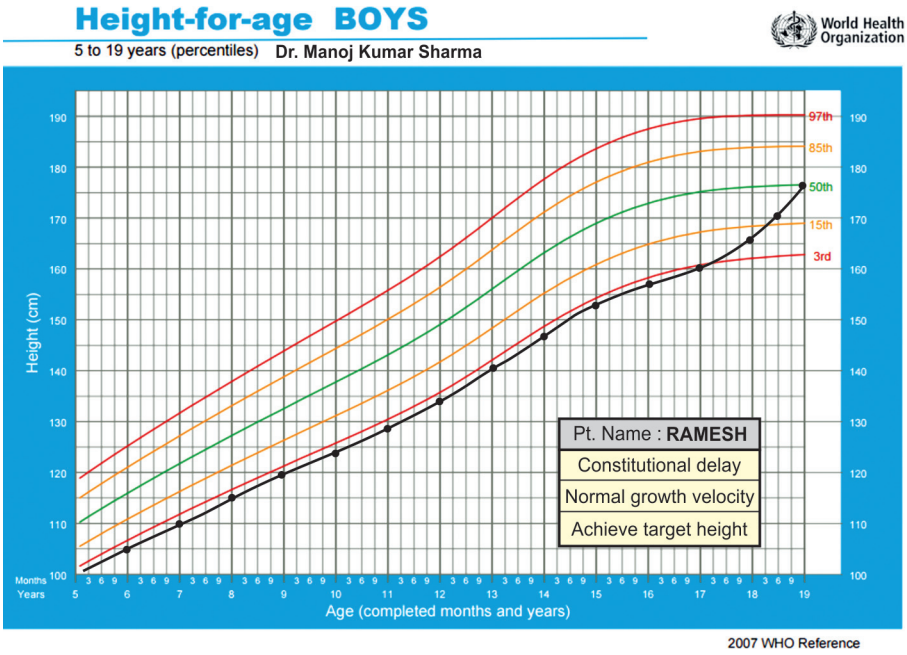
1. CA > BA = HA + normal GV = ***Constitutional delay**
2. CA > BA = HA + abnormal GV = All chronic disease (***celiac,** TB, CRF, asthma, CHD)
3. CA = BA > HA + normal GV = ***Familial** (genetic)
4. CA = BA > HA + abnormal GV = Chromosomal (***Down,** Russell silver, Turner) syndrome

B. Tall Stature

1. CA < BA = HA + normal GV = ***Obesity**
2. CA < BA = HA + abnormal GV = ***Precocious puberty, hyperthyroidism**
3. CA = BA < HA + normal GV = ***Familial**
4. CA = BA < HA + abnormal GV = Chromosomal ***(Marfan)** syndrome

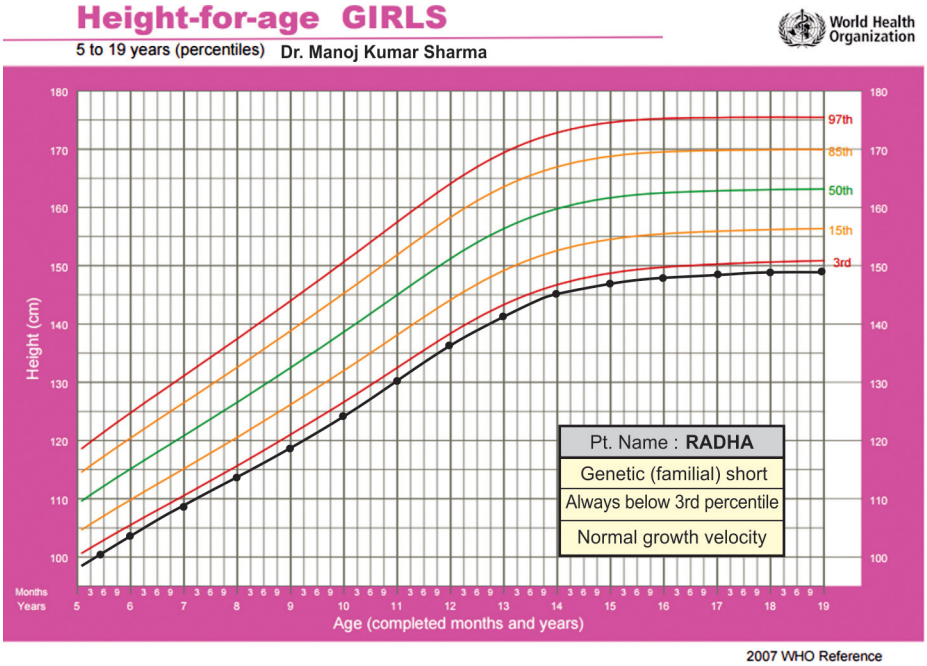
Constitutional Delay

1. MPH achieved, birth weight—normal and family history of delayed puberty.
2. Early deceleration, then normal growth velocity.



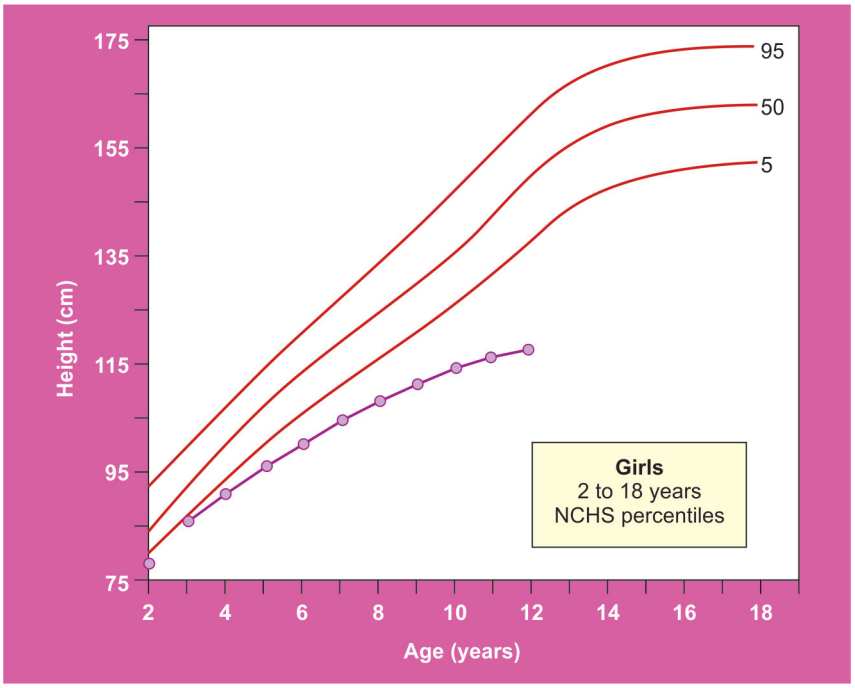
Familial (Genetic) Short Stature

1. Low birth weight and normal growth velocity.
2. MPH achieved and normal for family but short for population.



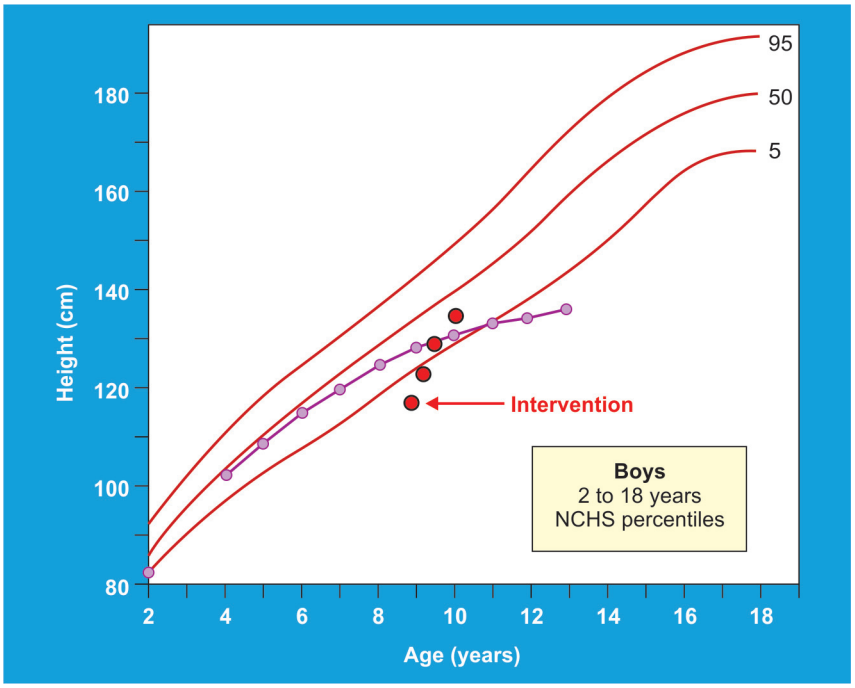
XO Karyotype (Turner Syndrome)

Persistent deviation from normal start from birth



Crohn's Disease and Hypothyroidism

Normal growth velocity till mid-childhood and later declaration



Patterns of Growth

1. Constitutional delay
2. Familial (genetic) short stature
3. XO karyotype
4. Crohn's disease

1. Early declaration, then normal growth velocity.
2. Short but constant growth velocity
3. **Persistent deviation from normal.**
4. Normal growth velocity later declaration

Assessing Growth Chart—Abnormal Weight Percentile

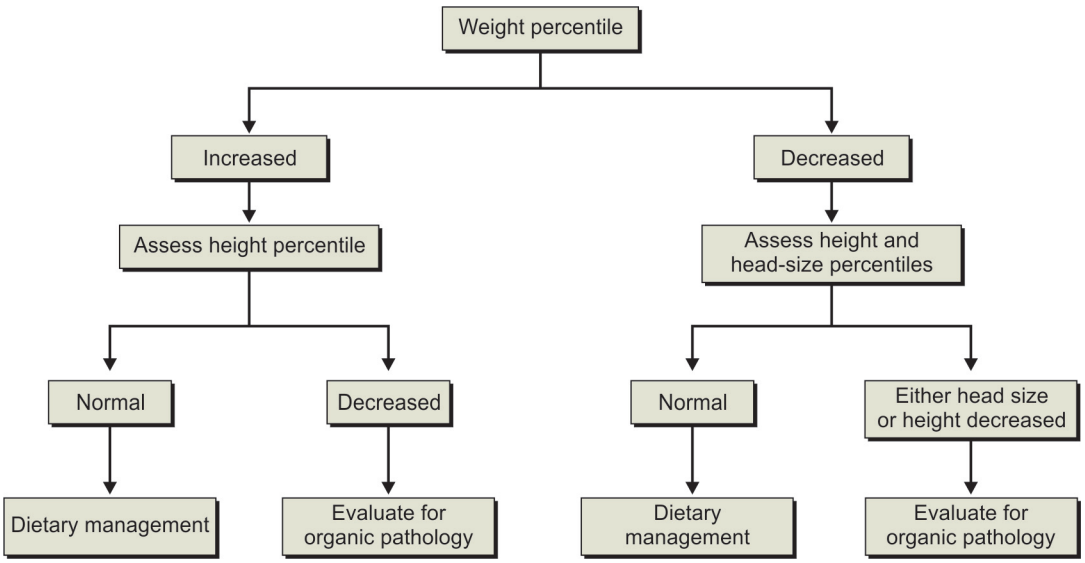
Common etiologies of weight disorders

A. Increased weight

- **Endocrine disorders**
  - Hypothyroidism
  - Excess production of cortisol (Cushing's disease)
  - Thalamic or pituitary disorders
- **Genetic disorders**
  - Down syndrome
  - Prader–Willi syndrome
  - Laurence–Moon syndrome

B. Decreased weight

- Undernutrition
- Hypothyroidism
- Failure of a major organ system (especially gastrointestinal, renal, pulmonary or cardiovascular)
- Crohn/gluten
- Lead intoxication
- Psychosocial deprivation



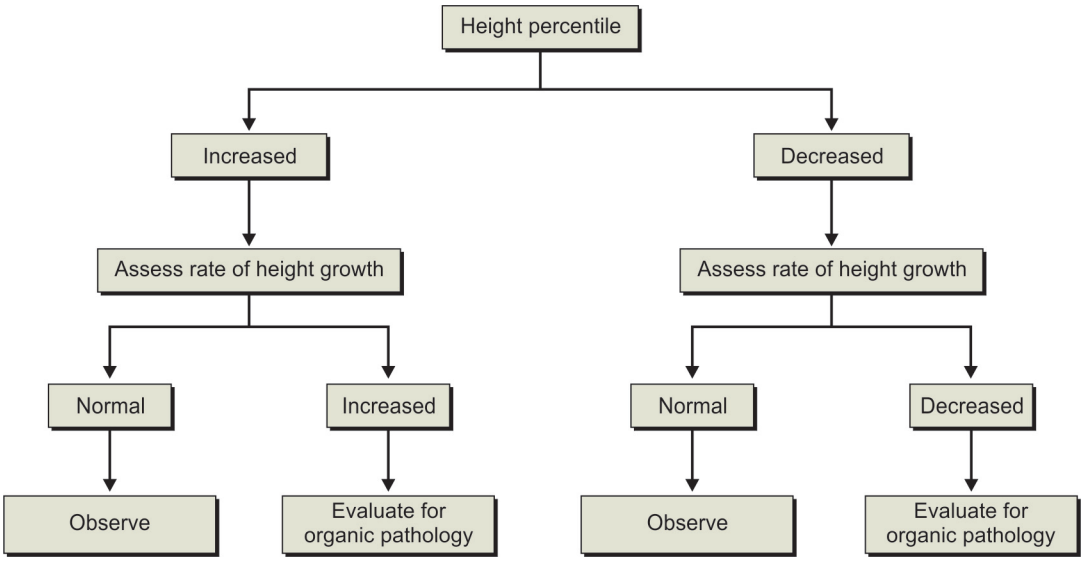
Assessing Growth Chart—Abnormal Height Percentile

A. Increased height

- Excess production of growth hormone
- Hyperthyroidism
- Klinefelter's syndrome
- Marfan syndrome
- Homocystinuria

B. Decreased height

- Growth hormone deficiency
- Hypothyroidism
- Chronic anemia
- Chromosomal disorders (Turner's syndrome)
- Failure of a major organ system (gastrointestinal, renal, pulmonary or cardiovascular)
- Skeletal dysplasia/rickets
- Psychosocial deprivation



Tranner's Staging

Boys—Development of External Genitalia

Stage 1: Prepubertal
Stage 2: Enlargement of scrotum and testes; scrotum skin reddens and changes in texture
Stage 3: Enlargement of penis (length at first); further growth of testes
Stage 4: Increased size of penis with growth in breadth and development of glans; testes and scrotum skin darker
Stage 5: Adult genitalia

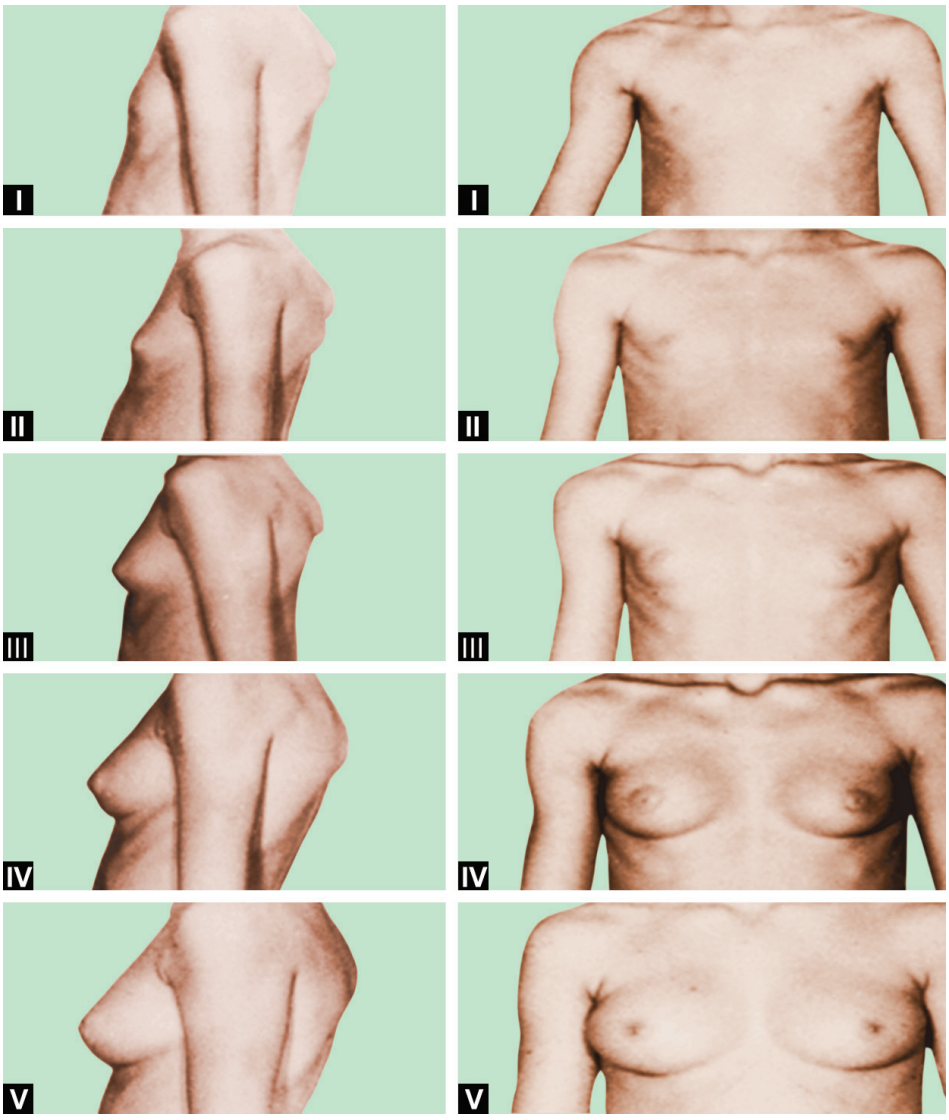
Girls—Breast Development

Stage 1: Prepubertal
Stage 2: Breast bud stage with elevation of breast and papilla; enlargement of areola

Stage 3: Further enlargement of breast and areola; no separation of their contour
Stage 4: Areola and papilla form a secondary mound above level of breast
Stage 5: Adult in type

Boys and Girls—Pubic Hair

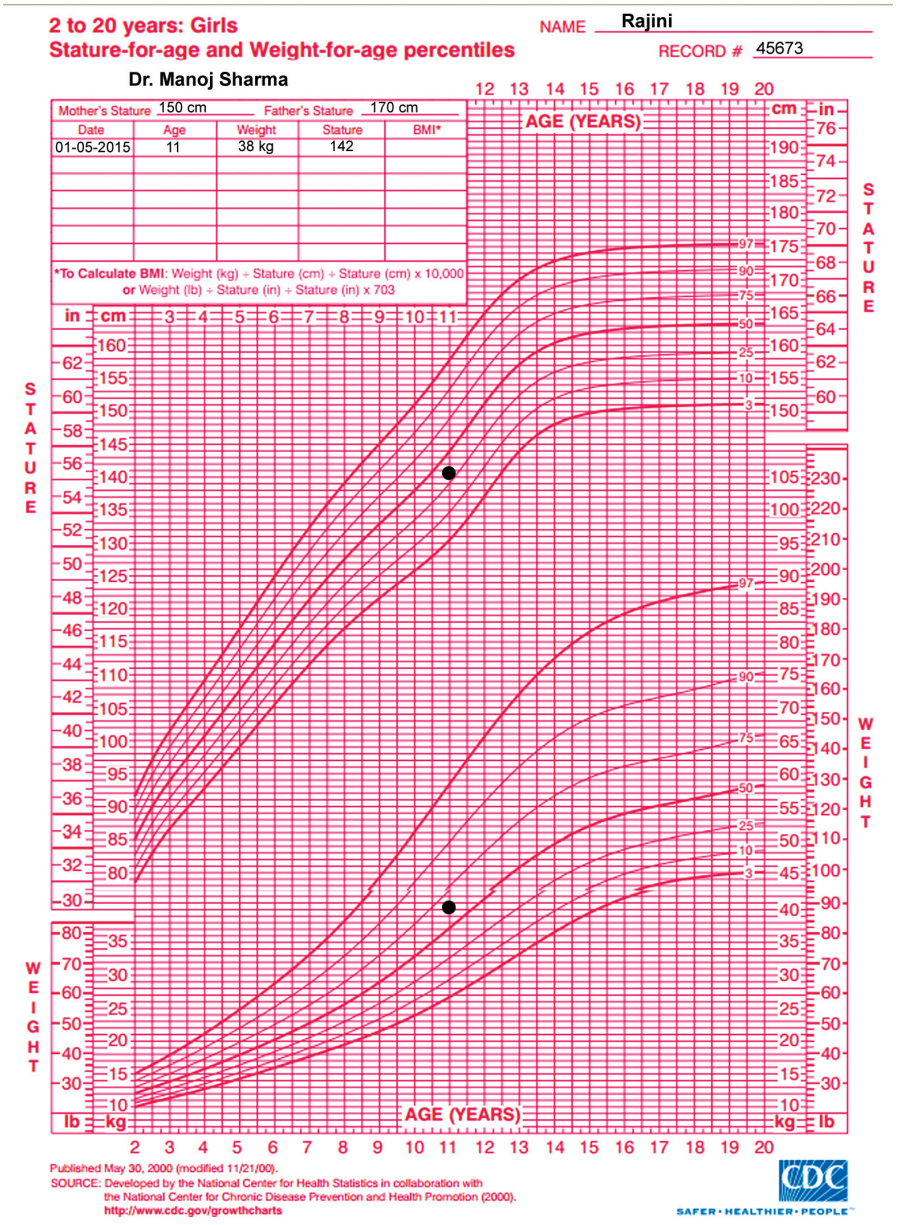
Stage 1: Prepubertal (can see vellus hair similar to abdominal wall)
Stage 2: Sparse growth of long, slightly pigmented hair, straight or curled, at base of penis or along labia
Stage 3: Darker, coarser and more curled hair, spreading sparsely over junction of pubes
Stage 4: Hair adult in type, but covering smaller area than in adult; no spread to medial surface of thighs
Stage 5: Adult in type and quantity, with horizontal distribution ("feminine")



EXERCISES

Q.1. In relation to growth charts:

1. Will the standards be applicable to all children?
2. What reference data should be used for children older than 5 years?
3. How will these new standards change current estimates of overweight (for 8 years old) and undernutrition (infancy) in children?
4. Which countries were involved in WHO MGRS study.
5. What is mid-parental height and target centiles?

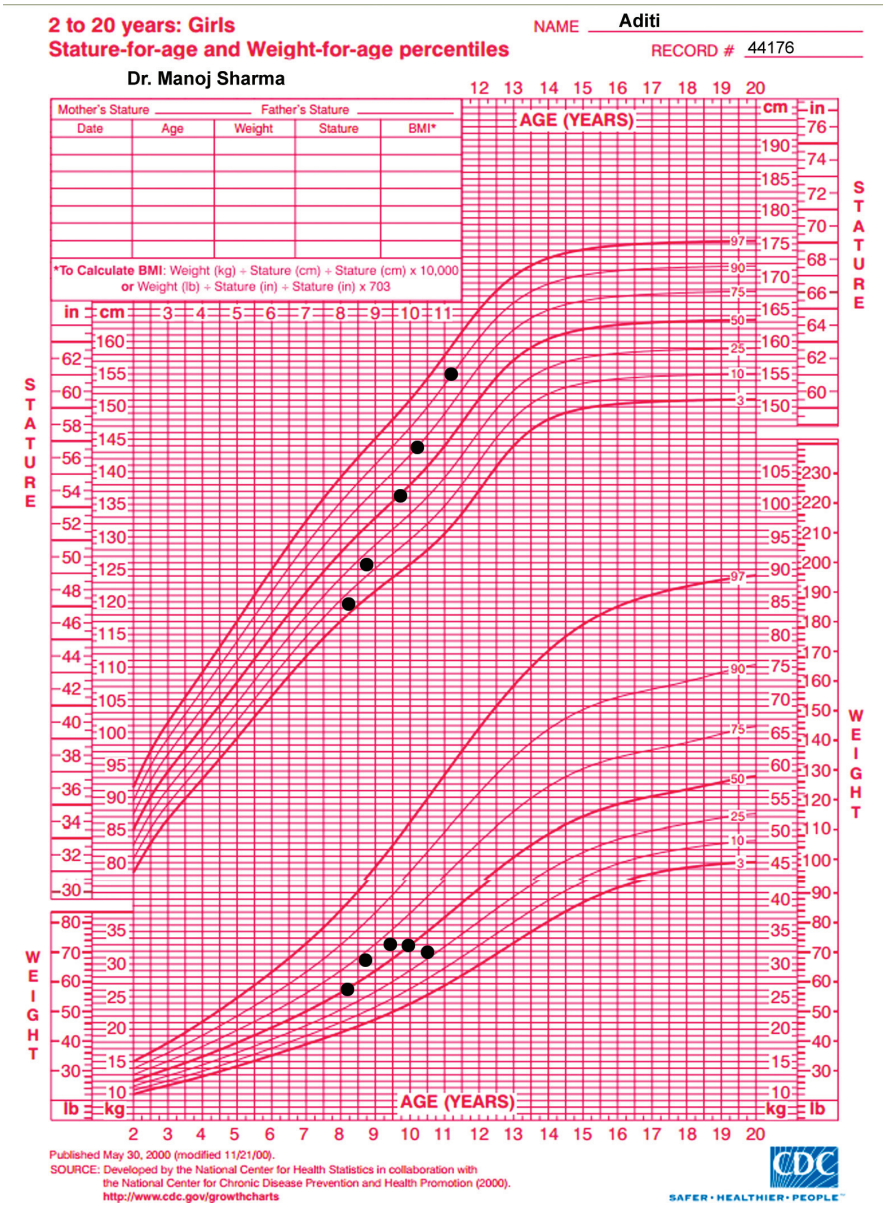


Q.2.* 10 years old Rajini, weight 38 kg and height 142 cm. Mother is 150 cm, father is 170 cm. Record this data: Calculate

1. MPH
2. Target range
3. Height age
4. Weight age
5. Ideal height
6. Stunted
7. Wasted

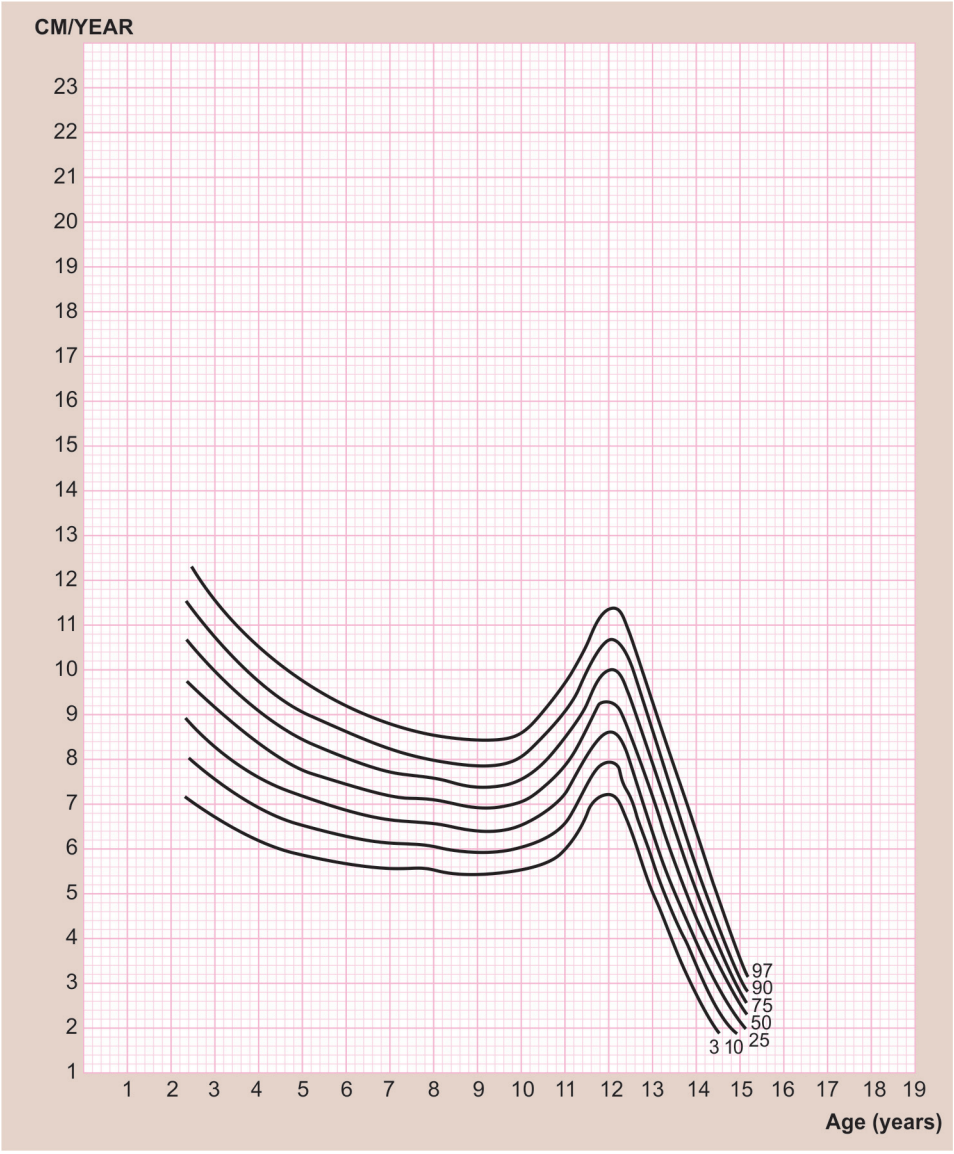
Q.3. 11-year-old female Aditi was brought with history of fever 2 days, caused by "viral pharyngitis". Her doctor after "routine" measurement of height and weight asked her to undergo certain tests:

1. Interpret the chart.
2. Likely diagnosis. Is this puberty?
3. Why this is not familial?
4. What investigations to confirm the clinical suspicion?



