Drugs used in pediatric advanced life support

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CPR quality

- Push hard (≥ 1/3 of anteroposterior diameter of chest) and fast (100 to 120/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Change compressor every 2 minutes, or sooner if fatigued
- If no advanced airway, 15:2 compression-ventilation ratio
- If advanced airway, provide continuous compressions and give a breath every 2 to 3 seconds

Shock energy for defibrillation

- First shock 2 J/kg
- Second shock 4 J/kg
- Subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose

Drug therapy

- **Epinephrine IV/IO dose:** 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Max dose 1 mg. Repeat every 3 to 5 minutes. If no IV/IO access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of the 1 mg/mL concentration).
- **Amiodarone IV/IO dose:** 5 mg/kg bolus during cardiac arrest. May repeat up to 3 total doses for refractory VF/pulseless VT

  or

  Lidocaine IV/IO dose: Initial: 1 mg/kg loading dose

Advanced airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement

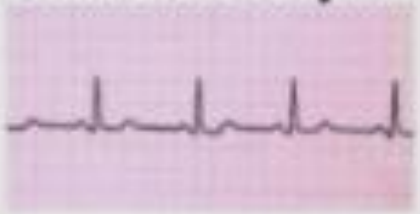
Reversible causes

- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypoglycemia
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

SAMPLE SHOCKABLE RHYTHMS

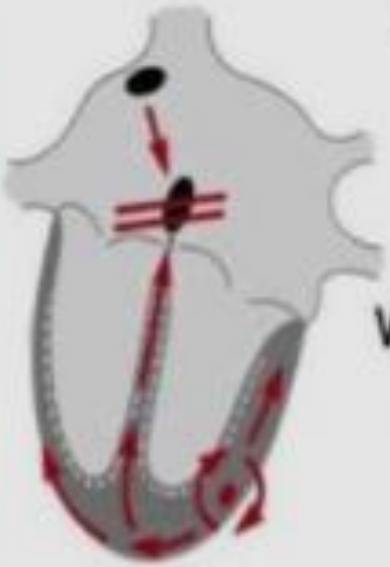
Ventricular Fibrillation

Normal Sinus Rhythm

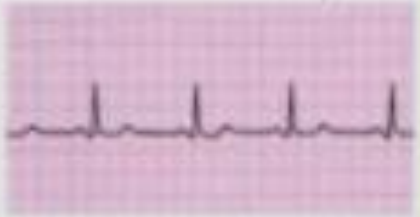


Ventricular Fibrillation

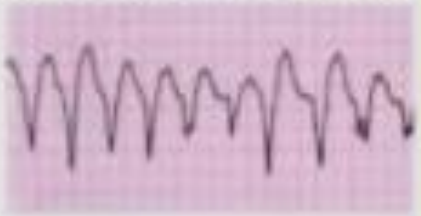
Ventricular Tachycardia



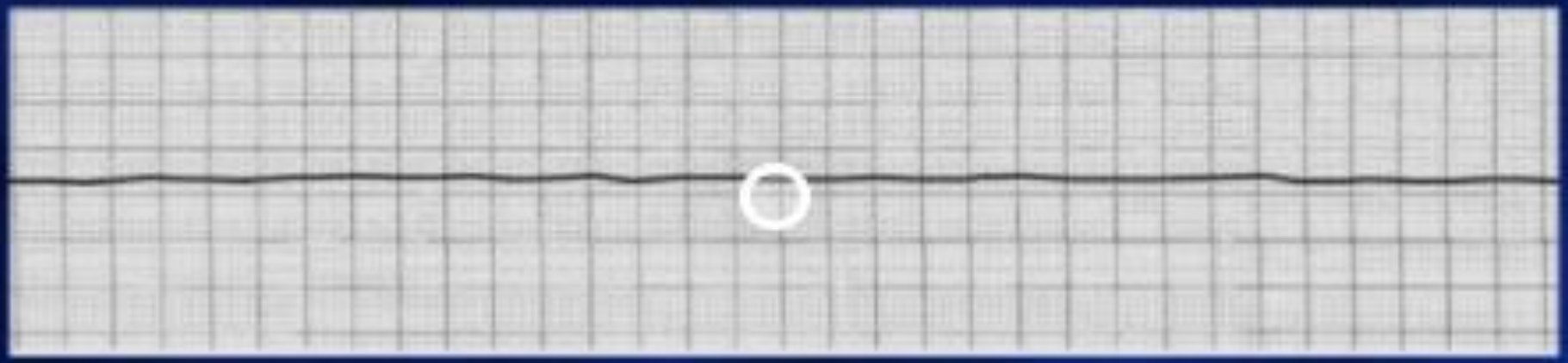
Normal Sinus Rhythm

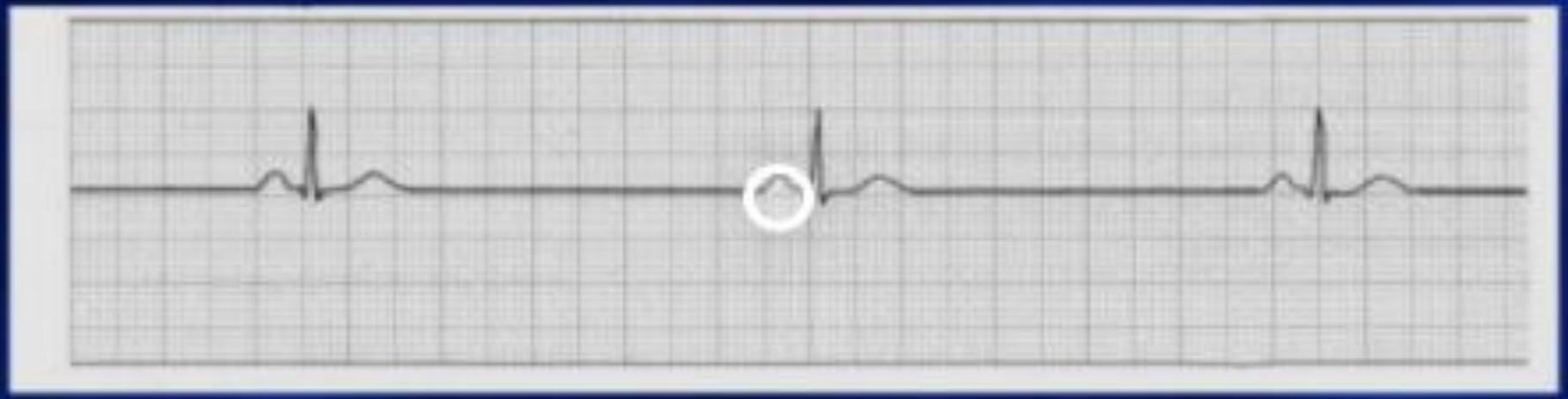


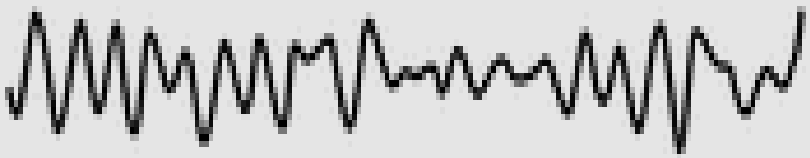
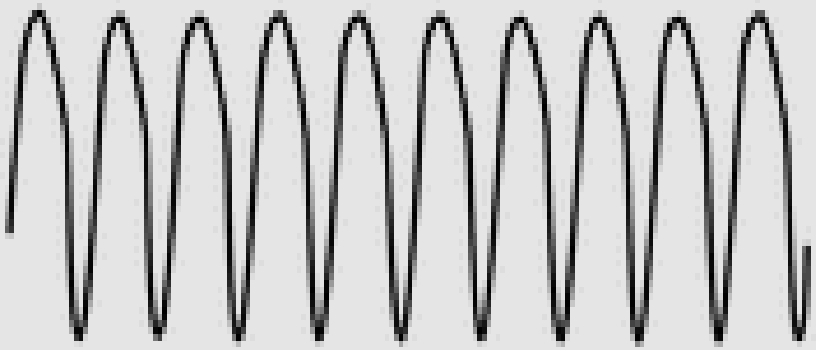
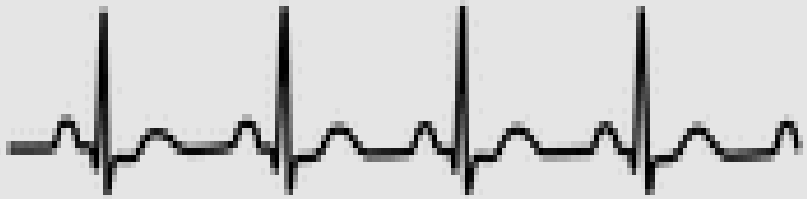
Ventricular Tachycardia



