

Pediatric Dysrhythmias

Early Recognition & Management

William Brady, MD
Department of Emergency Medicine
University of Virginia
&
Charlottesville-Albemarle Rescue Squad
Madison County EMS
Special Event Medical Management
Seminole Trail Fire Department

Pediatric Dysrhythmias

Outline

- **Introduction – the basics**
- **“Typical” scenarios**
- **Clinical stability**
- **General diagnosis & management issues**
- **Specific presentations**
- **Pitfalls**

Pediatric Dysrhythmias

- **Bradydysrhythmias**
 - Sinus bradycardia
 - Junctional & indioventricular rhythms
 - AV blocks
- **Tachydysrhythmias**
 - Sinus tachycardia
 - PSVT
 - Ventricular tachycardia
 - Wolff-Parkinson-White Syndrome-related rhythms
- **Cardiac arrest rhythms**
 - Ventricular tachycardia / fibrillation
 - Pulseless electrical activity
 - Aystole
- **Toxic-metabolic rhythms**
 - Toxins
 - Electrolytes

Pediatric Dysrhythmias

- **Common**
- **Rhythm possibilities span spectrum of severity**
 - from benign & of no clinical consequence
 - to malignant with immediate life threat
- **Frequently a consequence of another issue**
- **Focus on not only the rhythm but also the primary event**

Pediatric Dysrhythmias

- **Largely “secondary” events**
 - Respiratory
 - Vascular
 - Metabolic
 - Toxicologic
 - Congenital
- **Much less commonly “cardiac” in origin**
 -though primary cardiac causes are seen

Pediatric Dysrhythmias “Typical” scenarios

- **Young child with cough and fever**
 - Lethargy with low oxygen saturations
 - Slow pulse
 - DX: Pneumonia with hypoxia & sinus bradycardia
- **Teenager with illicit drug use**
 - Agitated
 - Tachycardic
 - Combative behavior
 - DX: Sympathomimetic ingestion with sinus tachycardia

Pediatric Dysrhythmias “Typical” scenarios

- **2 year-old female**
 - Cardiac arrest
 - s/p fall from significant height
 - Wide complex / bradycardia
 - DX: PEA cardiac arrest with idioventricular rhythm
- **14 year-old female**
 - Weak & dizzy
 - Rapid pulse noted
 - DX: PSVT

Pediatric Dysrhythmias Clinical Stability

1. Hypotension / hypoperfusion
 - a. Hypotension – age-related normals
 - b. Hypoperfusion – normal BP in compensated shock
2. Altered mental status
3. Chest pain -- coronary ischemic
4. Dyspnea -- pulmonary edema
5. Extreme rates

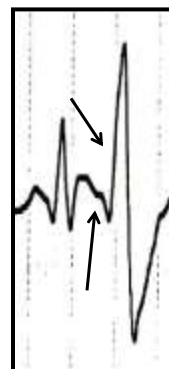
*#1-4 as described by the AHA
ACLS & PALS Curricula*

Pediatric Dysrhythmias Clinical Stability

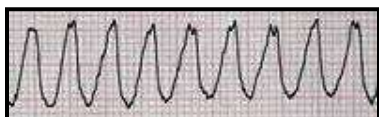
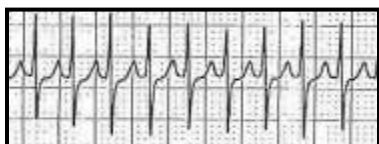
- **Extreme rates & instability**
 - Bradycardia – reasonably obvious
 - Tachycardia – less so
- **Extreme tachycardia**
 - As rate increases, time for cardiac filling & coronary perfusion decreases
 - Increased hypoperfusion
 - Development of acidosis
 - More irritable myocardium
 - Increasing opportunity for R-on-T event

Pediatric Dysrhythmias Clinical Stability

- **Extreme rates & instability**
 - Increasing opportunity for R-on-T event



Pediatric Dysrhythmias Clinical Stability



- **Stability is not entirely dependent upon the specific rhythm**
- **Must consider both the rhythm & its impact on the patient**

Pediatric Dysrhythmias General Diagnostic Issues

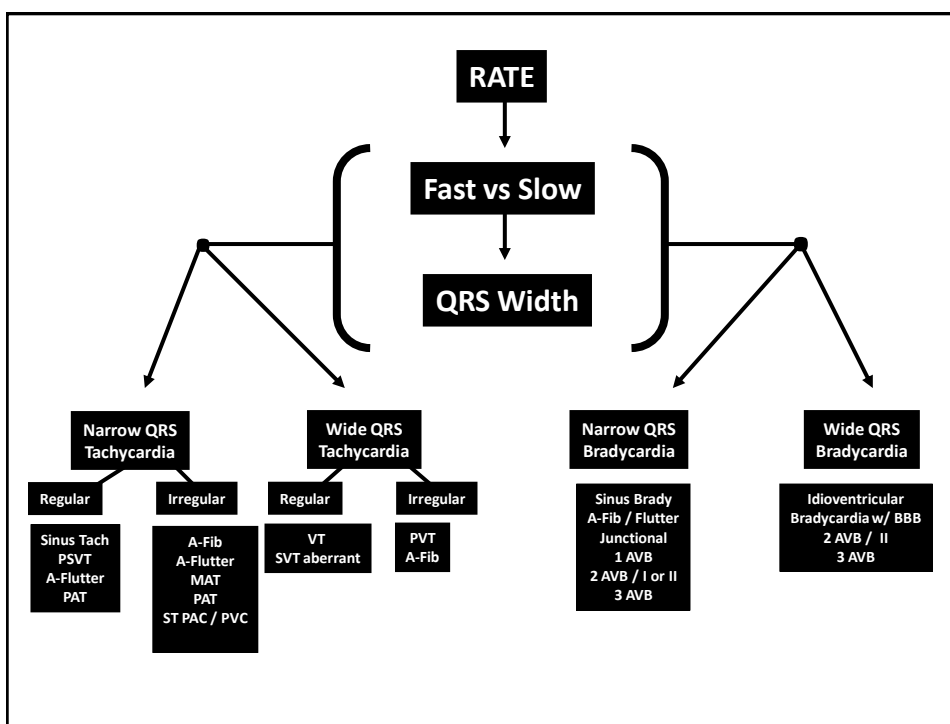
- **Rate**
- **QRS complex width**
- **Regularity of QRS complex**
- **P waves**
- **Association of P waves to QRS complexes**

Pediatric Dysrhythmias

General Diagnostic Issues

Key Issues

- Slow vs fast
- Wide vs narrow
- Regular vs irregular



Pediatric Dysrhythmias

General Diagnostic Issues

- **And do not forget about clinical stability**
- **.....or lack there of**
- **And the underlying cause of the dysrhythmia**

Pediatric Dysrhythmias

General Management Issues

- **ABCs**
- **IV-O₂-monitor**
- **General therapies**
 - **Bradycardias**
 - **Tachycardias**

Pediatric Dysrhythmias General Management Issues Bradycardia

• Oxygen • IV normal saline • 20 ml/kg • Atropine • 0.02 mg/kg IV • Min: 0.1 mg • Max: 0.5 mg	• Epinephrine • Bolus • Infusion • Glucagon • 0.05 mg/kg IV • Electrical pacing
--	---

Pediatric Dysrhythmias General Management Issues Tachycardia

• Oxygen – Minimal to maximal • IV normal saline – 20 ml/kg IV • Adenosine – 0.1 mg/kg IV (max 6 mg) – 0.2 mg/kg IV (max 12 mg) • Beta-blockers • Calcium channel blockers	• Amiodarone • Pulse: 5 mg/kg IV over 20-60 min • Pulseless: 5 mg/kg IVP • Lidocaine • 1-2 mg/kg IV • Electrical cardioversion • Cardioversion - 0.5-2 J/kg • Defibrillation - 2-4 J/kg
---	---

Pediatric Dysrhythmias

Some Important Questions

- **Q:** Is a specific rhythm diagnosis required in all cases?
- **Q:** Are you a poor provider if you cannot diagnose a specific rhythm in each & every case?

Pediatric Dysrhythmias

Some Important Questions

- **Q:** Is a specific rhythm diagnosis required in all cases?
- **A: No, focus on the general rhythm type.**
- **Q:** Are you a poor provider if you cannot diagnose a specific rhythm in each & every case?
- **A: Again no, adjust therapy to the patient presentation, including the vital signs, symptoms / signs, & the rhythm.**



The Cases

Case One

- 6 year-old male
- Lethargy
- Fever with N/V
- Floppy & pale
- Cough with increased work of breathing
- BP ?, P 30, R 12
- O₂ saturation 88%



Bradycardia

- Very compromising bradycardia
- What's going on?
 - Febrile illness with....
 - Gastroenteritis with dehydration -- VOLUME DEPLETION
 - Possible pneumonia -- HYPOXIA
- Does the ultimate diagnosis matter at this point?