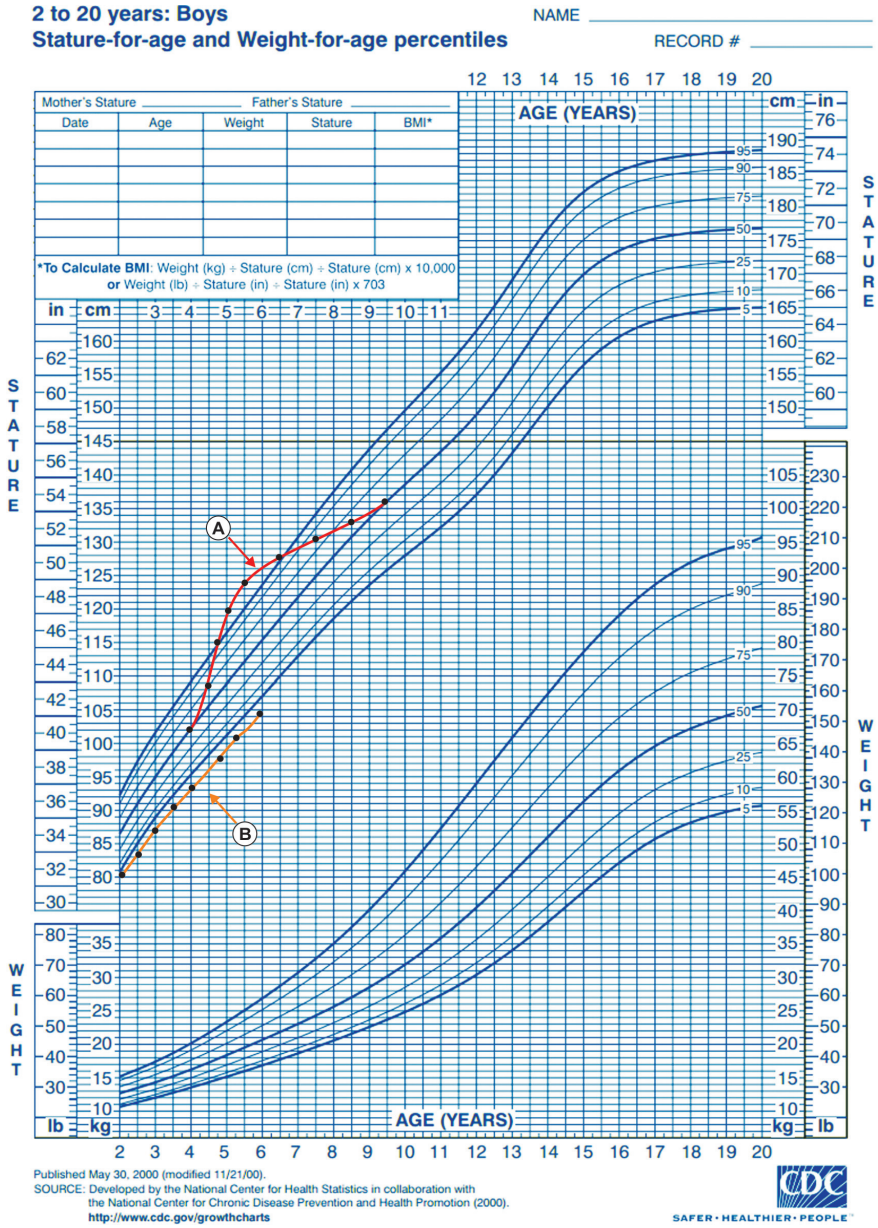
Q.4.*

1. What does this chart show?
2. How do you interpret the red lines?
3. Give the normal values for this parameter at different age groups.
4. What type of pathology do you think this child suffered from (give 2 examples)?



Q.5.*

1. In patient A, female, now age 11 years, what is your diagnosis? How do you interpret her growth chart?
2. Patient B, born with weight 2.3 kg and length 47 cm. His mother is 152 cm and father is 160 cm. Both do not have a skeletal dysplasia. What is your diagnosis? Give 3 points on which you base your diagnosis.

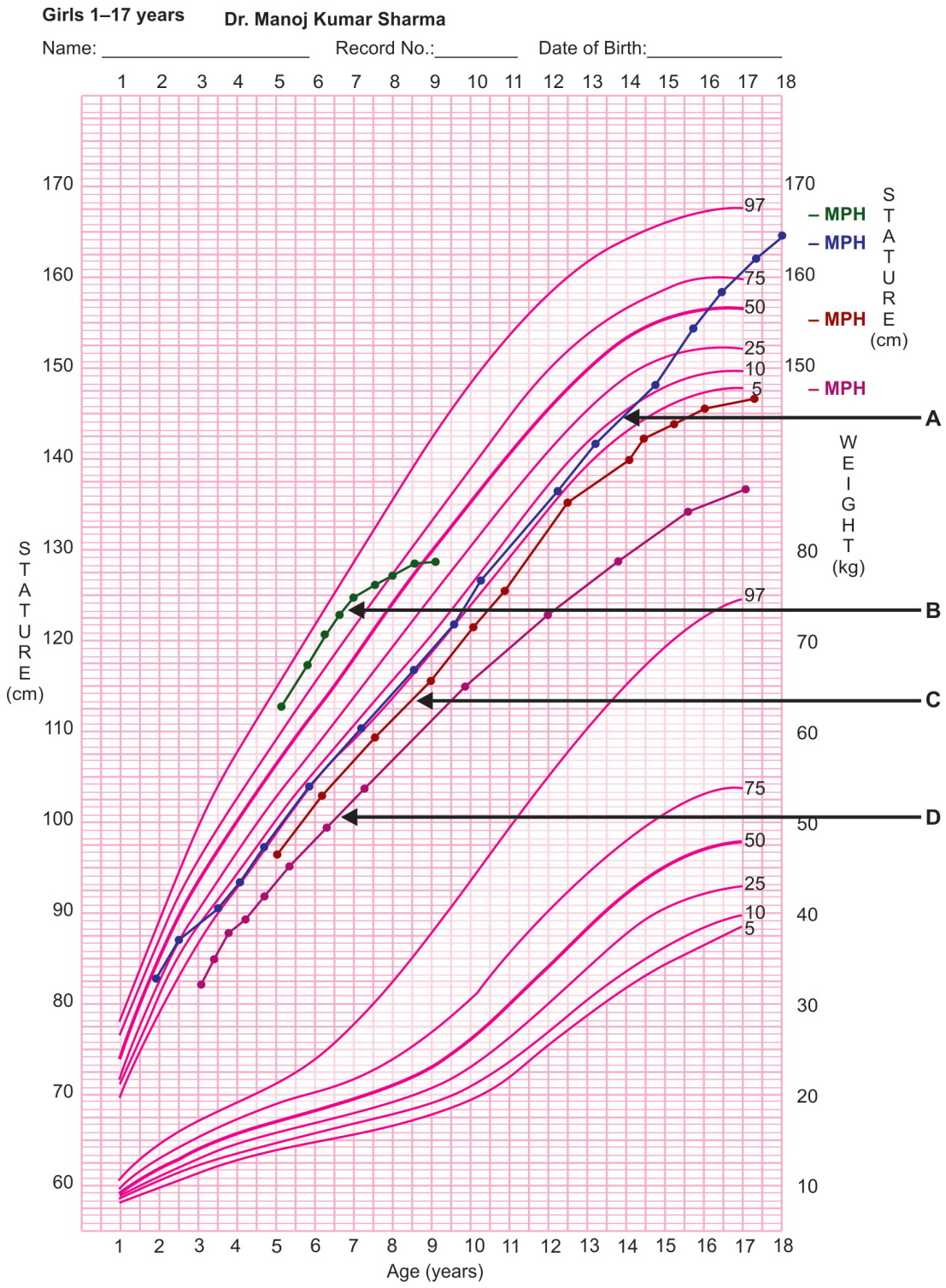


Q.6.*

1. Name this device and mention its use.
2. What do the individual numbers signify?
3. What you use if this device is not available during examination of a child with early puberty? And how you interpret the results?

Q.7.* Match

1. Construction growth delay
2. Familial
3. Hypothyroid
4. Turner



Agarwal growth chart for girls depicting typical growth patterns in familial short stature (—), constitutional delay of growth and puberty (—), Turner syndrome (—) and hypothyroidism (—)

Q.8.* May 2013:

Match the following in a child with short stature

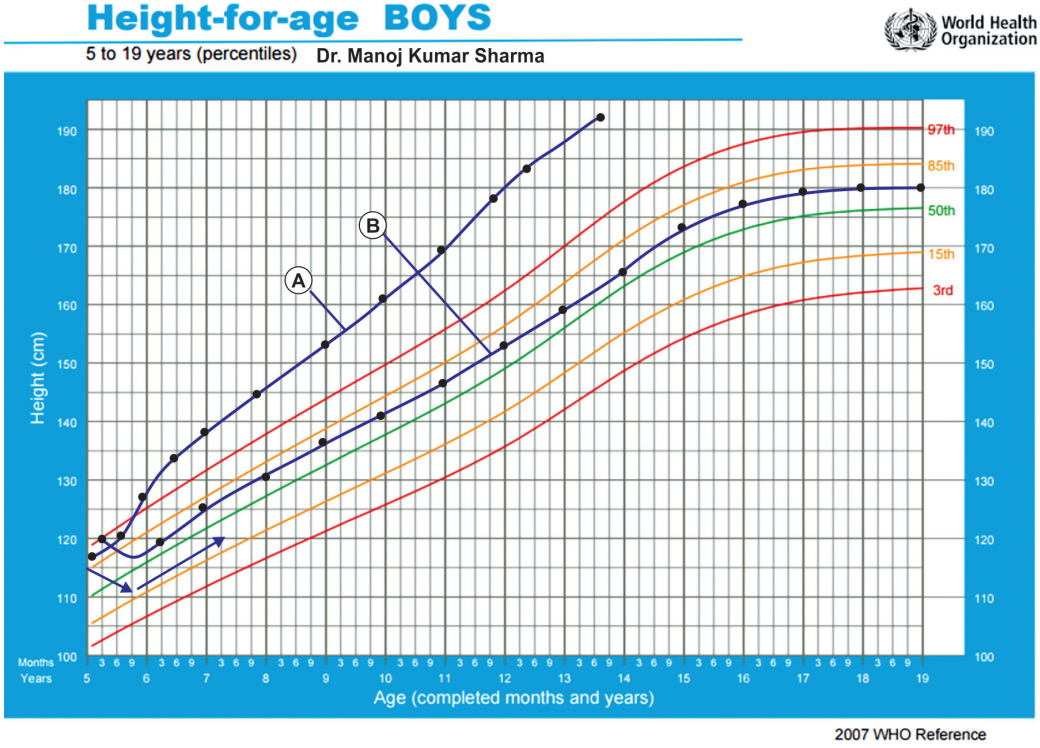
1. CA > BA = HA	A. Familial
2. CA = BA > HA	B. Celiac disease
3. CA > BA = HA + abnormal GV	C. Constitutional

Match the following in a child with tall stature

1. CA < BA = HA	A. Obesity
2. CA < BA = HA + abnormal GV	B. Precocious puberty

Q.9.*

1. Identify the chart.
2. What phenomenon is sought to be reflected in the sequential plot of values in this chart?
3. What does the arrow indicate? What is the significance of this?
4. What is difference between child A and child B?
5. How will the child A and child B be classified at 16 years age in terms of their BMI?

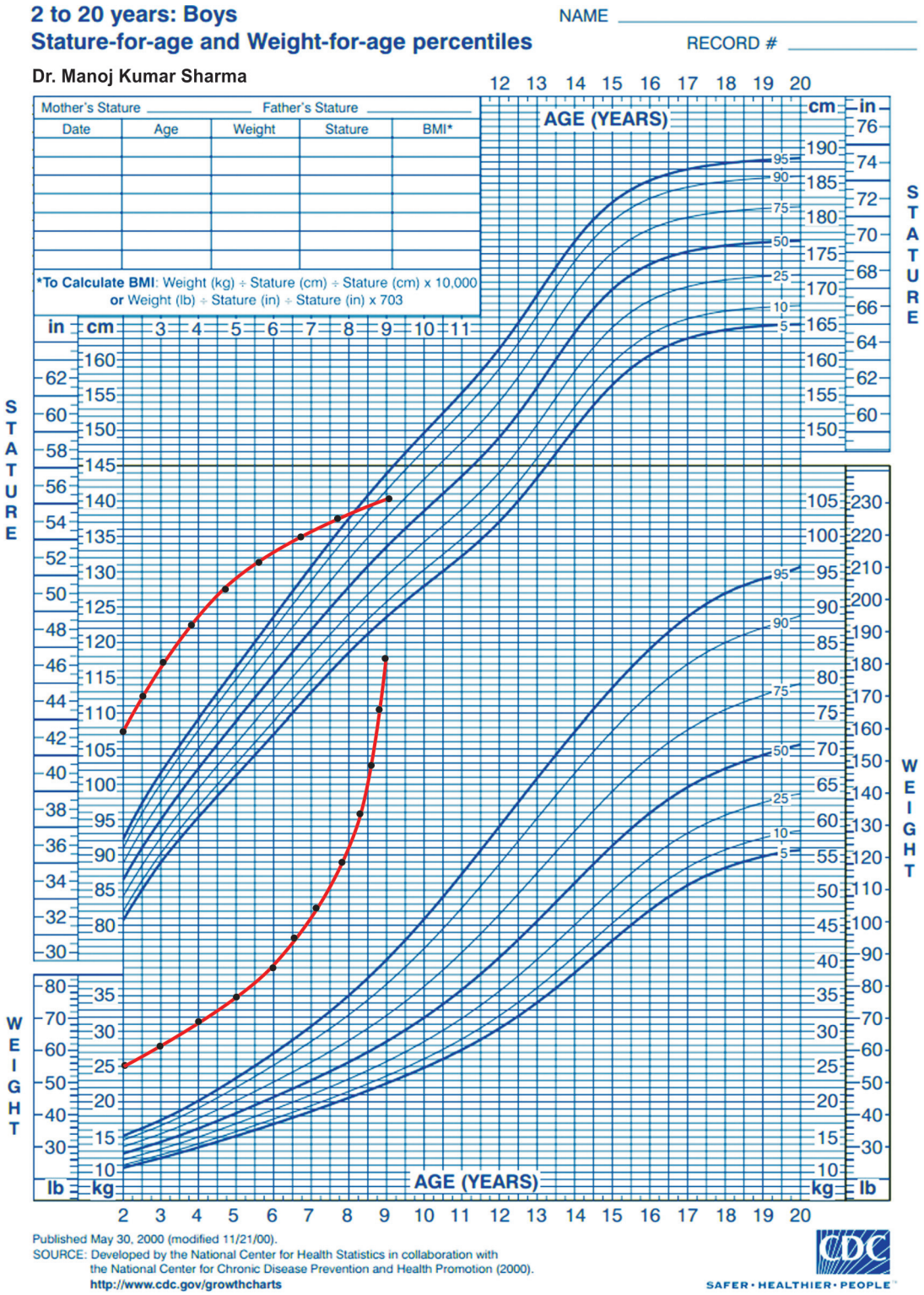


Q.10.*

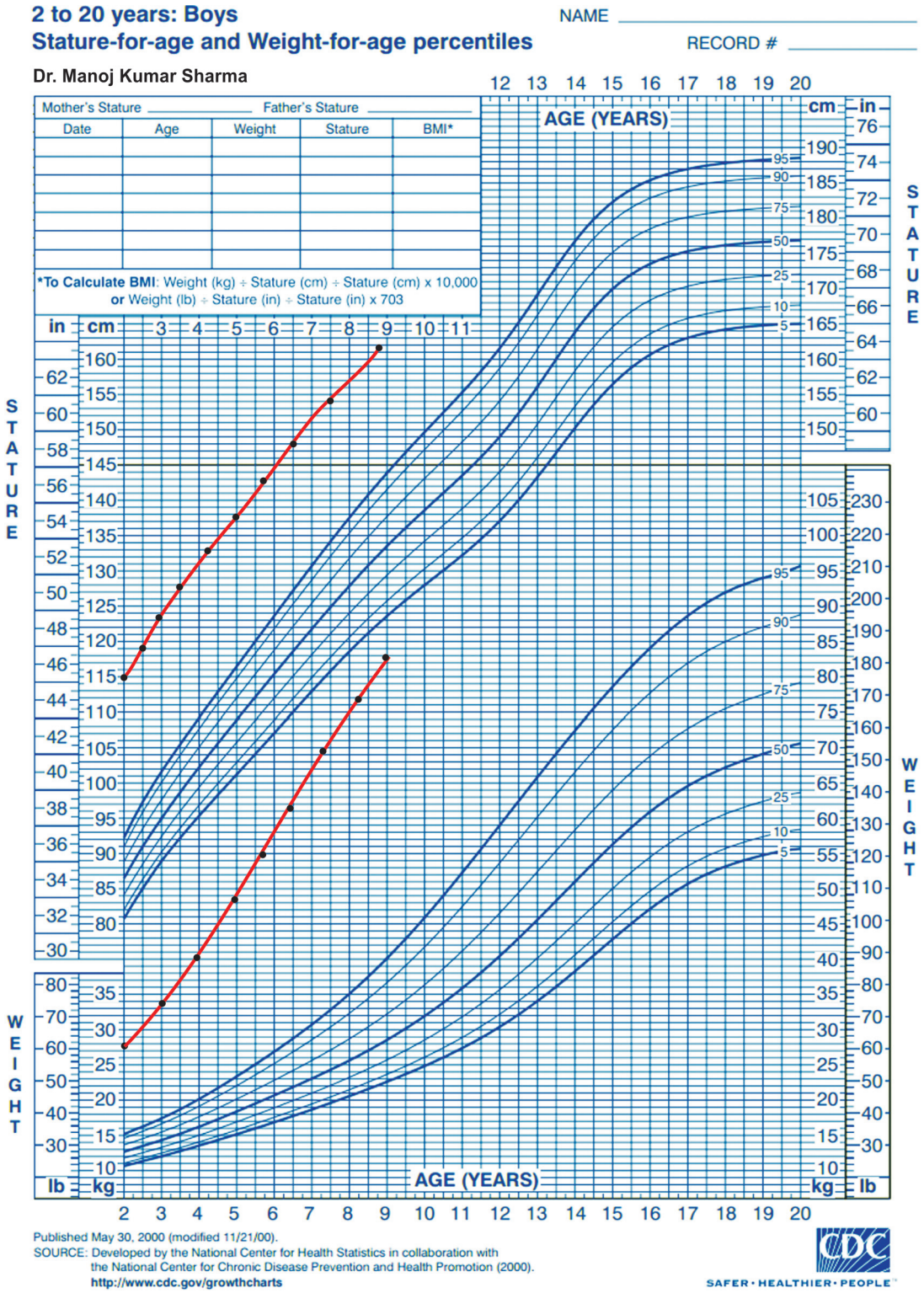
Study the growth patterns of child A and child B. Answer the following questions

1. Interpret the findings in respect of child A and child B and enlist them.
2. What condition can lead to the pattern seen in child A?
3. What is the commonest cause of the pattern seen in child A? Enlist 1 more condition which can result in a similar picture.
4. What is the basis of pattern seen in child B?
5. What will the weight-for-height plot show for child A.

Child-A


2 to 20 years: Boys
Stature-for-age and Weight-for-age percentiles
NAME
RECORD #
Dr. Manoj Kumar Sharma
Mother's Stature
Father's Stature
Date
Age
Weight
Stature
BMI*
*To Calculate BMI: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703
AGE (YEARS)
STATURE
WEIGHT
in
cm
lb
kg
95
90
75
50
25
10
5
Published May 30, 2000 (modified 11/21/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts
CDC
SAFER · HEALTHIER · PEOPLE

Child-B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NAME
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BMI*
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or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703
AGE (YEARS)
STATURE
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95
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SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts
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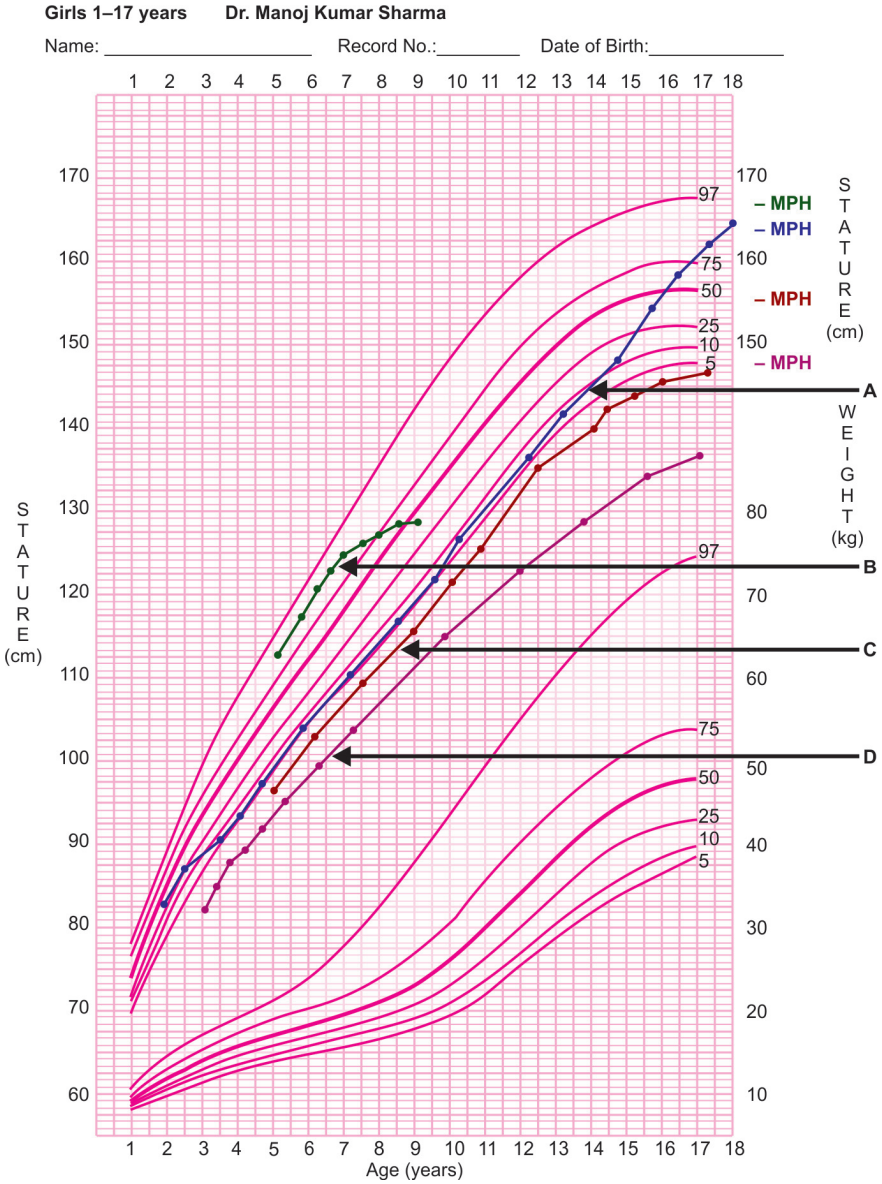
Q.11.* Growth assessment station:
This male child was born on 09 July 2000.

1. Assess the height and weight parameters of the child.
2. The fathers height is 168 cm and the mothers height is 158 cm. What is the child's expected adult height?
3. Does the child require evaluation for short stature or obesity? You are required to enumerate the steps of calculation.

Q.12.

1. Identify EACH of the growth patterns.
2. Write relation of bone age, height age and chronological age and growth velocity. w.r.t. each of the example.



Q.13. A below mention infant came to your OPD for routine visit. Mother want to know that her child is normal in development part of his growth of not. You examine the baby (See the images below). He is able to perform these activities but he is not able to drink from cup or use a spoon.

a. What are he doing in image A?
b. What is his possible development age?
c. What is important social milestone at this age?

ANSWERS

Ans. 1.
1. Can be applied to all children everywhere, regardless of ethnicity, socioeconomic status and type of feeding.
2. WHO Reference 2007 for boys and girls, 5–19 years.
3. Wasting rates will be substantially higher using the new WHO standards. With respect to overweight, use of the new WHO standards will result in a greater prevalence.
4. 6 countries representing different regions of the world: Brazil, Ghana, India, Norway, Oman, and the United States.
5. Boys: [(maternal height + 13) + paternal height]/2
   Girls: [maternal height + (paternal height – 13)]/2
   Chart these range at "18 years"= Target range

Ans. 2.
1. MPH: 166.5 cm
2. Target range: 158.5 to 174.5
3. Height age: 10 years
4. Weight age: 10 years
5. Ideal height: 140 cm
6. Stunted: No
7. Wasted: No

Ans. 3.
1. Increasing height centiles crossing two lines. Decreasing weight centiles.
2. Hyperthyroidism.
   Not pubertal spurt as weight loss is there.
3. Not genetic causes as growth velocity has increased (in genetic GV = Normal)
4. T_3/T_4/TSH.

Ans. 4.
1. Growth velocity chart
2. Sudden increase in growth velocity at age 7–8 years
3. Normal growth velocity (*see* the table below)
4. Precocious puberty and hyperthyroidism

Age period	*Gain in height*
0–12 months	25 cm
2nd year	12 cm
3rd–4th years	7 cm
>4 years—puberty	5 cm/year
12–13 years	10 cm/year

Ans. 5.
1. Child A was at normal GV till 5 years age but sudden increase in GV at 6–8 years age but again normal GV indicate some pathological conditions like precocious puberty or hyperthyroidism at this age but treatment was taken so again come in normal values.
2. Familial short stature, short parents, low birth weight, normal growth velocity.

Ans. 6.
1. Orchodometer, it is useful to know the testicular volume
2. Individual number are testicular volume
3. If orchidometer is not available, then we can use simple scale-rular
   <2.5 cm stage prepubertal (Stage-I)
   2.5–3.2 cm = Pubertal Stage-II

3.2–4 cm = Stage-III
4–4.5 cm = Stage-IV
>4.5 cm = Stage-V

Ans. 7. A-3, B-1, C-4, D-2

Ans. 8. *See* the text at beginning of the chapter.

Ans. 9.
1. CDC 2000 BMI-for-age percentile plot
2. Tracking of BMI from early childhood into adolescence
3. Adiposity rebound; early rebound associated with obesity
4. Earlier adiposity rebound in case of child A as compared to child B
5. Overweight (child A); risk for overweight (child B)

Ans. 10.
1. a. Child A: Decelerated linear growth with overweight
   b. Child B: Accelerated linear growth and increasing overweight
2. Corticosteroid excess
3. Iatrogenic steroids; Cushing
4. Exogenous/simple obesity
5. Increased weight-to-height ratio

Ans. 11. Introduces self and makes child comfortable
Calculate age of the child
1. Obtains accurate weight and height measurements (strips to underwear before weighing; Frankfurt plane for height).
   Selects the appropriate growth charts.
   Plots the height- and weight-for-age; weight-for-height.
   Interprets the percentiles for same for weight (wasting) and height (stunting), if any.
2. Calculate midparental height (father +mother)/2 (168 + 158/2 = 163 cm); expected height for child = midparental height + 6.5 cm (163 + 6.5 = 169.5 cm)
3. a. Check if height-for-age <3rd centile or difference between childs projected adult height and midparental height is more than 5 cm; if so the child needs to be evaluated for short stature
   b. Calculate BMI = weight (kg)/(height × height) (cm^2); plot on BMI-for-age chart for percentile of BMI; interpret <85th centile to >5th: Normal weight; no evaluation required for obesity; if >85th–94th centile: Risk for overweight; >95th centile: Overweight and needs evaluation.

Ans. 12.
1. Constitutional delay
   CA > BA = HA
   Normal growth velocity
2. Acquired growth failure (systemic), e.g. hypothyroid/PEM
   CA > BA = HA
   Abnormal growth velocity
3. Family short stature
   CA = BA > HA
   Normal growth velocity
4. Endocrine cause (e.g. Turner)
   CA = BA > HA
   Abnormal growth velocity

Ans. 13.
1. Pincer grip performing
2. 9–12 month (best answer is 9 month)
3. Stranger anxiety.

CHAPTER 9

Intensive Care

BURN CLASSIFICATION

- I degree: Swelling, erythema and pain
- II degree (partial): Blisters and pain
- III degree (full): Eschar without bleed or pain

ESTIMATION OF AREA

Rule of nine for age >14 years for children <14 years = Lund and Browder charts (*see* Nelson)

HEALING

- I degree: 2–5 days without scarring
- II degree: 5–21 days
- III degree: Grafting

EMERGENCY CARE

- Cover the area with clean dry sheet and apply cold compress in small injuries.
- Maintenance of airway, breathing and circulation.
- IV access for >15% of BSA.