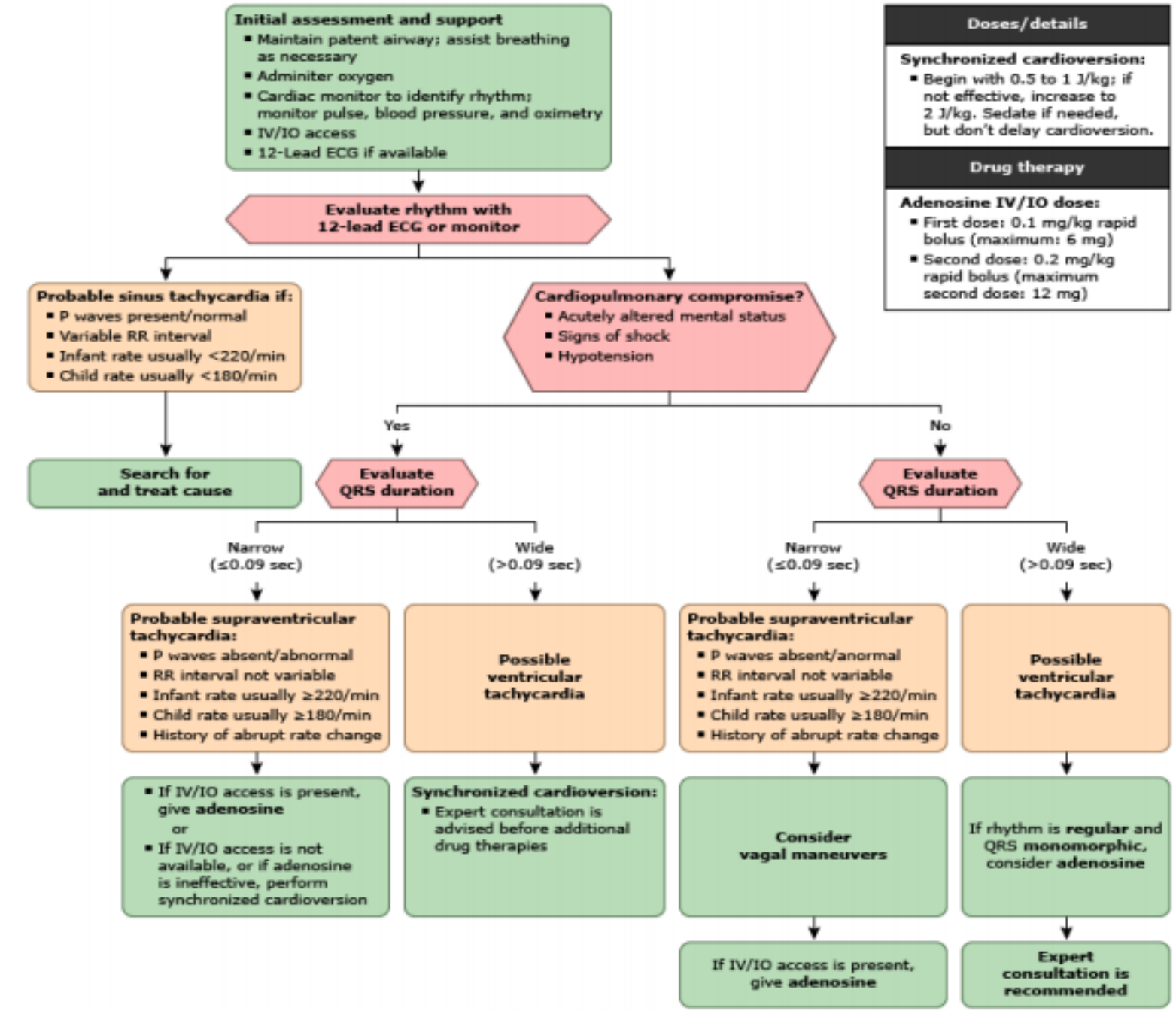
Non-Shockable Rhythms
Asystole and PEA





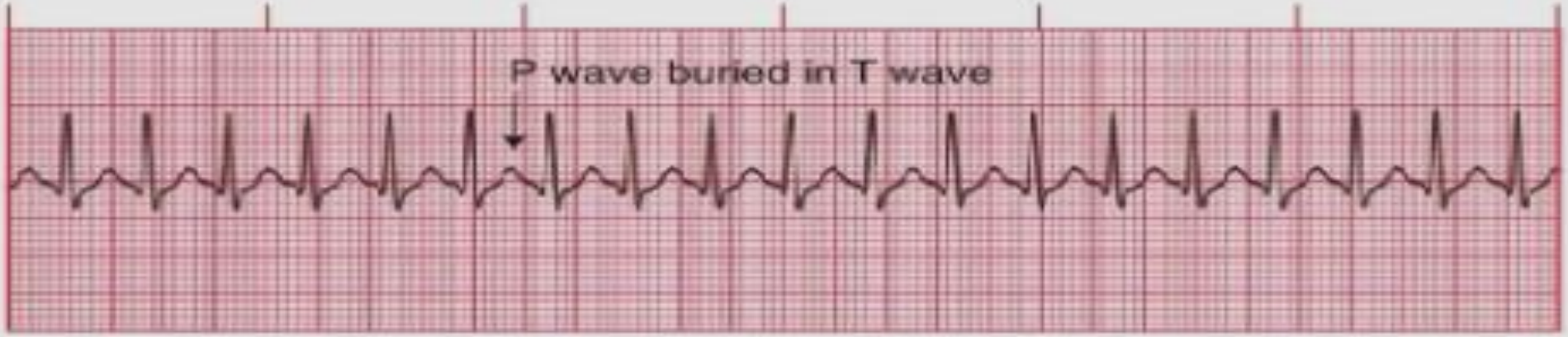
Shockable rhythms	Non-shockable rhythms
Ventricular fibrillation 	Asystole 
Ventricular tachycardia 	Pulseless electrical activity 

Pediatric tachycardia with a pulse 2020 update

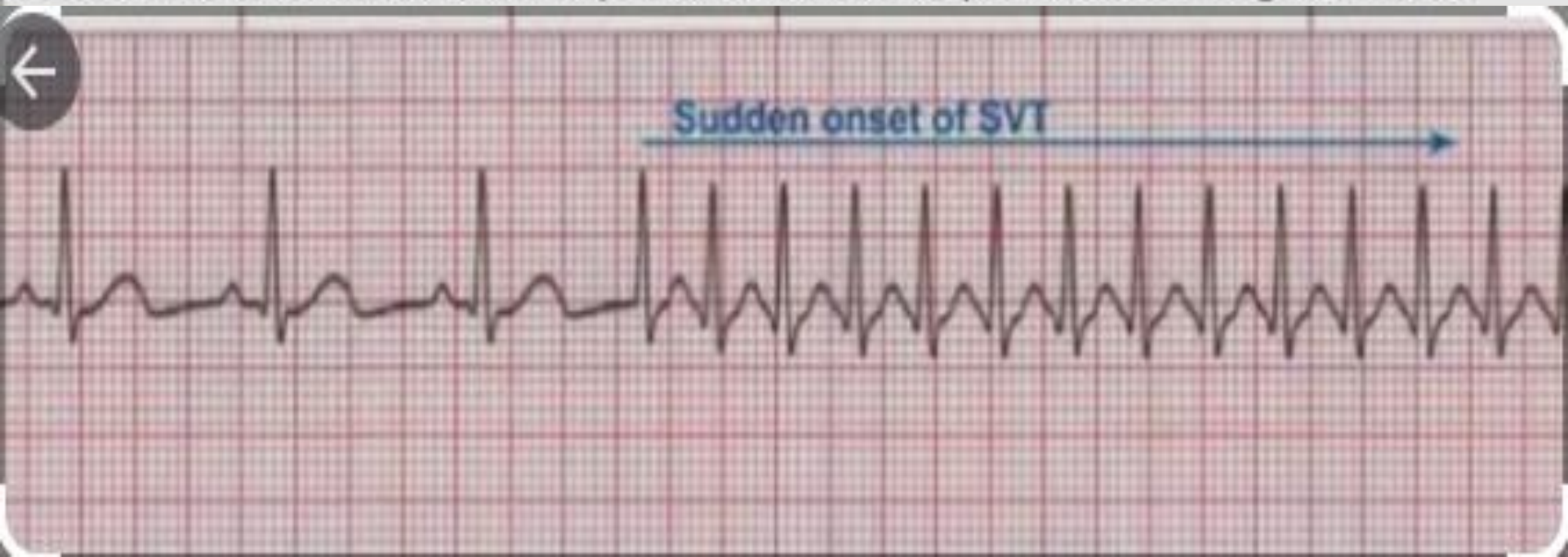


Supraventricular Tachycardia (SVT)

- This arrhythmia has such a fast rate that the P waves may not be seen.



