Evaluation of the Patient Suspected of Having Underlying Arrhythmias

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Cardiac arrhythmia (also dysrhythmia) is a term for any of a large and heterogeneous group of conditions in which there is abnormal electrical activity in the heart. The heart beat may be too fast or too slow, and may be regular or irregular.
**Classification Of Arrhythmias**

**Tachycardia**
- Sinus tachycardia
- SVT
- Vent. Fib
- Vent. Tachy
- Atril fib.
- Atrial flutter

**Bradycardia**
- Sinus bradycardia
- Heart block

**Irregular**
- Sinus arrhythmia
- PAC
- PVC
Major risk of an arrhythmia is either severe bradycardia or tachycardia leading to degeneration of cardiac output into more severe arrhythmias (vent. fib.).

To be aware of arrhythmias that occur in otherwise healthy children.
Symptoms

- **Range from**
  - Completely asymptomatic
  - Loss of consciousness
  - Sudden cardiac death

- **In infants**
  - Lethargy
  - Poor feeding
  - Irritability
  - Cardiac failure
  - Underlying congenital heart disease

- **In Children/Adults**
  - Palpitation
  - Syncope
  - Dizziness
  - Chronic fatigue
  - Shortness of breath
  - Chest discomfort
Examination

GPE
- Pulse: irregular, feeble, inc./dec. rate, absent
- Tachypnea
- B.P: Normal, hypotension
- JVP: elevated in CHF
- Cyanosis
- Pallor

CVS
- Precordial bulge
- Right ventricular heave
- Gallop
- Murmur
Evaluation Of The Patient With An Arrhythmia

**History**
- Symptoms
- Frequency and length of episode
- Onset and triggers
- Any underlying disease
- Medications
  - Triggering factor
  - Used for underlying cardiac disease
Physical examination

- ABC’s
- Hemodynamic stability

Adjunctive testing

- 12-Lead ECG
- Holter
- External event recorders
- Implantable Monitors
- Exercise testing
- EP Study
Evaluation Of A Patient With An Arrhythmia

- Patient with arrhythmia
  - Ensure ABCs
  - Assess rhythm
    - Absent: Asystole
    - Present:
      - Absent: Assess pulse
        - Absent: V FIB, Pulseless V Tach, PEA
      - Present:
        - Fast: Wide QRS, V TACH, V FIB
        - Narrow QRS:
          - Sinus Tachycardia
          - Atrial FIB
          - SVT (PAT)
          - Atrial flutter
          - PAC +/- Block
          - PVC
        - Slow: Sinus Bradycardia, AVN Block, Sick Sinus
Evaluation Of The Patient With An Arrhythmia

Assess Pulse

- Fast
- Irregular
- Slow

P- Wave
PR-Interval

- Normal
- Prolonged PR-Interval

- Sinus Bradycardia
- Heart- block
Assess Pulse

Fast

Irregular

Slow

P-Wave QRS-Complex

Normal

Sinus Arrhythmia

• Fibrillatory (Multiple P-Wave)
  • Normal QRS-Complex

Atrial Fib.

• Normal but different shape QRS complex
  • P-Wave Present

PAC

Wide QRS-complex

PVC
Tools for Diagnosis and Evaluation

**ECGs** No asymptomatic arrhythmias; limited duration

*24-48 hour Holter monitoring* Short duration

**Event recorders**
- Non-looping require frequent manual activations and/or symptoms
- Limited sensitivity/specificity of auto trigger algorithms

**Outpatient cardiovascular telemetry monitoring**
- Requires continuous wearing (patient compliance)
- Limited monitoring time

**Implantable loop recorders**
Tools for Diagnosis and Evaluation

External Ambulatory ECG Monitoring

A. Holter monitoring
Patient wears monitor (typically 24-48 hours)
Patient keeps diary of symptoms and times when they occur
Patient returns monitor to technician to be scanned after recording period
Technician gives physician final report