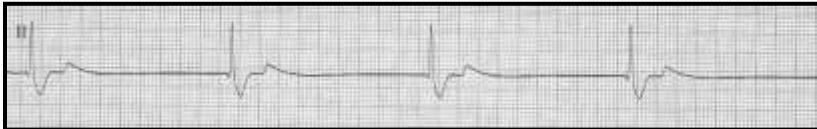
Types of Bradycardia

Slow Ventricular Rate

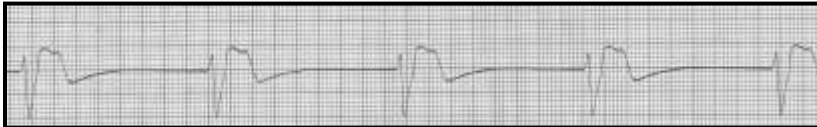
Sinus bradycardia - P to QRS relationship



Junctional bradycardia - No P wave w/ narrow QRS complex

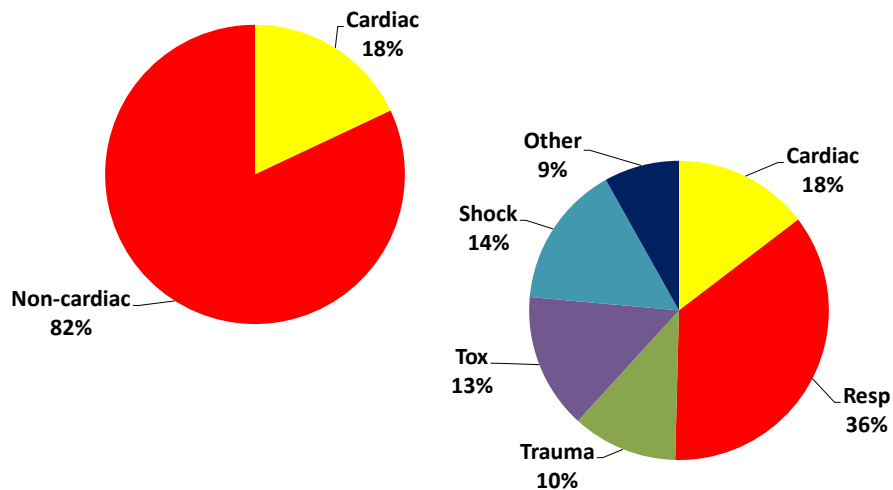


Idioventricular bradycardia – No P wave w/ widened QRS complex



Bradycardia

Causes of Compromising Bradycardia in Children



Bradycardia

- ABCs
- Respiratory support
 - Bag-mask ventilation with 100% O₂
 - IV fluid (normal saline) bolus – 20 ml / kg

Bradycardia

- Cardiovascular support
 - Medications
 - Atropine
 - Epinephrine
 - Glucagon
 - Dopamine
 - Transcutaneous pacing

Bradycardia

-and do not forget about the “D” in ABCDs
- Hypoglycemia
 - Serum glucose determination
 - Dextrose / glucagon
- Must treat both rhythm & underlying issue

Case One Closure

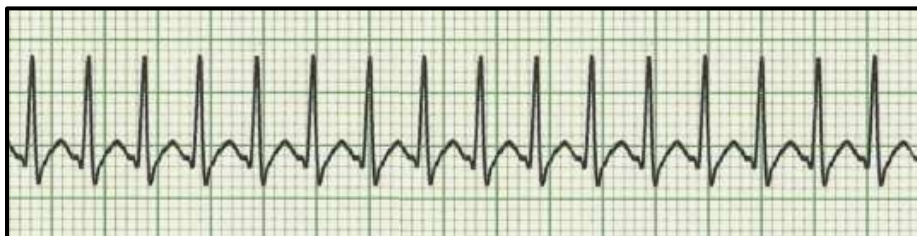
- Bag-mask ventilation
- IV fluid bolus
- Atropine
- Improved oxygenation, perfusion, & mental status at ED arrival
- Ultimate diagnosis: pneumonia with severe dehydration





Case Two

- 8 month-old male
- "Fussy & pale"
- 8 hours
- No other complaints
- PMH -- none
- Alert & consolable
- Pale
- P 260+, R 50, POX 93%
- Very tachycardic
- Prolonged CRT



Paroxysmal Supraventricular Tachycardia

- **Also known as PSVT**
- **Not uncommon**
- **Most often results from a problem in AV node – the focus for therapy**

Paroxysmal Supraventricular Tachycardia



- **Rapid**
- **Regular**
- **Narrow QRS complex**
- **P wave present – retrograde conduction**
- **No P-QRS relationship**

Paroxysmal Supraventricular Tachycardia

- **Can be compromising**
- **Usually not associated with significant underlying heart disease**
- **Considered to be a nuisance-type dysrhythmia**
- **Also consider WPW-related NCT**

Paroxysmal Supraventricular Tachycardia

- **ABCs**
- **Stable vs unstable**

Paroxysmal Supraventricular Tachycardia

- **Stable**

- **Use of AV nodal blocking agents**

- **Adenosine**
 - **Beta-blockers**
 - **Calcium channel blockers**

- **Electrical cardioversion**

Paroxysmal Supraventricular Tachycardia

- **Unstable**

- **Adenosine**

- **Electrical cardioversion**

- **WPW-related NCT**

- **Similar therapies**

Case Two

Closure

- IV access established
- Adenosine
- Improved perfusion at ED arrival
- Ultimate diagnosis: PSVT with normal cardiac function

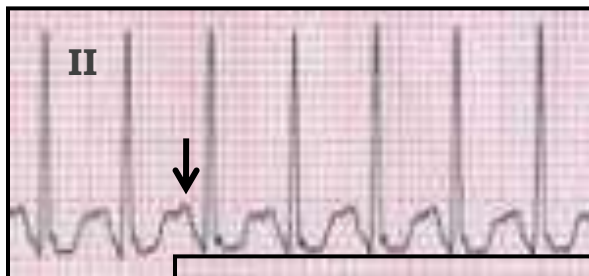


Case Three

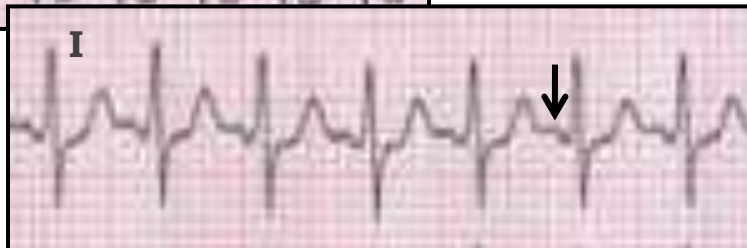
- 8 year-old male
- MVC --- roll-over
- Weakness
- Abdominal pain
- Alert & distressed
- Pale
- BP ?, P 170, R 38
- Left flank -- bruising



Case Three



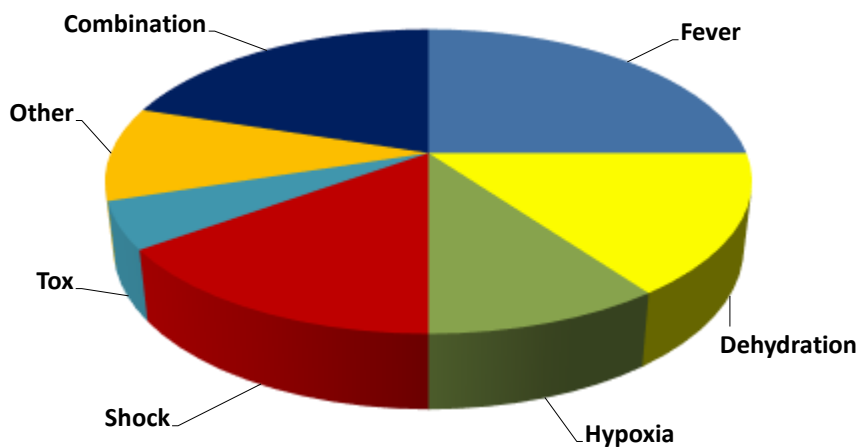
- If in doubt..... look at another lead
- Lead II vs Lead I



Sinus Tachycardia

- A “reactive” rhythm
 - Hypovolemia
 - Hypoxia
 - Pain
 - Anxiety
 - Fever
 - Medication (toxicologic) effect