INDICATIONS FOR PICU ADMISSION

- >10–15% of BSA of I and II degree
- III degree
- High voltage electricity burns
- Burns with smoke inhalation
- Suspicion of child abuse
- Hands, feet, perineum and face

PARKLAND FORMULA (FLUID RESUSCITATION) *MUST KNOW

First 24 hours: 4 ml/kg/% of BSA-RL
(half over 8 hours, half over 16 hours)
Next 24 hours: Half of first day requirement as RL in 5% dextrose

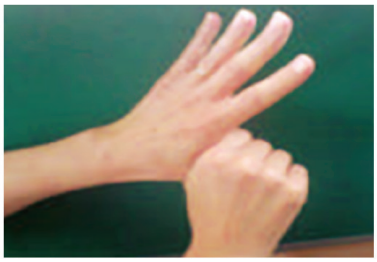
Handwash: For 2 minutes (each steps for 20 sec)

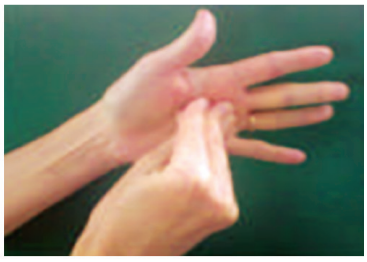

Rub palm to palm


Rub the back of both hands


Rub palm to palm interlacing the fingers


Rub the back of fingers by interlocking the hands

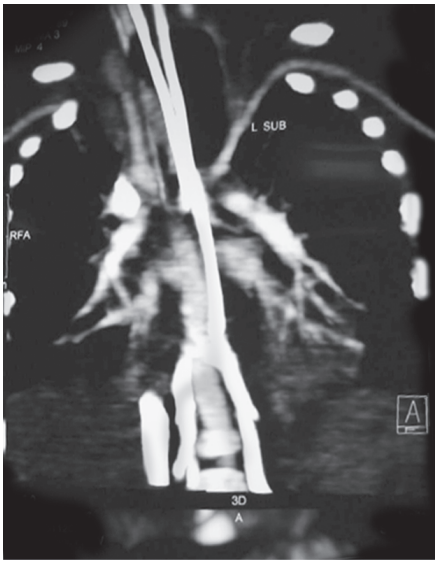

Rub the thumbs


Rub palm with fingertips

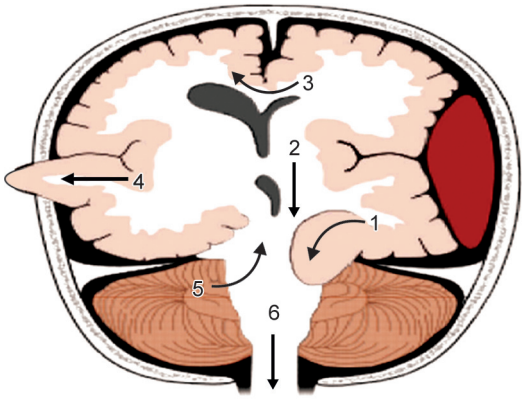
EXERCISE

Q.1.* A 3 months female child is admitted with history of recurrent episodes of respiratory distress on examination: Respiratory rate—70/min, suprasternal and subcostal retractions, bilateral reduced air entry, inspiratory and expiratory rhonchi CXR-bilateral hyperinflation:

1. Give your clinical diagnosis.
2. What is the CT scan suggestive of?
3. Enumerate initial steps of management.
4. Definitive treatment.



Q.2. In view of herniation of brain



Identify the numbers

Q.3.

- A 3-year-old male child is admitted in PICU with status epilepticus. He is on ventilator and on midazolam infusion at 10 µg/kg/min since last 3 days. He is seizure free and maintaining good blood pressure but is still very obtunded.
- ABG shows a pO_2 120 mm Hg, pCO_2 18 mm Hg, and pH 7.1.
- Laboratory tests reveal the following: Na: 138 mEq/L, K: 4.0 mEq/L, Cl: 96 mEq/L, HCO_3: 10 mEq/L, glucose: 80 mg/dl (4.4 mmol/L), and BUN: 4 mg/dl (1.1 mmol/L).
- Serum osmolality is 346 mOsm/kg.
  i. What do you think is the metabolic disorder in this child?
  ii. What is the cause of this metabolic disorder?
  iii. What is the supporting evidence for the diagnosis?
  iv. Mention other causes of similar metabolic disorder.

Q.4.* State which of the following situations would be expected to lower a patient's arterial pO_2. There may be none, one, or more than one correct answer:

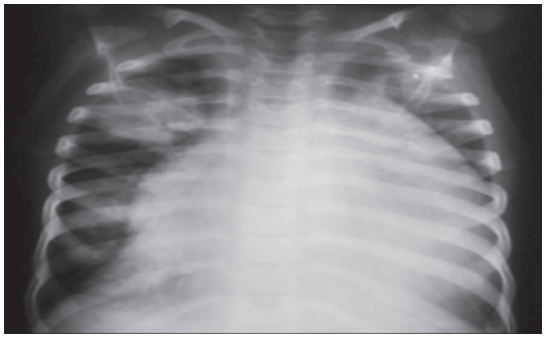
a. Anemia.
b. Carbon monoxide poisoning.
c. An abnormal hemoglobin that holds oxygen with half the affinity of normal hemoglobin.
d. An abnormal hemoglobin that holds oxygen with twice the affinity of normal hemoglobin.
e. Lung disease with intra-pulmonary shunting.

Q.5.* Which patient is more hypoxemic, and why?

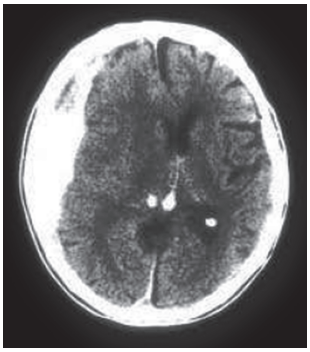
Patient A	*Patient B*
pH: 7.48	pH: 7.32
$paCO_2$: 34 mm Hg	$paCO_2$: 74 mm Hg
paO_2: 85 mm Hg	paO_2: 55 mm Hg
SaO_2: 95%	SaO_2: 85%
Hemoglobin: 7 g%	Hemoglobin: 15 g%

Q.6.*

1. Identify the chest X-ray.
2. What is the acute emergency therapy? Mention the technique.
3. Give the indications for the same.



Q.7.* A 12-year-old female presents after head injury, GCS, HR 60/min, irregular respiratory, normotensive with CT scan shown

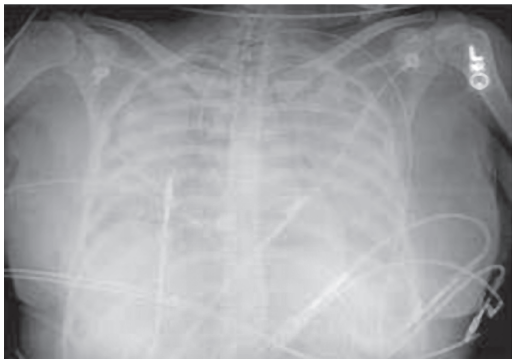


1. Identify the CT scan.
2. Immediate management.
3. Further management.
4. What is the most common electrolyte disturbance associated with above patient?

Q.8.*

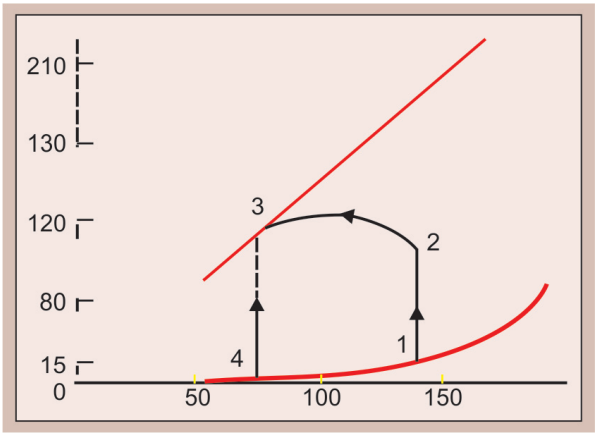
- A 6-year-old female child comes with history of progressive weight loss over the last several months, polydipsia and oral thrush. Now she has complaints of severe breathlessness, abdominal pain and vomiting.
- O/E-dehydrated, acidotic, urine sugar and ketones are 4^+
  1. What is your diagnosis?
  2. What is the therapy in the first hour?
  3. After 8 hours of treatment her K^+ report comes as 2.8. What actions will you take?
  4. What are her risk factors for developing cerebral edema?
  5. What are the mortality predictors in this condition?

Q.9.* Identify the CXR and give the diagnostic criteria for this condition.



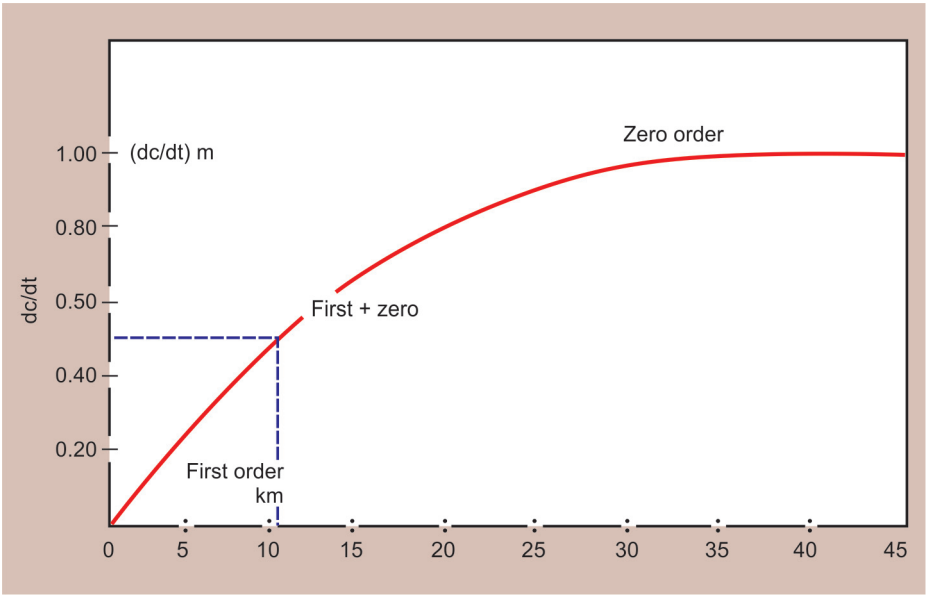
Q.10.*

1. Identify the diagram.
2. What does the X-axis and Y-axis stand for?
3. What does the numbers denote?



Q.11.*

1. What does the graph suggest?
2. Define zero order and first order kinetics.
3. Give example of drug following both types kinetics in dose dependent manner.

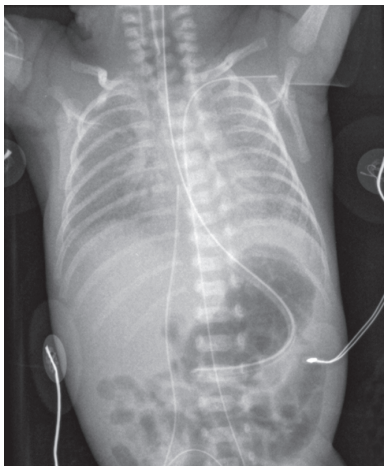


Q.12.*

1. A 4.5-year-old child on therapy for all has relapsed and had very high WBC counts (58000).
2. Following first cycle of reinduction child has following parameters WBC: 21900, Uric acid: 9, LDH: 2600, Ca: 7.6, PO_4: 8, and acidosis with K^+ of 6.8.

3. What is the diagnosis?
4. Mention the doses of fluid, HCO_3 and allopurinol.
5. What will you monitor?
6. What is the choice of dialysis?
7. Mention newer modality of treatment with its mechanism.

Q.13.*

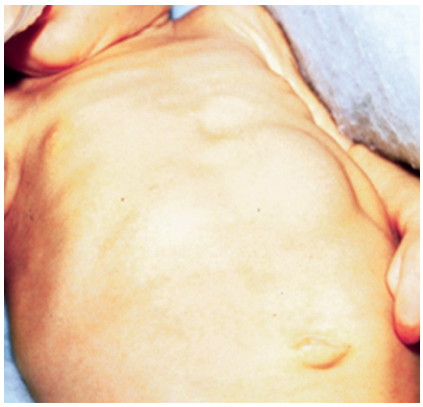


1. What is abnormal in this X-ray?
2. What is the ideal position of placement of umbilical arterial and umbilical venous line?
3. After putting in a UA line, the right lower limb appears pale. What would you do?
4. What is the level of the renal artery?
5. How do you maintain a UA line?

Q.14.* A 5-year-old child is caught in a house fire and brought to ER with 60% burns. His weight is around 16 kg:

1. What is the immediate complication likely to occur in this case and how will you identify this complication?
2. What are the 4 most important steps in the management of this child?
3. Write fluid therapy for first 24 hours for this child.

Q.15.* May 2013



A mother in pediatric emergency room states that her one-and-half month baby has been vomiting everything he eats for 2 weeks. The vomit contains no bile or blood, birth history was normal. Physical examination reveals a hungry dehydrated infant:

***Vital signs*: HR: 200; RR: 36; BP: 75/palpable; T: 37.6°C; weight: 3.7 kg. Infant is given a bottle and the following finding was noted during the physical examination:**

1. What is your diagnosis?
2. What will be the ABG findings in this child?

Q.16.*

1. Define reactive NST.
2. What is the definition of CLD?
3. What is permissive hypercapnia?
4. Enumerate Bell's staging for NEC.
5. What is threshold ROP?

ANSWERS

Ans. 1.
1. Intrathoracic upper airway obstruction
2. CT-vascular sling around the trachea causing extrinsic compression
3. Position, sedation, oxygen, intubation under anesthesia with the smallest ET available
4. Definitive cardiovascular surgery to remove the sling.

Ans. 2. Supratentorial herniation
1. Uncal
2. Central (transtentorial)
3. Cingulate (subfalcine)
4. Transcalvarial infratentorial herniation
5. Upward (upward cerebellar or upward transtentorial)
6. Tonsillar (downward cerebellar)

Ans. 3.
1. Metabolic disorder—high anion gap metabolic acidosis.
2. Propylene glycol—used as the vehicle for midazolam.
3. High osmolal gap (346–282 = 64).
4. Other differentials—methanol, ethylene glycol, salicylate toxicity, other drugs which contain propylene glycol—phenytoin and melphalan.

Ans. 4. Only (e) lung disease cause low pO_2
a. Affects only content, not oxygen saturation or pO_2
b. Through d. affect only oxygen saturation and content, not pO_2

Ans. 5.
- The body needs oxygen molecules, so oxygen content takes precedence over partial pressure in determining degree of hypoxemia. In this problem the amount of oxygen molecules contributed by the dissolved fraction is negligible and will not affect the answer. Also, the $paCO_2$ and pH are not needed to answer the question.
- Patient A: Arterial oxygen content = .95 × 7 × 1.34 = 8.9 ml O_2/dL
- Patient B: Arterial oxygen content = .85 × 15 × 1.34 = 17.1 ml O_2/dL
- Patient A, with the higher paO_2 but the lower hemoglobin content, is more hypoxemic

Ans. 6.
1. Chest X-ray suggestive of massive pericardial effusion with right mid-zone consolidation
2. Acute emergency therapy—pericardiocentesis
3. Indications for pericardiocentesis
   a. Clinical features of cardiac tamponade or obstructive cardiogenic shock
   b. 2 D echo suggestive of diastolic buckling of RA or RV

Ans. 7.
1. CT scan suggestive of—right subdural hematoma with midline shift
2. Take care of ABC, intubation and hyperventilation
3. Neurosurgical evacuation of the subdural hematoma is the definitive therapy. Maintain mean arterial pressure to maintain cerebral perfusion pressure (CPP = MAP–ICP). Decongestive measures such as mannitol or 3% NaCl.
4. Hyponatremia

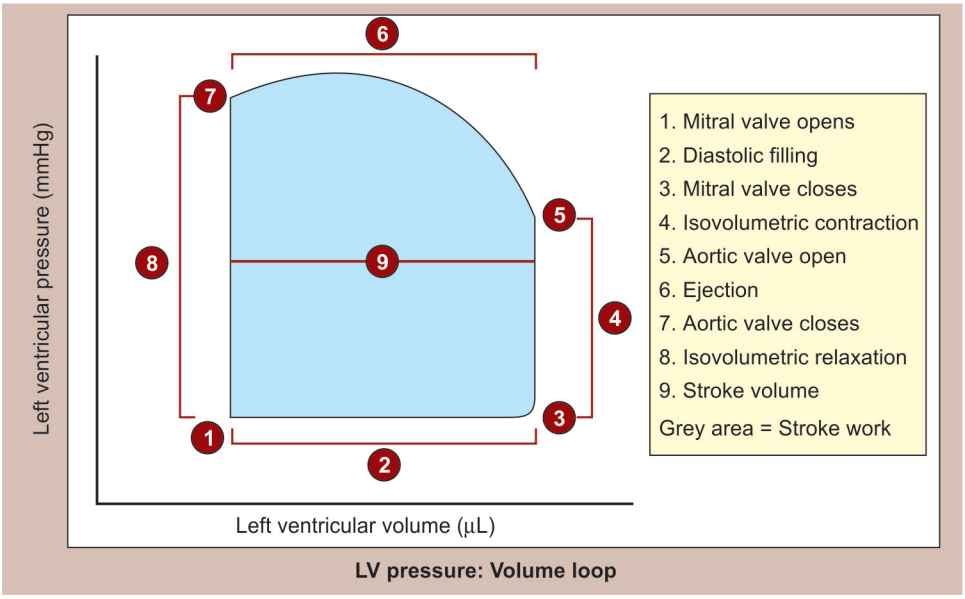
Ans. 8.
1. Diabetic ketoacidosis
2. First hour—normal saline bolus 10 ml/kg

3. Add KCl in the IV fluids to 60 mEq/L, reduce insulin to 0.5 to 0.8 µ/kg/hour
4. Younger age (<3 years), new onset, and longer duration of symptoms, lower pCO_2, severe acidosis (pH <7.1), increased BUN, use of bicarbonate, greater volumes of rehydration fluids (in excess of 4 L/m^2/24 hrs) and failure of serum Na to rise with treatment.
5. Cerebral edema and hypokalemia

Ans. 9. ARDS

1. Acute onset
2. Bilateral pulmonary infiltrates on chest radiography
3. Pulmonary artery occlusion pressure <18 mm Hg or no clinical evidence of left atrial hypertension
4. paO_2: FiO_2 ratio ≤300 = ALl
5. paO_2: FiO_2 ratio ≤200 = ARDS

Ans. 10. Left ventricular events



LV pressure: Volume loop

Ans. 11. 1. Graph suggests progression of drug metabolism from first order kinetics to zero order kinetics with increasing circulating drug levels.

2. First order kinetics—where a fixed proportion of circulating drug gets metabolised.
3. Zero order kinetics—fixed amount of drug irrespective of the circulating drug level gets metabolised.
4. Phenytoin

Ans. 12. 1. Tumour lysis syndrome

2. Fluid: 3000 ml/m^2
3. Allopurinol: 10 mg/kg/day
4. HCO_3: 50–80 mEq/L (role controversial)
5. Monitor signs of fluid overload, urine output and urinary pH
6. Choice of dialysis—hemodialysis

Ans. 13.
- Abnormally placed umbilical arterial line in the subclavian artery.
- For umbilical arterial line: High: Between T_7–T_{10}. In the thoracic aorta above diaphragm between ductus and celiac axis; Low: Between L_2–L_3, or L_3–L_4, in abdominal aorta, between inferior mesenteric artery and aorta bifurcation.
- For umbilical vein: Just above the diaphragm.
- Warm the other limb; if still pale >1/2 hour, remove the UA line.
- L-1
- Use heparin infusion at rate of 0.5–1.0 unit per hour.

Ans. 14.
1. Airway obstruction and inhalational injury (singed nasal hairs, carbonaceous material in throat, hoarseness of voice, persistent cough, stridor).
2. Airway management, BC, IV access and fluids, pain management, management of hypothermia.
3. Parkland formula (4 ml/kg/% burn) + maintenance fluids.

Ans. 15.
1. HTPS (hypertropic pyloric stenosis)
2. Hypochloremic metabolic alkalosis

Ans. 16.
1. HR 120–160, normal beat to beat variability, two accelerations of 15 beat/min, lasting for 15 sec over a 20 min observation period.
2. Persistent O_2 or ventilatory requirement for >28 days for infants born after 32 weeks or at 36 weeks post-menstrual age for infants born before 32 weeks.
3. pCO_2: 55–65, pO_2: 50,with a pH: >7.2
4. Stage 1 (suspect): Clinical signs and symptoms and nondiagnostic radiographs
   Stage 2 (definite): Clinical sign and symptoms with pneumatosis intestinalis on radiograph.
   Stage 3 (advanced): Above plus crtically ill, impending perforation, proven perforation.
5. Five or more contiguous or eight cumulative clock hours of stage 3 with plus disease in either zone 1 or 2.

CHAPTER 10

Advanced Life Support

Shyam Sunder Sharma

NALS (10–20 Marks Must to Pass Exam)**

1. CPAP (Nov 2014)** **2. Warmer Care (** Nov 2014)**

Laryngeal Mask Airways (LMA)

LMA fit over the laryngeal inlet have been shown to be effective for ventilating newborns weighing more than 2000 g or delivered ≥34 weeks gestation. A laryngeal mask should be considered during resuscitation if facemask ventilation is unsuccessful and tracheal intubation is unsuccessful or not feasible. The laryngeal mask has not been evaluated in cases of meconium-stained fluid, during chest compressions, or for administration of emergency intratracheal medications.

Endotracheal Tube Placement—Indication

1. Initial endotracheal suctioning of non-vigorous meconium-stained newborns.
2. If bag-mask ventilation is ineffective or prolonged.
3. When chest compressions are performed?
4. For special resuscitation circumstances, such as congenital diaphragmatic hernia or extremely low birth weight.

Withholding Resuscitation

When gestation, birth weight, or congenital anomalies are associated with almost certain early death and when unacceptably high morbidity is likely among the rare survivors, resuscitation is not indicated.

1. Extreme prematurity (gestational age <23 weeks or birth weight <400 g)
2. Anencephaly
3. Major chromosomal abnormalities, such as trisomy 13.

NEONATAL RESUSCITATION PROGRAM (NRP) (8th Edn 2021)

Why NRP

- Around 4 million neonatal deaths per year due to birth asphyxia.
- 38% of deaths of children under-5 mortality.
- 2–10 neonatal/1000 live birth.
- Most newborns make the transition to extrauterine life without intervention.

- Before birth, pulmonary blood vessels in the fetal lungs are tightly constricted, and the alveoli are filled with fluid, not air.
- The most important and effective step in neonatal resuscitation is to ventilate the baby's lungs.
- Very few newborns will require chest compressions or medication.
- Teamwork, leadership, and communication are critical to successful resuscitation of the newborn.

Few Facts

- 85% babies—spontaneous cry
- 10%—initial steps
- 5%—PPV
- 2%—intubated
- 0.5%—chest compression
- 0.05%—chest compression with adrenaline.

Equipment Checklist

Warm	• Preheated warmer • Warm towels or blankets • Temperature sensor and sensor cover for prolonged resuscitation • Hat • Plastic bag or plastic wrap (<32 weeks' gestation) • Thermal mattress (<32 weeks' gestation)
Clear airway	• Bulb syringe • 10F or 12F suction catheter attached to wall suction, set at 80–100 mm Hg • Tracheal aspirator
Auscultate	• Stethoscope
Ventilate	• Flowmeter set to 10 L/min • Oxygen blender set to 21% (21–30% if <35 weeks' gestation) • Positive-pressure ventilation (PPV) device • Term and preterm-sized masks • 8F orogastric tube and 20 ml syringe • Laryngeal mask (size 1) and 5 ml syringe (if needed for inflation) • 5F or 6F orogastric tube if insertion port is present on laryngeal mask • Cardiac monitor and leads
Oxygenate	• Equipment to give free-flow oxygen • Pulse oximeter with sensor and cover • Target oxygen saturation table
Intubate	• Laryngoscope with size O and size 1 straight blades (size 00, optional) • Stylet (optional) • Endotracheal tubes (sizes 2.5, 3.0, 3.5) • Carbon dioxide (CO_2) detector • Measuring tape and/or endotracheal tube insertion depth table • Waterproof tape or tube-securing device • Scissors

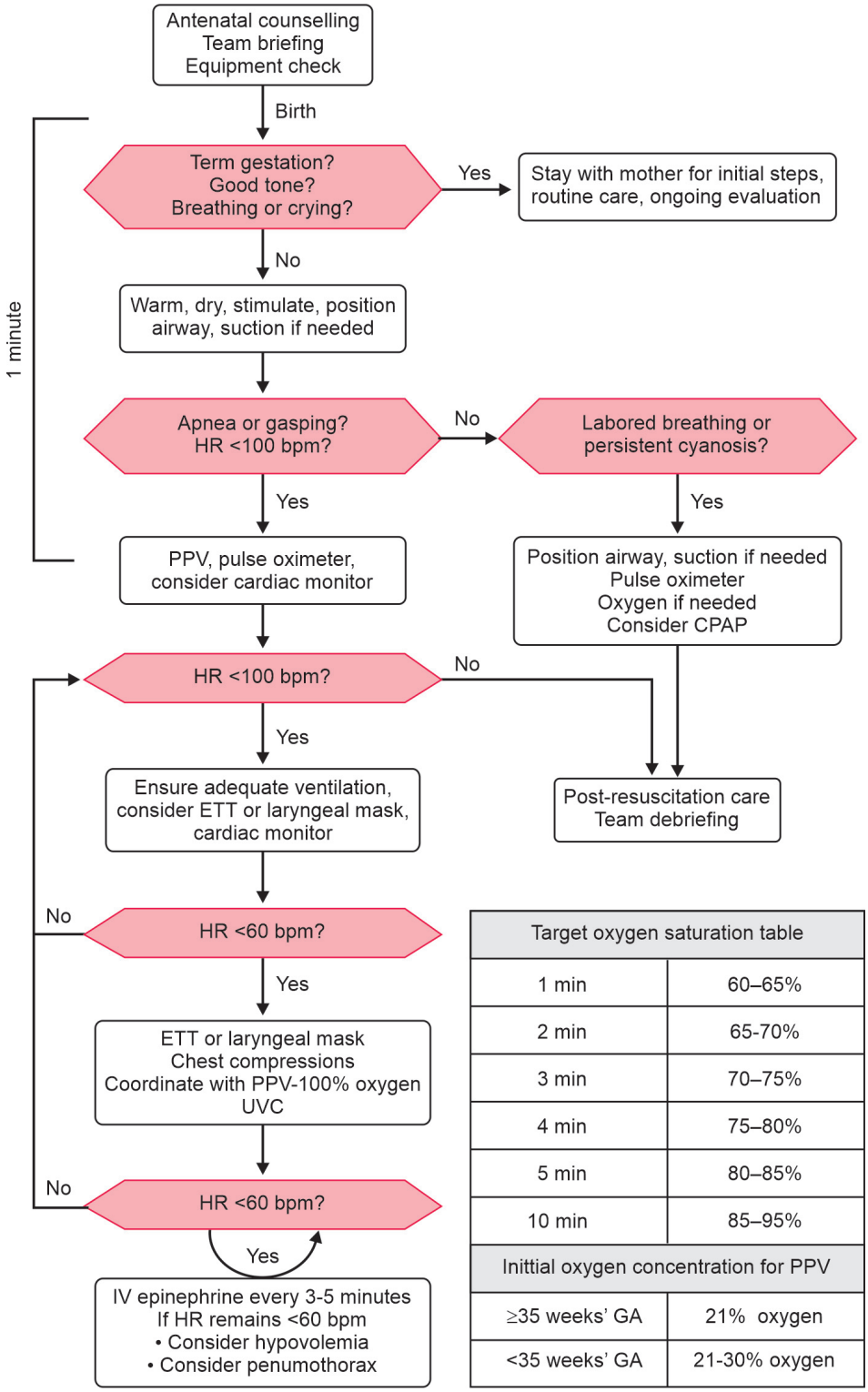
Medicate	Access to • Epinephrine (0.1 mg/ml = 1 mg/1 O ml) • Normal saline (100 ml or 250 ml bag, or prefilled syringes) • Supplies for placing emergency umbilical venous catheter and administering medications • Table of pre-calcuated emergency medication dosages for babies weighing 0.5–4 kg

Table 10.1: Overview of NRP 8th Edition Practice Changes

Change	*NRP 7th edition*	*NRP 8th edition*
Umbilical cord management plan added to 4 pre-birth questions replacing "How may babies?"	The 4 pre-birth questions: 1. Gestational age? 2. Amniotic fluid clear? 3. How many babies? 4. Additional risk factors?	The 4 pre-birth questions: 1. Gestational age? 2. Amniotic fluid clear? 3. Additional risk factors? 4. Umbilical cord management plan?
Initial steps recorded to better reflect common practice	Initial steps: Warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate	Initial steps: Warm, dry stimulate, position airway, suction if needed.
An electronic cardiac monitor is recommended earlier in the algorithm	An electronic cardiac monitor is the preferred method for assessing heart rate during cardiac compressions	When an alternative airway becomes necessary, a cardiac monitor is recommended for the most acourate assessment of the baby's heart rate
Epinephrine intravenous intraosseous (IV/IO) flush volume increased	Flush IV, IO epinephrine with 0.5 to 1 ml normal saline	Flush IV/IO epinephrine with 3 ml normal saline (applies to all weights and gestational ages)
Epinephrine IV/IO and endotracheal doses have been simplified for educational efficiency. The dosage range is unchanged. The simplified doses (IV/IO and ET) do not represent an endorsement of any particular dose within the recommended dosing range. Additional research is needed.	Range for IV or IO dose = 0.01–0.03 mg/kg (equal to 0.1–0.3 ml/kg) Range for endotracheal dose = 0.05–0.1 mg/kg (equal to 0.5–1 ml/kg)	The suggested initial IV or IO dose = 0.02 mg/kg (equal to 0.2 ml/kg) The suggested endotracheal dose (while establishing vascular access) = 0.1 mg/kg (equal to 1 mg/kg)
Expanded timeframe for cessation of resuscitative efforts	If there is a confirmed absence of heart rate after 10 minutes of resuscitation, it is reasonable to stop resusoitative efforts; however, the decision to continue or discontinue should be individualized	If confirmed absence of HR after all appropriate steps performed, consider cessation of resuscitation efforts around 20 minutes after birth (decision individualized on patient and contextual factors)

IV: Intravenous; IO: Intraosseous; ET: Endotracheal; HR: Heart rate.

Flowchart 10.1: Neonatal resuscitation program® 8th Edition Algorithm



Target oxygen saturation table	
1 min	60–65%
2 min	65-70%
3 min	70–75%
4 min	75–80%
5 min	80–85%
10 min	85–95%
Inittial oxygen concentration for PPV	
≥35 weeks' GA	21% oxygen
<35 weeks' GA	21-30% oxygen

NRP CASE SCENARIOS

1. A baby born at 38 weeks gestation delivered by normal vaginal delivery. Cried immediately after birth with normal tone.