B. Event monitoring
Patient carries monitor (typically 30 days)
Patient places monitor on chest to record during symptom
Patient transmits data over telephone to monitoring station
Monitoring station sends data to physician

C. Loop monitoring
Patient wears monitor (typically 30 days)
Patient activates monitor during symptom (some devices auto-trigger if arrhythmia is detected and alert patient)
Patient transmits data over telephone to monitoring station
Monitoring station sends data to physician
Tools for Diagnosis and Evaluation

Second Generation External Ambulatory ECG Monitoring

A. Holter monitoring
   - Patient wears monitor patch (up to 7-14 days)
   - Patch monitor records all ECG data during period
   - Patient mails back monitor after recording period to central receiving station
   - Technician reviews data and sends report to physician

B. Ambulatory Telemetry monitoring - (Non-Real Time)
   - Patient wears monitor (up to 30 days)
   - Monitor sends all ECG data to a handheld device
   - The handheld device transmits ECG data to a central monitoring station
   - Physicians are notified by technician if significant arrhythmia is detected

C. Ambulatory Telemetry monitoring - (Real Time)
   - Patient wears monitor (up to 30 days)
   - Monitor sends all ECG data continuously to central monitoring station
   - Physicians are notified by technician if significant arrhythmia is detected
   - Physicians can also log onto secure web server at any time to view real time ECG data
Symptoms / Intermittent monitoring

Continuous monitoring
Brugada syndrome
hypertrophic cardiomyopathy
short or long QT syndrome

ventricular tachycardia
fibrillation

vasovagal
(POTS)
(non-cardiac)

sinus node, AV node,
and/or His-Purkinje system
dysfunction

(CSH)
(OH)
# Dysrhythmias

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Reproduced from Zitelli’s Atlas of Pediatric physical diagnosis, 2007, pg 140.
Every QRS complex is preceded by a P wave and every P wave must be followed by a QRS (the opposite occurs if there is second or third degree AV block).

The P wave morphology and axis must be normal and

PR interval will usually be normal for that age
Sinus Arrhythmia

- Most common irregularity of heart rhythm seen in children
- Normal variant
- Reflects healthy interaction between autonomic respiratory and cardiac control activity in CNS
- Heart rate increases during inspiration and decreases during expiration
Sinus Arrhythmia

- Normal phasic variation of heart rate with respiration
- Variable P-P intervals
- No treatment needed
Wandering Atrial Pacemaker

- normal QRS complex
- Change in P-wave configuration
Wandering Atrial Pacemaker

- Atrial pacemaker shifts intermittently from sinus node to another atrial site
- Normal variant
- May also be seen in CNS disturbances like subarachnoid hemorrhage
Premature Atrial Contraction

- Ectopic focus in atria or AV node
- Narrow but normal QRS
- Normal P wave
Isolated PAC’s

- Premature atrial contractions
- Benign in absence of underlying heart disease
- Early p wave, sometimes with different morphology than a sinus p wave
- Can be either:
  - Not conducted to ventricle, apparent pause
  - Conducted to ventricle with aberrant or widened QRS complex (careful not to mix up with PVC’s)
Premature Ventricular Contraction

- Ectopic beat activates ventricle before the wave of depolarization from normal sinus node
- Abnormally wide QRS complex appears early which are not preceded by P-wave
- T-wave points in the direction opposite to QRS complex

- Bigeminy, trigeminy, couplet
- Unifocal, multifocal
- Three or more successive PVCs are termed as ventricular tachycardia
Premature Ventricular Contraction

- Not very commonly seen in children
- Incidence of 0.3 to 2.2 %
- Myocarditis
- cardiomyopathy
- CHD
- hypokalemia
- Hypoxia

**Drugs:** Digitalis toxicity, catecholamines, theophylline, caffeine, anesthetics, Class I and III anti-arrhythmics

- myocardial injury
- long QT syndrome
- hypomagnesemia
PVC’s

- unifocal,
- disappear with exercise, and
- associated with structurally and functionally normal heart, then considered benign, no therapy needed
PVC’s Evaluation