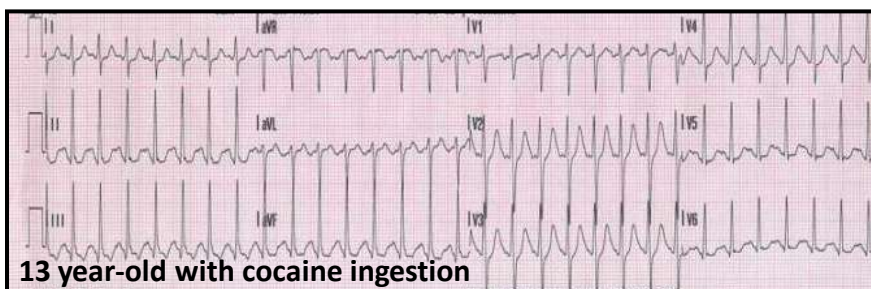
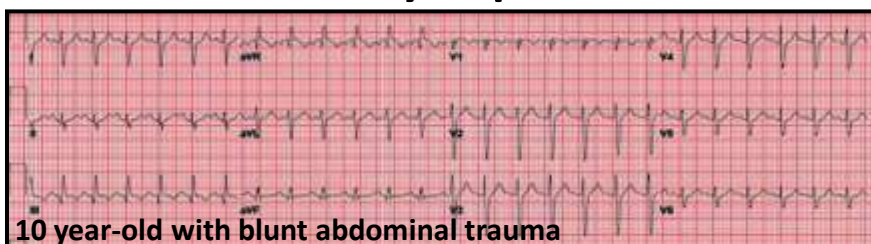
Causes of Sinus Tachycardia in the Pediatric Emergency Department



Sinus Tachycardia

- **Consider & treat cause rather than rhythm**
 - Exception: toxicologic presentation
- **Sympathomimetic agents**
 - Cocaine & methamphetamine
 - Caffeine & other stimulants
 - Albuterol & other adrenergic agonists
- **Therapy**
 - IV fluids
 - Benzodiazepines
 - Antihypertensive agents – caution unopposed beta-blockers

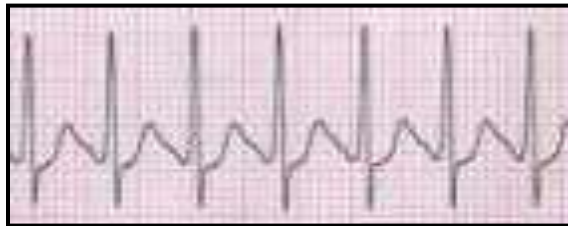
Sinus Tachycardia Extremely Rapid Rates



Case Three

Closure

- IV fluid resuscitation at (20 ml/kg)
- Splenic rupture noted after ED arrival
- To OR for splenectomy



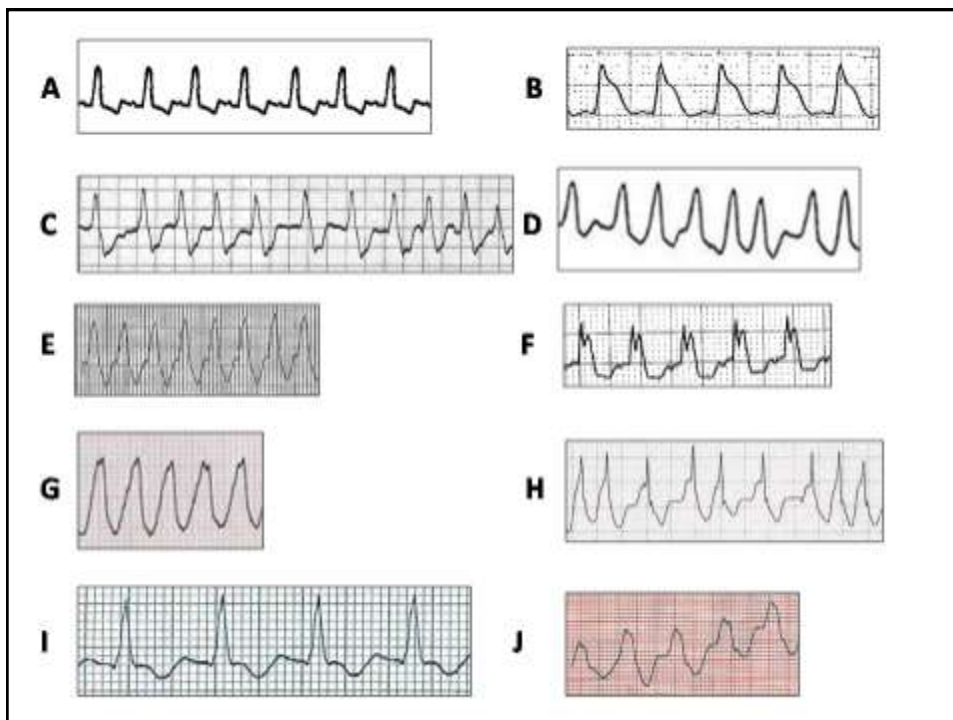
Case Four

- 8 year-old female
- SOB
- Used albuterol
- PMH
 - Asthma on albuterol
 - Palpitations w/ albuterol
- Alert & distressed
- Mild distress
- BP 110/70, P 240
- Lungs minimal expiratory wheeze



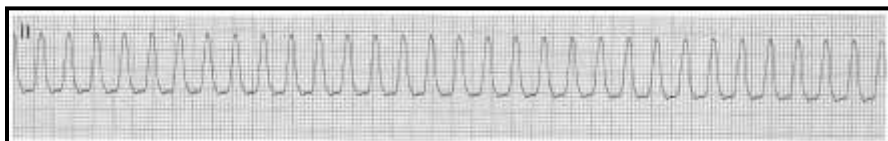
Ventricular Tachycardia

- Unusual but not impossible rhythm in children
- ECG differential considerations -- WCT
 - Ventricular tachycardia
 - SVT with aberrant conduction
 - Tox-related rhythms
 - Hyperkalemia



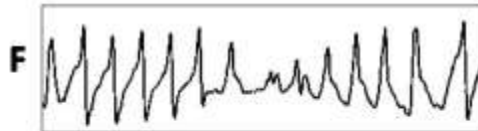
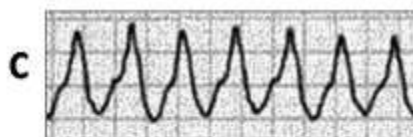
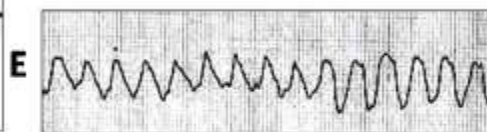
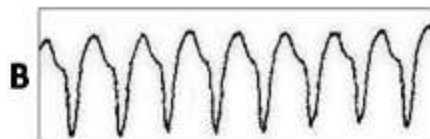
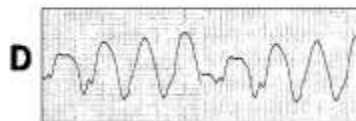
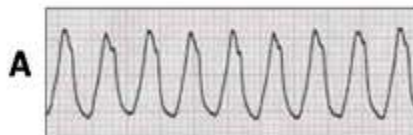
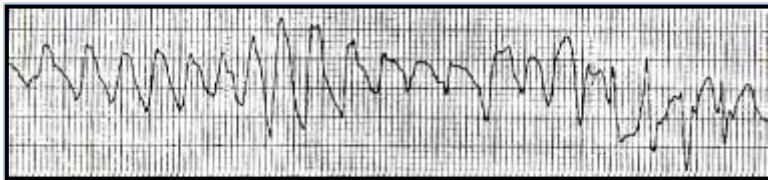
Ventricular Tachycardia Monomorphic

- Rapid rate
- Wide QRS complex
- Regular rhythm

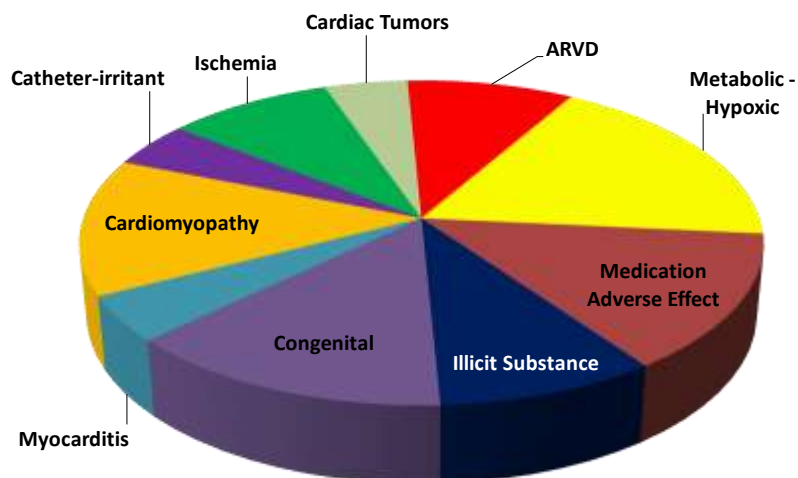


Ventricular Tachycardia Polymorphic

- Rapid rate
- Wide QRS complex
- Changing morphology
- Irregular rhythm



Causes of VT in Children



Meldon S, Brady W, Berger S: Pediatric Ventricular Tachycardiia. Ped Emerg Care 1994;10:294.