A. What are the three questions?

Ans. Term? Tone? Cry?

B. What next?

Ans. Routine care-Stay with mother?? maintain warmth with skin to skin contact, position airway, clear secretions if needed, ongoing evaluation.

2. A baby born to primi mother delivered at 30 weeks of gestation, with birth weight of 1100 grams is delivered by emergency LSCS for PPROM. Mother did not receive antenatal corticosteroids.

A. What are the 4 pre-birth questions that need to be asked to the obstetrician? (Latest NRP 8th edition)

- Gestational age
- Amniotic fluid clear?
- Additional risk factors
- **Umbilical cord management**.

B. How would you proceed to resuscitate the baby?

Ans. 1. Switch on the warmer (½ mark)
2. Wash hands (½)
3. Check equipment (2)
   - **Food grade plastic bag** and thermal mattress (½)
   - **T-piece resuscitator**/Self inflating bag with reservoir functioning (½)
   - Endotracheal tubes, Laryngoscope (½)
   - Oxygen and suction (½)

C. Baby did not cry at birth, what are your initial steps? (2)

Ans. Initial steps **(Newer order as per latest NRP 8th edition)**

- Warmth
- Dry
- Stimulate
- Position airway
- Suction if needed.

D. Baby is gasping after initial steps. How will you proceed?

Ans.
- PPV with **FiO_2 21–30%** (½)
- SpO_2 monitoring (½)
- Consider cardiac monitor (ECG)-> mandatory only when alternate airway needed

E. After 15 seconds of PPV, no chest rise, HR <100 bpm, how will you proceed?

Ans. Ventilation corrective steps

MRSOPA (2 marks)

M: Mask adjustment (½)

R: Reposition of head and neck

S: Suction mouth followed by nose (½)

O: Opens the mouth
P: Increase pressure (½)
A: Alternate airway (½)

F. After 30 seconds of effective PPV, baby has cried, HR >100 but now has laboured breathing. Next step?

Ans.
- Position and clearing airway (1)
- Oxygen if needed
- Consider CPAP (1)

3. You came to attend a delivery, 40-week term baby with meconium-stained liquor, how will you proceed?

A. 1. Switch on the warmer (½ mark)
2. Wash hands (½ mark)
3. Equipment check (2 marks)
- Self inflating bag with reservoir functioning
- Endotracheal tube and laryngoscope
- **Suction catheters 10 or 12 F and meconium aspirator/Bulb syringe**
- Pulse oximeter and oxygen.

B. Baby did not cry at birth how will you proceed? (2 marks)

Ans. Initial steps
- Warmth
- Dry
- Stimulate
- Position airway
- Suction if needed.

C. After initial steps HR is 46 per min, how will you proceed?
- PPV with **FiO_2 21%** (½ mark)
- SpO_2 monitoring (½ mark)

D. After 30 seconds of effective PPV HR is 52 per min, how will you proceed.
- Intubate if not already done (½ mark)
- **100% oxygen** (½ mark)
- **ECG monitor** (½ mark)
- Chest compression coordinated with PPV (½ mark)
- Place UVC

E. When will you check heart rate after starting chest compression?
- After **60 seconds** of effective chest compression coordinated with PPV (½)

F. HR is 58 per min after 1 min of chest compression how will you proceed?
- IV Epinephrine **0.2 ml/kg**, 1:10000 IV or **1 ml/kg intratracheal dose** (½)
- Epinephrine followed by **3 ml saline bolus irrespective of weight or gestation when given through UVC**.

G. No response to IV epinephrine, what will you consider?
- Hypovoemia (½)
- Pneumothorax. (½)

4. You have assigned as a team leader to attend the delivery of primigravida mother with twin babies with gestation age of 28 weeks, due to PPROM, perform the resuscitation steps as per current NRP recommendations.

A. As a team leader, how will you proceed?

Ans. 1. Antenatal counseling (¼)
2. Team briefing (¼)
3. Check equipment required to resuscitate two neonates (¼)
4. Arrange for at least 4 qualified people to resuscitate (2 qualified people for one high risk baby is needed). (¼)

B. Twin 1 delivered and was limp and not crying. How will you proceed? (2 marks)

Ans. Initial steps (2)
1. Immediate cord clamp and receive baby in a food graded plastic bag (½)
2. Initial steps
   a. Warmth
   b. **No need to dry since in food grade plastic bag**
   c. Stimulate
   d. Position airway

C. Baby had apnea and heart rate 60 bpm. How will you proceed? (2 marks)
1. PPV with T piece resuscitator with **FiO_2 (21–30%)** (<35 w) (1)
2. SpO_2 monitoring (½)
3. Consider ECG monitoring (½)

D. After 30 seconds of effective positive pressure ventilation HR 50 bpm. How will you proceed? (2 marks)
1. Intubate-alternate airway (½)
2. Coordinated chest compressions with T piece ventilation (one and two and three and breathe) (½)
3. 100% FiO_2 (½)
4. ECG monitoring (½)

E. After one minute of coordinated chest compressions HR is 80. How will you proceed? (1 mark)
- Stop chest compressions and continue PPV with T piece (breath two three) (1)

F. Now HR 110 bpm, baby had spontaneous respiratory efforts. How will you proceed? (2 marks)

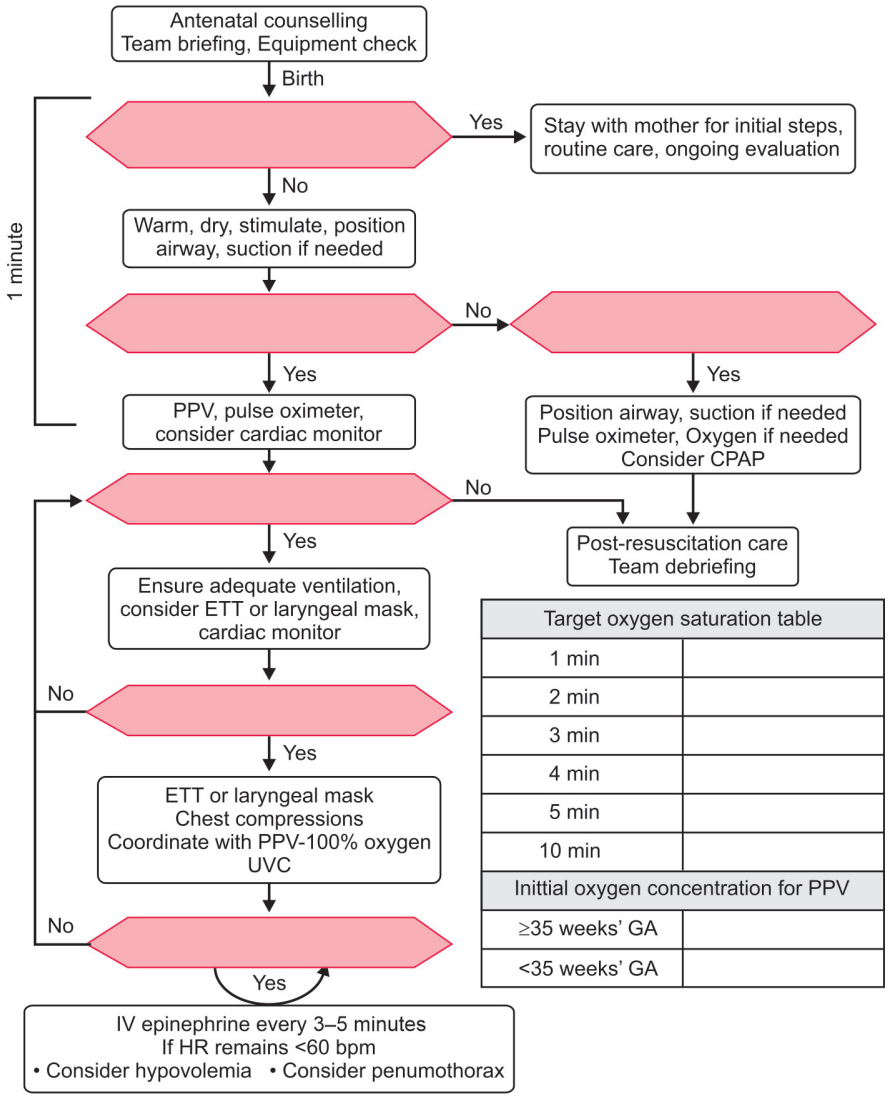
Ans. 1. Consider surfactant (1)
2. Post resuscitation care (½)
3. Team debriefing. (½)

G. Twin 2 has been through 20 min of resuscitation with confirmed absence of heart rate. How does one proceed?

Ans. New NRP 8th recommends that if after 20 min of resuscitation and there is confirmed absence of heart rate, it is reasonable to consider cessation of resuscitative efforts. However, the decision to continue or discontinue should be individualized.

EXERCISES

Q.1.* May 2013. Fill in the blanks:



Target oxygen saturation table	
1 min	
2 min	
3 min	
4 min	
5 min	
10 min	
Inittial oxygen concentration for PPV	
≥35 weeks' GA	
<35 weeks' GA	

Q.2.* May 2014 (15–20 Marks)

1. You are called to attend a delivery in labour room that in view of baby need resuscitation. You are now in labour room 30 minutes before the delivery so please check/call all things you may need in newborn care.
2. A 28 weeks preterm baby delivered, you called to handle the baby, baby is just delivered, commentary when you need to ask about the newborn condition/vitals?

Q.3.* Nov 2014 (15–20 Marks):

A 28 weeks preterm baby is delivered and shifted to NICU, you attend the baby and put CPAP and give instruction for care of baby on CPAP to NICU nurse (nurse provided).

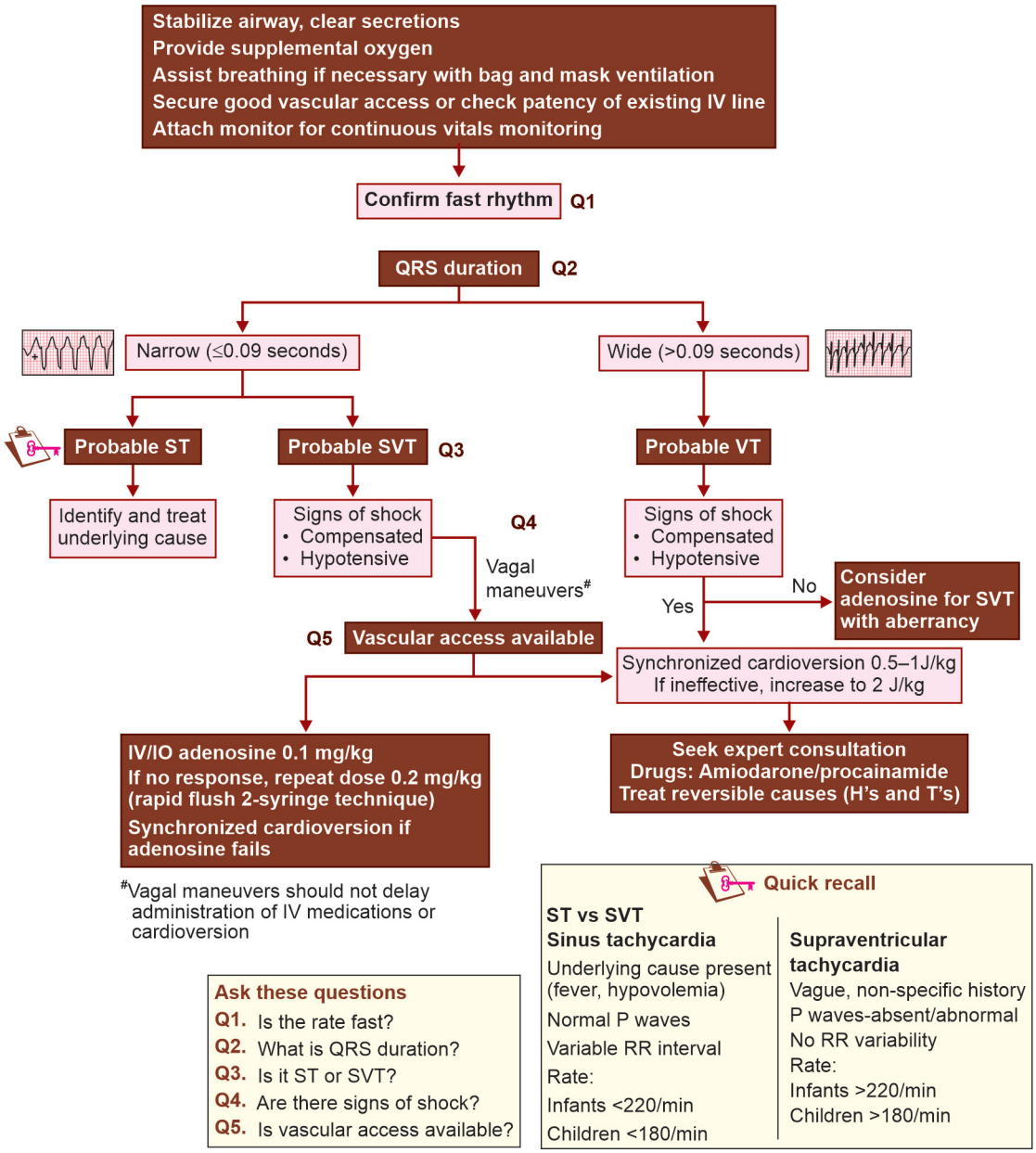
1. A new nurse join the NICU, you are posted doctor, please instruct this new nurse about the care of baby on warmer, different mode of warmer and monitoring of baby on warmer.

Q.4.* You are called to attend the delivery of a baby who is term by gestation but gynecologist told you that NST suggest acute fetal distress.

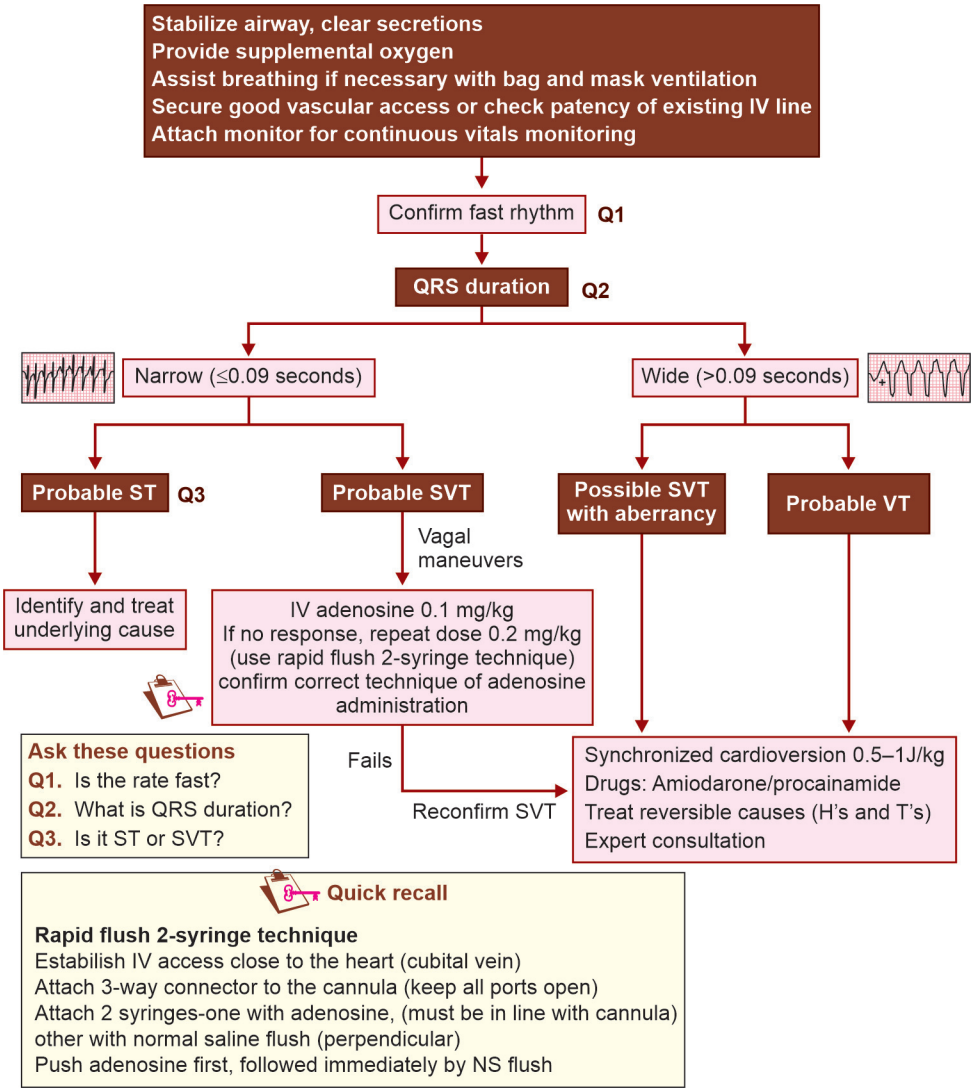
Now baby is delivered and handed over to you. Ask the needful question or condition of baby when you need and perform advance resuscitation if baby need. Wrong step considered for negative marking.

PALS (10 Marks)

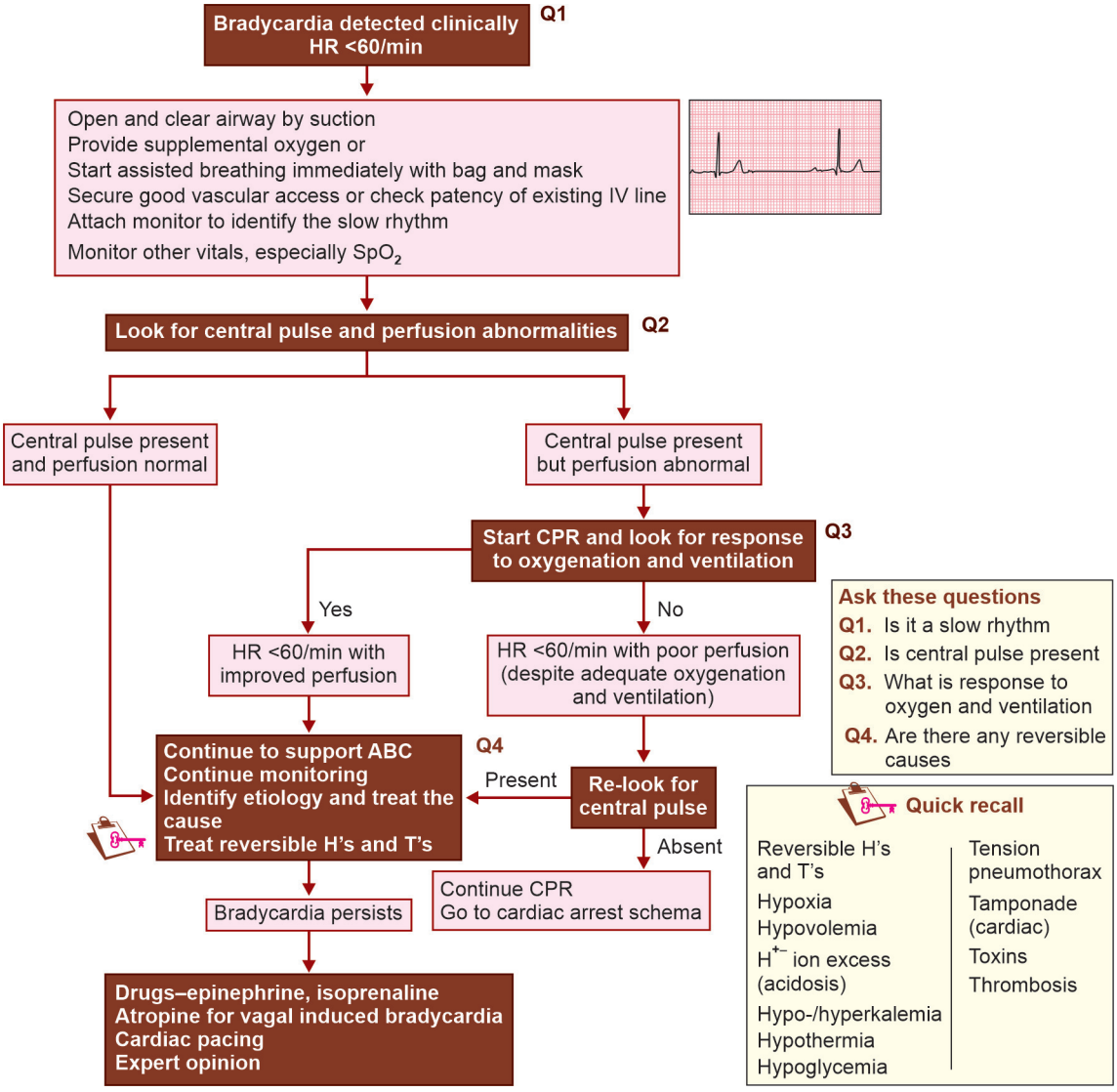
Flowchart 10.2: Approach to tachycardia with hemodynamic compromise



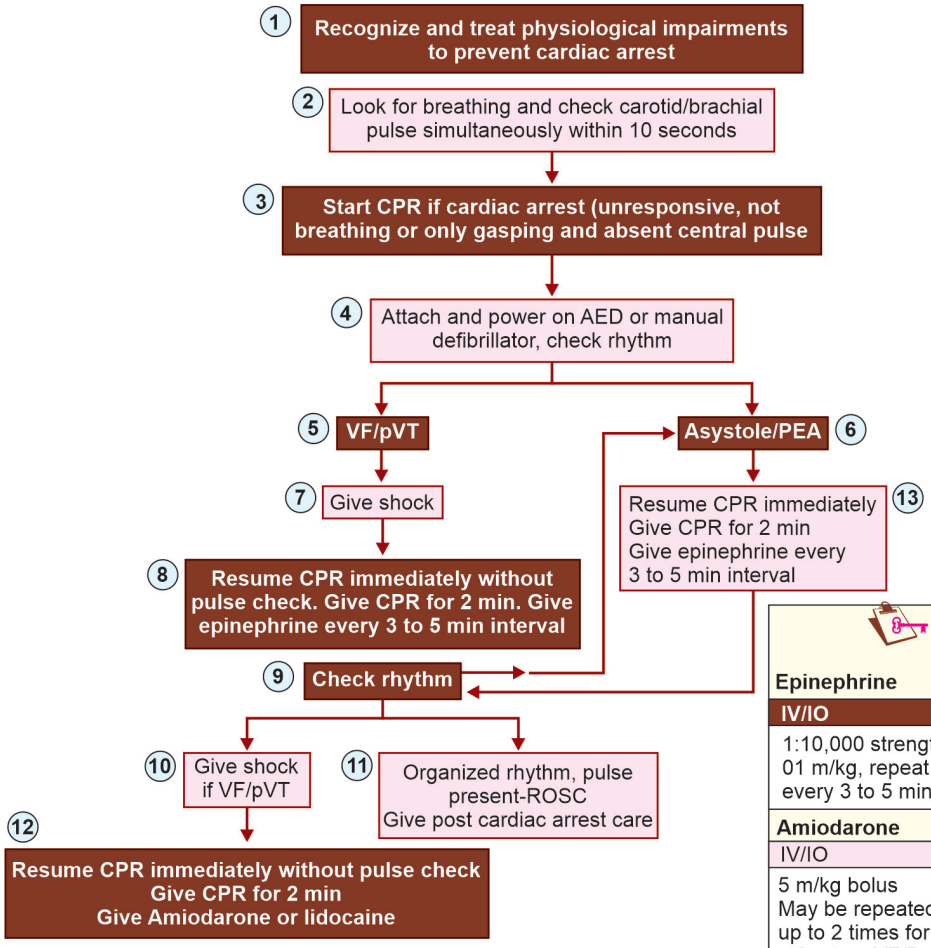
Flowchart 10.3: Approach to tachycardia with normal hemodynamic



Flowchart 10.4: Approach to bradycardia with hemodynamic compromise



Flowchart 10.5: Approach to pulseless arrest



Essence

- During CPR, give bag and mask ventilation using 100% oxygen
- Establish IV/IO access
- Prepare for advanced airway if multiple rescuers are available
- Identify the reversible causes: H's and T's
- Talk to relatives if additional staff available

Adapted from: Pediatric advanced life support guidelines update for cardiopulmonary resuscitation. Circulation 2015:132 S526-S542

Quick recall

Medication

Epinephrine

IV/IO	Endotracheal
1:10,000 strength 01 m/kg, repeat every 3 to 5 min	1:10,000 strength 0.1 m/kg

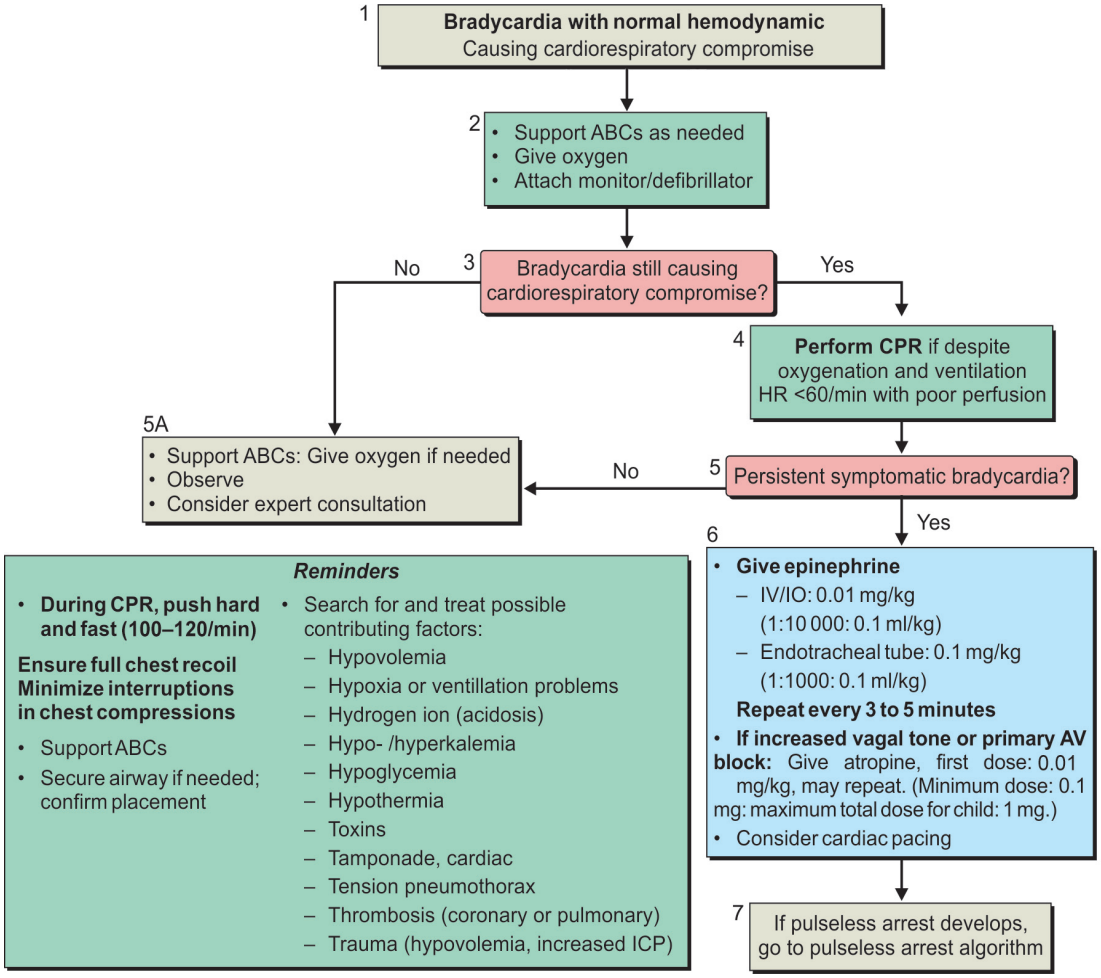
Amiodarone

IV/IO	Endotracheal
5 m/kg bolus May be repeated up to 2 times for refractory VF/Pvt	Not recommended

Lidocaine

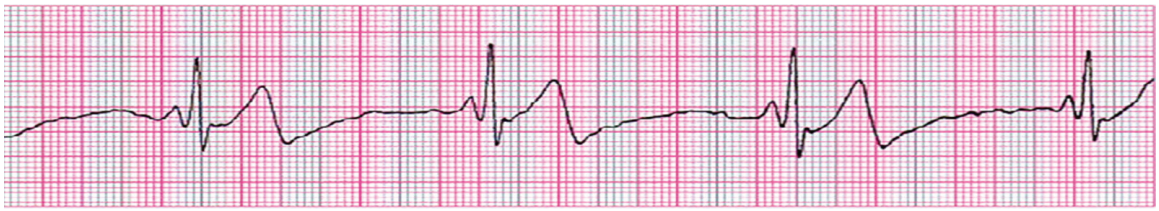
IV/IO	Endotracheal
Initial 1 mg/kg loading dose Maintenance: 20 to 50 mcg/kg/min infusion	2 to 3 mg/kg

Flowchart 10.6: 2020 American Heart Association



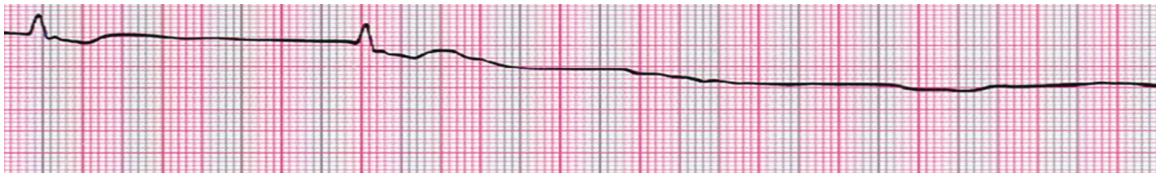
Q.5. A 2-year-old child was struck by an automobile respiratory rate = 0, central pulse = absent, ECG given below:

1. What is this diagnosis after reading ECG and clinical condition.
2. After initial assessment you found that rhythm is shockable. Write down all steps in view of continue shockable rhythm.