Rate: 150–250 bpm
Rhythm: Regular
P Waves: Frequently buried in preceding T waves and difficult to see
PR Interval: Usually not possible to measure
QRS: Normal (0.06–0.10 sec) but may be wide if abnormally conducted through ventricles



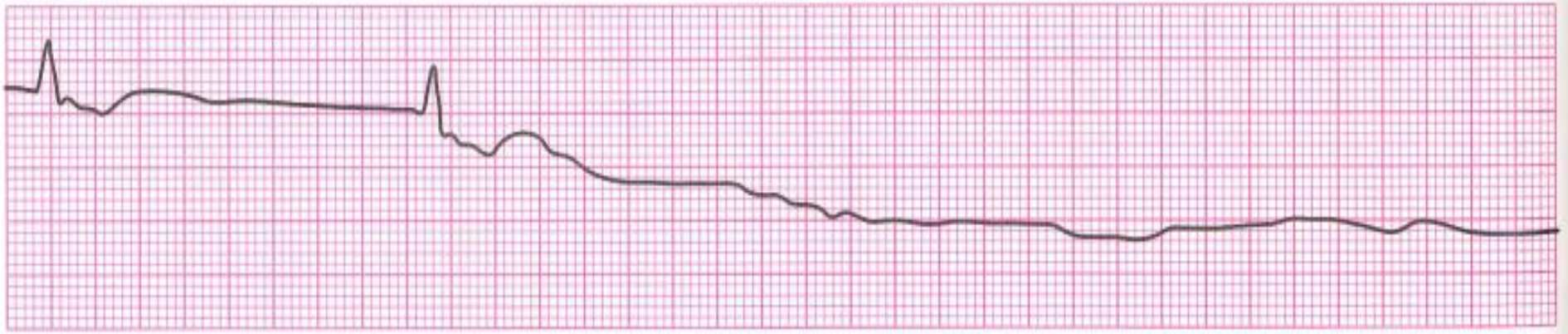
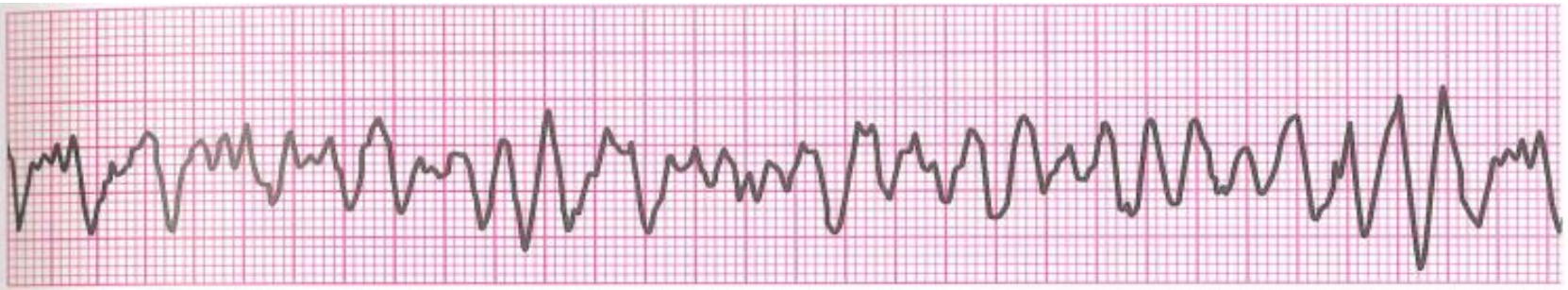
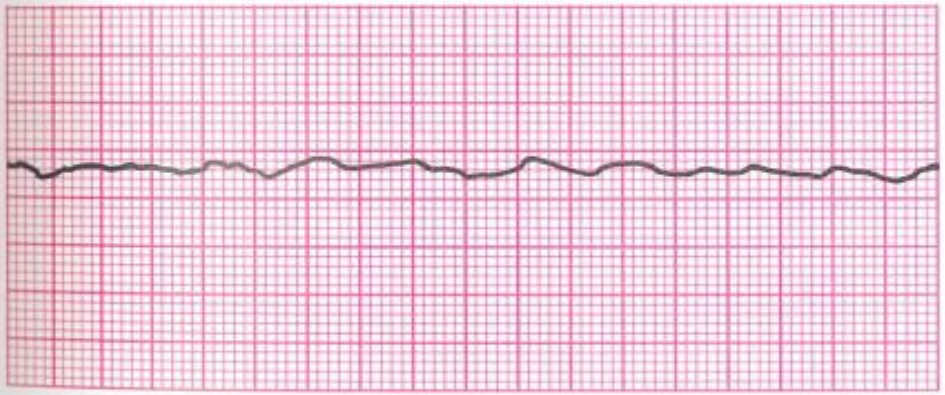


Figure 14. Agonal rhythm (slow ventricular rhythm progressing to asystole).