Ventricular Tachycardia

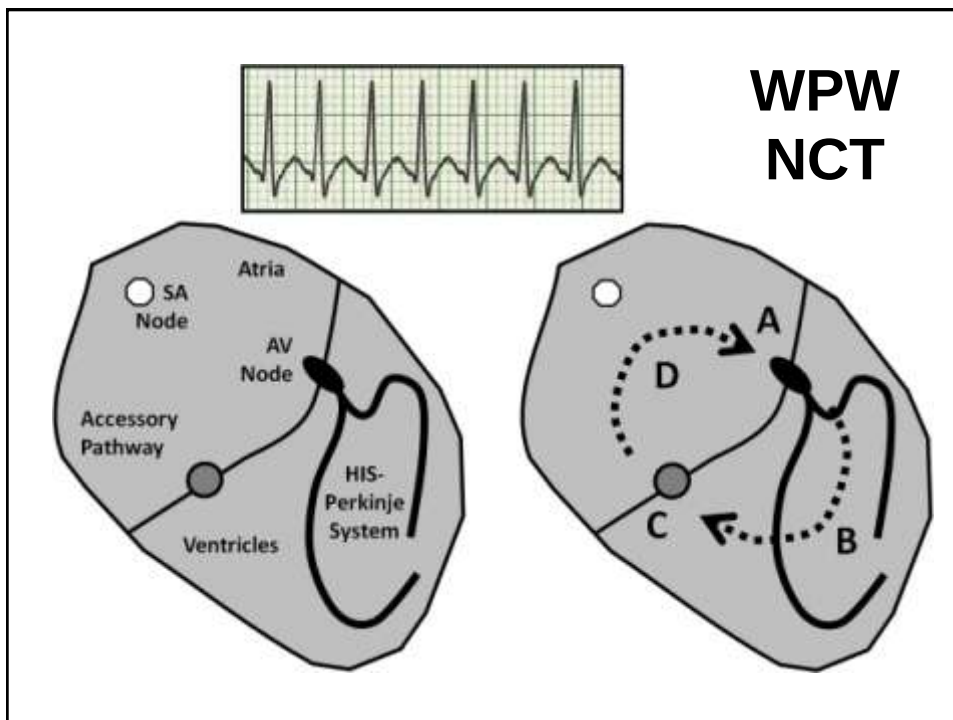
- **ABCs**
- **Stable vs unstable**
- **Stable**
 - Amiodarone
 - Lidocaine
 - Procainamide
- **Unstable**
 - Electrical cardioversion

Case Four

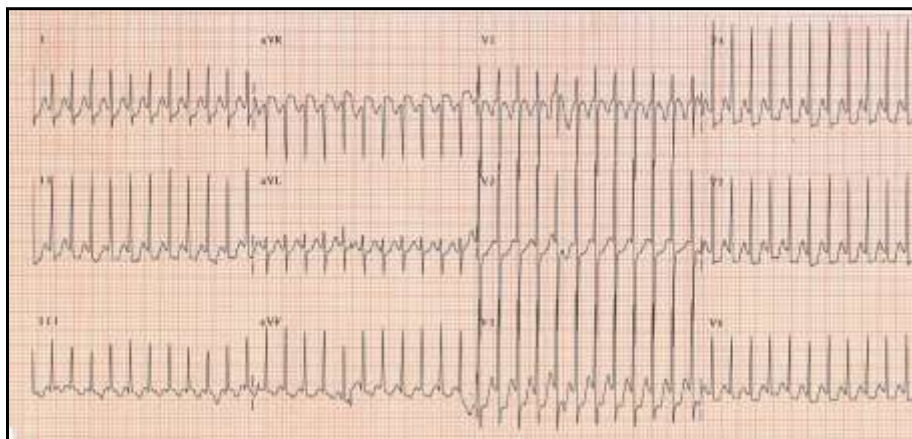
Closure

- Amiodarone IV
- Hypotension developes
- Electrical cardioversion at 2 J/Kg
- Admitted to ICU
- Etiology -- myocarditis





Narrow Complex Tachycardia AVRT / Orthodromic Tachycardia



With Therapy



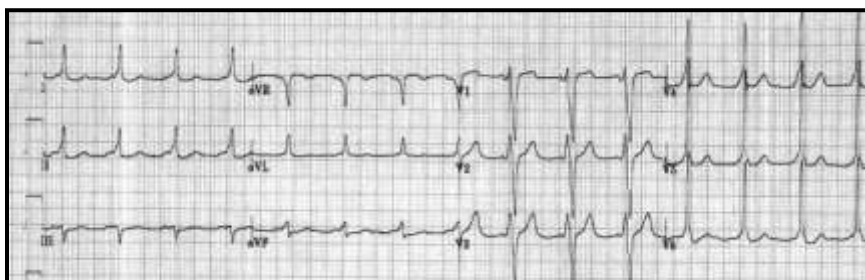
NCT at 225 bpm

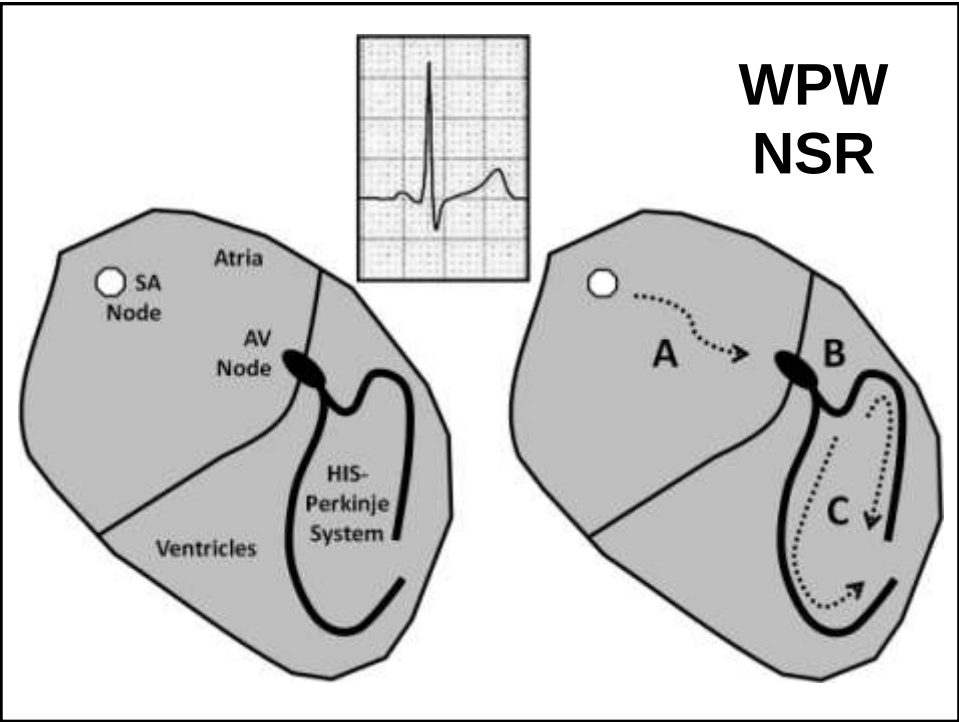
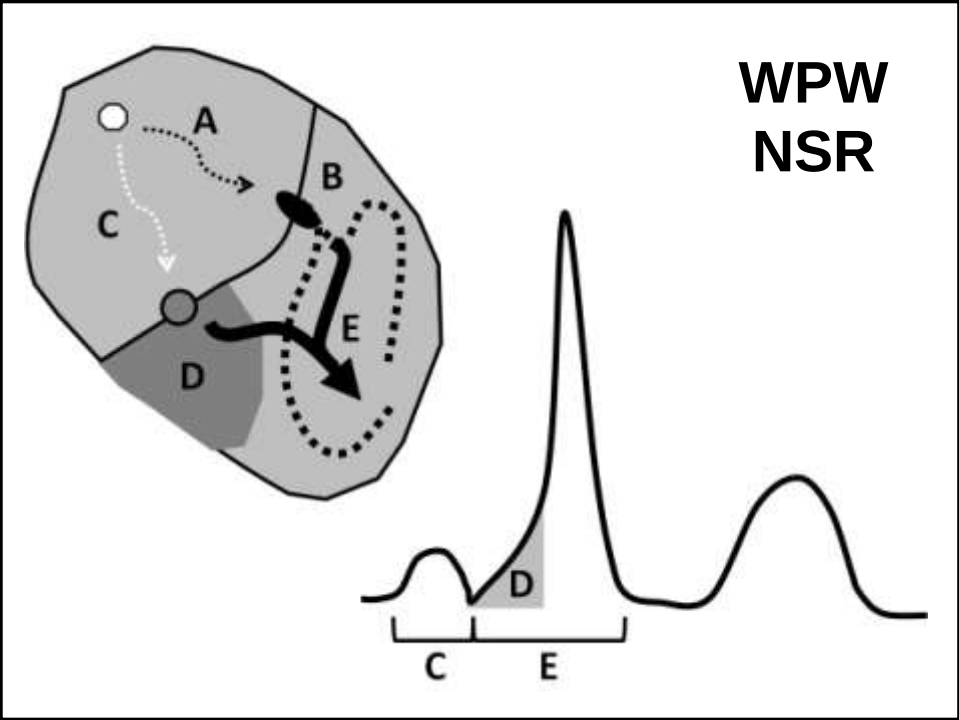
- Patient in shock – medication vs electricity?
- Electrical cardioversion at 2 J/Kg
- Sedation