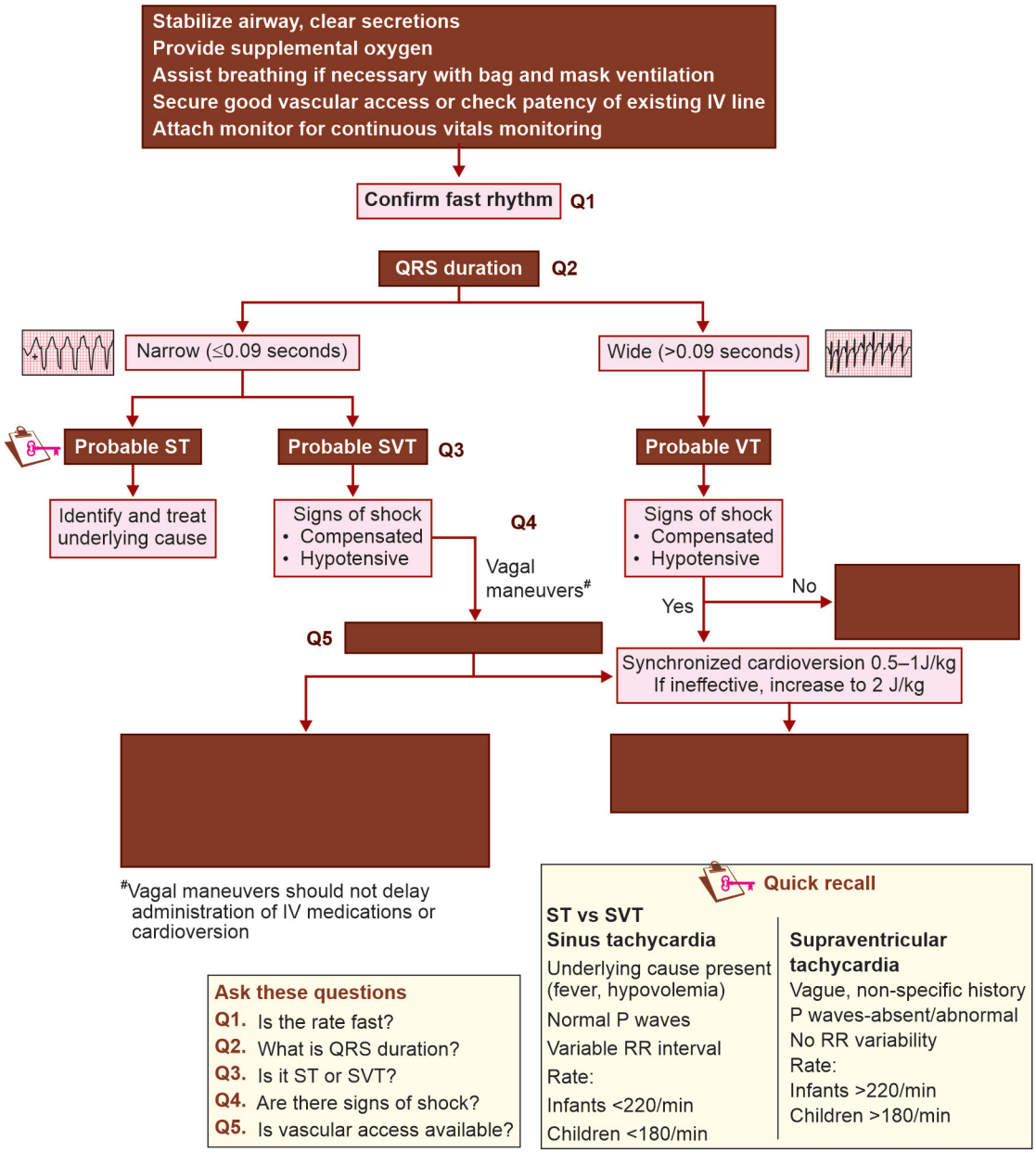
Q.6.* A 5-year-old child was struck by an automobile respiratory rate = 0, central pulse = absent, ECG given below:

1. What is this diagnosis after reading ECG and clinical condition?



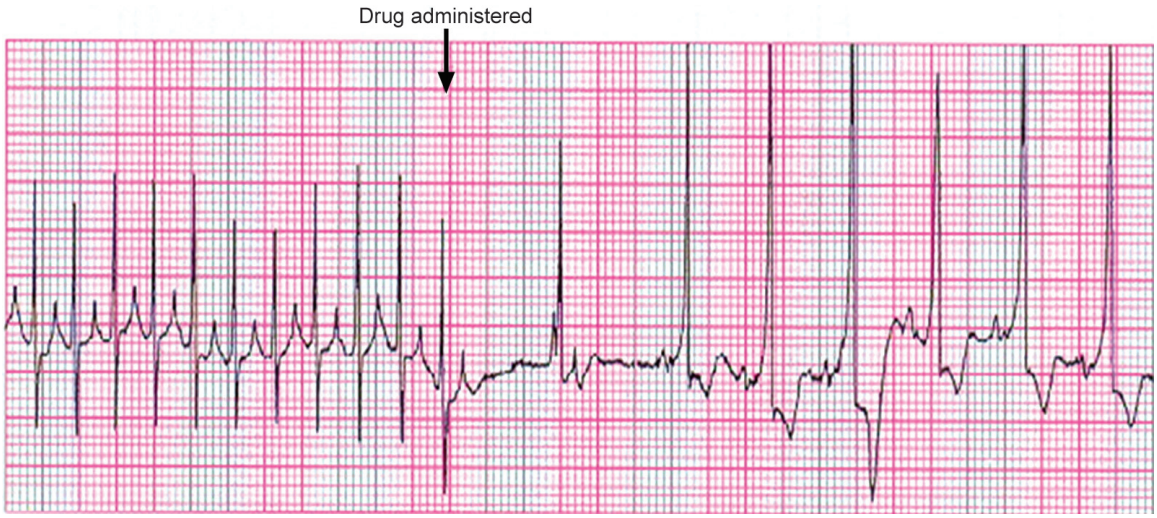
2. After initial assessment you found that rhythm is non-shockable. Write down all steps in view of continue non-shockable rhythm.

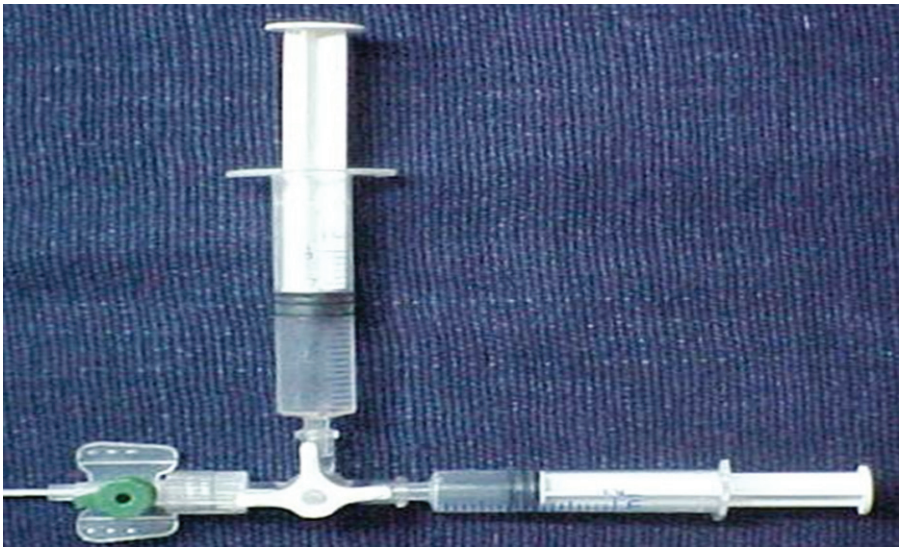
Q.7.* Fill in the blanks:



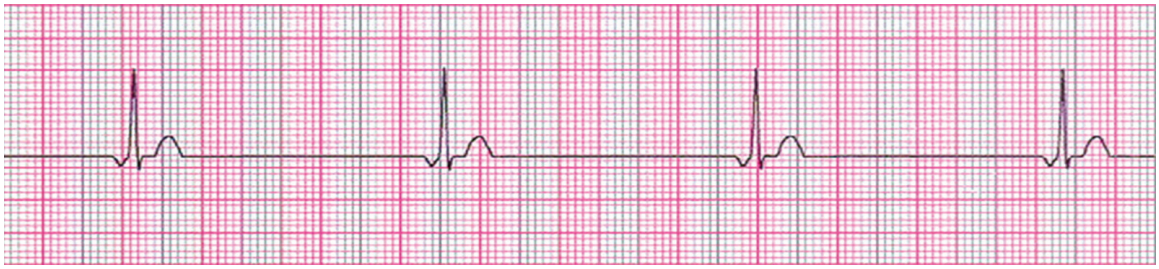
Q.8.* An 8-year-old submersion victim with apnea and no palpable pulse.
What arrhythmias could be present?

Q.9.* A 4-month-old male baby present irritability, sweating and poor feeding, got admitted in PICU, doctor diagnose the problem and give the drug with ECG below:
1. What is ECG diagnosis and what drug is given?
2. What is dose of drug with max dose and maximum attempt?





Q.10.*
1. What is the rhythm?
2. What are the possible contributing factors?
3. What interventions should you consider?



Q.11.**

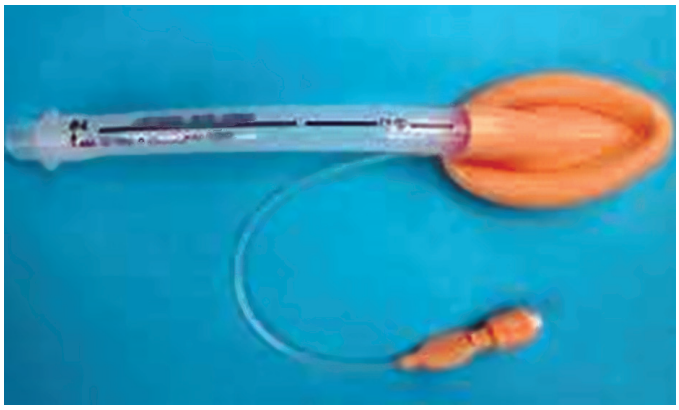
1. An 8-month-old male child with his mother came in emergency department with history of sudden onset cough than chocking. Mother gave history of pea ingestion.

Or

2. A 4-year-old child with sudden onset cough and chocking. Perform the step for given condition (dummy given)—ask the question regarding the condition of child, when you proceed.

Q.12.

1. What is this device?
2. Indication
3. Contraindication
4. Limitation
5. Complication



Q.13.* A 12-year-old girl Ritu has sustained injury to the neck due to a road traffic accident. He is breathing but cannot move or feel her arms or legs:

1. What maneuver you will use to opening the airway in neck injuries?
2. X-ray of the cervical spine shows no bony injury. Is it still possible for the boy to have a spinal cord injury? Name the condition and its mode of diagnosis.
3. What is the emergency drug treatment that can be offered to this boy?

Q.14.*

1. Define: a. Drowning b. Near drowning
2. List three predisposing factors for drowning.

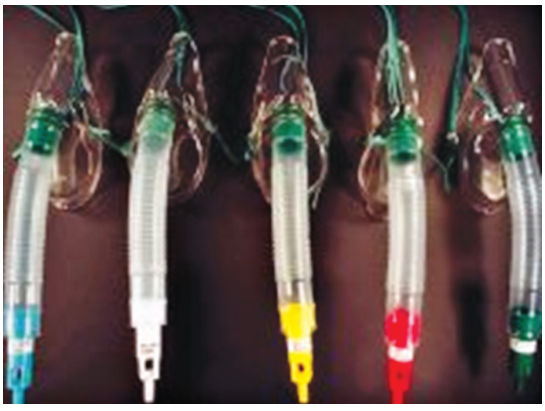
3. List 2 electrolytic and one hematological disturbance in near drowning.
4. What is commonest radiological finding in X-ray chest?

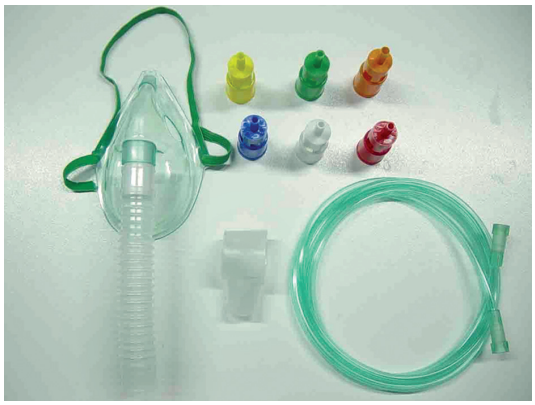
Q.15.

1. Identify the instrument.
2. Name its parts.
3. What size would you use in a 6-year-old child?
4. Mention 5 physiological changes, which occur when it is used in children.

Q.16.

1. Name of the device shown.
2. What does the colour of the mask's aperture and adaptors reflects?
3. Mention the FiO_2 achieved with various colours.
4. Percentage of oxygen delivered by the following devices:
   a. Nasal prongs b. Simple face mask c. Non-breathing mask





Q.17. You are asked to perform rapid sequence intubation. Write the steps sequentially. Mention the names of drugs wherever necessary.

Q.18. A 3-year-old child brought in ER at 10:30 AM with 12 kg and 45% burn while playing at 8:30 AM, as a attending pediatrician.

1. Calculate his fluid requirement in next 48 hr (as per Parkland formula)
2. His 24 hr correction will be complete by which time?
3. What is the desired S. albumin level in this child?
4. In this patient how much 0.5% albumin you will infuse?

ANSWERS

Ans. 1. *See* the NRP Flowchart 10.1.

Ans. 2. **Prepare the incubator**

1. Pre-warmed to a temperature appropriate to the infant's age, size and condition.
2. Use in air mode and must always be switched on with the motor running if in use for a baby.
3. Check and record the incubator temperature hourly.
4. Position away from draughts or direct sunlight.
5. Do not routinely use on the humidity function while in use for babies in Starship hospital—this function is generally required for premature infants only.

Note: Ensure alarms self-test has been completed (automatic). If the unit fails the self- test, the alarm sounds, and one or more messages are displayed in the trend/alarm window.

Care of baby

1. Maintain axilla temperature between 36.5°C and 37.2°C
2. Access baby by using the portholes, limit opening of large door as this interferes with air temperature.
3. Ensure baby is nursed naked apart from a nappy.
4. Position baby utilizing rolled towels/cloth nappies to provide boundaries that support 'nesting' and flexion of limbs but keeping face clear.

Explain to parents/caregivers the purpose of an incubator for their baby

1. Ensure they are familiar with how to access baby as it is optimal for parents to continue to touch and provide comfort.
2. Maintain a quiet environment
3. There is no tapping on the canopy.
4. No equipment is placed on top of the canopy.
5. Careful opening and closing of doors.

Adjusting incubator temperature

1. Default incubator temperature in NICU is 35 degrees
2. Adjust the incubator temperature by no more or less than 0.5 of a degree at a time.
3. Re-check the temperature within half an hour of making any adjustment.

Monitoring

1. Axilla temperature is taken on admission into the incubator and rechecked in the first hour.
2. Temperature is documented 4–6 hourly as condition dictates.

Ans. 3. 1. **Care of the baby**

- *Respiration:* Rate, effort, breath sounds, signs of distress (tachypnea, nasal flaring, sternal indrawing, rib retractions, grunting).
- Temperature
- *Cardiovascular:* Central and peripheral perfusion, blood pressure and auscultation
- *Neurological:* Tone, response to stimulation and activity.
- Gastrointestinal: Specific characteristics (e.g. cleft palate, omphalocele), abdominal distension, visible loops, and bowel sounds.

Regular observations

1. Minimal handling is essential for a sick infant therefore "hands on" intervention should be limited to 2–4 hourly, if possible. Initially some fine tuning of the CPAP system may be necessary but limit handling to essentials such as suctioning and core temperature monitoring.
2. Complete blood drawing, IV insertion, X-rays, etc. with the minimum delay.
   Keep the baby's parents informed of what is happening. Answer questions and offer information, as you do with regard to all other aspects of the baby's care.
3. Once the infant is stable on CPAP and is tolerating handling without compromise or agitation the usual activities of care can be performed.
4. Parents can be encouraged to participate by being shown the techniques of soothing and containment. They can perform oral cares, nappy changes, etc. as their confidence and the baby's condition permits.
5. Change the baby's position 4–6 hourly. Kangaroo care is an ideal variation in position along with its other tactile emotional advantages.

Ans. 4.
1. Hygiene—wash hand/hand rub/glove……..
2. Handle the baby in your hand with towel and ask the examiner……..
   Baby is term, crying, tone of baby (if you do not ask—you will get negative marks) examiner—not crying, not breathing, term baby.
3. Put the baby under warmer, clean, suction by bulb syringe (1st mouth than nose), put off wet towel, stimulate by flicking the sole or rubbing the back.
4. Ask the examiner …….. Sir HR, respiration? Examiner say 80, gasping.
5. Call for help***take AMBU with mask and start resuscitation (at room air) with commentary …. Breath. 1. 2 breath … 1 … 2 … for 5–10 time tell your assistant to put pulse on right hand of baby and on the pulse ox …
6. Ask the examiner now 3 thing—hr, respiration and saturation … examiner-hr 72, poor respiration, no saturation recored.
7. Tell you assistant to attach oxygen in AMBU, Do-MRSOPA …
   Now give PPV for 30 sec, in between tell your assistant to check air entry, chest rise (you also see), HR, saturation ….
8. Ask the examiner again 3 thing … HR, respiration, saturation examiner-hr 40, gasping, SpO_2: 40 %.
9. Intubate the child, start chest compression with your assistant … 1, 2, 3, and breath (3;1) call one more person to prepare for umbilical line and load adrenaline (tell dose also).
10. Ask same 3 question to examiner, if examiner say hr <60 then give ADR or examiner say HR >60, BUT <100 then continue CPR … if HR > 100 stop chest compression but continue PPV.

Asking to examiner about condition of child is must … otherwise you will get negative marks.

Ans. 5.
1. Pulseless electrical activity
2. Write down according to Flowchart 10.5.

Ans. 6.
1. Asystole
2. Write down according to Flowchart 10.5.

Ans. 7. *See* the Flowchat 10.2.

Ans. 8. Absent pulse. Differential diagnosis of arrhythmias
- Asystole
- Ventricular fibrillation
- Pulseless ventricular tachycardia
- Pulseless electrical activity/electromechanical dissociation

Ans. 9. 1. PSVT and adenosine
2. Ist dose 0.1 mg/kg (max 6 mg), IInd dose. 2 mg/kg (max dose 12 mg)

Ans. 10. 1. Bradycardia
2. Contributing factors—hypoxia, hyper-/hypokalemia, hypothermia, hypovolemia, toxin, tamponade …… *see* Flowchart 10.3.
3. Management
   - Oxygenation (FiO_2 = 1.00) and ventilation
   - Chest compressions
   - Epinephrine
   - Atropine

Ans. 11. For all Q of FB follow these steps according to age and condition of child.
1. Hygiene steps.
2. Inspect the mouth for visible FB. If visible remove out with finger sweep clearance if not visible do not sweep your finger blindly (blind sweep, or blind suctioning is contraindicated).
3. See the child is conscious or unconscious.
4. A conscious child allows to cough until cough is no longer effective or develop respiratory distress or became unconscious.
6. If child is unconscious or became unconscious put the child on safe place in supine position with head tilt/chin lift position.
7. Start mouth to mouth ventilation with close the nose of child and make a good seal at mouth to mouth.
8. If ventilation is unsuccessful repositioning the airway and attempt again mouth to mouth respiration.
9. If baby <1 year put the child on your thigh prone and give 5 back thrust, then supine the baby and give 5 chest thrust (like CPR of neonate—two-finger technique).
10. If child >1 year age (conscious) … give 5 abdominal thrust by placing your fist between xiphisternum and umbilical but if >1-year-old child who is unconscious put the child supine and give 5 thrust.
11. After step 9 or 10 see the mouth again if any FB clear it.
12. If no FB in mouth, then again follow steps 7–9/10.

Ans. 12. 1. Laryngeal mask airway
2. Indications:
   - Routine airway in operating room, and
   - In cases with difficult bag-mask ventilation
3. Contraindication: Severe airway obstruction
4. Two limitations
   - Dislodgement during transport, and
   - Minimizes but cannot prevent aspiration

5 Complication: Regurgitation and aspiration

Ans. 13. 1. Jaw thrust without head tilt.
2. Yes, sciwora (spinal cord injury without radiographic bone abnormalities) MRI spine.
3. High dose methylprednisolone (30 mg/kg) within 8 hours of injury.

Ans. 14. 1. a. Death within 24 hours of an immersion event
b. Any survival from an immersion event
2. a. Seizures b. Long QT syndrome c. Poisoning with drugs
3. a. Hypernatremia, hyperkalemia, hypercalcemia, hypermagnesemia
b. Hemolysis
4. Pulmonary edema

Ans. 15. 1. Endotracheal tube uncuffed
2. Adaptor, markings on tube for nasal/oral fixing, vocal cord guide, Murphy's eye, radiological marker
3. 5.5 cm uncuffed (tubes 0.5 cm less and greater in size to be kept ready)
4. ICP ↑
   - Laryngospasm
   - Hypoxia
   - Tachycardia and hypertension in older children
   - Bradycardia and hypotension in infants

Ans. 16. 1. Venturi mask (oxygen)
2. The colour of the mask's aperture reflects the FiO_2 achieved
3. (24%: blue; 28%: white; 35%: yellow; 40%: red; 60%: green)
4. Percentage of oxygen delivered by the following devices:
   a. Nasal prongs (flow of 2–4 L/min) 24–28%
   b. Simple face mask (flow of 6–10 L/min) 35–60
   c. Nonrebreathing mask or reservoir 90–95%

Ans. 17. Brief history and assessment
- Assemble equipment, medications, etc.
- Preoxygenate patient
- Premedicate with lidocaine atropine
- Sedation and analgesia induced
- Pretreat with nondepolarizing paralytic agent
- Administer muscle relaxants
- Sellick maneuver
- Endotracheal intubation
- Secure tube, verify position with roentgenogram
- Begin mechanical ventilation

Drugs: Thiopental, diazepam, ketamine, fentanyl, morphine, succinylcholine, vecuronium or pancuronium or rocuronium

Ans. 18. 1. 1st 24 hours RL 4 ml × 12 (weight) × 45 (% of burn)
   - ½ in first 8 hours and ½ in over 16 hours (2160 ml)
   - 2nd 24 hours RL with 5 % D (½ of 1st day fluid)
2. Next day 8:30 AM
3. 2 g/dL
4. 30–50% burn, 0.3 ml of 5% albumin/kg/% of burn over 24 hours
(0.3 × 12 × 45 = 162 ml).

CHAPTER 11

Clinical Biostatistics

Types of Data

- Discrete data—limited number of choices
  - Binary: Two choices (yes/no)
    - Dead or alive
    - Disease-free or not
  - Categorical: More than two choices, not ordered
    - Race
    - Age group
  - Ordinal: More than two choices, ordered
    - Stages of a cancer
    - Likert scale for response
      - Example, strongly agree, agree, neither agree non disagree, etc.

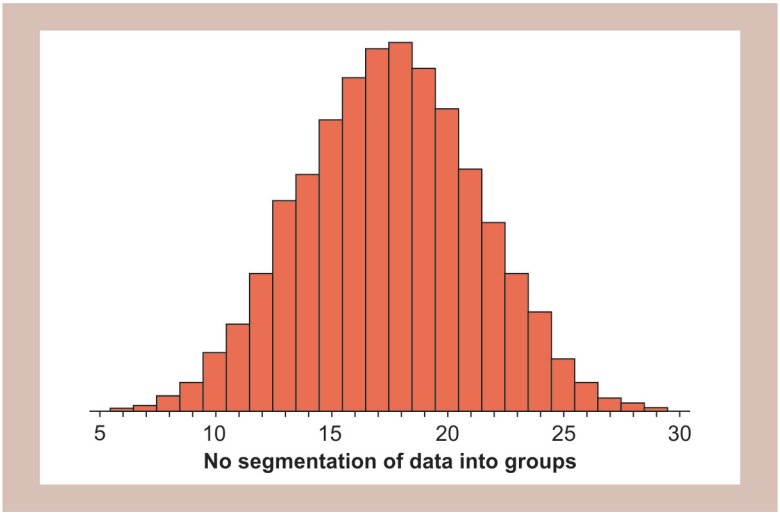
Types of Data

- Continuous data
  - Theoretically infinite possible values (within physiologic limits), including fractional values
    - Height, age, weight
  - Can be interval
    - Interval between measures has meaning
    - Ratio of two interval data points has no meaning
    - Temperature in celsius, day of the year
  - Can be ratio
    - Ratio of the measures has meaning
    - Weight and height

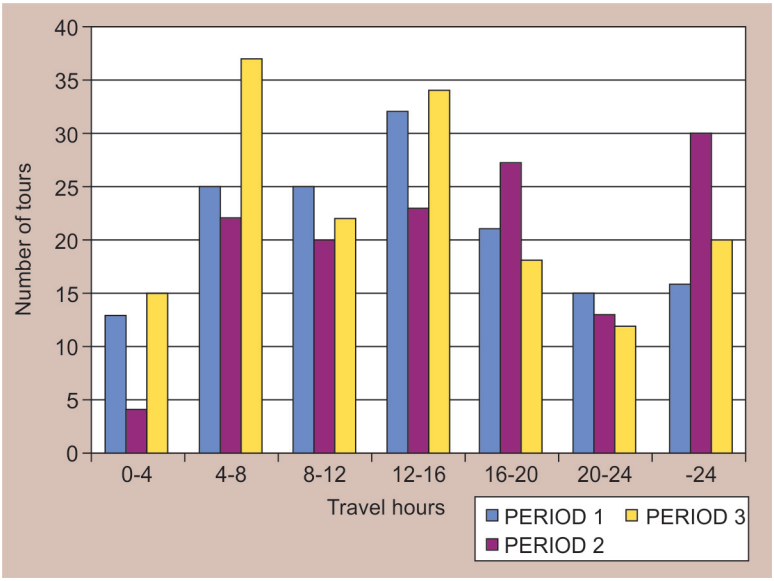
Descriptive Statistics

- Characterize data set
  - Graphical presentation
    - Histograms
    - Frequency distribution
    - Box and whiskers plot
- Numeric description
  - Mean, median, SD, interquartile range

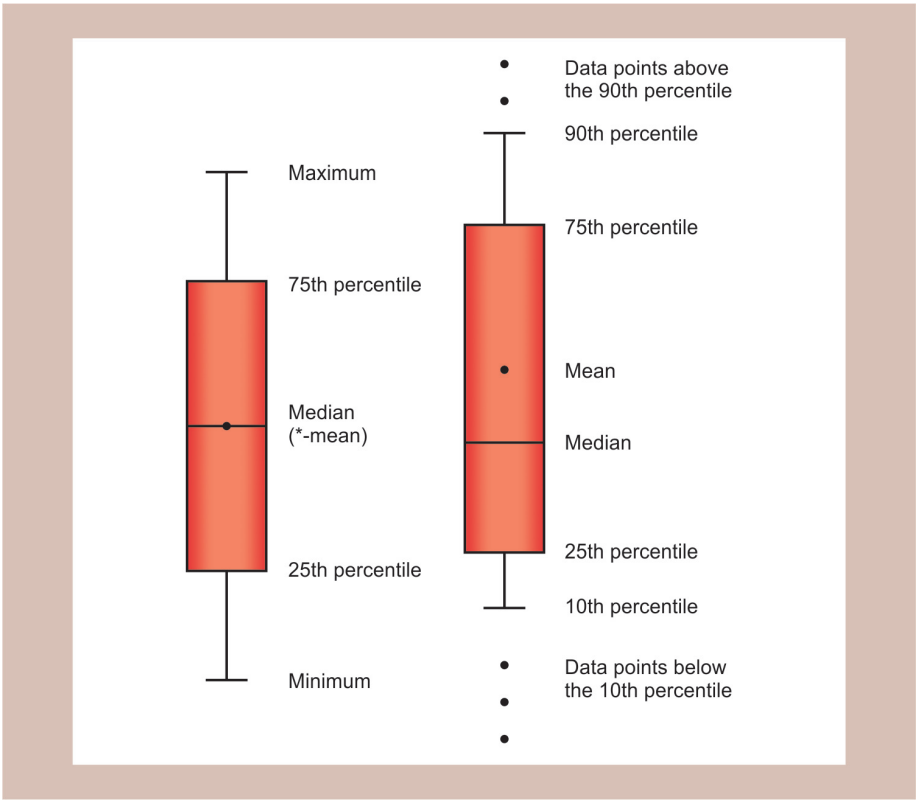
Histogram
Continuous Data



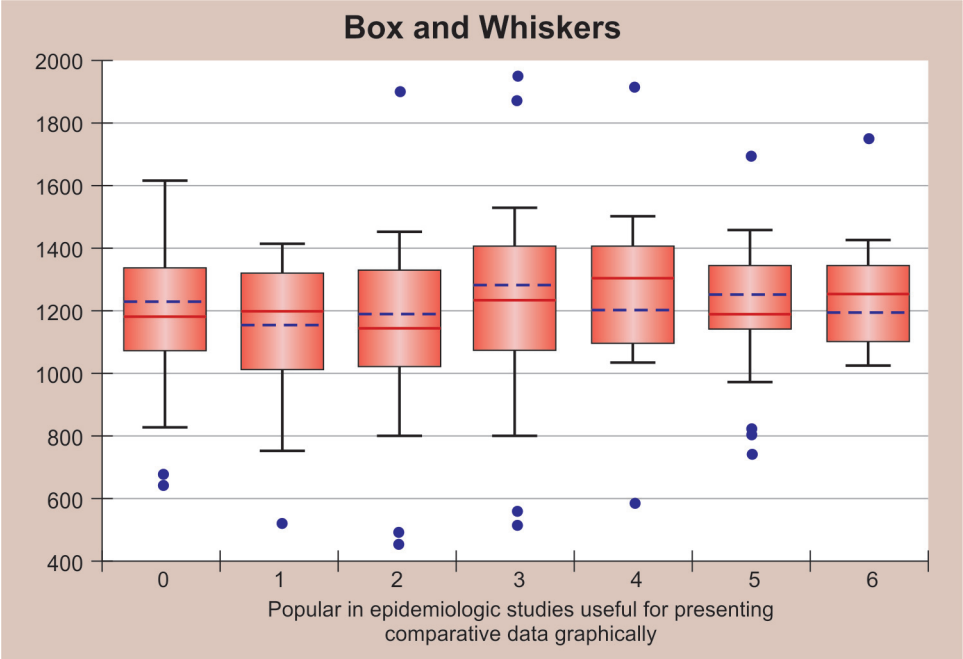
Frequency Distribution



Box and Whiskers Plots



Box and Whiskers Plots



Mean

- Definition: Sum of all the values in a sample, divided by the number of values.