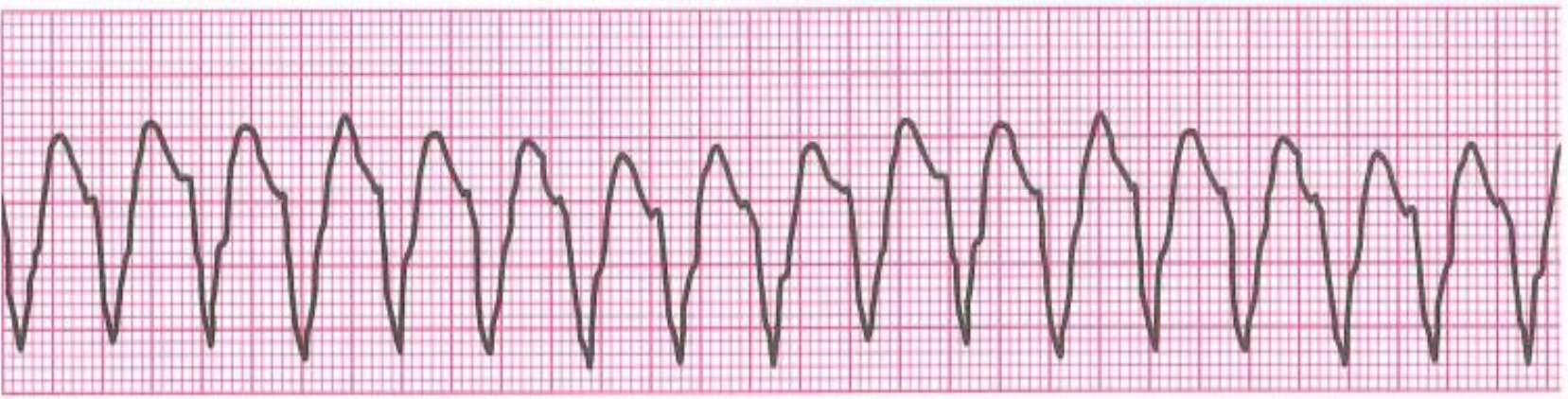


A

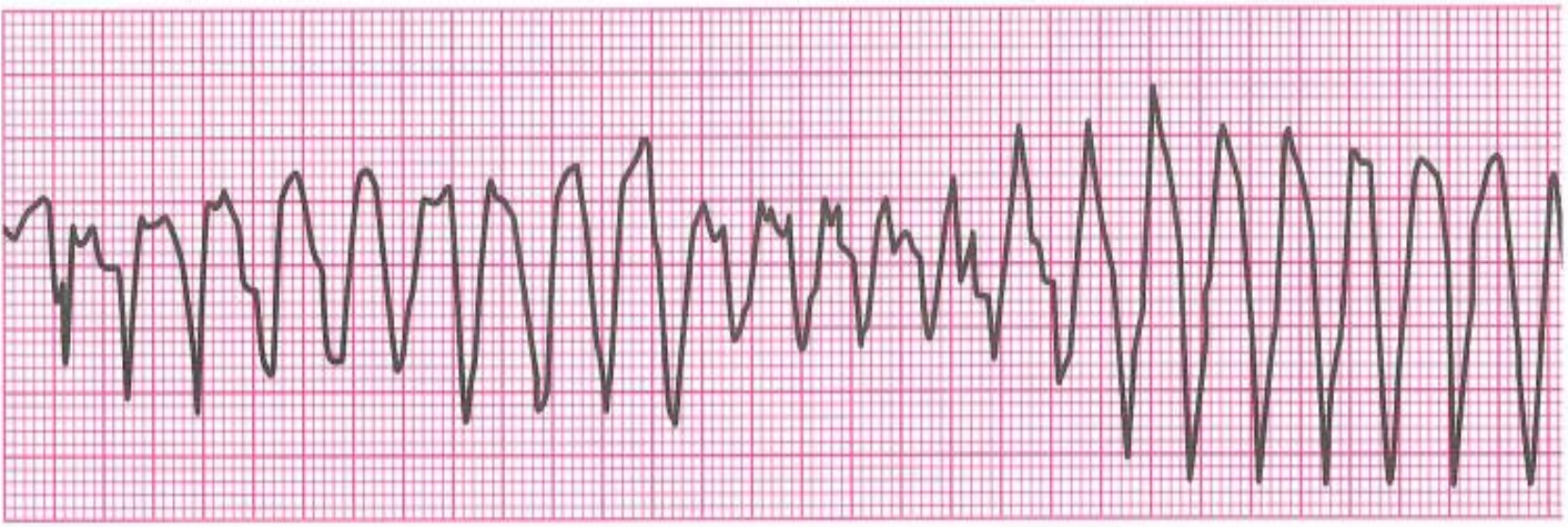


B

Figure 15. Ventricular fibrillation. **A,** Coarse VF. High-amplitude electrical activity varies in size and shape, representing chaotic ventricular electrical activity with no identifiable P, QRS, or T waves. **B,** Fine VF. Electrical activity is reduced as compared with previous (**A**) rhythm strip.

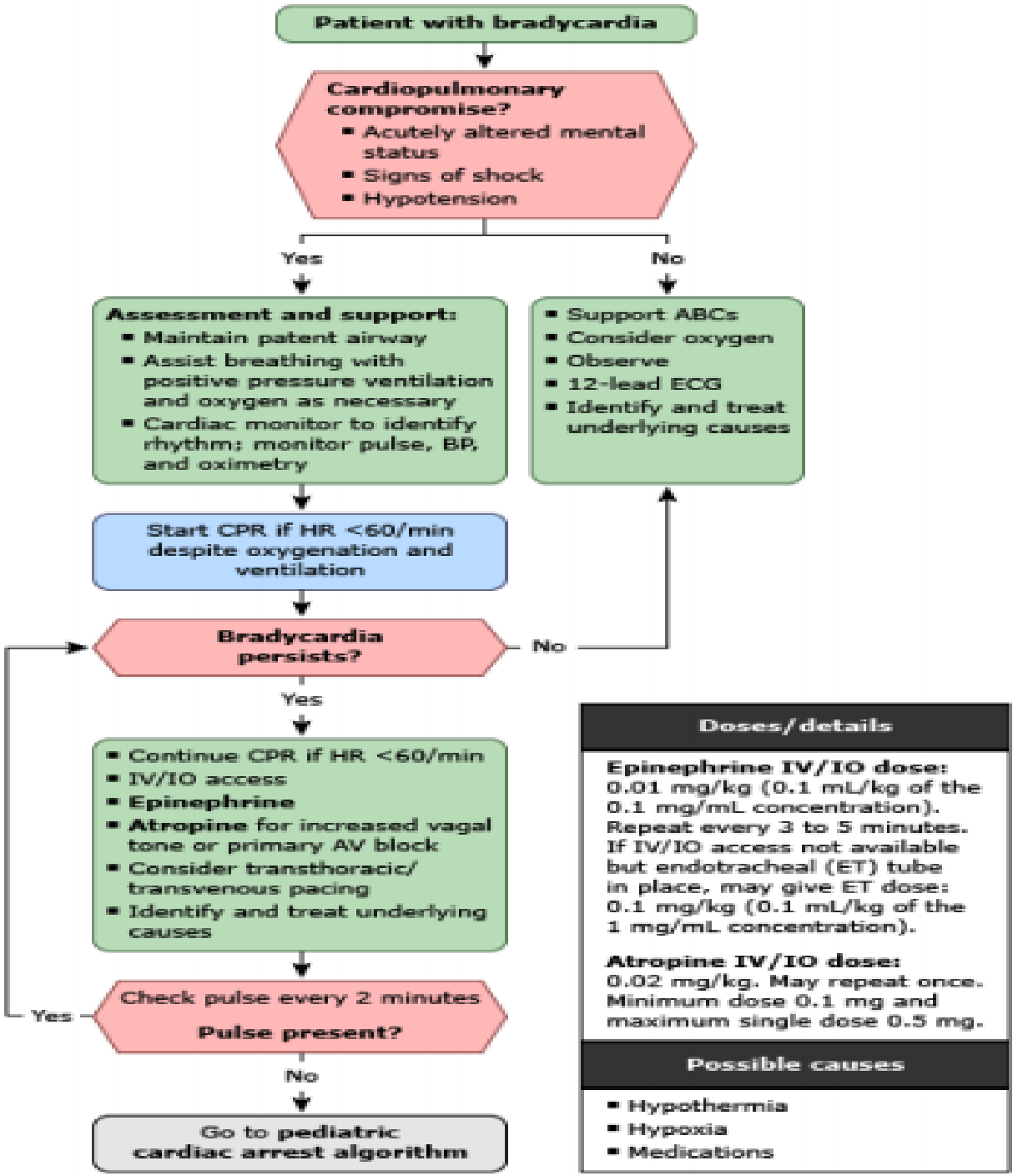


A



B

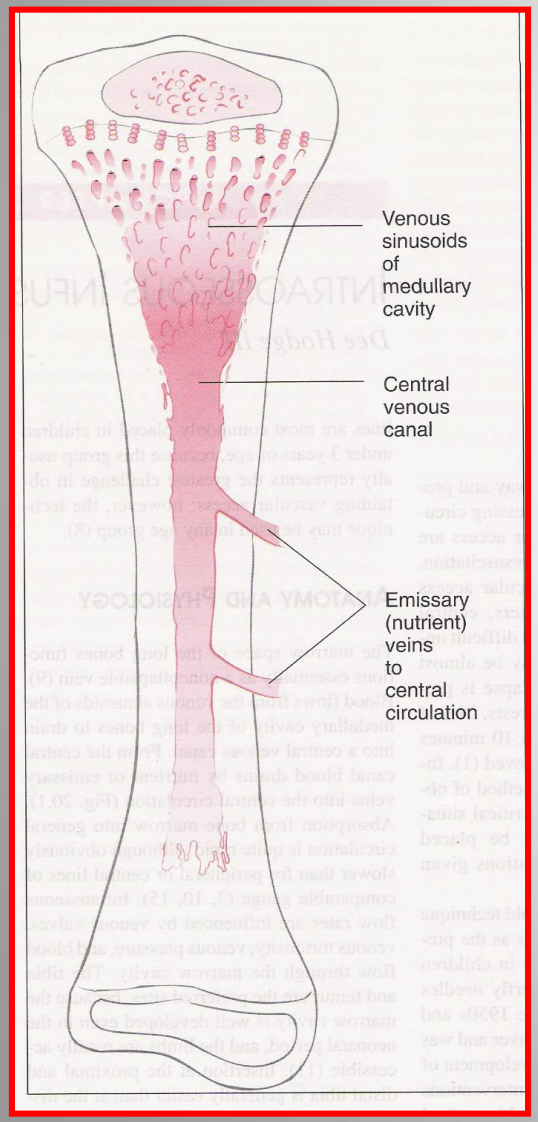
Figure 16. Ventricular tachycardia (VT). **A**, VT in a child with muscular dystrophy and known cardiomyopathy. The ventricular rhythm is rapid and regular at a rate of 158/min (greater than the minimum 120/min characteristic of VT). The QRS is wide (greater than 0.09 second), and there is no evidence of atrial depolarization. The complexes are uniform in appearance, so the VT is monomorphic. **B**, Torsades de pointes in a child with hypomagnesemia. The complexes differ in appearance, so this is a form of polymorphic VT. With this form of VT, the complexes appear to be "turning on a point."