s/p cardioversion



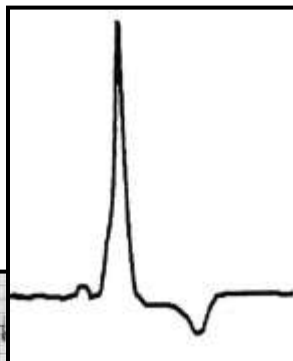
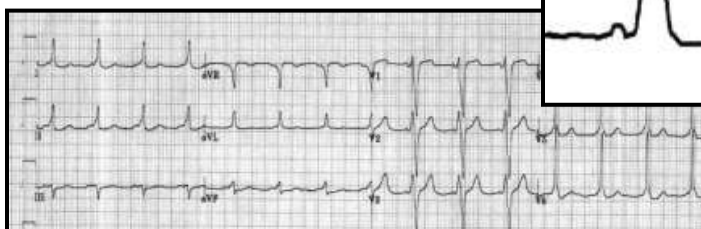
s/p Cardioversion Alert & Oriented in No Distress





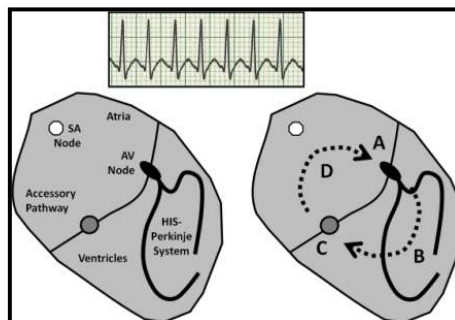
Wolff-Parkinson-White Syndrome

- **Classic triad**
 - Shortened PR interval
 - Delta wave
 - Widened QRS complex



Wolff-Parkinson-White Syndrome Narrow Complex Tachycardia

- ABCs
- Approach similar to PSVT for this WPW rhythm
- AV nodal blocking agent safe in this WPW rhythm
 - Not true in other WPW rhythms



Wolff-Parkinson-White Syndrome

- **AV nodal blocking agents**
 - Adenosine
 - Beta-blockers
 - Calcium channel blockers
- **Procainamide**
- **Electrical cardioversion**

Case Five

Closure

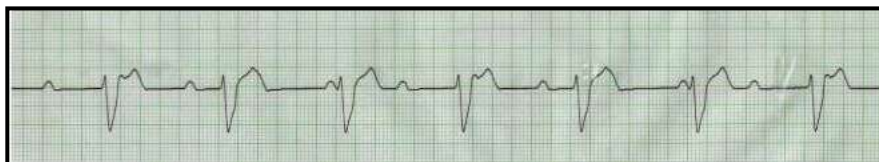
- **Adenosine**
- **Converts to NSR**
- **Alert and oriented**
- **Dx: Wolff-Parkinson-White syndrome-related NCT**
- **Admitted to hospital**
- **Electrophysiologic study with ablation**





Case Six

- 1 month old with lethargy
- Limited feeding
- Otherwise no issues
- PMD – slow pulse noted – 911 called
- Lethargic infant
- “Floppy”
- Poor perfusion
- P 40s, R 60, SAT 90% RA
- Extremities cool



Complete Heart Block

- Third-degree heart block
- Uncommon but malignant
- Usually very symptomatic
 - Shock
 - Respiratory compromise
- Causes
 - Maternal systemic lupus erythematosus (SLE)
 - Consequence of congenital heart disease surgery
 - Others

Third Degree Block (complete)



P Wave	PR Interval	QRS Rate	Rhythm	Pacemaker	Comment
Normal configuration	No relationship between P & QRS	Atrial > Vent	Atrial & ventricular complexes are regular...but dissociated	Ventricular escape as pacemaker	Usually very compromising

Complete Heart Block

- **IV & oxygen**
- **Atropine**
- **Glucagon**
- **Epinephrine**
- **Transcutaneous pacing**

Case Six Closure

- **EMS**
 - **Atropine & IV fluid**
 - **Medical Command – IV epinephrine & transcutaneous pacing**
- **After hospital arrival**
 - **Congenital heart block**
 - **Pacemaker placed**
 - **Discharged on hospital Day #4**



Case Seven

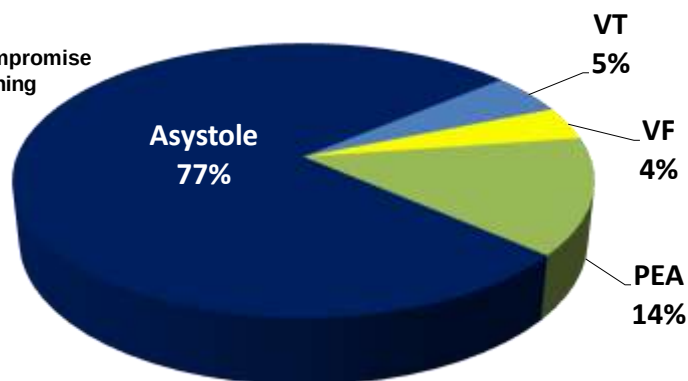
- 10 year-old male
- MVC
- Ejected
- Multiple trauma noted
- No pulse noted
- ECG rhythm as below
- IV
- Airway
- Medications



Initial Cardiac Arrest Rhythms Pediatric Patients

Causes

1. SIDS
2. Trauma
3. Airway compromise
4. Near drowning



Outcome

- Resuscitation attempted 57%
- Survival 15%
- Adequate neuro status 10%

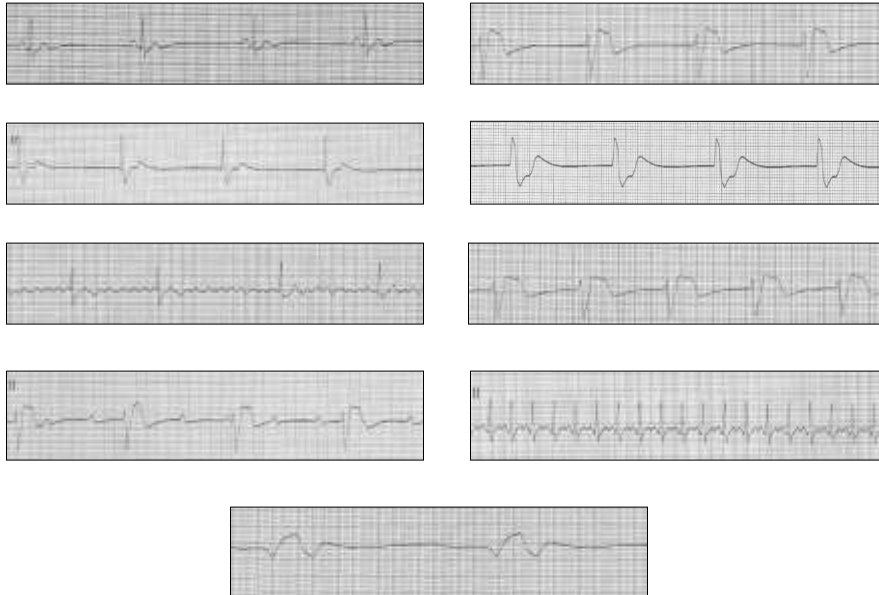
Kuisma et al, Resuscitation 1995

What is PEA?