Median

It is the middle value from an ordered listing of the values

- If an odd number of values, it is the middle value 1, 2, 3, 4, 5, i.e. 3
- If even number of values, it is the average of the two middle values 1, 2, 3, 4, 5, 6, i.e. 3 + 4/2 = 3.5

Mode

- Infrequently reported as a value in studies.
- It is the most common value, e.g. 1, 3, 8, 9, 5, 8, 5, 6
- Mode = 5

Interquartile Range

- It is the range of data from 25th to 75th percentile.
- Common component of a box and whiskers plot
  - It is the box, and the line across the box is the median or middle values

NNT (NUMBER NEEDED TO TREAT)

Definition

The Number Needed to Treat (NNT) is the number of patients you need to treat to prevent one additional bad outcome (death, stroke, etc.). For example, if a drug has an NNT of 5, it means you have to treat 5 people with the drug to prevent one additional bad outcome.

Calculation

To calculate the NNT, you need to know the Absolute Risk Reduction (ARR); the NNT is the inverse of the ARR:

NNT = 1/ARR

Where ARR = CER (Control Event Rate)–EER (Experimental Event Rate).
NNTs are always rounded up to the nearest whole number.

Example: The ARR is therefore the amount by which your therapy reduces the risk of the bad outcome. For example, if your drug reduces the risk of a bad outcome from 50% to 30%, the ARR is:

ARR = CER–EER = 0.5 – 0.3 = 0.2 (20%)

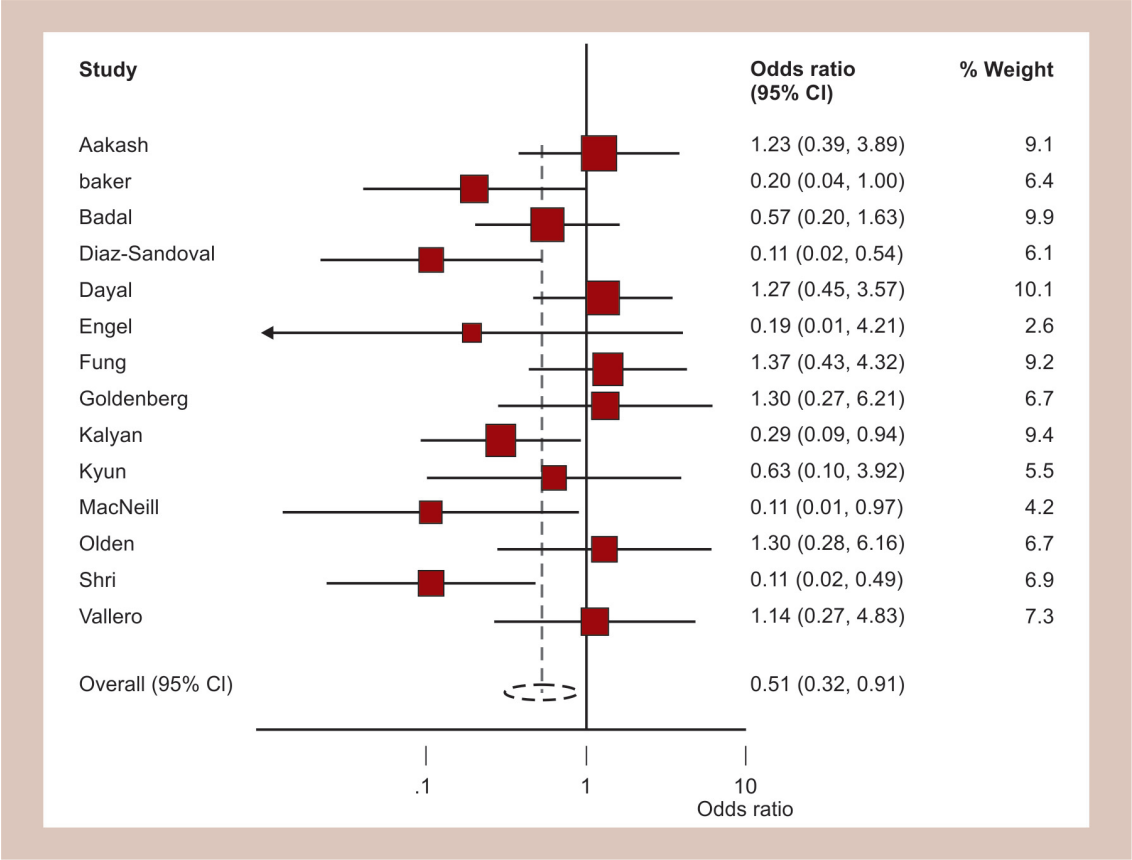
therefore

NNT = 1/ARR = 1/0.2 = 5

EXERCISES

Q.1. ** **May 2013:**

1. What is name of this plot?
2. What is the arrowed figure named as?
3. In given studies, which study shown in best association in view of outcome?
4. Where is this plot used in medical research.



Q.2. You are doing a study is "acupuncture better for depression than medicine". And the result are like this:

1. Calculate the odds ratio.
2. What is its significance in a study?

Acupuncture		Medication	
Improvement	N_A	Improvement	N_M
12	27	6	20

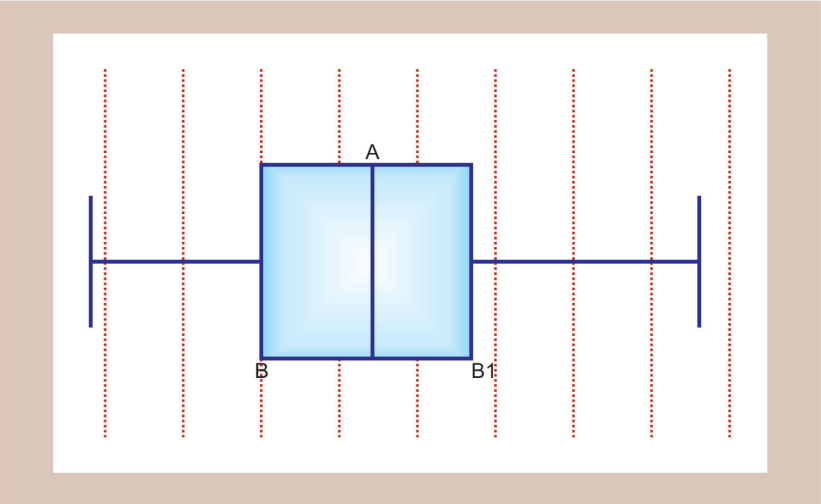
Q.3. In an area the under-5 mortality is 8/1000 live births:

1. Calculate the child survival index in that area and also write down formula for child survival index.

2. Write down formula of incidence, prevalence and stillbirth rate.
3. Write down formula for case fatality rate, attack rate and secondary attack rate.

Q.4.

1. What is the name of this plot?
2. What is its use in medical research?
3. Describe the following points in this plot (points—A and B, B1).



Q.5. ** **The following is a table which shows cigarette smoking and lung cancer:**

1. Calculate the relative risk.
2. What is value of relative risk in medical research?

Cigarette smoking	*Developed cancer*	*Did not develop cancer*
Yes	70	6930
No	3	2997

Q.6. * **On auditing urine growth, following were the result:**

1. Calculate positive predictive value of urine microscopy.
2. Calculate negative predictive value of urine microscopy.
3. Calculate sensitivity and specificity.

Urine microscopy	*Pure growth*	*Multiple growth*
>50 WBC	95(A)	15(B)
<50 WBC	10(C)	200(D)

Q.7. **

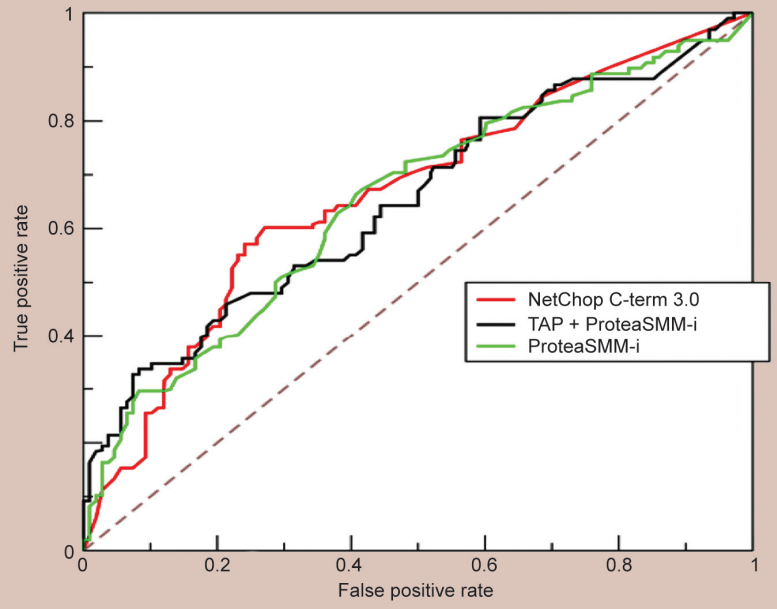
1. Define median, 1st quartile and 3rd quartile.
2. Define rate and ratio. What is difference in these two?
3. What is the difference in "Case control" and "Cohort" study design.
4. What is the difference between incidence and prevalence?

Q.8. Calculate the mean, median, mode, mean deviation and SD of the diastolic pressures given below:**

83, 75, 81, 79, 71, 95, 75, 77, 84, 71, 75, 75, 77, 79, 81, 83, 84, 95.

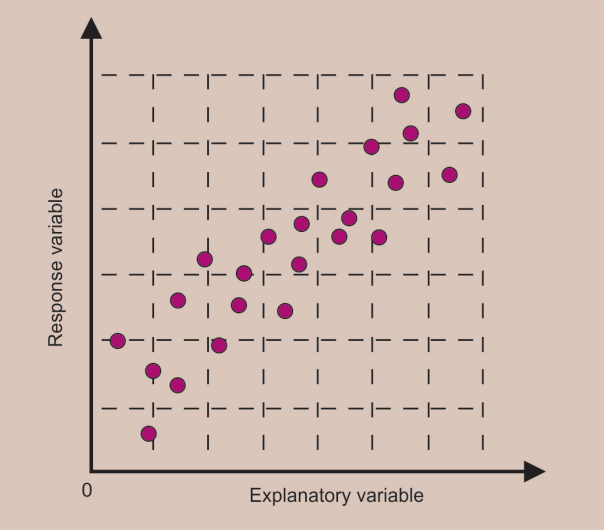
Q.9A.**

1. What is name of curve?
2. What are uses?
3. What does it represent?



Q.9B. Station

1. What is name of curve?
2. What are uses?



Q.10. During a study at hospital the PEFR of 100 adolescences boys follow a normal distribution with a mean of 280 lit/min, standard deviation 30 lit/min and standard error of 2 lit/min.

1. What will be the range in which 95% of the boys PEFR will lie in the sample?
2. What will be the range in which mean PEFR of the population will lie from which the sample was taken?

Q.11. A study was carried out to assess the utility of IgM ELISA test in the diagnosis of leptospirosis. Blood culture positive cases were considered the gold standard for diagnosis. A total of 100 cases were studied.

Leptospira were grown in blood culture in 40 of these cases. IgM ELISA was positive in 70 out of 100 cases. Out of these 70 cases, Leptospira were cultured in 30. IgM ELISA was negative in 30 cases, out of this 30, Leptospira was grown in culture in 10 cases.

Calculate the following for IgM ELISA as a diagnostic test for leptospirosis.

1. Specificity
2. Sensitivity
3. Positive predictive value
4. Negative predictive value

Q.12. A new rapid test was compared with the gold standard of blood culture for diagnosing enteric fever. Of total 500 fever cases, culture was positive in 400 children. Rapid test was positive in 300 children and both culture and rapid test were positive in 260 children.

1. Calculate the following for the rapid test:
   a. Sensitivity
   b. Specificity
   c. Positive predictive value
   d. Negative predictive value
   e. Likelihood ratio positive
   f. Likelihood ratio negative

Q.13. Write following journal article in Vancouver style.

Article: Hand grip strength and its relationship with birth weight in adolescent population
Authors: Bhargava S, Sharma M and Kalra E
Journal: Indian Pediatrics: Year 2013, volume 78, page 301–305

Q.14. Yearly data (for year 2000) pertaining to deliveries and their outcome in a community is as follows:

No. of total births: 10000
No. of stillbirths: 80
No. of preterm deliveries: 1500
No. of newborn deaths
In first week of life: 320
During 2–4 weeks of life: 180
No. of deaths during first year of life: 500
Calculate perinatal and neonatal mortality rates for this community, demonstrating the steps taken to arrive at the results.

Q.15. Match the following:

Level of evidence	*Characteristics*
I	Case series
II	Lesser quality RCT (e.g. <30% follow up; no blinding; improper randomization/systematic review of level II RCT)
III	Expert opinion
IV	High quality RCT with statistically significant difference or no statistically significant difference but narrow confidence interval/systematic review of level I RCT
V	Case control study, observational, retrospective comparative study/systematic review of level III RCT

Q.16. Determine the sample size to find out the vitamin A requirement in the under five children of Pune district. From the existing literature the mean daily requirement of the same was documented as 930 I.U. with a SD of 90 IU. Consider the precision as 9.

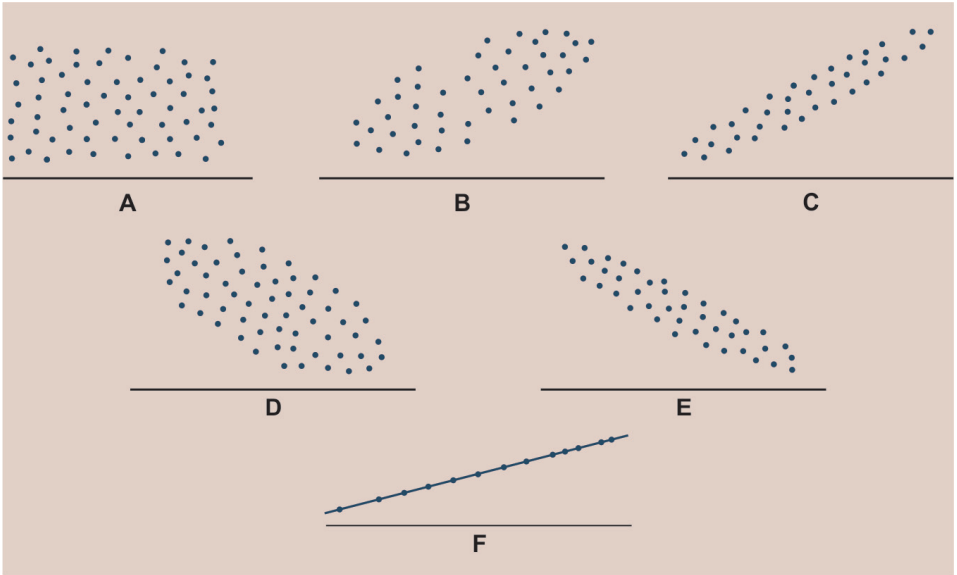
Q.17. The peak flow rates of 10 children of same age are as follows:

250, 260, 290, 200, 240, 240, 260, 270, 270, 290

1. What is the range?
2. What is the mean deviation and mean?
3. What is the standard deviation?

Q.18.

1. Identify diagram.
2. What are the uses?
3. Name each components A to F along with interpretation of each.



ANSWERS

Ans. 1. 1. Forest plot 2. Diamond 3. Study by Kalyan 4. Meta-analysis

Ans. 2. 1. $\text{OR} = \dfrac{\text{n (Exposed)}}{\text{n (Non-exposed)}}$

$$= \frac{12/15}{6/14} = 1.86 \text{ to } 1.9$$

2. Outcome variable is 1.9 times more in the acupuncture group than in the medicine group.

Ans. 3. 1. $\text{Child survival index} = \dfrac{1000 - \text{under 5 mortality}}{10}$

$$= \frac{1000 - 8}{10} = 99.2$$

2. $\text{Incidence} = \dfrac{\text{Number of new cases of a disease during a given period of time}}{\text{Population at risk}} \times 1000$

$\text{Prevalence} = \dfrac{\text{Number of old + new cases}}{\text{Population at given time}} \times 100$

$\text{Stillbirth date} = \dfrac{\text{Number of fetal deaths (with weight >1000 g)}}{\text{Total live + stillbirths (with weight > 1000 g)}} \times 1000$

3. $\text{Case fatality rate} = \dfrac{\text{Total number of deaths due to a particular disease}}{\text{Total number of cases due to the same disease}} \times 100$

$\text{Attack rate} = \dfrac{\text{Number of cases in a year of a disease}}{\text{Number of population at risk for the same disease}}$

$\text{Secondary attack rate} = \dfrac{\text{Secondary cases}}{\text{Number of susceptible person came in contract}}$

Ans. 4. 1. Box-and-whisker plot
2. They display a statistical summary of a variable: Median, quartiles, range and possibly extreme values.
   – The central box represents the values from the lower to upper quartile (25–75 percentile).
3. A. The middle line represents the median.
   B. 25 quartile
   B1–75 quartile

Ans. 5. 1. RR = Incidence of disease in exposed/incidence of disease in non-exposed

$\text{Incidence of disease in exposed} = \dfrac{70}{7000} = 10 \text{ per } 1000$

Incidence of disease in non-exposed $= \frac{3}{3000} = 1$ per 1000

So RR $= \frac{10}{1} = 10$

2. Incidence of disease is 10 time in cigarette smoker than non-smoker.

Ans. 6. 1. PPV = True positive/true positive + false positive

$$\frac{95}{(95+15)} = 86.3\%$$

2. NPV = True negative/true negative + false negative

$$\frac{200}{(200+10)} = 95.2\%$$

3. Sensitivity $= \frac{A}{A+C} = \frac{95}{105}$

Specificity $= \frac{D}{D+B} = \frac{200}{215}$

Ans. 7. 1. If the observations are arranged in ascending or descending order:
Median: 50% observations are below and 50% above this value
1st quartile: 25% observations are below and 75% above this value
3rd quartile: 75% observations are below and 25% above this value

2. *Rate:* Numerator is part of denominator
Ratio: Numerator is not part of denominator

3. Case control study is retrospective and cohort study is prospective

4. *Incidence:* The number of new cases occuring in defined population during a specified period of time
Prevalence: Number of all cases old or new at a given point of time or over a period of time in a given population

Ans. 8. Mean = 80 Median = 79 Mode = 75 MD and SD = Value

Ans. 9A. 1. A **receiver operating characteristic** (**ROC**) curve.

2. ROC analysis provides tools to select possibly optimal models and to discard suboptimal ones.

3. It is a graphical plot of the sensitivity, or true positive rate, versus false positive rate (1-specificity or 1-true negative rate), for a binary classifier system as its discrimination threshold is varied.

Ans. 9B. 1. A scatter plot chart

2. It displays series as a set of points specified by x and y coordinates. A scatter plot is useful for showing nonlinear relationships between variables. It requires at least one category and two series (representing the x and y coordinates).

Ans. 10. 1. Range in which 95% of girls PEFR in the sample will lie:
Mean +/–2SD = 280 +/–2(30) = 220 – 340

2. Range in which mean PEFR value will lie: Mean +/– 2SE (standard error)
95% Confidence interval = 280 +/–2(2) = 276 – 284

Ans. 11.

	Blood c/s+	*Blood c/s–*	
IgM ELISA +	30(a)	40(b)	70
IgM ELISA –	10(c)	20(d)	30

1. Specificity:

$$\frac{d}{d+b} \times 100, \quad \frac{20}{20+40} \times 100 = 33.3\%$$

2. Sensitivity:

$$\frac{a}{a+c} \times 100, \quad \frac{30}{30+10} \times 100 = 75\%$$

3. Positive predictive value:

$$\frac{a}{a+b} \times 100, \quad \frac{30}{30+40} \times 100 = 42.85\%$$

4. Negative predictive value:

$$\frac{d}{c+d} \times 100, \quad \frac{20}{10+20} \times 100 = 66.6\%$$

Ans. 12.

	Culture positive	*Culture positive*	
Rapid test positive	260(a)	40(b)	300(a+b): Test positive
Rapid test negative	140(c)	60(d)	200(c+d): Test negative
Total	400: Disease positive	100: Disease negative	500: Total

- Sensitivity: a/a + c = 260/400 = 65%
- Specificity: d/b + d = 60/100 = 60%
- Positive predictive value: a/a + b = 260/300 = 87%
- Negative predictive value: d/c + d = 60/200 = 30%
- Likelihood ratio positive = sensitivity/1-specificity = 0.65/0.4 = 1.625
- Likelihood ratio negative = 1-sensitivity/specificity = 0.35/0.6 = 0.58

Ans. 13. Author's surname initials. Title of Article, Title of Journal [abbreviated]. Year of Publication, Month and Date; Volume Number (Issue Number): Page numbers.

- Bhargava S, Sharma M and Kalra E. Hand grip strength and its relationship with birth weight in adolescent population. Indian Pediatr. 2013; 78: 301–5.

Ans. 14. 1. Perinatal mortality rate:

$$= \frac{80+320}{10,000} \times 1,000$$

= 40 per 1000 live births.

2. Neonatal mortality rate:

$$= \frac{320 + 180}{10,000} \times 1000$$

= 50 per 1000 live births.

Ans. 15.

Level of evidence	*Characteristics*
I	High quality RCT with statistically significant difference or no statistically significant difference but narrow confidence interval/systematic review of level I RCT
II	Lesser quality RCT (e.g. <30% follow-up; no blinding; improper randomization)/systematic review of level II RCT
III	Case control study, observational, retrospective comparative study/systematic review of level III RCT
IV	Case series
V	Expert opinion

Ans. 16. $N = 4SD^2/L^2$

$$\frac{4 \times 90 \times 90}{9 \times 9} = 400$$

Ans. 17. 1. 200 to 290

2. Mean deviation = $\frac{\Sigma (x - \bar{x})}{N}$

Mean: 257, mean deviation: 19.8

3. Standard deviation = $\sigma = \sqrt{\frac{\Sigma (x - \bar{x})^2}{N}}$

N when sample size >30

(N–1) when sample size <30

- Take the deviation of each value from mean (x–x)
- Square each $(x–x)^2$
- Add and squared deviation $\Sigma (x–x)^2$
- Divide by no. of observation or n – 1 if <30
- Then take square root

Ans. 18. 1. Scatter diagram and correlations.

2. A scatter diagram is a tool for analyzing relationships between two variables. One variable is plotted on the horizontal axis and the other is plotted on the vertical axis. The pattern of their intersecting points can graphically show relationship patterns.

3. A. **No correlation** B. **Weak positive correlation**
C. **Strong positive correlation** D. **Weak negative correlation**
E. **Strong negative correlation** F. **Perfect correlation**

CHAPTER 12

Fluid and Electrolyte

BASIC CONCEPTS OF VARIOUS IV FLUIDS

- **Dextrose** 5%:
  Provides fluid and calories without electrolytes. Used in preterm babies or other neonates for titrating sugars.
- **Dextrose** 10%:
  Provides fluid and calories without electrolytes. Used in neonates in first 48 hours of life. Recommended dose in symptomatic hypoglycemia is 2 ml/kg bolus. 10% dextrose means 10 grams dextrose in 100 ml. Similarly 5% dextrose means 5 grams dextrose in 100 ml. So 1 vac (500 ml) of D 5% will provide 25 grams of dextrose.
- **Isotonic saline (0.9% NaCl)**
  The best agent to treat hypotension, hypovolemia, **shock** and salt depletion.
- **RL**
  Most physiological fluid. Solution of choice in patients of burns, dengue shock, etc. Cautiously used in renal failure, avoided in liver failure. 4 mEq/L of K^+ is present.
- **Isolyte M**
  Used in adults or adolescents as maintenance fluid. Best agent to provide **potassium.**
- **Isolyte E:** For correcting acidosis.
- **Isolyte G:** Only fluid to correct metabolic alkalosis and for replacement of gastric losses.
- **Isolyte P:** Contains electrolytes 1/2 of isolyte M. Used in neonates after 48 hours of life. Also useful in pediatric patients.
- Maintenance fluid in pediatric patients are based on **Na^+** requirement, which is roughly 3 mEq/kg + deficit. So, in a 10 kg child normal Na^+ requirement is ~30 mEq/d. This is fulfilled by N/3 or N/4 (i.e. 154/3 or 154/4).
- **Sodium deficit** is calculated using following formula.
  Na^+ deficit = (135 – plasma Na^+) × 0.6 × body weight.
  Hyponatremia should be corrected slowly over 24–48 hours. 1/3rd of the deficit should be corrected or replacement in first 8 hours, 1/3rd is given in next 16 hours and remaining 1/3rd over subsequent 24 hours.

Composition of IV Fluids Per Litre

Type of fluid	*Electrolytes*	*Used in/remarks*
NS (0.9% saline)	Na^+ 154, Cl^- 154	(Isotonic saline with osmolarity 308) used in shock, dehydration, DKA, diarrhea
0.45% NS (Half normal saline)	Na^+ 77, Cl^- 77	Hypernatremia
N/3, N/4, N/5		Hypernatremia
DNS	Na^+ 154, Cl^- 154, Dextrose 5% (50 g/L)	
0.45 DNS (5% dextrose with 0.45% NS)	Na^+ 77, Cl^- 77, Dextrose 50 g	Can be used as maintenance fluid in children after initial correction
RL	Na^+ 130, Cl^- 109, K^+ 4, Ca^{++} 3, HCO_3^- 29	Most physiological fluid. (Osmolarity 273) Preferred in burns, dengue shock, intraoperative
Isolyte P	Glu 50 g Na^+ 25, Cl^- 22, K^+ 20, Acetate 23, PO_4^{-3}	Maintenance fluid in 1–4 year
Isolyte M	Glu 50 g Na^+ 40, Cl^- 30 **K^+ 35,** Acetate 20, PO_4^- 15	Maintenance fluid in adolescents
10% Dextrose	Glu 100 g	Fluid for neonates day 1, 2
5% Dextrose	Glu 50 g	Day 1, 2 fluid for ELBW preterms, fluid for starvation deficit

Remember

- Fluids useful for correction of acidosis → NS
- Fluids of choice for correction of dehydration in diarrhea → RL, NS.
- Fluid useful to improve microcirculation—dextran 40 (colloid)
- Plasma expanders → albumin, hetastarch, dextran and other colloids.
- In neurosurgical cases or in a patient of stroke → NS given and dextrose containing fluids are avoided.