Patient with bradycardia
Cardiopulmonary compromise?
Acutely altered mental status
Signs of shock
Hypotension
Yes
No
Assessment and support:
Maintain patent airway
Assist breathing with positive pressure ventilation and oxygen as necessary
Cardiac monitor to identify rhythm: monitor pulse, BP, and oximetry
Support ABCs
Consider oxygen
Observe
12-lead ECG
Identify and treat underlying causes
Start CPR if HR <60/min despite oxygenation and ventilation
Bradycardia persists?
No
Yes
Continue CPR if HR <60/min
IV/IO access
Epinephrine
Atropine for increased vagal tone or primary AV block
Consider transthoracic/ transvenous pacing
Identify and treat underlying causes
Check pulse every 2 minutes
Pulse present?
Yes
No
Go to pediatric cardiac arrest algorithm
Doses/details
Epinephrine IV/IO dose: 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Repeat every 3 to 5 minutes. If IV/IO access not available but endotracheal (ET) tube in place, may give ET dose: 0.1 mg/kg (0.1 mL/kg of the 1 mg/mL concentration).
Atropine IV/IO dose: 0.02 mg/kg. May repeat once. Minimum dose 0.1 mg and maximum single dose 0.5 mg.
Possible causes
Hypothermia
Hypoxia
Medications

Intraosseous Access

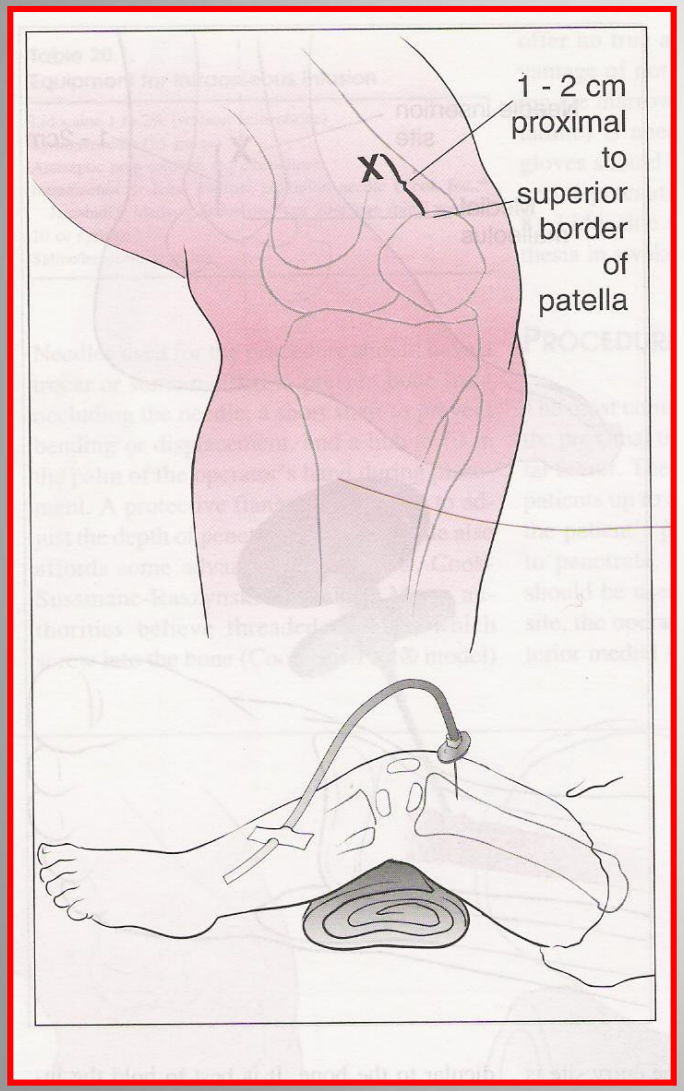
- An initial blood sample for type & crossmatch & for chemical & blood gas analysis even during resuscitation
- CBC is inaccurate
- Acid-base analysis is inaccurate after sodium bicarbonate administration via the IO cannula.