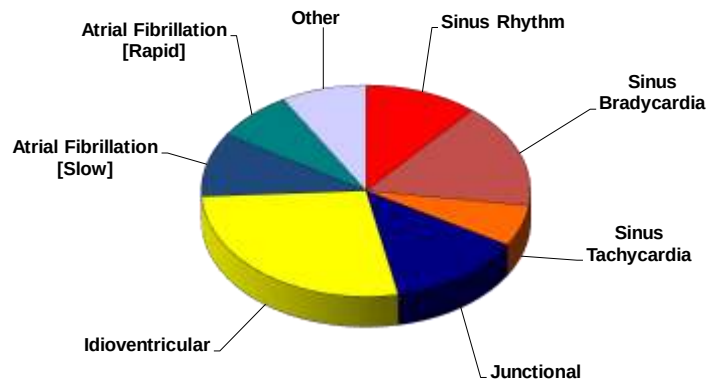
“PEA is a rhythmic display of some type of electrical activity other than VT, but without an accompanying pulse that can be palpated by any artery.”

AHA – 2005 ACLS & PALS Curricula

Potential Electrical Rhythms in the PEA Presentation



Cardiac Electrical Activity (Rhythm-type) in Pulseless Electrical Activity



PEA is a Survivable Rhythm

Key to Survival: Rapidly determining underlying causes

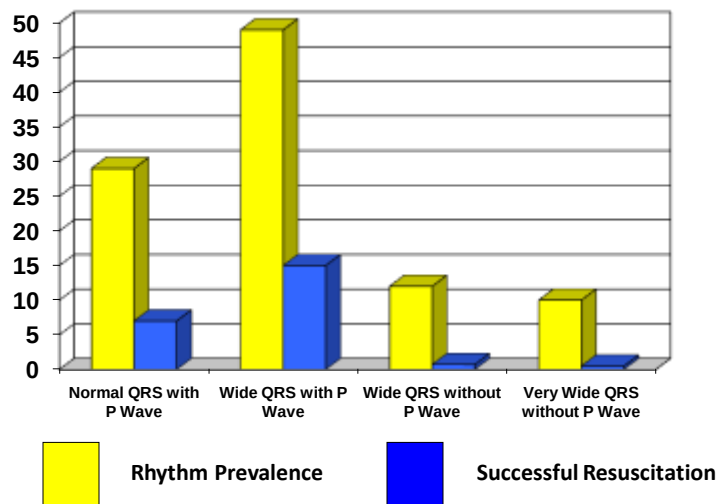
6 H's

- Hypovolemia
- Hypoxia
- Hydrogen Ion (acidosis)
- Hyper/hypo-kalemia
- Hypothermia
- Hypoglycemia

6 T's

- Tablets, toxins
- Tamponade, Cardiac
- Tension Pneumothorax
- Thrombosis, Cardiac
- Thrombosis, Pulmonary
- Trauma

Rhythm Characteristics in PEA Relative to Resuscitation Outcome



Case Seven

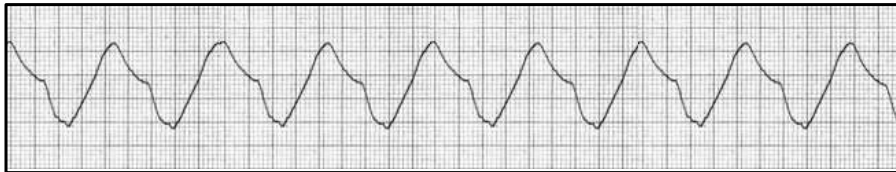
Closure

- Full PALS therapy provided
- No return of pulse
- Resuscitation stopped after 30 minutes
- Patient pronounced expired
- Autopsy – large epidural hematoma with pneumothorax & splenic fracture



Case Eight

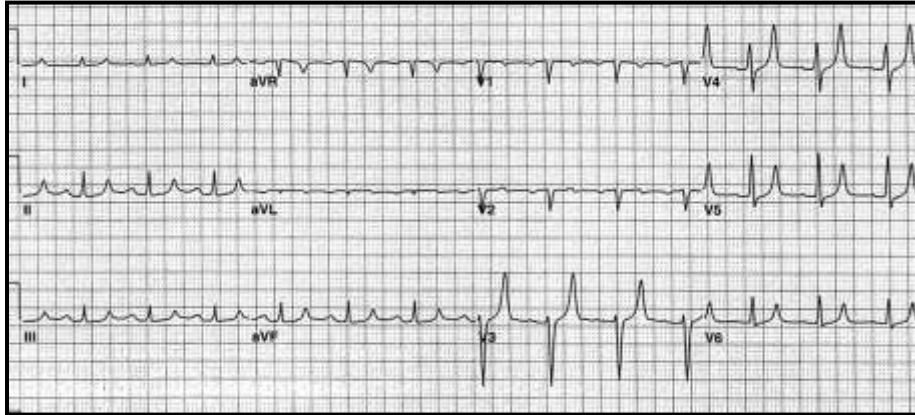
- 5 year-old male
- Weakness, confused, & vomiting
- Recent renal transplant
- Lethargic
- BP ?, P 60, R 12
- Saturations – 90% RA
- Active emesis
- Graft tender



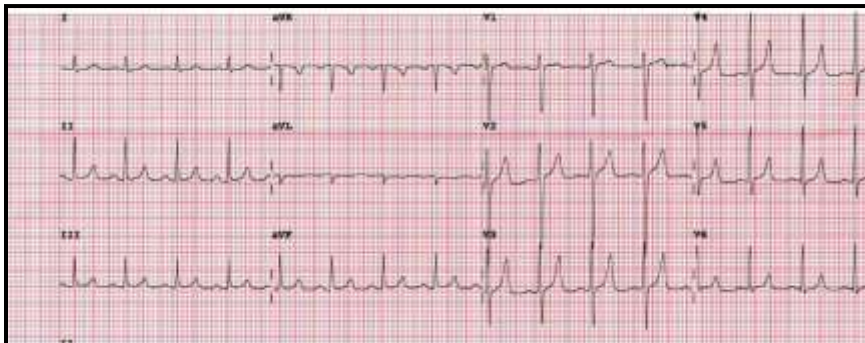
Hyperkalemia

- Elevated serum potassium
 - “Irritates” the myocardium
 - PVCs
 - VT / VF
 - Disrupts conduction
 - Blocks
 - Bradycardia