Biomedical Waste (Management and Handling) Rules 2011

Schedule I
Category of Biomedical Waste

Category	*Waste type*	*Treatment/disposal*
1.	Human anatomical waste (tissues, organs, body parts)	Incineration
2.	Animal waste	Incineration
3.	Microbiological and biotechnology and other laboratory waste (lab waste included in category 8 in earlier rules is included here, note that category 8 has been scraped in 2011 rule)	Disinfection at source by chemical treatment. *or* Autoclaving/microwaving followed by mutilation/shredding. Then final disposal of above by secured landfill or disposal of recyclable waste (plastic/glass) by authorised cyclers.
4.	Waste sharps (needle, syringes, blade scalpel) Note: That glass syringes with fixed needle come in this category and disposable syringe with needle removed in cat 7.	Disinfection by chemical treatment or destruction by needle cutters, autoclaving, microwaving followed by mutilation/ shredding. Then final disposal into secured land fill or in designated concrete waste sharp pit.
5.	Discarded medicine/cytotoxic drugs	Disposal in secured landfill/incinera-tion
6.	Soiled waste (Items contaminated with blood and body fluid as cotton, dressing, soiled pop, linen, beddings)	Incineration
7.	Infectious solid waste (Disposable waste other than sharps including tubings, IV sets, gloves, saline bottle, catheters)	Disinfection by chemical/autoclaving/ microwaving followed by mutilation/ shredding. Then finally sent for recycling.
8.	Chemical waste (Chemical used in production of biologicals/used in disinfection)	Chemical treatment and discharge into drains, solids into secured landfill

Colour Coding and Type of Container for Disposal of Biomedical Wastes

Colour coding	*Type of container to be used*	*Waste category number*	*Treatment options as schedule I*
Yellow	Non-chlorinated plastic bags	Category 1, 2, 5, 6	Incineration
Red	Non-chlorinated plastic bags/puncture proof container for sharps	Category 3, 4, 7 (4-waste sharps) (In the earlier rules, soiled wastes are for red colour)	As per schedule I (Rule 7)
Blue	Non-chlorinated plastic bags container	Category 8 (chemical wastes)	As per schedule I (Rule 7)
Black	Non-chlorinated plastic bags	Municipal waste	Disposal in municipal dump sites

MAINTENANCE REQUIREMENTS

HOLLIDAY-SEGAR METHOD

Example: Based on the Holliday–Segar method, determine the correct fluid rate for an 8-year-old child weighing 24 kg:

4 ml/kg/hr × 10 kg = 40 ml/hr (for first 10 kg)
2 ml/kg/hr × 10 kg = 20 ml/hr (for second 10 kg)
1 ml/kg/hr × 4 kg = 4 ml/hr (per additional kg)
} 24 kg = 64 ml/hr

Or

100 ml/kg/day × 10 kg = 1000 ml/day (for first 10 kg)
50 ml/kg/day × 10 kg = 500 ml/day (for second 10 kg)
20 ml/kg/day × 4 kg = 80 ml/day (per additional kg)
} 25 kg = 1580 ml/day

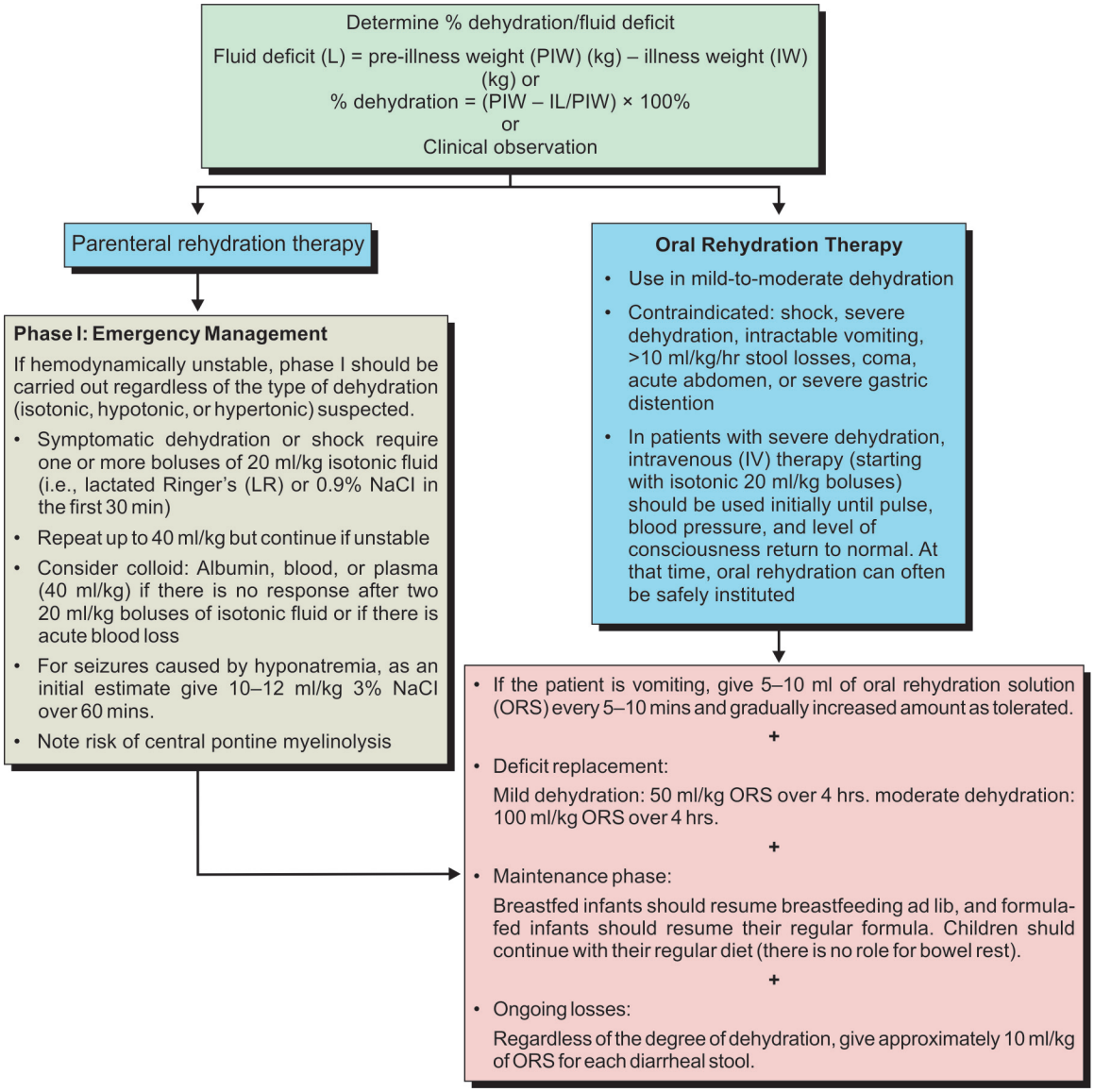
DEFICIT THERAPY

Fluid deficit (L) = pre-illness weight (kg) – illness weight (kg)
% Dehydration = (pre-illness weight – illness weight)/pre-illness weight × 100%

Table 12.1: Clinical Observations in dehydration

Examination	*3% (30 ml/kg)* *5% (50 ml/kg)*	*Older child* *6% (60 ml/kg)* *infant* *10% (100 ml/kg)*	*9% (90 ml/kg)* *15% (150 ml/kg)*
Dehydration	Mild	Moderate	Severe
Skin turgor	Normal	Tenting	None
Skin (touch)	Normal	Dry	Clammy
Buccal mucosa/lips	Moist	Dry	Parched/cracked
Eyes	Normal	Deep set	Sunken
Tears	Present	Reduced	None
Fontanelle	Flat	Soft	Sunken
CNS	Consolable	Irritable	Lethargic/obtunded
Pulse rate	Normal	Slightly increased	Increased
Pulse quality	Normal	Weak	Feeble/impalpable
Capillary refill	Normal	~2 sec	>3 sec
Urine output	Normal	Decreased	Anuric

Flowchart 12.1: Dehydration management



DEHYDRATION CALCULATION

The extracellular fluid space is about 20% of the body's weight (40% in the newborn) and is divided 3:1 between interstitial (15% of body weight) and intravascular (5% of body weight).

Intracellular Fluid (ICF) and Extracellular Fluid (ECF) Compartments

1. Normal ICF and ECF composition
2. In dehydration, there are variable losses from the extracellular and intracellular compartments. The percentage deficit from these compartments is based on the total duration of illness.
   a. Illness <3 days: 80% ECF deficit, 20% ICF deficit.
   b. Illness ≥3 days: 60% ECF deficit, 40% ICF deficit.

3. Electrolyte deficit (from ECF and ICF losses):
   Na^+ deficit (mEq) = fluid deficit (L) × proportion from ECF × Na^+ concentration (mEq/L) in ECF
   K^+ deficit (mEq) = fluid deficit (L) × proportion from ICF × K^+ concentration (mEq/L) in ICF

EXERCISES

Q.1. Mohan, 2-year-old child, weighing 10 kg is admitted with loose stools and vomiting with no obvious signs of dehydration. His serum sodium is 161 mEq/L and serum potassium is 3.5 mEq/L. Urine output is adequate:

1. Calculate the free water deficit
2. Write the fluid orders for this child.

Q.2. 2-year-old child weighing 9.2 kg brought to the hospital with dehydration (8%). Na: 172, K: 4.2, Cl: 101, blood sugar: 80 mg/dL, BUN: 65, serum creatinine: 1. Calculate (with formulae) and write final IV fluid orders for first 24 hours.

Q.3. In relation to hyponatremia in a child:

1. What is the dreaded complication of overzealous correction of hyponatremia in children?
2. This complication is more common during correction of chronic than acute hyponatremia—True/False.
3. What is the advisable rate of correction of hyponatremia to prevent this complication in case of hyponatremia?
4. When do the clinical features develop in this condition?
5. What are the neurological features seen?

Q.4. A 10-year-old child meets with a RTA and has injury to the cervical region. Vitals are as follows: Airway partially obstructed with snoring noises, RR: 22/min, paradoxical breathing, mild retractions, SpO_2: 95%, HR: 78/min, peripheral pulses are feeble, cold extremities, BP: 88/36, cold peripheries, GCS: 13/15.

1. What is the physiological status of this child?
2. What is the probable cause of shock?
3. What are the points in favor of your diagnosis?
4. Initial steps in management.

Q.5. Write total parental nutrition order for a 3-year-old boy with weight of 10 kg who is getting all his drugs and infusions in 200 ml of 5% dextrose.

Q.6. Serum Na: 136, Cl: 101 and HCO_3: 10

1. What is the anion gap?
2. What is the normal anion gap?
3. In which of the following is anion gap normal or increased?
   - Diarrhea
   - ARF
   - Urinary tract diversion
   - Post-hypocapnea
   - Lactic acidosis
   - RTA
   - IEM
   - DKA
   - Salicylate poisoning
   - Septic shock

Q.7.

1. How will you replace ongoing loss in diarrhea?
2. What is the average composition of diarrhea and gastric fluid with respect to
   - Sodium
   - Potassium
   - Bicarbonate/Chloride

ANSWERS

Ans. 1. FWD = 0.6 × weight × (1–145/current sodium)
= 560 ml

Hypernatremia should be corrected over 48 hours (slowly)
Serum sodium should be monitored serially (6–8 hourly)
Fluid order for each day = maintenance fluid + half of FWD + ongoing losses
Adequate urine out implies 2 ml/kg/hour = 480 ml/day
(Maintenance fluid = 1000 ml + half of FWD = 280 ml + ongoing losses = 480 ml total fluid requirement per day = 1760 ml)
.45DNS 440 ml IV Q 6 hourly with 5 mEq inj KCl in each 500 ml of IV fluid to be given each day for two days.

Ans. 2. Pre admission weight 10 kg (10 kg – 8% = 9.2 kg)

- FWD = 450 = 3 ml/kg (Na >170) × 10 kg × 15 mEq (target reduction max 15 mEq)
- TFD = 8 × 10 × 10 = 800
- SFD = 800 – 450 = 350
- Solute Na deficit = 0.6 × 145 × 0.35 = 30.5
- Solute K deficit = 0.4 × 150 × 0.35 = 21
- Maintenance:
- Water 1000/Na 30/K 20
- 1st 24 hours:
  - Fluids: Maintenance + ½ FWD + SFD = 1575 ml
- Fluids: Maint + ½ FWD + SFD = 1575 ml
- Total Na 30 + 30.5 = 60
- Total K 20 + 21 = 41
- 500 ml (5% dextrose) + 7 ml CRL + 7 ml KCl at a rate of 65 (60) ml/hour.

Ans. 3.

1. Central pontine myelinolysis/osmotic demyelination syndrome.
2. True
3. Not >12 mEq/L/day (usually .5 mg/L/hour)
4. **At least 2–6 days after the rapid correction of hyponatremia**
5. Spastic quadri-/paraparesis, locked-in syndrome, obtundation, seizures, dysarthria.

Ans. 4.

1. Airway obstructed/respiratory distress/hypotensive shock/ALOC
2. Neurogenic shock
3. Normal heart rate, paradoxical breathing (diaphragmatic breathing), hypotensive shock and wide pulse pressure.
4. Initial steps in management:
   a. Stabilise airway by jaw-thrust maneuver, C-spine immobilisation.
   b. High flow O_2 by NRBM
   c. Trendelenberg position
   d. Isotonic fluid NS 20 ml/kg boluses as rapidly as you can up to 3 boluses/till perfusion improves and ionotropes if fluid refractory.
   e. Look for and evaluate other life-thtreatening conditions like systemic bleeding and pneumothorax.

Ans. 5.
- Fluids 100 ml/kg = 1000 ml
- 200 ml 5% dextrose = Calories = 10 × 3.4 = 34
- Total calories needed = 1000
- Protein 2 g/kg = 20 g
- Fat 3 g/kg = 30 g × 10 = 300 cal
- 20% fat 150 ml = 110 cal
- 20% amino acid solution = 100 ml = 80 cal
- 1000 – 410 = 590 cal in 600 ml
- 25% dextrose 600 ml = 150 × 3.4 = 510 cal
- Na 3 × 10 = 30
- K 2 × 10 = 20, 30/600 ml = 1/20 = 50/1000, N/3
- 20/600 = 1/30 = 3.3/100 = 1.5 ml, KCl/100 ml
- 1 ml KCl =2 mEq
- Final order = 600 ml N/3 in 25% dextrose with KCl 1.5/100 IV over 24 hr
- 150 ml 20% intralipid over 18 hour
- 100 ml 20% amino acid IV over 24 hour

Ans. 6.
1. (136)–(102 + 10) = 24
2. 8–16
3. Diarrhea—normal
   - Lactic acidosis—increased
   - DKA—increased
   - ARF—increased
   - RTA—normal
   - Salicylate—increased
   - Urinary tract diversion—normal
   - IEM—increased
   - Septic shock—increased
   - Post-hypocapnea—normal

Ans. 7.
1. Replace stools ml by ml every 1–6 hours using:
   D5 0.2 Normal saline + 20 mEq/L Sod bicarb + 20 mEq/L KCl
2. Average composition of diarrhea with respect to

	Diarrhea	*Gastric fluid*
• Sodium	55 mEq/L	60 mEq/L
• Potassium	25 mEq/L	10 mEq/L
• Bicarbonate	15 mEq/L	_____
• Chloride	_____	90 mEq/L

CHAPTER 13

Immunization

PROCESS

The process for issuing recommendations included review of recent published literature including standard indexed journals, vaccine trials, recommendations of reputed international bodies like Advisory Committee on Immunization Practices, Center for Disease Control and Prevention (CDC), USA, World Health Organization (WHO) and unpublished data from vaccine manufacturers. Data generated by studies done in India was specifically looked at and available local information was given preference. The summary of the key updates of ACVIP 2020–2021 recommendations is given in Box 13.1.

Box 13.1: Key Updates and Major Changes in Recommendations for IAP Immunization Timetable 2020/21

Polio immunization

- A booster of the injectable polio vaccine (IPV) is recommended at 4–6 years.
- The importance of IPV in the immunization schedule is re-emphasized.

Inactivated influenza vaccines

- A uniform dosing of 15 µg (0.5 ml) of inactivated influenza vaccines is recommended for all children older than 6 months.

Varicella vaccine

- The second dose of varicella vaccine should preferably be administered 3–6 months after the first dose.

New vaccines introduction

- DTaP/IPV combination vaccine: Tetraxim
- Quadrivalent conjugate meningococcal vaccine: Menveo
- Monoclonal antibody cocktail for post exposure prophylaxis of rabies: Twinrab
- Conjugate (CRM 197) typhoid vaccine: Typhi BEV
- 10-valent pneumococcal conjugate vaccine: Pneumosil.

RECOMMENDATIONS

The ACVIP-IAP recommendations for the year 2020–21 are being given in Tables 13.1 and 13.2. The recommendations about the newly introduced vaccines are summarized in Box 13.2 and vaccines for high risk children are summarized in Box 13.3. Rabies immunoglobulin and monoclonal antibody updates are shown in Table 13.3.

Box 13.2: IAP-ACVIP Recommendations on Newer Vaccines

- Approves the use of Menveo vaccine in the 2–55 years age group. It reiterates the use of this vaccine only in special situations, as published before [45].
- Approves the use of Typhibev vaccine for age >6 months and up to 45 years as single dose. There is no recommendation for a booster dose.
- Recommends the use of rabies mAbs over RIGs in the management of category 3 bites. Human monoclonal rabies antibody (Rabishield) and murine cocktail monoclonal rabies antibodies (Twinrab), both are available in India and approved for the post-exposure management of suspected rabies exposure.
- Approves the use of Tetraxim for the second booster of DPT/IPV at 4–6 years of age.
- Approves the use of Pneumosil till 2 years of age in a 3+1 schedule, with the booster administered between 12–18 months.
- In the absence of studies in the 2–5 years age group, the ACVIP does not presently recommend the use of Pneumosil beyond 2 years of age.

Box 13.3: IAP Recommended Vaccines for High-risk Children

Vaccines

1. Meningococcal vaccine
2. Japanese encephalitis (JE) vaccines
3. Oral cholera vaccine
4. Rabies vaccine
5. Yellow fever vaccine
6. Pneumococcal polysaccharide vaccine (PPSV 23)

High-risk conditions

1. Congenital or acquired immunodeficiency (including HIV infection, immunosuppressive therapy, radiation)
2. Chronic cardiac conditions
3. Chronic pulmonary conditions (including asthma if treated with prolonged high-dose oral corticosteroids),
4. Chronic systemic diseases: Renal (including nephrotic syndrome), hematological, hepatic diseases, diabetes mellitus
5. Functional/anatomic asplenia/hyposplenia
6. Cerebrospinal fluid leaks, cochlear implants; for pneumococcal infections

Specific high-risk groups

1. Children having pets in home: Rabies vaccine
2. JE endemic areas: Japanese encephalitis vaccine
3. During outbreaks: Oral cholera vaccine
4. For travelers rabies vaccine, meningococcal vaccine, yellow fever vaccine.

Table 13.1: IAP immunization timetable 2020–21: IAP recommended vaccine for routine use

Age	*Vaccines*	*Comments*
Birth	BCG OPV Hepatitis B-1 (BD)	BCG: Before discharge OPV: As soon as possible after birth Hep B should be administered within 24 hours of birth
6 weeks	DTwP/DTaP-1 IPV-1 Hib-1 Hep B-2 Rotavirus-1 PCV-1	DTwP or DTaP may be administered in primary immunization IPV: 6–10–14 weeks is the recommended schedule. If IPV, as part of a hexavalent combination vaccine, is unafforadable, the infant should be sent to a government facility for primary immunization as per UIP schedule.
10 weeks	DTwP/DTaP-2 IPV-2 Hib-2 Hep B-3 Rotavirus-2 PCV-2	RV1:2-dose schedule; all other rotavirus brands: 3-dose schedule
14 weeks	DTwP/DTaP-3 IPV-3 Hib-3 Hep B-4 Rotavirus-3 PCV-3	An additional 4th dose of Hep B vaccine is safe and is permitted as a component of a combination vaccine
6 months	Influenza (IIV)-1	Uniform dose of 0.5 ml for DCGI approved brands
7 months	Influenza (IIV)-2	To be repeated every year, in pre-monsoon period, till 5 years of age
6–9 months	Typhoid conjugate vaccine	As of available data, there is no recommendation for a booster dose
9 months	MMR-1	
12 months	Hepatitis A	Single dose for live attenuated vaccine
15 months	MMR-2, Varicella-1, PCV booster	
16–18 months	DTwP/DTaP-B1, Hib-B1, IPV-B1	
18–19 months	Hep A-2, Varicella-2	Only for inactivated Hep A vaccine
4–6 years	DTwP/DTaP-B2, IPV-B2, MMR-3	
10–12 years	Tdap, HPV	Tdap is to be administered even if it has been administered earlier (as DTP-B2) HPV: 2 doses at 6 months interval between 9–14 years; 3 doses: from 15 years or immunocompromised of any age (0–1–6 months for HPV2, 0–2–6 months for HPV4)

Age in completed weeks/month/years.

Table 13.2: ACVIP recommendations 2020–21

Vaccine	Age in completed weeks/months/years															
	Birth	6w	10w	14w	6m	7m	9m	12m	13m	15m	16-18m	18-24m	2-3 Y	4-6 Y	9-14 Y	15- 18 Y
BCG																
Hepatitis B	HB 1[a]	HB 2	HB 3	HB 4[b]												
Polio	OPV	IPV 1[c]	IPV 2[c]	IPV 3[c]							IPV[c] B1			IPV[c] B2		
DTwP/DTaP		DPT 1	DPT 2	DPT 3							DPT B1			DPT B2		
Hib		Hib 1	Hib 2	Hib 3							Hib B1					
PCV		PCV 1	PCV 2	PCV 3				PCV B								
Rotavirus		RV 1	RV 2	RV 3[d]												
Influenza					Dose 1[e]	Dose 2	Annual Vaccination									
MMR							Dose 1			Dose 2				Dose 3		
TCV																
Hepatitis A								Dose 1				Dose 2[f]				
Varicella										Dose 1		Dose 2[g]				
Tdap[h]/Td																
HPV															1 & 2[i]	1, 2 & 3[i]
Meningococcal[k]							Dose 1	Dose 2								
JE								Dose 1	Dose 2							
Cholera								Dose 1	Dose 2							
PPSV 23																
Rabies																
Yellow Fever																

Recommended age **Catch up age range** **Vaccines in special situations**

(a) To be given within 24 hours after birth. When this is missed, it can be administered at first contact with health facility; (b) An extra dose of hepatitis B vaccine is permitted as part of a combination vaccine when use of this combination vaccine is necessary; (c) IPV can be given as part of a combination vaccine; (d) 3rd dose of rota vaccine is not necessary for RV1; (e) Influenza vaccine should be started after 6 months of age, 2 doses 4 weeks apart, usually in the pre-monsoon period. At other times of the year, the most recent available strain should be used. Annual influenza vaccination should be continued, for all, till 5 years of age; after the age of 5 years, this vaccine is recommended in the high-risk group only; (f) Single dose is to be given for the live attenuated hepatitis A vaccine. The inactivated vaccine needs two doses; (g) 2nd dose of Varicella vaccine should be given 3–6 months of age after dose 1. However, it can be administered anytime 3 months after dose 1 or at 4–6 years; (h) Tdap should not be administered as the second booster of DPT at 4–6 years. For delayed 2nd booster, Tdap can be given after 7 years of age. A dose of Tdap is necessary at 10–12 years, irrespective of previous Tdap administration. If Tdap is unavailable/unaffordable, it can be substituted with Td; (i) Before 14 completed years, HPV vaccines are recommended as a 2-dose schedule, 6 months apart; (j) From 15th year onwards and the immunocompromised subjects at all ages, HPV vaccines are recommended as a 3-dose schedule, 0-1-6 (HPV2) or 0-2-6 (HPV4); (k) Menactra is approved in a 2-dose schedule between 9–23 months. Minimum interval between two doses should be 3 months. Menveo is recommended as a single dose schedule after 2 years of age.

Table 13.3: Rabies immunoglobulins and monoclonal antibody updates

1. **Rabies immunoglobulins:**
   i. *Equine rabies immunoglobulin* (*ERIG*): Dosage—40 IU/kg body weight. It is indigenously manufactured; to be used only after skin sensitivity test as per product insert.
   ii. *Human rabies immunoglobulin* (*HRIG*): Dosage—20 IU/kg body weight. It is imported and expensive; no skin sensitivity test required. It is available in prefilled syringe.
2. **Rabies monoclonal antibody:**
   i. *Human RMAb* (*single MAB—Rabishield*^{TM}): Dosage—3.33 IU/kg body weight. Potency: 40 IU/ml.
   ii. *Cocktail of RMAbs* (*Docaravimab and Miromavimab-Twinrab*^{TM}): Dosage—40 IU/kg body weight. Potency: 600 IU/mL.

   No skin sensitivity test required before administration of RMABs

The WHO (2018) recommends that if available, the use of RMAbs instead of RIG is encouraged.

Procedure of RIG/RMAb administration: As must of the calculated dose of RIG/RMAb, as is anatomically feasible, should be infiltrated into and around all the wounds. The RIG/RMAb shall be injected into the edges and base of the wound(s) till traces of RIG/RMAb oozes out. The remainder of the calculated dose of RIG does not need to be injected IM at a distance from the wound but can be fractionated in smaller, individual syringes to be used for other patients following aseptic precautions.

For multiple bites, the calculated dose of RIG/RMAb may not be sufficient to infiltrate all wounds. In these circumstances, it is advisable to dilute the RIG/RMAb in sterile normal saline to a volume sufficient to inject all wounds. RIGs/RMAbs are always to be used along with rabies vaccine as early as possible. A full course of vaccination should follow thorough cleansing of wounds and passive immunization, otherwise treatment failures can occur.

EXERCISES

Q.1. Mother of a 14-day-old baby came to you to know about the polio vacine:

1. What is meaning of polio drop at birth and what is its significance?
2. What are the contents of OPV and what is the new name of OPV?
3. Why multiple doses of OPV are recommended despite it is a live vaccine?
4. What specific instruction has to be given to the mother after OPV administration?

Q.2. A 32 weeks pregnant lady found to be HBsAg positive, gives birth to a 3 kg male baby:

1. What is the risk of the baby getting hepatitis B infection from mother?
2. How do you protect the baby from getting this infection?
3. Is there a possibility for the baby to be infected in spite of proper management?
4. What is the prognosis in the infected newborns?

Q.3. All vaccines are susceptible to loss of potency when exposed to warm temperatures:

1. What is meaning of cold chain?
2. What is a vaccine carrier?
3. How long can you keep vaccines in a vaccine carrier when going in field for vaccination.

Q.4. Answer the following questions regarding MMR vaccine:

1. What is the upper age limit of giving this vaccine in children?
2. What is the dose and by which route is it given in children?
3. Which of the following side effects may occur after MMR vaccination (True/False)?
   a. Rash immediately after giving the vaccine

b. Parotid swelling
c. Carditis

4. What is the current schedule of MMR vaccine?

Q.5.* Answer the following regarding UIP (Universal Immunization Programme):

1. When was the programme initiated in India?
2. What was the main aim of the UIP?
3. What are the objectives of UIP other than the immunization of children?
4. Name the vaccines used in UIP in India.
5. What are the immunization targets in the UIP?

Q.6. Many vaccines have been licensed for use in India (for routine office use):

1. Name 1 live-attenuated bacterial vaccines used in India.
2. Name 4 live-attenuated viral vaccines used in India.
3. Name 2 killed bacterial vaccines used in India.
4. Name 2 killed viral vaccines.

Q.7. Certain substances like aluminium salts are used in some vaccines as adjuvants:

1. Name 2 vaccines in which adjuvants are used in India.
2. Give 2 advantages of using adjuvants in various vaccine.
3. Give 2 drawbacks of using adjuvants in vacine.
4. Name some newer adjuvants under trial.

Q.8. A 5-year-old well child has no BCG scar. According to the parents a definite scar was present initially. But after that it disappears:

1. What are the possibilities of absence of BCG-scar?
2. Do you need to re-vaccinate with BCG of this child?
3. Can you give BCG to this child along with OPV and DT as he is due for these vaccine?
4. How should you clean the skin before giving BCG?

Q.9. A child has developed a painless nodule in the thigh following DPT injection given 2 months back at thigh:

1. What needs to be done for this condition?
2. What are the contents of a standard recommended dose of DPT vaccine in children?
3. Can DPT vaccine be frozen when not in use?
4. List all absolute and relative contraindications to the use of DTP vaccine.

Q.10. A 13-year-old boy came to casualty for a dose of TT injection as he had sustained a trivial fall. He had received all his immunizations as per schedule and also had been taking TT after every fall in last 3 years.

1. Does he need a dose of TT now for this fall?
2. Are there any hazards of taking repeated unnecessary doses of TT injections?
3. What you know about Td vaccine?

Q.11. A child developed parotid swelling 10 days after MMR vaccine given as per schedule:

1. What is the likely cause of this parotid swelling?
2. Can MMR be given to children who already have had mumps in the past?

3. Should MMR be given only to girls?
4. Should adolescent girls be given MMR vaccine if they have not received vaccine in their childhood?
5. What is recent change in schedule of MMR vaccine in 2021?

Q.12. A mother of 2 children is worried as her husband is down with typhoid from last 4 days and she wants to immunize the children:

1. Do you recommend the children be vaccinated against typhoid?
2. How long does it take before the protection becomes effective following vaccination?
3. What other precautions you would advice the mother about thyphoid.
4. What are the vaccines against typhoid available?
5. What are recent changes in 2021 in typhoid vaccine?

Q.13. Blood banks refuse to take blood from donors with history of jaundice few days back:

1. Does it mean that all cases of jaundice are due to hepatitis B?
2. Can HAV or non-A non-B hepatitis be transmitted through blood transfusion?
3. Does vaccination against hepatitis B protect against hepatitis D also?
4. What is the efficacy of transmission of hepatitis B via infected blood transfusion?

Q.14. A pregnant lady presents with history of dog bite 3 hours back:

1. Is rabies prophylaxis indicated for this lady?
2. Is transplacental transmission of rabies to the foetus possible?
3. Can a lactating mother be given rabies vaccine if dog bite occur.
4. Can neonates be given rabies vaccine?

Q.15. A child presents with history of questionable bite by a stray animal:

1. Is rabies prophylaxis indicated in this child?
2. What is Essen protocol?
3. Can a vaccinated dog transmit rabies to human?
4. What are the dog vaccines available against rabies and what is the commonly used schedule?

Q.16. A doctor would like to give Hib vaccine along with OPV, DPT, Hep B and MMR to his patient at the same sitting:

1. Can all these vaccines be given on the same day in a child?
2. How many types of conjugate vaccines are available against *Haemophilus influenzae* type b?
3. Why are Hib vaccines combined with carrier protein?

Q.17. The parents of a 15-year-old teenager would like to protect her from chickenpox as her exams were nearing. According to them she has never suffered from chickenpox earlier:

1. What is the vaccine available for chickenpox?
2. Would you like to vaccinate her now?
3. If yes, what is the dose schedule?
4. What is the protective efficacy?
5. What is the change in new schedule 2021?

Q.18.* A baby born to a HIV positive mother is brought for immunization at your clinic:

1. Write down IAP vaccine schedule for this child.

2. A 3-month-old baby develop axillary lymphadenitis after BCG vaccine. What will you advice for this?

Q.19. An affluent mother would like to immunize her child against hepatitis A?

1. How many types of vaccines have been licensed for use? And what are recent changes in 2021?
2. Would you vaccinate this child for Hep A?
3. Give two indications for administration of Hep A other than routine schedule.
4. Give other important measures to reduce hepatitis A infection.

Q.20.*

1. Write the vaccination schedule for a child who has been bitten by a dog 3 hours back. The patient had been bitten by the same animal 10 months back and has received a full course of vaccinations at that time.
2. What are classes of dog bite and what are treatment recommended for them?

Q.21. Give the answer about vaccine preparation:

1. What is procedure called lyophylization?
2. Name 3 lyophylized vaccines.

Q.22.*

1. What is meaning of IPV?
2. How many doses IPV are needed in a child first 2 years of life as per IAP recommendations and what are the recent changes?
3. What does VVM mean in context to a polio vaccine vial? And when not to use vaccine according to VVM?
4. The average risk of vaccine induced poliomyelitis with oral polio vaccine.
5. Write down contents of IPV.

Q.23. Draw a figure of a refrigerator (cross section) to illustrate the placement of vaccines, diluent.