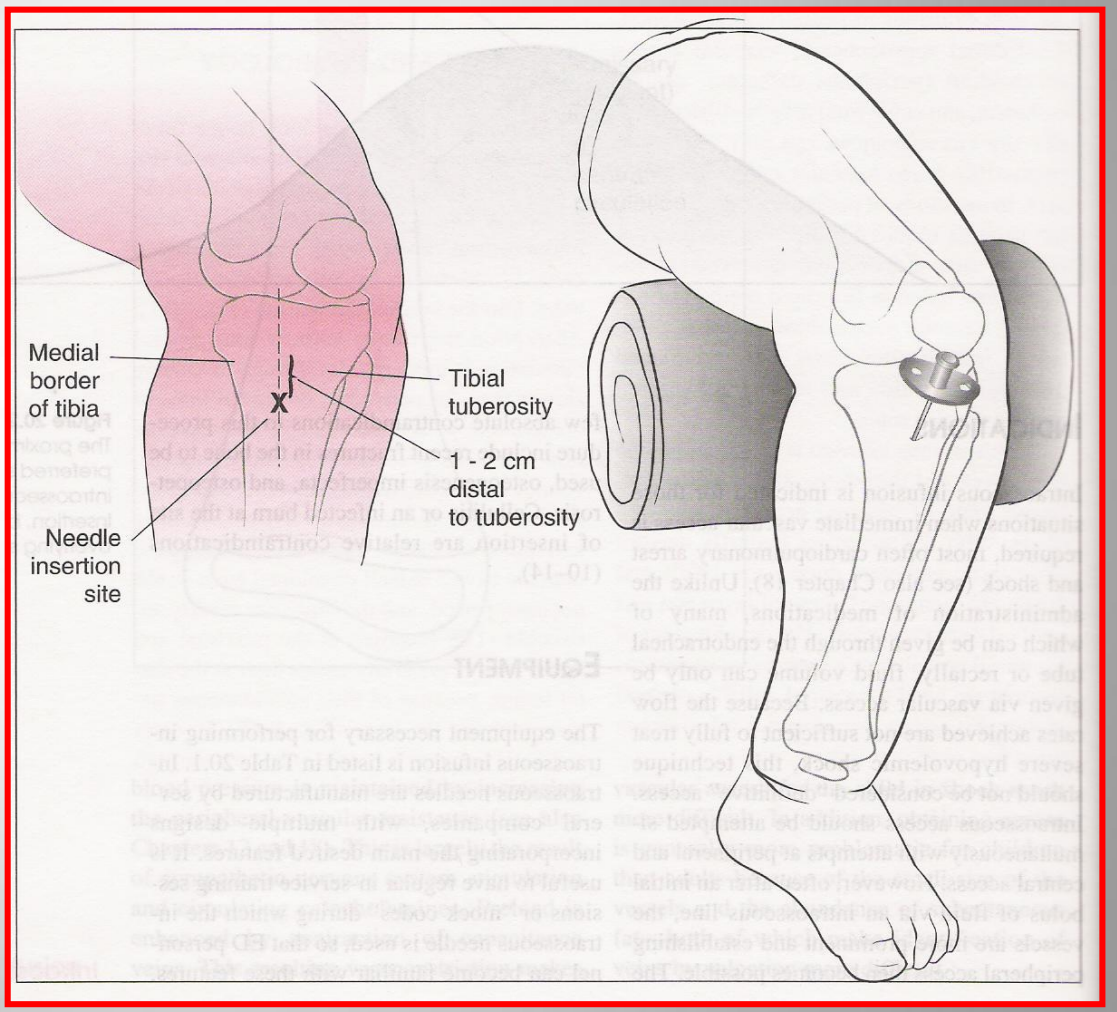
Intraosseous Access



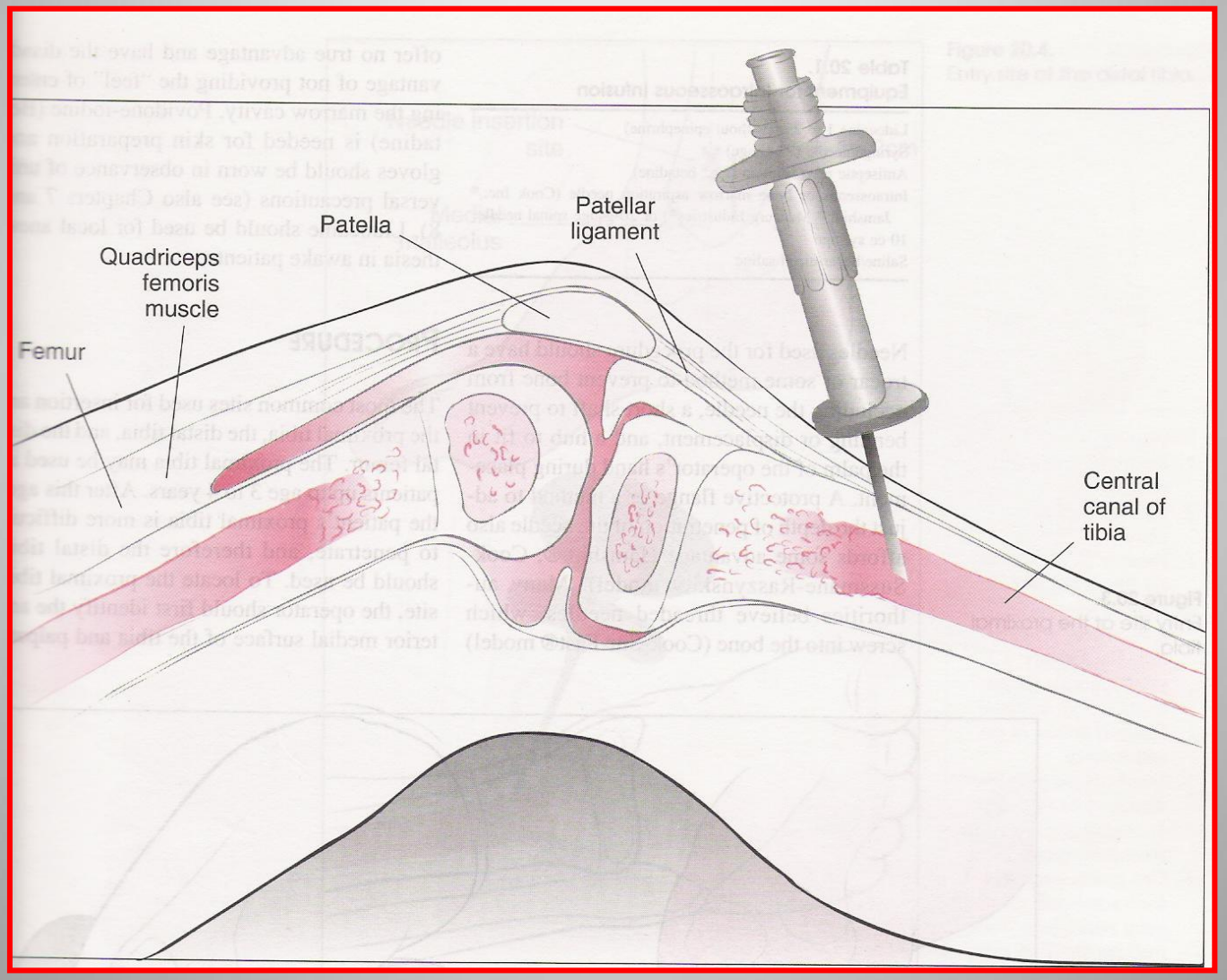
- A rapid, safe, & effective route for the administration of medications & fluids
  - Epinephrine
  - Adenosine
  - Fluids
  - Blood products
  - Catecholamines

Intraosseous Access





Intraosseous Access



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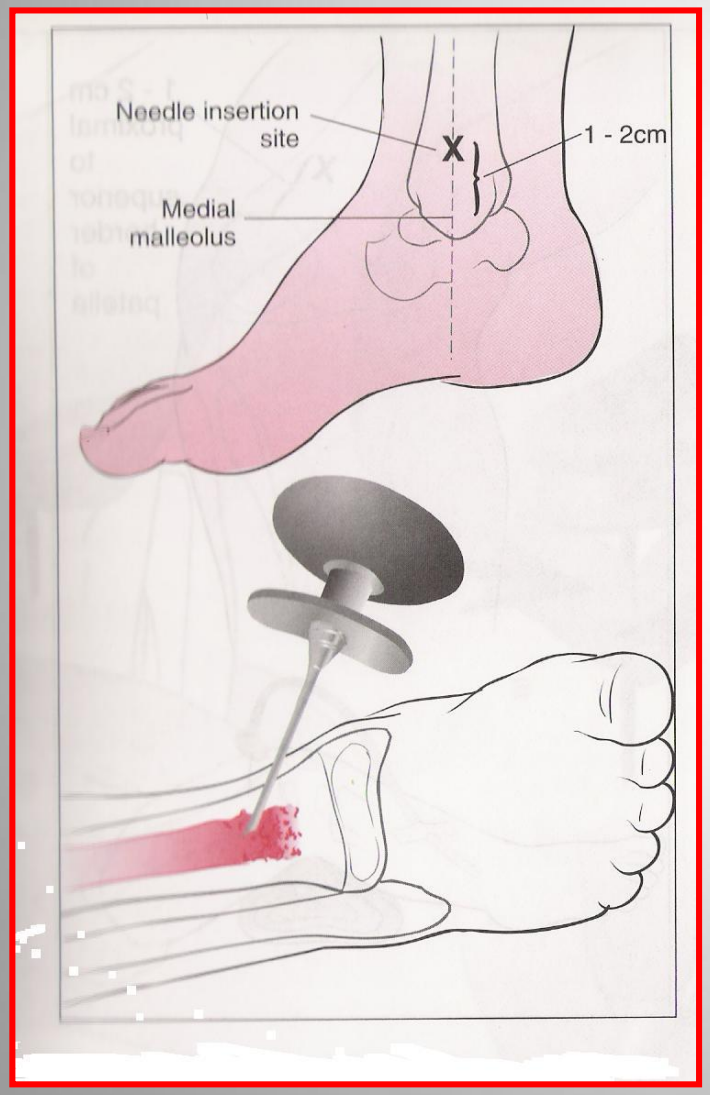
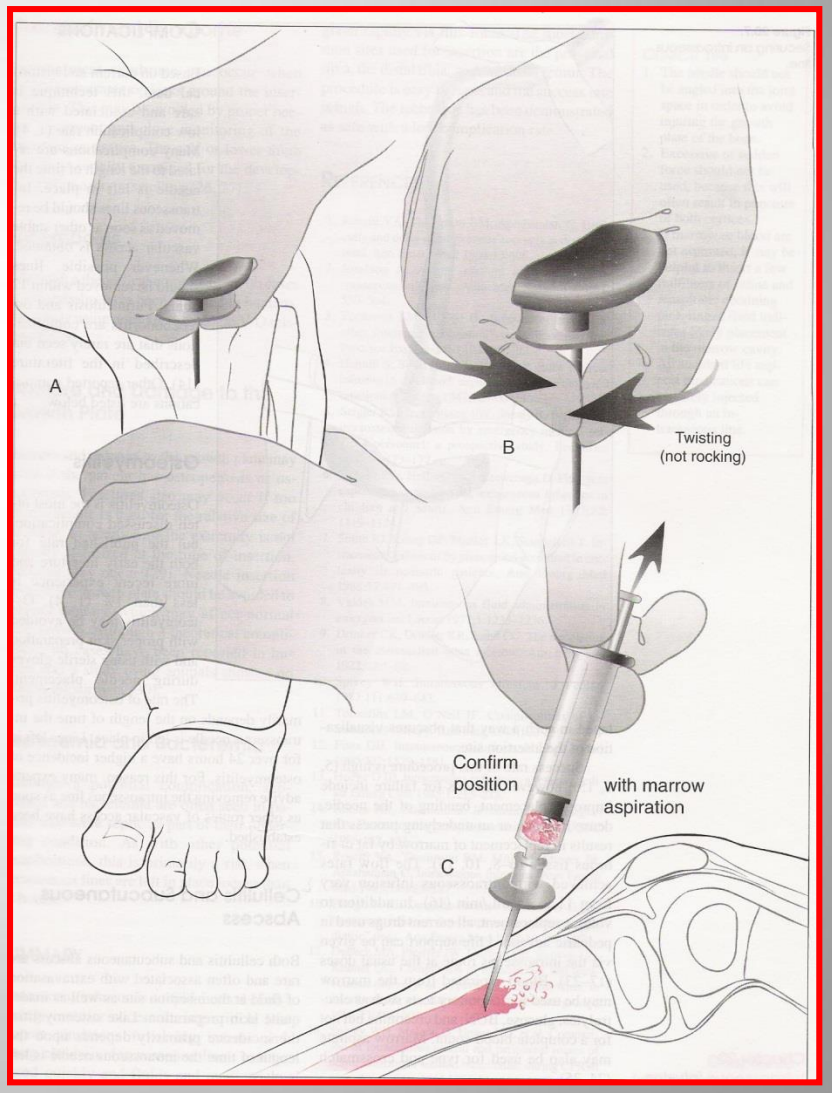