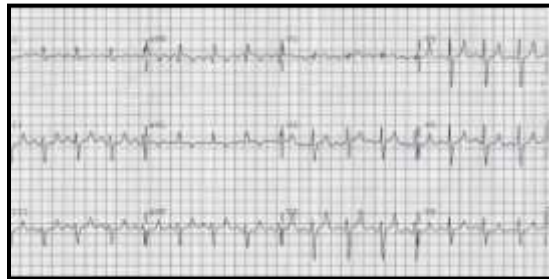
Prominent T Waves



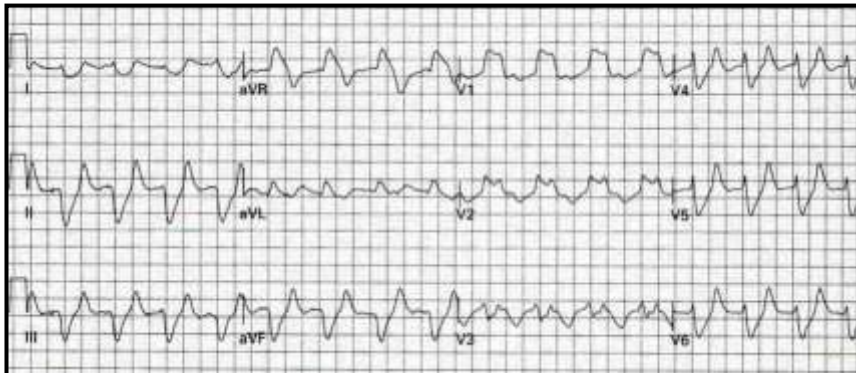
Prominent T Waves



Widened QRS Complex

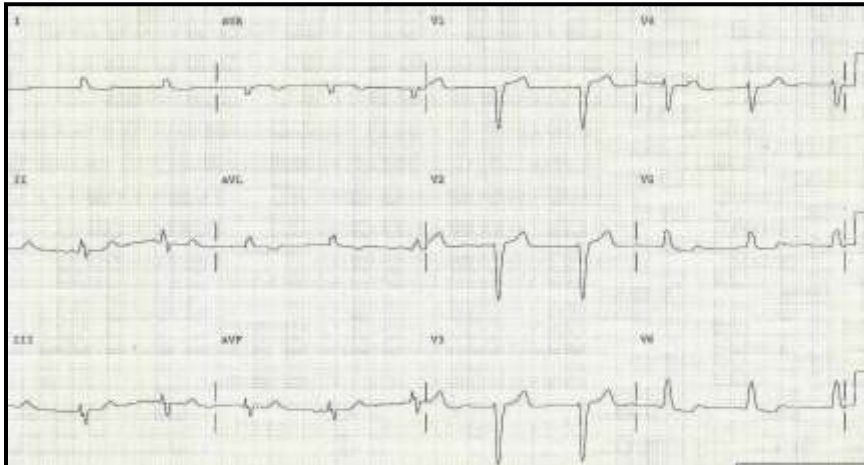


Widened QRS Complex



Widened QRS Complex

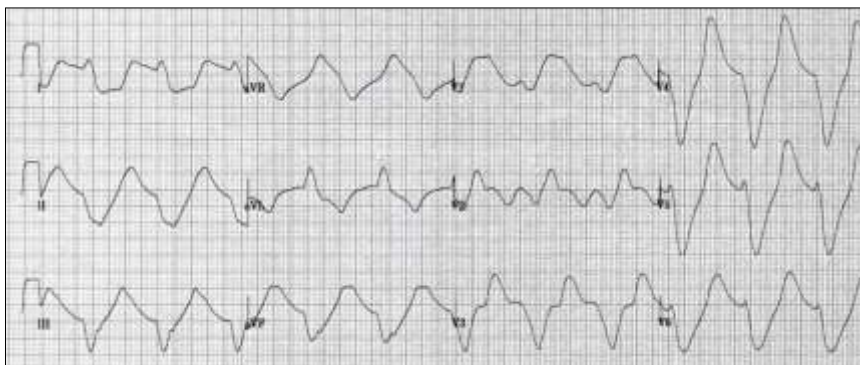
Bundle Branch Block Mimic



Sinoventricular Rhythm

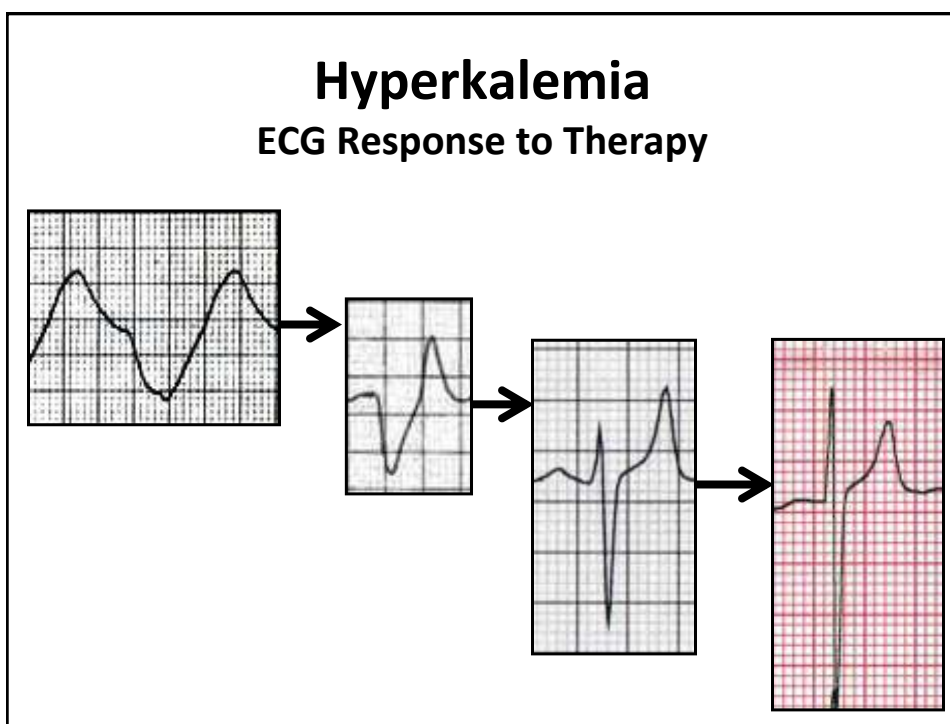
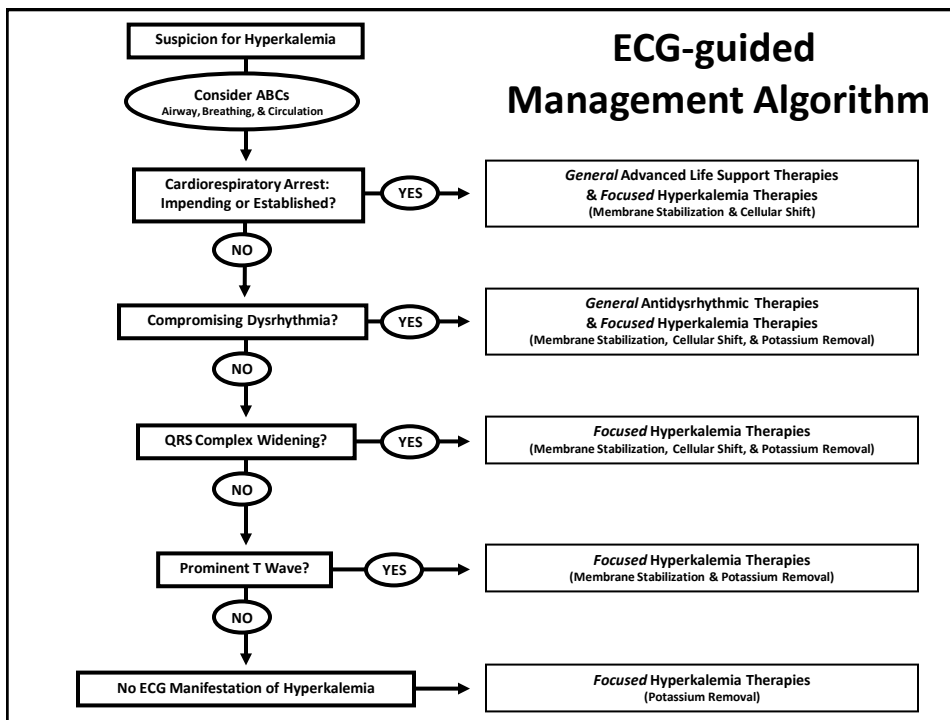


Sinoventricular Rhythm



Hyperkalemia Management

- **Membrane stabilizer**
 - Calcium
- **Potassium shift**
 - Bicarbonate (only if pH <7.35)
 - Glucose / insulin
 - Adrenergic agonists
 - Magnesium
- **Potassium removal**
 - GI binding resin
 - Hemodialysis



Case Eight

Closure

- Serum potassium 7.8 (normal < 4.8)
- Continued medications
- Hemodialysis
- Treated for graft rejection
- Improved renal function
- No further hemodialysis