Indicated if

- Two or more PVCs in a row
- Multifocal origin
- Increased vent. Ectopic activity with exercise
- R on T phenomenon (PVC occurs on preceding beat)
- Presence of underlying heart disease
12 lead EKG, Echocardiogram
Perhaps Holter monitoring
Brief exercise in office to see if ectopy suppressed or more frequent

**Treatment:**
- Correction of underlying condition
- IV lidocaine – 1st line drug
- Amiodarone in refractory cases with hemodynamic compromise
Evaluation Of The Patient With An Arrhythmia

Assess Pulse

- Fast
- Irregular
- Slow
  - P-Wave
    - Normal
    - Prolonged PR-Interval
      - Sinus Bradycardia
      - Heart-block
Sinus Bradycardia

- Normal P wave axis and P-R interval
- HR < 5th percentile for age
Sinus Bradycardia

- Athletic individuals (normal)
- Increased ICP
- Hyperkalemia
- Vagal stimulation
- Hypothermia
- Drugs: digoxin, beta-blockers, clonidine, opioids, sedative-hypnotics, amiodarone
- Treatment: address underlying cause

- Hypoxia
- Hypercalcemia
- Hypothyroidism
- Long QT syndrome
Long Q-T Syndrome

- Bradycardia
- Prolonged QT interval
- Notched T-wave
Long Q-T Syndrome

- Genetic abnormality of vent. Repolarization
- 50% cases familial
- Romano Ward syndrome – common form of LQTS
- Drugs causing LQTS: terfenadine, cisapride, droperidol
- Clinical manifestation:
  - Syncope induced by exercise, fright, startle
  - Some events occur during sleep
  - Seizures
  - Palpitation
  - Cardiac arrest (10%)
Long Q-T Syndrome

Diagnostic criteria:
- QTc >0.47 __ indicative
- QTc >0.44 __ suggestive
- Notched T-wave
- Low heart rate for age
- Syncope
- Family H/O LQTS or unexplained sudden death

Investigation
- 12 lead ECG
- Holter Monitoring
- Exercise testing
Long Q-T Syndrome

Treatment:
- Beta blockers - to blunt heart response to exercise
- Pacemaker if drug induces profound bradycardia
- Implanted cardiac defibrillators
  - Continuous syncope
  - No response to drug treatment
  - Experienced cardiac arrest
Sick Sinus Syndrome

- Result of abnormality in sinus node or atrial conduction pathway or both
- Arrhythmias include sinus bradycardia, blocks, sinus arrest with junctional escape, paroxysmal atrial tachycardia.
- Most common after surgical correction of CHD
- Clinical manifestations depend on heart rate
  - Asymptomatic
  - Dizziness
  - Syncope
- Treatment: pacemaker therapy in symptomatic patient
AV Nodal Block First-Degree Heart Block

- Delayed conduction through AV node
- Prolongation of PR interval
First degree AV Block

- Commonly seen
- PR interval is greater than upper limits of normal for a given age
- PR interval is age and rate dependent
  - 70-170 msec in newborns is normal
  - 80-220 msec in young children and adults
- Generally does not cause bradycardia since AV conduction remains intact
AV Nodal Block First-Degree Heart Block

- Usually asymptomatic
- Diseases that can be associated with first degree AV block:
  - Acute rheumatic fever
  - Lyme disease,
  - CHD (ASD, Ebstein’s anomaly),
  - cardiomyopathy,
  - post-cardiac surgery,
  - normal children
  - Hypothermia
  - Electrolyte disturbances
AV Nodal Block First-Degree Heart Block

- Drugs: Digitalis toxicity
- Treatment: Address underlying cause
- Isolated finding- benign, no treatment and no follow up needed
Progressive lengthening of PR interval until a QRS is not conducted (ventricular contraction does not occur)