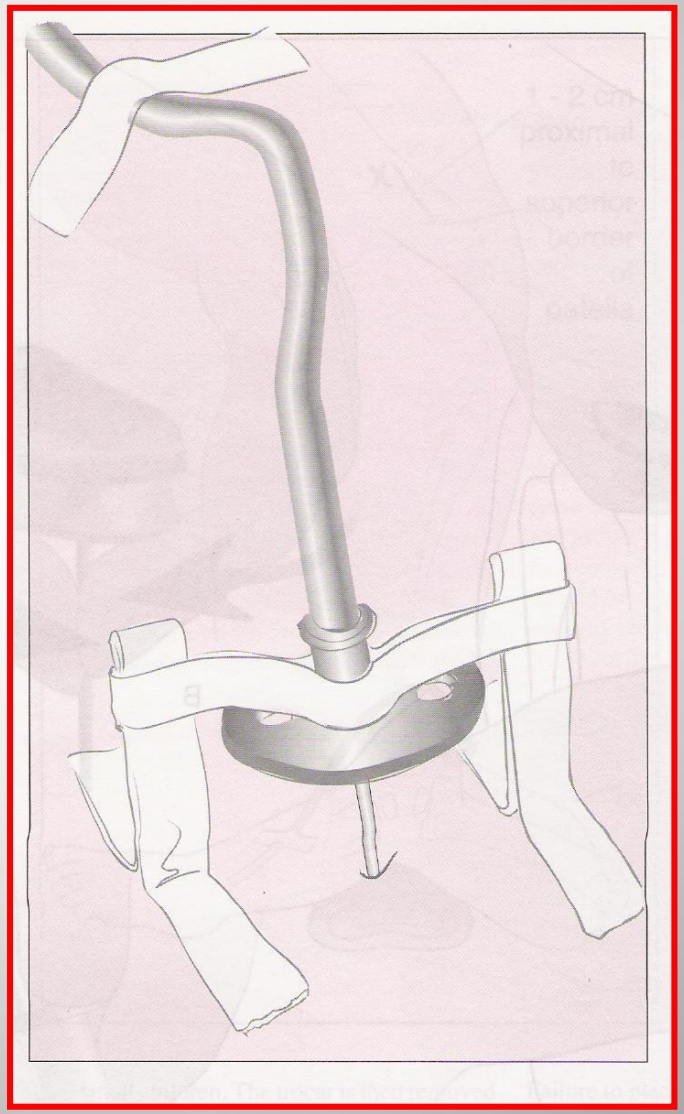


Intraosseous Access

Contraindication;

1.FX bone

2.Infected site



ENDOTRACHEAL DRUG ADMINISTRATION

- lidocaine, epinephrine, atropine, and naloxone ("LEAN")
- Increase the epinephrine dose 10-fold and the dose of other medications (atropine, lidocaine, naloxone) two- to threefold.
- ●Hold compressions during ETT administration.

....ENDOTRACHEAL DRUG ADMINISTRATION

- ●Dilute the medication in normal saline to a volume of 3 to 5 mL and instill into the endotracheal tube or beyond the tip of the endotracheal tube with a suction catheter.
- ●Follow drug administration with 3 to 5 mL of normal saline.
- ●Provide five positive pressure ventilations after instilling the drug.

Oxygen

- *The fundamental goal of basic and advanced life support is to support cerebral, myocardial, and systemic oxygenation before irreversible injury occurs.*

- *Because respiratory compromise is the leading cause of cardiac arrests in children, 100 percent oxygen should be administered, to any child who is suspected of being hypoxemic using an appropriate delivery device.*

- *The potential negative effects of high concentrations of oxygen are not a consideration in the setting of cardiopulmonary arrest.*

- *However, in perfusing patients and those who were in arrest but regained spontaneous circulation, oxygen therapy should be titrated to maintain PaO_2 between 60 and 300 mmHg or pulse oximetry of 94 to 99 percent to avoid oxygen toxicity.*

Epinephrine

Mechanisms :

- both alpha- and beta-adrenergic stimulation.

Indications :

- Asystole
- Pulseless electrical activity
- Pulseless ventricular arrhythmias not responsive to initial defibrillation
- Bradycardia not responsive to oxygen and support of airway and breathing

Contraindications :

- Hypersensitivity to epinephrine or one of its components
- Narrow angle glaucoma

Dose and administration:

- 0.01 mg/kg IV or IO given as 0.1 mL/kg using the 0.1 mg/mL solution up to 1 mg per dose
- Repeat every 3 to 5 minutes as needed;
- not compatible with sodium bicarbonate
- Only if IV and IO are not available, may give endotracheal (ET) 0.1 mg/kg as 0.1 mL/kg using the 1 mg/mL solution ***up to 2.5 mg per dose*** diluted to 3 to 5 mL with saline; repeat every 3 to 5 minutes as needed (IV or IO are preferred)

Adenosine

Mechanisms :

interacts with Adenosine1 receptors on the surface of cardiac cells; the resulting effects include slowing of the sinus rate and an increase in the atrioventricular node conduction delay.

Indications :

drug of choice for the acute medical conversion of SVT unresponsive to vagal maneuvers

Contraindications :

- Wolff-Parkinson-White syndrome
- patients with pre-existing second or third degree heart block or sinus node disease

Dose and administration

- Initial dose 0.1 mg/kg (children >50 kg receive 6 mg) given as rapid IV or IO push closest to central circulation; follow immediately with 5 mL saline flush (10 to 20 mL saline flush for larger child or adolescent)

- If not responsive in 2 minutes, give second dose of 0.2 mg/kg (children >50 kg receive 12 mg) follow immediately with 5 mL saline flush; if not responsive after additional 2 minutes, give third dose of 0.3 mg/kg (maximum 12 mg) follow immediately with 5 mL saline flush

- The most common side effects reported after adenosine administration are flushing, chest discomfort, nausea, and headache.

Amiodarone

Mechanisms:

- Amiodarone is a class III antiarrhythmic agent that slows atrioventricular (AV) node conduction, prolongs the AV node refractory period and QT interval, and slows ventricular conduction (widens the QRS). These actions are mediated through effects on sodium, potassium, and calcium channels as well as blocking alpha- and beta-adrenergic receptors.

Indications :

- Pulseless ventricular arrhythmias not responsive to CPR, defibrillation, and epinephrine
- Stable ventricular tachycardia
- SVT refractory to adenosine

Contraindications :

- should not be administered together with another drug that causes QT prolongation
- patients with congenital prolonged QT syndrome

Dose and administration

- **Cardiac arrest:** 5 mg/kg rapid IV or IO bolus (maximum dose 300 mg); may repeat 5 mg/kg dose two times up to a maximum of 15 mg/kg

- **Perfusing patient:** 5 mg/kg IV or IO (maximum dose 300 mg) dilute to 2 mg/mL or less and infuse over 20 to 60 minutes; may repeat 5 mg/kg dose two times up to a maximum of 15 mg/kg during acute treatment

Procainamide

Mechanisms :

- is a sodium channel blocker that prolongs the refractory period of both the atria and ventricles and slows conduction velocity. Unlike adenosine, procainamide does not block reentry at the atrioventricular node and can be safely used in patients with Wolff-Parkinson-White syndrome.

Indications :

- Stable ventricular tachycardia
- SVT in patients with Wolff-Parkinson-White syndrome or refractory to adenosine

Contraindications :

- should be **avoided** in patients who have received amiodarone. It is contraindicated for patients with allergy to procainamide or related drugs (eg, procaine penicillin), heart block (eg, complete or second degree heart block), or torsades de pointes.

Dose and administration

- Loading dose (pediatric cardiology consultation advised):
  - Neonates: 7 to 10 mg/kg IV or IO
  - Older infants and children ≥1 year: 15 mg/kg IV or IO (Maximum: 1 g)
  - To avoid transient hypotension caused by rapid administration, give the loading dose slowly over 30 to 60 minutes.
- After the loading dose, start a continuous IV infusion at 20 mcg/kg per minute and titrate up to a maximum dose of 80 mcg/kg per minute, as needed, for rhythm control (maximum daily dose, 2 g over 24 hours)
- Adverse effects of procainamide include heart block, negative inotropic effects, and prolongation of the QRS and QT intervals

Lidocaine

Mechanisms :

- blocks sodium channels in cardiac conductive tissue when they are in the inactivated state at the end of depolarization and during early repolarization. This action results in inhibition of electrical conduction and automaticity, particularly in ischemic tissue

Indications :

- Pulseless ventricular arrhythmias not responsive to CPR, defibrillation, and epinephrine

Contraindications :

- patients with Wolff-Parkinson-White syndrome
- those who are allergic to amide-type local anesthetics

Dose and administration

- 1 mg/kg rapid IV or IO bolus
- Follow the bolus with an infusion of 20 to 50 mcg/kg/minute. If the start of the infusion will be delayed longer than 15 minutes, then a second IV or IO bolus dose of 1 mg/kg is suggested.