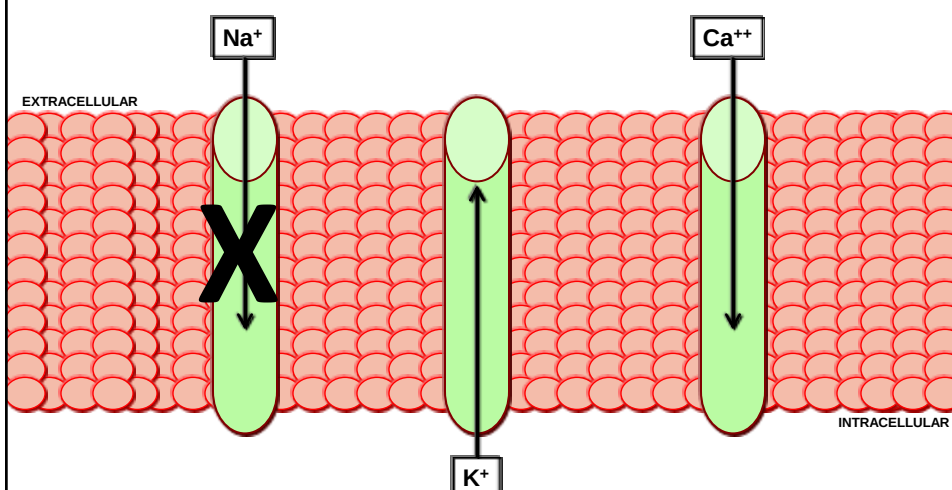


Case Nine

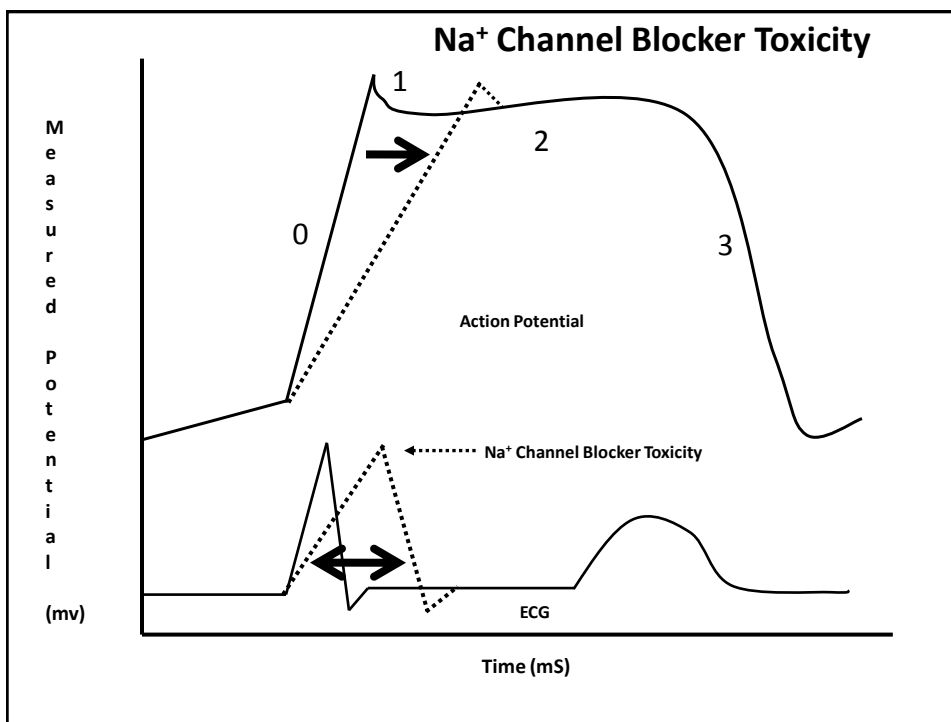
- 16 year-old female
- Ingestion
- Cocaine & alcohol use
- Elavil overdose
- Lethargic
- BP 120/80, P 135, R 12
- Pupils mid range
- Otherwise no findings



Ion Channels



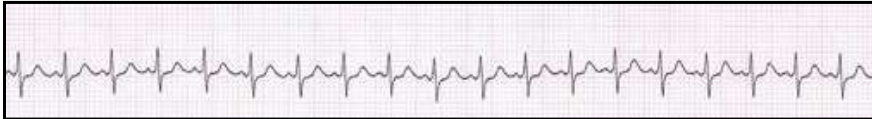
Phase 0 Rapid Influx is Lessened



Sodium Channel Blockers

- | | |
|----------------------|------------------|
| • Amantadine | • Imipramine |
| • Amitriptyline | • Loxapine |
| • Amoxapine | • Maprotiline |
| • Carbamazepine | • Moricizine |
| • Chloroquine | • Nortriptyline |
| • Cocaine | • Orphenadrine |
| • Desipramine | • Phenothiazines |
| • Diltiazem | • Procainamide |
| • Diphenhydramine | • Propranolol |
| • Disopyramide | • Propafenone |
| • Doxepin | • Propoxyphene |
| • Encainide | • Thioridazine |
| • Flecainide | • Quinidine |
| • Hydroxychloroquine | • Quinine |

Sinus Tachycardia



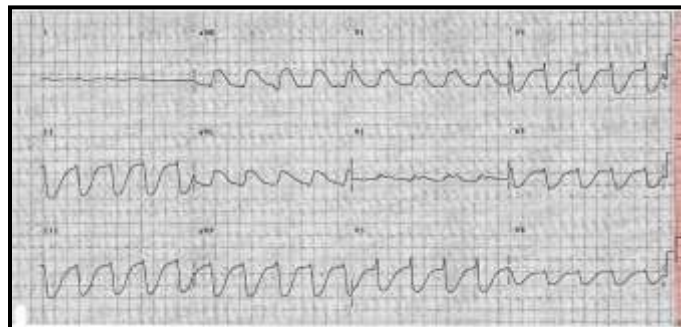
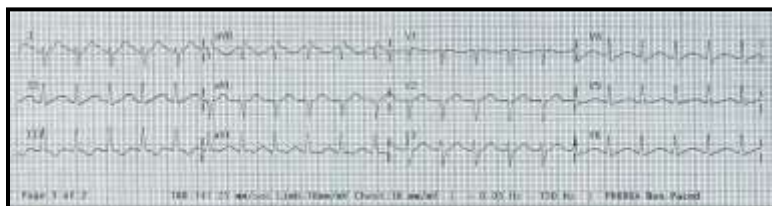
Common

Nonspecific

Multifactorial

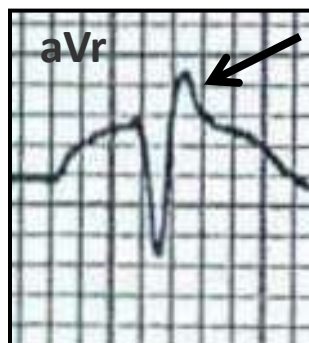
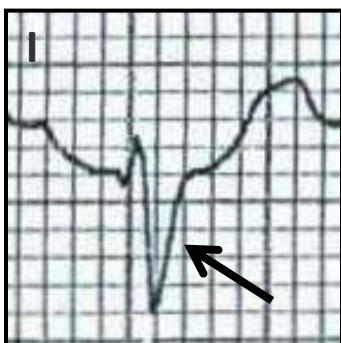


QRS Complex Widening



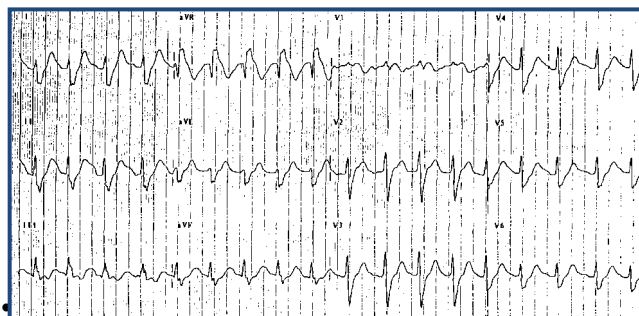
Terminal Rightward Axis Deviation

$S_I + R_{aVr}$ Pattern

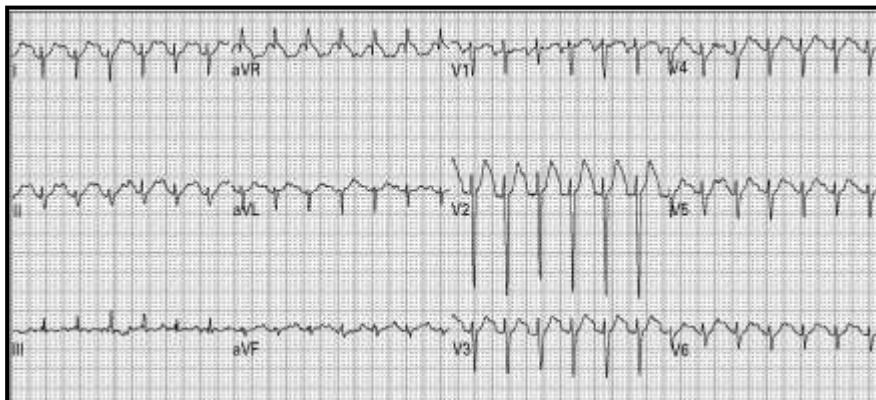


“Bundled” Abnormalities

- Sinus tachycardia
- Widened QRS complex
- Terminal rightward axis



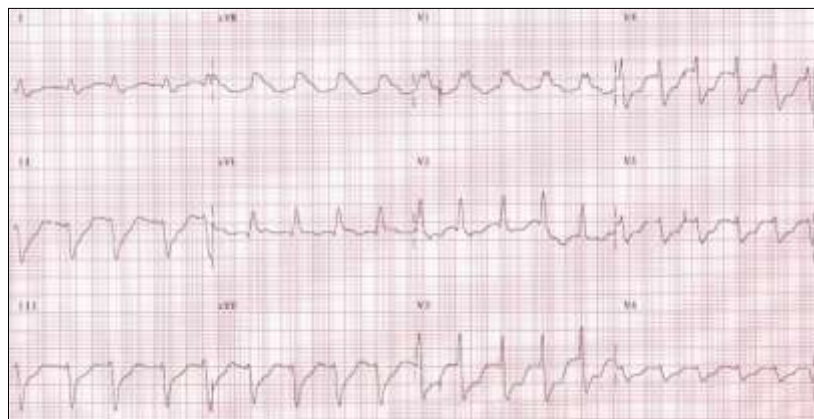
17 year-old Female with Unknown Purposeful Ingestion



.....ultimately diagnosed with TCA
ingestion



Progression of ECG over 45 minutes



TCA Ingestion Management

in brief

- ABCs
- Low threshold for intubation
- Benzodiazepines, etc
- IVF
- Vasopressors
- Sodium bicarbonate



Case Nine Closure

- Progressive lethargy
- Intubated by EMS
- IV saline & HCO_3
- Diagnosed with mixed ingestion
 - Sedative
 - Stimulant
 - Sodium Channel blocker



Pitfalls

- Non-use of age-related parameters
- Lack of rhythm interpretation within the clinical context of the patient
- “Kids can’t have VT!”
- Reluctance to escalate therapy

The End

wjbrady@virginia.edu