Q.24. What is the dosage schedule of new pneumococcal vaccine for a 4-year-old child who is suffering from sickle cell disease? Which new pneumococcal vaccine is available now.

Q.25. A 3-year-old male child from UP, admitted as a case of Japanese encephalitis from last 7 days. Father want to know how can he protect his younger boy of age 17 month from this disease?

1. What is indication for this vaccine?
2. Which vaccine of JE recommended by IAP?
3. What is dose and schedule of JE vaccine?

Q.26.**

1. Name strain/strains of cholera vaccine in India.
2. Name two contraindications (other than hypersensitivity, etc.) for use of cholera vaccine.
3. Name the WHO approved available cholera vaccine.
4. What is available rapid test for diagnosis of cholera?
5. Write two drugs above 9 years of age and two drugs below 9 years of age.

Q.27. Enumerate adolescent (for a 12-year-old) immunization schedule (IAP recommendation): Who has received immunization as per EPI at a government hospital till 8 years.**

Q.28. Mother brings her 14-year-old daughter Geeta for immunization advice. She has already reached her 10 years Tdap and 2nd dose of MMR vaccine:**

1. What vaccine will you advice?
2. Give information on different types of vaccines (with respect to)
   A: Serotype
   B: Schedule
   C: Disease protection

Q.29.* Match the following:

1. BCG	Toxoid and killed bacteria
2. OPV	Live-attenuated bacteria
3. DPT	Bacterial subunit
4. Hib	Viral antigen
5. Hep B vaccine	Live-attenuated viral
6. Typhoid VI	Killed virus
7. Hep A vaccine	Capsular polysaccharide
8. Acellular pertussis	Capsular polysaccharide

Q.30.* Answer the following:

1. What is the diluent used for BCG?
2. What is the diluent used for MMR?
3. How long can reconstituted BCG be used at a vaccine centre?
4. How long can reconstituted MMR be used at a vaccine centre?
5. Name 5 vaccines which should not be frozen at any cost.
6. What does IAP recommend at 5 years (DPT/DT)?

Q.31. Answer the following questions about rabies vaccine:

1. What are class III bites according to WHO bite category?
2. What is the schedule of post-exposure vaccination in a case of dog bite?
3. What is the indications of extended immunisation?
4. What are the prerequisites for wound suture in rabies bite cases?

Q.32. Answer the following questions about meningococcal conjugate vaccine (MCV):

1. Dosage and administration of MCV
2. Composition of MCV
3. Contraindication for MCV

4. IAP recommendations for use (any 2) other than routine use
5. What are two vaccine available of MCV?

Q. 33. A 11-year-old boy Mahesh is brought with a penetrating crush injury with a compound fracture. His immunity and immunization status for tetanus is unknown according to mother. Which of the following action is correct with regard to tetanus prevention?

a. Nothing is required
b. Toxoid 1 dose
c. Toxoid 1 dose + TIG
d. Toxoid complete course + TIG

Q.34. His 8-year-old sister Ritu has multiple clean abrasions. She has earlier received 3 doses of DPT in the first year and 1 booster at 1½ year and no other vaccines after that. What prevention will you carry out?

a. Nothing
b. TT1
c. TT1 + TIG
d. TT complete course + TIG

Q.35. An 8-month-old child Tarun with history of egg allergy in the form of generalized urticaria is brought to your hospital:

1. What advise will you give, e.g. skin testing/contraindication, etc. (w.r.t. his allergy and vaccine) for?
   - MMR, chickenpox vaccine, influenza IM vaccine, intranasal influenza and yellow fever vaccine.
2. Which vaccines (any 2) are contraindicated in patients with allergy to neomycin?
3. What HBV immunization instruction will you give to a newborn 1.8 kg born 2 hours back to a mother whose HBsAG is not known?

Q.36.

1. How will you immunize a child Manish with bleeding disorder?
2. Name the vaccines which can be placed in the freezer compartment of the refrigerator.
3. Write down the time limits for using the following vaccines after reconstitution:
   - Varicella
   - Measles/MMR
4. Write the schedule of rabies vaccine for a person, who has been bitten by a dog but has received 5 doses of rabies vaccine earlier.

ANSWERS

Ans. 1.
1. Polio drops at birth is called zero dose polio drops. It is responsible for better absorption of polio vaccine because in neonatal period as there is no gut flora to interfere. Also as it is the first contact period between the baby and the health care provider, it enables logistic ease of administration.
2. Each dose of OPV contains:
   Type 1: 10^6 $TCID_{50}$
   Type 3: $10^{5.5}$ $TCID_{50}$
   *Type 2 polio antigen has been withdrawl now. New name of oral polio vaccine is Bipolio.
3. Because of poor antigenicity of OPV, multiple doses of OPV are needed for satisfactory seroconversion. Thermal lability requiring stringent cold chain maintenance and interference by enteroviruses in the gut for proper uptake of the oral vaccine.
4. The mother need not be given any specific instructions after OPV, except that she has to report for subsequent immunizations regularly.

Ans. 2.
1. This baby has a 30% chance of getting the infection. If the mother is also HBeAg positive, the risk rises to 80–90%.
2. I will give the first dose of hepatitis B vaccine within 12 hours of birth. Hepatitis B immunoglobulin (HBIg) preferably should also be given to the baby on the other thigh simultaneously. This is then followed by 2 more doses of the vaccine at 1 and 2 months of age and a booster at 1 year of age.
3. Yes, the baby can be found to be infected in spite of proper management if the baby has already acquired the infection *in utero*.
4. Once infected, 90% of the newborns become chronic carriers and 25% of them go onto develop complications like chronic hepatitis, cirrhosis and hepatocellular carcinoma.

Ans. 3.
1. The system of transporting, distributing and storing vaccines under refrigeration using any convenient methods, from the manufacturer right up to the point of use is referred to as the cold chain.
2. A vaccine carrier is a thick-walled, insulated box with a tight lid, used for carrying 6–8 vaccines for use in field.
3. One working day in vaccine carriers.

Ans. 4.
1. No upper age limit
2. 0.5 ml subcutaneous
3. False, True, False
4. Three dose schedule at 9 month, 15 month and 4 years of age.

Ans. 5.
1. UIP watch initiated in 1985.
2. Main aim was to immunize all children before the first birthday against 6 vaccine preventable diseases and TT immunization of pregnant women
3. Self sufficiency in vaccine production
   Establishment of a functional cold chain system
   Introduction of district level monitoring

4. BCG, OPV, DPT, hepatitis B, Hib, rotavirus, PCV and MR, JE and TT in pregnant women
5. 100% coverage

Ans. 6. 1. BCG
2. MMR, OPV, hepatitis A (bio vac A), varicella
3. *V. cholerae*, *B. pertussis*
4. Rabies, Japanese B encephalitis

Ans. 7. 1. DPT, hepatitis B vaccine
2. Adjuvants increase effective particle size and immunogenicity of antigens resulting in antibody production that is many times higher than that evoked by unadjuvanted vaccines.
   They also increase the stability of the vaccines.
3. They induce only humoral immunity and do not enhance the immune response to all antigens
   They increase the cost of the vaccine and also adjuvanted vaccines cannot be frozen but are freeze dried.
4. Liposomes, squalene, live vectors and bacterial products

Ans. 8. 1. Fading away of the scar over time; improper uptake of the BCG due to inadequate potency/improper technique.
2. Mantoux test should be done and if there is no reaction (≥5 mm) even after 12 weeks, then BCG should be repeated.
3. Yes. BCG can be given along with OPV and DT
4. The skin should be cleaned only with sterile water before BCG, as cleaning with spirit/other disinfectants may destroy vaccine bacillus and affect the immune response adversely.

Ans. 9. 1. Nothing needs to be done as a painless residual nodule will resolve on its own
2. Each 0.5 ml contains:
   Diphtheria toxoid 25 Lf
   Tetanus toxoid 5 Lf
   Pertussis 4 I.U (20,000 million killed bacteria)
3. DPT vaccine should never be frozen and it should be stored at 2–8°C
4. Absolute: Encephalopathy, anaphylaxis
   Relative
   a. Temp of >40.5°C or more within 48 hours
   b. Collapse or shock like state presents within 48 hours
   c. Persistent or inconsolable cry lasting 3 hours or more within 48 hours
   d. Convulsions within 3 days, with or without fever.

Ans. 10. 1. No. He does not need a dose of TT now as he has had all his immunizations per schedule
2. Unnecessary doses of TT injections may lead to decreased immunogenicity, hypersensitivity, haemolytic anaemia, amyloidosis.
3. Td vaccine consists of tetanus toxoid: 5 Lf along with a smaller component of diphtheria toxoid: 2 Lf/dose instead of the regular 25 Lf as in DPT, recommended

for use in older children beyond 7 years of age instead of TT, so as to simultaneously boost immunity against both tetanus and diphtheria; DPT/DT should not be given to older children >7 years as it can cause severe reactions.

Ans. 11. 1. It is most likely a side effect of mumps component of the MMR vaccine, as parotitis occurring within 1–2 weeks after vaccination is a known complication.
2. Parotitis itself can have different etiologies other than mumps. Moreover MMR protects against measles and rubella as well, hence MMR can be given to children who have had mumps in the past.
3. MMR should be given to both sexes as both are vulnerable to measles, mumps as well as rubella.
4. It is advisable to give MMR to adolescent girls if they have not received the same in their childhood in order to prevent the possible congenital rubella syndrome in the future offspring especially if the mother has no protective antibodies against rubella. However, pregnancy following the vaccine should be avoided for at least 3 months.
5. 3 doses of MMR at 9, 15 month and 4 year of age.

Ans. 12. 1. It is advisable to immunize the children against typhoid at 6 month of age (conjugated)
2. It takes 2–3 weeks before protection becomes effective following vaccination.
3. Mother should be advised about environmental sanitation, safe drinking water and hygienic food habits.
4. Conjugated vaccine (new)
5. Recent changes 2021 6 month—only conjugated vaccine
   Typhoid conjugate vaccines (6 month to 45 years), available and licensed in india. Only a single dose of the vaccine at 6 month.
   - MMR vaccine should be maintained
   - ***Boosters*:** No need of any booster dose
   - Duration of protection
   - *Catch-up schedule: Up to 45 years*

Ans. 13. 1. Though all cases of jaundice are not due to hepatitis B, it is a fairly common infection in our country, hence blood banks are justified in refusing blood from a donor with history of jaundice.
2. HAV is not transmitted through blood. Non-A non-B hepatitis can be transmitted through blood as well as feco-oral routes.
3. Vaccination against hepatitis B also protects against hepatitis D, as hepatitis D is an incomplete virus and depends on co-existing hepatitis B infection for its growth.
4. Nearly 100%

Ans. 14. 1. Yes, pregnancy is not a contraindication to the vaccine.
2. Transplacental transmission of rabies is not a possibility as rabies virus is of high molecular weight and cannot be transported across the placental barrier.
3. Yes, a lactating mother has to be given rabies vaccine if required as it does not produce any harmful effects on infants.
4. Neonates have to be given rabies vaccine in the event of a bite.

Ans. 15. 1. Yes, even questionable bites by any stray animal does require rabies prophylaxis as risk of rabies overrides all other considerations.

2. Essen protocol is the WHO standard schedule which comprises 5 injections of rabies vaccine on days 0, 3, 7, 14 and 28 or 30.
3. Yes, even vaccinated dogs can transmit rabies especially if they have not received booster doses regularly and also if there was inadequate potency of the vaccine in the first place.
4. Dog vaccines available are: Live-attenuated vaccine, nerve tissue vaccine and tissue culture vaccine.

   Dose: 3 ml single dose followed by booster every 3 years.

Ans. 16. 1. Hib vaccine can be given on the same day as OPV, DPT, Hep B, MMR, but should be given on different limbs.
2. 4 types of conjugate vaccines are available at present: PRP-D, PRP-T, PRP-CRM and PRP-OMP.
3. The vaccines become adequately immunogenic only when combined with a T-cell dependent protein carrier.

Ans. 17. 1. Live-attenuated varicella vaccine containing OKA strain is available.
2. It is advisable to vaccinate her as children acquiring infection in older age groups tend to get a more severe disease. Also, varicella is usually never a subclinical infection. Hence, a nagative past history of chickenpox indicates susceptibility to infection.
3. Two doses of 0.5 ml per dose subcutaneously one month apart.
4. Protective efficacy is said to be 98% in normal vaccines and 80–90% in immunocompromised hosts.
5. Second dose should be given after 3 months of first dose.

Ans. 18. 1. *See* Table 13.4.
2. No treatment needed, if persist than I/D, never use at

Ans. 19. 1. Presently live and inactivated type of vaccines are available 2021—single dose of live vaccine (>12 months of age) and 2 doses of killed vaccine (at 12 and 18 months).
2. If finance is not a constraint the child can be vaccinated as the available vaccine is safe and effective with an efficacy of 95–100% seroconversion.
3. Travellers to endemic areas, laboratory workers.
4. Improved sanitation and personal hygiene.

Ans. 20. 1. 2 doses of the vaccine are recommended on day 0 and 3, only (if history of bite is less than 3 years and when child is fully immunized for that)
2. *See* Table 13.5.

Ans. 21. 1. Live vaccines in powder form and need reconstitution before usage
2. Measles, BCG, MMR and oral typhoid vaccine

Ans. 22. 1. Enhanced potency inactivated polio vaccine (eIPV)
2. IAP-3 doses of 6, 10 and 14 weeks along with DPT and 4th dose at 16–18 months, now 5th dose of IPV is recommended at 4–6 years of age along with DPT.
3. Vaccine vial monitor (VVM) (*see* Fig. 13.1 on page 185)
4. 1 in 2.5×10^6 doses
5. Type 1–40 D
   Type 2–8 D
   Type 3–32 D

Table 13.4: IAPCOI recommendations for immunization of HIV infected children

Vaccine	*Asymptomatic*	*Symptomatic*
BCG	Yes (at birth)	No
DTwP/DTaP/TT/Td/Tdap	Yes as per routine schedule at 6w, 10w, 14w,18m and 5 years	
Polio vaccines	IPV at 6, 10, 14 weeks, 15–18 months and 5 years If indicated IPV to household contacts If IPV is not affordable, OPV should be given*	
Measles vaccines	Yes, at 9 months	Yes if CD4 count >15%
MMR vaccine	Yes, at 15 months and at 5 years	Yes if CD4 count >15%
Hepatitis B	Yes, at 0, 1 and 6 months	Yes, four doses, double dose, check for seroconversion, regular boosters
Hib	Yes as per routine schedule at 6w, 10w, 14w and 18 months	
Pneumococcal vaccines (PCV)	Yes as per routine schedule at 6w, 10w, 14w and 15 months	
Inactivated Influenza vaccine	Yes as per routine schedule beginning at 6 months, revaccination every year	
Rotavirus vaccine	Insufficient data to recommend	
Hepatitis A vaccine	Yes	Yes, check for seroconversion, boosters if needed
Varicella vaccine	Yes, two doses at 4–12 weeks interval	Yes, if CD4 count >15%, two doses at 4–12 weeks interval
Vi typhoid vaccine	Yes as per routine schedule	
HPV vaccine	Yes as per routine schedule 2 doses at 0, 6 months at 9 years	

*OPV has been found to be generally safe in HIV infected especially in early stages

Table 13.5: Categories of contact and recommended post-exposure prophylaxis (PEP)

Categories of contact with suspect rabid animal	*Post-exposure prophylaxis measures*
Category I—touching or feeding animals, licks on intact skin	None
Category II—nibbling of uncovered skin, minor scratches or abrasions without bleeding	Immediate vaccination and local treatment of the wound
Category III—single or multiple transdermal bites or scratches, licks on broken skin; contamination of mucous membrane with saliva from licks, contacts with bats	Immediate vaccination and administration of rabies immunoglobulin; local treatment of the wound

All category II and III exposures assessed as carrying a risk of developing rabies require PEP. This risk is increased if:

- The biting mammal is a known rabies reservoir or vector species;
- The animal looks sick or displays an abnormal behaviour;
- A wound or mucous membrane was contaminated by the animal's saliva;
- The bite was unprovoked; and
- The animal has not been vaccinated.

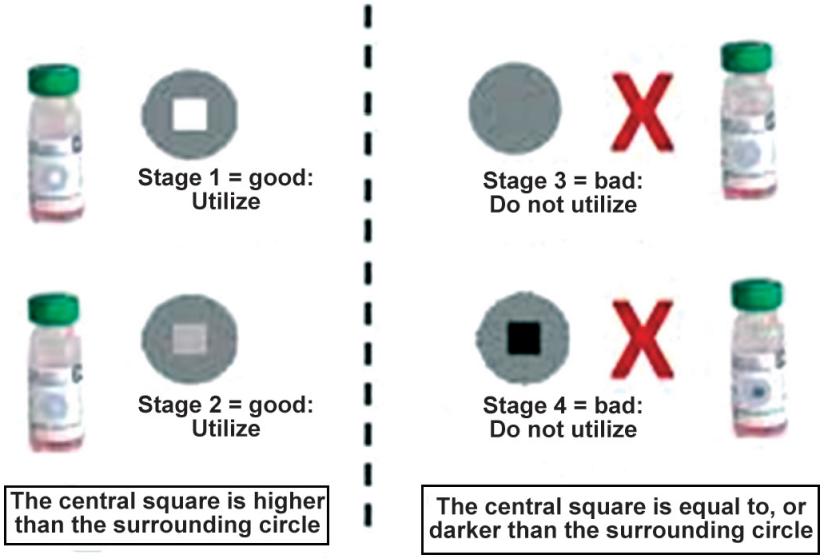
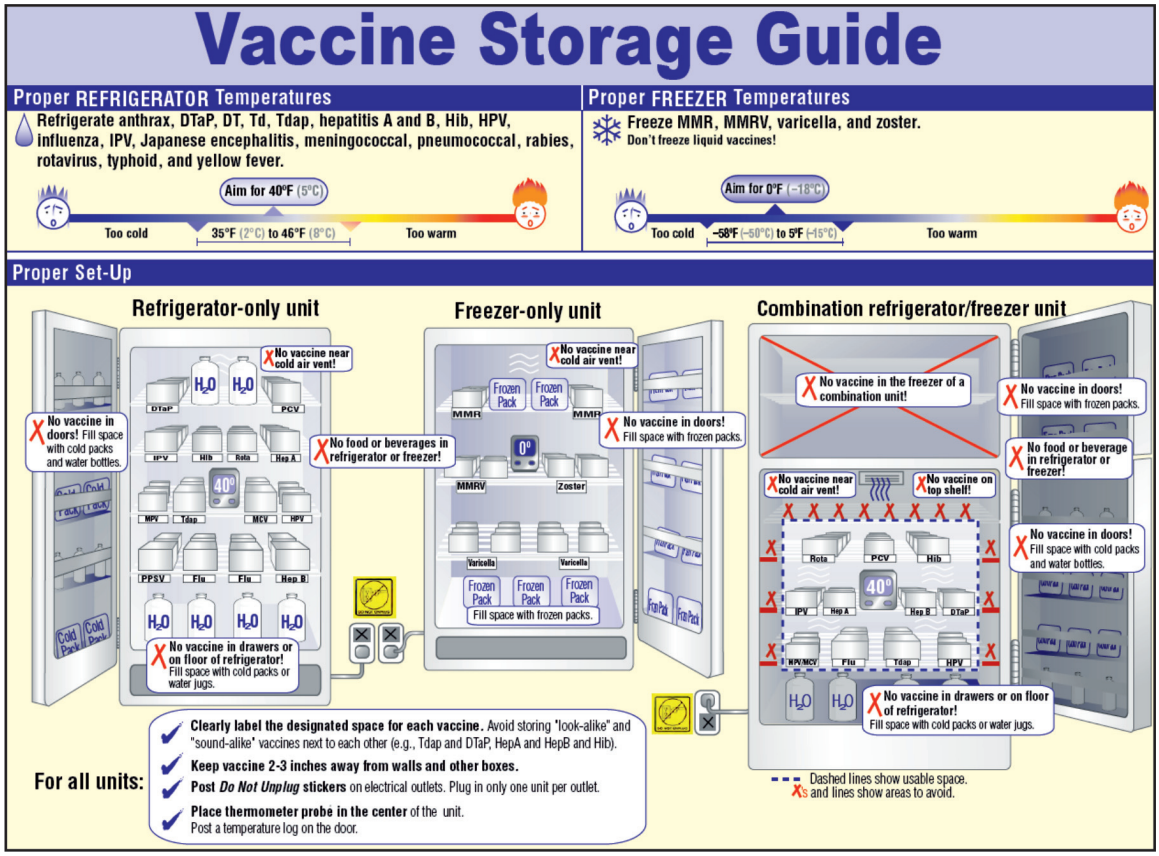


Fig. 13.1: Vaccine vial monitor

Ans. 23.



Vaccine Storage Guide

Proper Management

Designate one fully trained staff member to be the primary vaccine coordinator and at least one person to be backup. Ensure ongoing training for all immunization staff.

Manage vaccine inventory

- Review your vaccine inventory on a monthly basis and with each vaccine order to avoid over-ordering.
- Check vaccine expiration dates. Identify vaccine that will expire and determine if it should be transferred.
- Rotate your vaccine supply by placing vaccines with the earliest expiration dates in front of other vaccines and always use them first.
- Call the MnVFC program if you have MnVFC vaccine that will expire within three months that you cannot use.
- If you have stock of both private and MnVFC vaccine, mark them clearly.
- Make sure you have enough space to store vaccine for the back-to-school rush and flu season.

Store vaccine correctly

- Place the thermometer's temperature probe in the center of the refrigerator or freezer with the vaccines.
- Use open trays, wire baskets, or other uncovered containers to help organize vaccines.
- Clearly label each container with the vaccine type. Avoid storing look-alike, sound-alike vaccines next to each other (e.g., Tdap and DTaP, Hep A and Hep B).
- Keep vaccines in their original packaging.
- Store vaccines on the middle shelves and two to three inches from the walls of the combination refrigerator/freezer, not in the door or bins.
- Keep water bottles, jugs, or cold packs in the refrigerator and frozen packs or other ice-filled containers in the freezer. Mark water bottles "DO NOT DRINK."

Monitor temperatures

- Use thermometers that come with a certificate stating they have been calibrated according to national standards. Thermometers without this certificate are not acceptable.
- Check and record refrigerator and freezer temperatures twice a day, first thing in the morning and last thing at the close of business.
- Record temperature readings on a temperature log and post it in a visible location on or near the refrigerator or freezer.
- Make sure to record the date, time, and name or initials of the individual checking the temperatures.
- Record the minimum and maximum temperatures each morning and reset, if needed, after recording them.
- Take immediate action on all out-of-range temperatures!

Take action on out-of-range temperatures

- Determine the cause, if possible.
- Adjust the thermostat, if necessary.
- Monitor the temperature.

If the temperature doesn't stabilize in the correct range within 30 minutes:

- Stop using the vaccine.
- Mark the vaccine "DO NOT USE."
- Move the vaccine to a refrigerator or freezer that's maintaining the correct temperature.
- For MnVFC vaccine, call the MnVFC program at 651-201-5522 to report out-of-range temperature incidents.
- Call the vaccine manufacturer and ask to speak to a medical consultant or quality assurance staff.
- Be ready to share the lot numbers, expiration dates, temperature logs, and the time the unit may have been out-of-range.

Ans. 24. 1. Both PCV13 and PCV10 should be offered. Both should be given 1st single dose of PCV13–0.5 ml IM followed by single dose of PPV13–0.5 ml IM, 2 months later.
- The new pneumococcal vaccine is PCV14

Ans. 25. 1. JE vaccine is now in routine schedule of IAP all over the India.
2. 3 types of vaccine available –2 inactivated and one live (not available in market)
3. Killed SA 14–14–2, two dose schedule at >1 year 1 month apart, 3 mcg IM (6 mcg > 3 years). Minimum age 1 year.

Ans. 26. 1. O_1 (Ogawa/Inaba) O_{139} (Bengal)
2. Below 1 year and pregnancy
3. Dukoral (swedish) cholera vaccine
4. To see darting motility under dark-field microscopy which stops on adding O_1 and O_{139} antiserum.
5. Above 9 years: Tetracycline/doxycycline
Below 9 years: Sulpha-trimetho/erythro/furazolidine
   1. **Dukoral**—monovalent vaccine formalin killed classical, El Tor, inagba and ogawa) 1.5 ml 2 dose 7 days apart per oral, >1 year age, CI—pregnancy, <1 years age
   2. **Sanchol**

Ans. 27.

TT/Td/Tdap	Tdap preferred to Td every 10 years
MMR	12–13 years (mono/MMR)
Hepatitis B	0–1–6 months (if not given)
Typhoid conjugated	1 dose only, no booster
Varicella	2 doses schedule
Hepatitis A	0–6 months, single dose is live vaccine
HPV	2 doses (0, 6 months)

Ans. 28.
- HPV
- Types of vaccine:

	HPV4 (Gardasil 4)	*HPV4 (Corvavac)*	*HPV-9*
L1 protein of HPV-serotype	16/18/6/11	16/18/6/11	16/18/6/11/31/33/45/52/58
Schedule (months)	0–6 months (9–14 years) 0, 2, 6 months (>14 years)	0, 6 (9–14 years) 0, 2, 6 (>14 years)	0, 6 (9–14 years) 0, 2, 6 (>14 years)
Protection	Cervical cancer + genital warts (hpv) + vaginal + vulval	Cervical cancer + genital warts (hpv) + vaginal + vulval	Cervical cancer + genital warts (hpv) + vaginal + vulval
	*For girls only	9–14 years for boys and girls both >14 years for girls only	9–14 years for boys and girls both >14 years for girls only

Ans. 29.
1. BCG: Live attenuated bacteria
2. OPV: Live attenuated viral
3. DPT: Toxoid and killed bacteria
4. Hib: Capsular polysaccharide
5. Hep B vaccine: Viral antigen
6. Typhoid VI capsular polysaccharide
7. Hep A vaccine: Killed virus live vaccine also
8. Acellular pertusis: Bacterial subunit

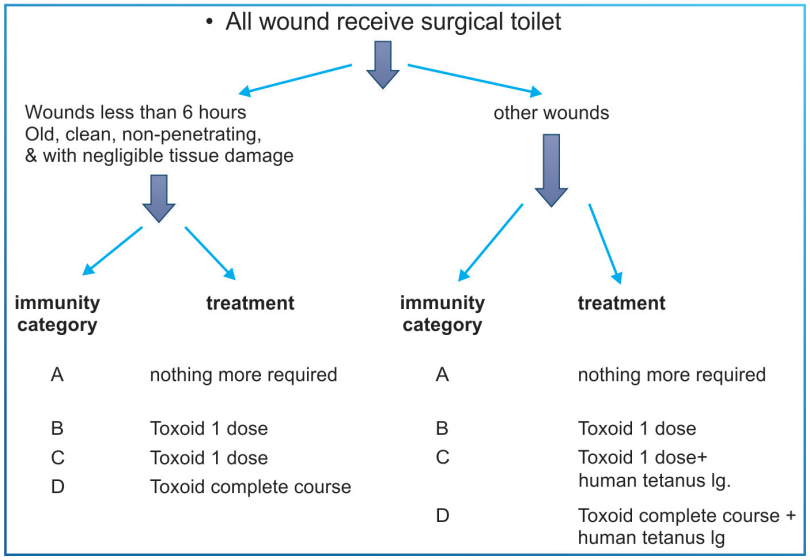
Ans. 30.
1. Diluent for BCG is sterile NS
2. Diluent for MMR is distilled water
3. Reconstituted BCG can be used for 3 hours
4. Reconstituted MMR can be used for 1 hour
5. DPT, hepatitis A and B, varicella, Hib, TT
6. IAP recommends DPT at 5 years alongwith IPV

Ans. 31. Rabies vaccines
1. Single or multiple transdermal bites or scratches. Contamination of mucous membrane with saliva
2. 0, 3, 7, 14, 28
3. Immunocompromised extra dose at day 90
4. Wound infiltration with HRIG or ERIG prior to closure.

Ans. 32.
1. 0.5 ml, intramuscular
   2 doses at 9 months and 12 months.
2. Quadrivalent A, C, Y and W-135 polysaccharide 4 µg each conjugated to 48 µg of diphtheria toxoid
3. Anaphylaxis after previous dose of MCV
   Guillian-Barré syndrome
4. Disease outbreaks, immunocompromised children, lab/health care workers, **Saudi pilgrims**, students.
5. 1. Menactra (2 doses schedule at 9 and 12 months), 2. Manveo (single dose >2 year)

Ans. 33.

Post-exposure prophylaxis:



Ans. 34. *See* answer 33.

Ans. 35. Egg allergy

- MMR—allowed without skin testing. Keep ready and patient should wait 90 mins after vaccine
- Chickenpox vaccine—can be given
- Influenza IM vaccine—no contraindication
- Yellow fever vaccine after skin testing if no reaction can be given (0.5*5 = 2.5)
- Contraindicated in patients with allergy to neomycin
- IPV
- MMR
- Varicella (0.5*2 = 1)
- HBsAG status unknown 1.8 kg
- Give HBV vaccine (0, 1, 2, and 6 or 7 months) dose immediately
- Test mother's status… if +ve give HBIg 0.5 ml immediately at different site as early as possible (within 7 days of life)
- HBV vaccine (0, 1, 2, and 6 or 7 months) 4 doses (0.5*3 = 1.5)

Ans. 36. 1. Subcutaneous route should be used (unless contraindicated)
For aluminium adjuvanted vaccines that can only be given intramuscularly, vaccination should be scheduled after factor replacement therapy
Needles <23 G should be used for injection and the parents should be asked to apply firm and sustained pressure, without rubbing, for at least 5 minutes.

2. Freezer compartment: BCG, OPV, measles, and MMR.
3. Varicella = 30 min (and protect from light)
Measles/MMR = 4–6 hours
4. Two doses are given on days 0 and 3.
(For re-exposure at any point of time after completed (and documented) pre- or post-exposure prophylaxis).