- Only if IV and IO not available, may give via endotracheal tube (ET) 2 to 3 mg/kg, flush with 5 mL NS and follow with 5 assisted manual ventilations (IV and IO are preferred

Magnesium sulfate

Mechanisms :

- Magnesium is a crucial cofactor in the sodium-potassium-ATPase enzyme system. It stabilizes the motor membrane by reducing the sensitivity of the motor end plate to acetylcholine. A decreased intracellular magnesium level promotes myocardial excitability but, even in the absence of a low magnesium level, a bolus of IV magnesium will suppress ectopic ventricular beats. At high levels, magnesium acts as a calcium channel blocker and can produce bradycardia with atrioventricular block and cardiac arrest

Indications :

- Polymorphic ventricular tachycardia (torsades de pointes)
- Documented hypomagnesemia

Contraindications :

- Magnesium should be administered with caution to patients with myasthenia gravis or other neuromuscular disease and patients with renal impairment.

Dose and administration

- **Cardiac arrest** (pulseless torsades): 25 to 50 mg/kg; given as 0.05 to 0.1 mL/kg of 50% magnesium sulfate solution up to maximum 2 g (4 mL) per dose; dilute in 10 mL D5W, give IV or IO over 1 to 2 minutes
- **Perfusing patient** (torsades, hypomagnesemia, status asthmaticus)†:Same dose as for cardiac arrest, except dilute dose in 10 to 50 mL D5W or NS and infuse over 15 minutes (maximum 150 mg per minute)
- Conversions: 50% magnesium sulfate = 500 mg/mL magnesium sulfate = 2 mmol/mL magnesium

Atropine

Mechanisms :

- is a parasympatholytic drug that increases heart rate by accelerating the sinus and atrial pacemaker and improving conduction through the AV node.

- Although the dominant cardiac response is tachycardia, the heart rate may decrease transiently when small doses are administered . This decrease is thought to occur because atropine, at low doses, blocks the M1 muscarinic postganglionic receptors that provide feedback inhibition for synaptic acetylcholine release ; the resulting increase in acetylcholine inhibits spontaneous impulse generation in the SA node.

Indications :

- Vagally mediated bradycardia
- Primary atrioventricular block
- Bradycardia not responsive to oxygen, airway support, and epinephrine administration
- Prevention of bradycardia during endotracheal intubation for children <1 year of age, children 1-5 years of age receiving succinylcholine, and children over 5 years of age receiving a second dose of succinylcholine

Contraindications :

- patients with obstructive gastrointestinal or genitourinary conditions (eg, surgical abdomen, paralytic ileus, posterior urethral valves), and myasthenia gravis (unless treating side effects of acetylcholinesterase inhibition) because it may exacerbate the underlying condition .

- Atropine may cause additional tachycardia in patients with thyrotoxicosis and mucous plugging in patients with asthma.

Dose and administration

- 0.02 mg/kg IV or IO (minimum 0.1 mg$^{\Delta}$, maximum single dose 0.5 mg for child or 1 mg for adolescent); may repeat once in 3 to 5 minutes
- Maximum total dose 1 mg (child) or 2 mg (adolescent)$^{\lozenge}$
- Only if IV and IO not available, may give via endotracheal tube (ET) 0.04 to 0.06 mg/kg diluted with 3 to 5 mL saline; repeat once if needed (IV or IO are preferred)

Sodium bicarbonate

Mechanisms :

- increases blood pH by buffering excess blood hydrogen ion as long as the patient has adequate ventilation to excrete carbon dioxide

Indications :

- Hyperkalemia
- Poisoning by sodium channel blocking agents (eg, cyclic antidepressants, type Ia antiarrhythmic agents) with prolongation of QRS interval (>0.1 msec)
- Prolonged cardiac arrest with documented severe metabolic acidosis (routine use in resuscitation is NOT recommended)
- Shock with documented metabolic acidosis

Contraindications :

- should **not** be given to children with inadequate ventilation because inadequate respiratory excretion of carbon dioxide will lead to retention and worsening respiratory acidosis

Dose and administration

- Infants <6 months: 1 mEq/kg IV or IO given as 2 mL/kg of 4.2% solution
- Infants ≥6 months and children: 1 mEq/kg IV or IO given as 1 mL/kg of 8.4% solution
- Maximum single dose 50 mEq (child) to 100 mEq (adolescent)
- 0.5 mEq/kg subsequent doses after 10 minutes given as:
  - Child: 0.5 mL/kg of 8.4% solution
  - Infants under 6 months: 1 mL/kg of 4.2% solution
- Forms precipitate with calcium and can inactivate epinephrine, do not co-infuse

Calcium

Mechanisms :

- Calcium increases cardiac inotropy. Influx and efflux of calcium ions are important for the maintenance of normal conductivity and rhythm.

Indications :

- Hypocalcemia
- Hypermagnesemia
- Hyperkalemia
- Calcium channel blocker (CCB) overdose

Contraindications :

- It is otherwise not recommended for pediatric cardiopulmonary arrest because of an observed association with decreased survival and poor neurologic outcomes after pediatric arrests

Dose and administration

- Calcium chloride is preferred over calcium gluconatebecause it provides greater bioavailability of calcium but should only be given if central venous access is available because administration through a peripheral intravenous line is associated with skin necrosis and sloughing .

- The recommended dose of elemental calcium is 5 to 7 mg/kg . Dosing in this range can be achieved by giving 0.2 mL/kg of calcium chloride 10 percent which provides 5.4 mg/kg **of elemental** calcium or 0.6 mL/kg of calcium gluconate 10 percent which provides 5.6 mg/kg **of elemental** calcium.
- The maximum single dose is 540 mg **of elemental** calcium. Calcium chloride or calcium gluconate should be administered by slow intravenous push over 10 to 20 seconds in cardiac arrest and more slowly (eg, over 5 to 10 minutes) in perfusing patients.

- Rapid administration may cause bradycardia or asystole. If sodium bicarbonate is being given through the same intravenous line, the tubing must be thoroughly flushed before and after calcium administration. Otherwise an insoluble precipitate can form in the catheter lumen.

Dextrose (glucose)

Mechanisms :

- Glucose is the primary metabolic substrate for the neonatal myocardium, and hypoglycemia may contribute to myocardial dysfunction. Glucose also is a significant energy source in older infants and children during periods of ischemia. Whether glucose administration improves cardiac function or survival in hypoglycemic children with cardiac arrest is not known

Indications :

- Documented blood glucose ≤60 mg/dL (3.3 mmol/L)

Contraindications :

- The routine administration of glucose during pediatric resuscitation is **not** recommended because of the absence of data demonstrating benefit and the potential harm of hyperglycemia. Large volumes of dextrose-containing fluids should not be given to normoglycemic children during resuscitation because they can cause hyperglycemia, which can induce osmotic diuresis, produce or aggravate hypokalemia, or worsen ischemic brain injury

Dose and administration

- 0.5 to 1 g/kg, IV or IO, as follows:
- Infants and children <5 years: 5 to 10 mL/kg of 10% dextrose solution
- Children ≥5 years: 2 to 4 mL/kg of 25% dextrose solution (preferred) or 1 to 2 mL/kg of 50% dextrose solution

- After the initial dextrose infusion, the unconscious child should receive additional intravenous dextrose at an infusion rate that will maintain glucose levels (5 to 6 mg/kg per minute in infants and 2 to 3 mg/kg per minute in children) and undergo frequent measurement of blood glucose.

The primary drugs used in pediatric advanced life support:

- ·**Hypoxemia - - - - - - - - ->** Oxygen
- ·**Hypoglycemia - - - - - - - - - - - ->** Glucose
- ·**Asystole or pulseless electrical activity ->** Oxygen, epinephrine
- ·**Hypomagnesemia or TdP - - ->** Magnesium sulfate
- ·**Bradycardia - - - - >**Oxygen, epinephrine, atropine

- ·Pulseless with a shockable rhythm (ventricular fibrillation, pulseless ventricular tachycardia, or torsades de pointes) -> Oxygen, epinephrine, and, for VF and pVT, lidocaine or amiodarone, and for TdP, magnesium sulfate as adjuncts to high quality cardiopulmonary resuscitation and defibrillation

- ·Severe metabolic acidosis associated with prolonged cardiac arrest or shock -> ***Sodium bicarbonate***

- ·Hypocalcemia, hypermagnesemia, hyperkalemia or calcium channel blocker overdose - - - - - - - - - - - -> Calcium chloride

- ·Uncomplicated supraventricular tachycardia (SVT) - - - - - - - - - -> Oxygen, adenosine

- ·Possible ventricular tachycardia or aberrant SVT - - - - - - - - - - - - - - - - -> Oxygen, adenosine, amiodarone, procainamide


Thank You
Thank You
Thank You!!!!