Second-Degree Heart Block: Mobitz Type I - Wenckebach
Second-Degree Heart Block: Mobitz Type I - Wenckebach

- Does not usually progress to complete heart block
- Diseases that can be associated
  - Myocarditis,
  - cardiomyopathy,
  - CHD,
  - cardiac surgery,
  - MI,
  - normal children at times of increased parasympathetic activity
- Drugs: digitalis toxicity, beta-blocker toxicity
- Treatment: address underlying cause
Second-Degree Heart Block: Mobitz Type II

- Constant PR interval before a skipped ventricular conduction
Second-Degree Heart Block: Mobitz Type II

- Block below the AV node in the bundle of His
- Not found in normal children, usually those with structural disease or post-op
- May progress to complete heart block
- May require pacemaker
Third-Degree Heart Block: Complete

- Complete dissociation of atrial and ventricular conduction
- P wave and PR interval normal
- Junctional pacemaker – narrow QRS
- Ventricular pacemaker – wide QRS
- Rate 30 – 50 beats/min
Third-Degree Heart Block: Complete

- Congenital: maternal lupus or CT disease, CHD (L-TGA or abnormal AV septum)
- Acquired: post-op, acute rheumatic fever, Lyme carditis, myocarditis, cardiomyopathy, MI
- Slower the heart rate, and wide QRS escape rhythms place into high risk group
- May need implantable pacemaker: significant bradycardias, syncope, exercise intolerance, ventricular dysrhythmias, or ventricular arrhythmias, structural disease
- Possible acute treatment: isoproterenol
Sinus Tachycardia

- Normal sinus rhythm
- HR >95th percentile for age
- Usually < 230 beats/min
Sinus Tachycardia

- Hypovolemia
- Anemia
- Fever
- CHF
- Drugs: Beta-agonists, aminophylline, atropine

Treatment: Address underlying cause.
Supraventricular Tachycardia

- > 230 beats/min
- Narrow QRS
- P waves not visible
Supraventricular tachycardia

- Most common abnormal tachycardia seen in pediatric practice
- Most common arrhythmia requiring treatment in pediatric population
- Most frequent age presentation:
  - 1\textsuperscript{st} 3 months of life,
  - 2\textsuperscript{nd} peaks @ 8-10 and in adolescence

**Causes:**

- Idiopathic
- CHD (Ebstein’s anomaly, transposition)
Paroxysmal, sudden onset & offset

Rates of SVT vary with age

Overall average rate for all ages: 235 bpm

P waves difficult to define, but 1:1 with QRS

Important to differentiate from sinus tachycardia
SVT - Presentation

- May describe a sensation of a fast heart rate, palpitations, or chest tightness
SVT - Treatment

Goal:
- identify unstable patients,
- differentiate from sinus tachycardia, and
- terminate the rhythm
SVT - Treatment

- Need post conversion EKG – identify those with WPW syndrome (25% pts with SVT)
- Will also need an echo – identify structural problems
- Medications (to prevent recurrence)
  - Digoxin and beta blockers as first line
  - Flecainide, sotalol, amiodarone
- Observation and expectant management
- Radiofrequency catheter ablation
  - Frontline treatment
  - Very effective
  - Cutoff points usually are 5 y.o. and 15 kg, unless severe SVT
Accessory pathway establishes cyclic pattern of signal reentry.

Impulse arrives at ventricle rapidly without delay at the AV node.

Independent of AV node.

Most common cause of nonsinus tachycardia in children.
Wolff-Parkinson-White Syndrome

- Delta wave
- Slurred upstroke of QRS
- Reflects pre-excitation
- Short PR- interval
- Wide QRS complex

Normal rhythm with WPW

Tachycardia
Atrial Flutter

- Atrial rate 250-350 beats/min
- Sawtooth (no discrete P waves)
- Normal QRS complex

- Dilated Atria, intraatrial surgery
- Digitalis toxicity
- Post-Fontan procedure patients
Atrial Flutter

Management

Emergency:
- Vagal maneuver
- Adenosine

Synchronized cardioversion 0.5-2 J/kg

Overdrive pacing

Long term:
- Digoxin +/- B- Blockers
- Ablation

Chronic atrial flutter:

- Inc. risk of thromboembolism and stroke
- Anticoagulation
- Radiofrequency ablation in CHD in older child
Atrial Fibrillation

- Atrial rate 350-600 beats/min
- Atrial waves are totally irregular
- P wave vary in size and shape from beat to beat
- vent. response is irregularly irregular
- QRS complexes are usually normal
Atrial Fibrillation

- Much less common
- Chronically stretched atria
  - Intra atrial surgery
  - Left atrial enlargement due to mitral valve insufficiency
  - WPW syndrome
  - Thyrotoxicosis
  - Pulm. Embolism
  - Pericarditis
  - familial
Treatment:
- Restore normal heart rate by digitalization (avoided in WPW syndrome)
- Restore normal rhythm by adding quinidine/procainamide/DC cardioversion
- Prevention of thromboembolic phenomenon and stroke by warfarin
Ventricular Tachycardia

- 120-150 beats/min
- Wide QRS
- 3 or more consecutive beats from the ventricle (PVCs)

- 85% have abnormal cardiac anatomy
- Metabolic abnormalities
- Drugs/toxins: tricyclic antidepressants
V-Tach

- Associated with
  - Myocarditis
  - Anomalous origin of coron. A.
  - Rt. Vent. Dysplasia
  - Mitral valve prolapse
  - CMP
  - LQTS
  - WPW synd.
  - Drugs (cocaine, amphetamine)
  - HOCM
  - Ischemic Heart Disease
V-Tach

- Treatment: IV lidocaine, procainamide, amiodarone
- If critically ill: synchronized cardioversion
- Long term: meds, ablation, or defibrillator
Rapid and irregular ventricular arrhythmia
Low amplitude QRS
primary form or from degeneration of unstable SVT

Rare in children
MI, post-op, myocarditis, severe hypoxia, long QT syndrome
Digitalis and quinidine toxicity, catecholamines
V-fib

- Presents with pulse less cardiac arrest
- Fatal dysrhythmia. Death if untreated/uncorrected
- Thump on chest may occasionally restore sinus rhythm
- Treatment: immediate defibrillation, CPR
V-fib

- Anti-arrhythmic drugs indicated if defib. Ineffective or fib. recurs
- After recovery from fib. Search for underlying cause
- Ablation in WPW syndrome
- If no correctable abnormality identified, ICD indicated b/c of inc. risk of sudden death
What is sinus rhythm?

a. When each P-wave is followed by QRS-complex
b. When each QRS-complex is preceded by P-wave
c. Normal P-wave and PR interval
d. All of above
This is the ECG of a 2yr old girl presented with history of vomiting and fast heart rate

a. What two abnormalities are shown up on ECG?

b. What is most likely diagnosis?

c. Three possible therapeutic procedure?
a. Tachycardia (Heart rate 214/min)
   No P-wave
b. Supraventricular Tachycardia
c. Carotid sinus message
   Submerge face in cold water or put an ice bag on face
   IV Adenosine
This is the ECG of six year old boy referred to the output patient clinic with a heart murmur.

a. What three abnormalities are shown in ECG?

b. What is diagnosis?

c. Name two complications which may arise?
A

a. Short PR interval
  Wide QRS
  Delta Waves
b. Wolf parkinson-White-Syndrome
c. Supraventricular tachycardia
  Heart block
a. What is diagnosis?
b. What treatment is required in an asymptomatic patient without underlying heart disease if these disappear with exercise?
A

a. PVC
b. No Treatment
Q

a. What is diagnosis?
b. What is immediate treatment?
A

a. Ventricular fib.
b. Defibrillation