Tachyarrhythmias
IJN Cardiac Emergency Symposium

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Content

- Atrial Fibrillation and atrial flutter
- Supraventricular tachycardia
- WPW
- Ventricular ectopics
- Ventricular tachycardia
Systematic approach to ECGs

- The system we will practice is:
  - Rate
  - Rhythm (including intervals and blocks)
  - Axis
  - PR, QRS, T wave
  - Hypertrophy
  - Ischemia
Normal Intervals

- **PR**
  - 0.20 sec (less than one large box)

- **QRS**
  - 0.08 – 0.12 sec (1-3 small boxes)

- **QT**
  - 450 ms in men, 460 ms in women
Tachycardia ( > 100 bpm)

Narrow complex tachycardia:
- QRS < 120 ms
- Activation of ventricles via His-Purkinje network

Wide complex tachycardia:
- QRS ≥ 120 ms
- Originates below His bundle bifurcation, or
- Arrhythmia with aberrant ventricular conduction (BBB or preexcitation)
The Conduction System

- Internodal Tracts
- Bundle of His
- Left Anterior Fascicle
- Purkinje Fibers
- Left Posterior Fascicle
- Right Bundle Branch
- SA Node
- AV Node
- RA
- LA
- RV
- LV
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Tachyarrhythmias

**Automaticity** – Increased spontaneous depolarization

**Reentry** – Impulse in a reentry circuit

**Triggered** – Altered transmembrane potentials due to electrolyte disturbance or medication
Case 1

- 73 year old female admitted with pneumonia, reports acute onset of shortness of breath
What does this ECG show?

1. Sinus rhythm
2. Atrial fibrillation
3. Atrial flutter
4. Atrial tachycardia
What does this ECG show?

1. Sinus rhythm
2. Atrial fibrillation
3. Atrial flutter
4. Atrial tachycardia
Case 2

- 61 year old male presents to the ED with palpitations
- HR 155bpm, BP 122/76
Case 2
With Adenosine, what does the ECG show?

1. Sinus tachycardia
2. Atrial fibrillation
3. Atrial flutter
4. Atrial tachycardia
5. Artifact
Atrial Fibrillation - fibrillatory waves

Atrial Flutter - sawtooth pattern
**ATRIAL FLUTTER**

Impulses travel in a circular course in atria

Variable block

Rapid flutter waves, ventricular response irregular
Management of Afib/flutter

- Is the patient hemodynamically stable?

- If there’s hypotension, acute heart failure, mental status change, ischemia, then cardiovert
Atrial Fibrillation: Cardioversion or Rate Control

- If < 2 days duration: Cardiovert
  - amiodarone
  - flecainide
  - DC shock
- If > 2 days duration: Rate control first
  - digoxin
  - B blockers
  - verapamil
  - amiodarone
  - elective DC cardioversion
Anticoagulation for AF

1. Non-valvular AF
   - <65 years and lone AF, including women
     - No
     - Stroke risk assessment using CHA₂DS₂-VASc
       - 0
       - 1
       - ≥2
         - Oral anticoagulant
           - Assess bleeding risk (HAS-BLED score); consider patient/preferences
             - No antithrombotic therapy
             - Novel oral anticoagulant; rivaroxaban, dabigatran or apixaban
             - VKA

2. Valvular AF
What do you do?

1. Give Amiodarone
2. Give metoprolol
3. Give adenosine
4. DC cardioversion
5. Carotid sinus massage
Case 4 - Adenosine
SVT treatment

- Vagal maneuvers (with ECG)
- Adenosine (with ECG)
  - 6mg, 12mg, central line if possible
- Beta-blockers/Ca channel blockers (on telemetry)
- Amiodarone (on telemetry)
- Procainamide (on telemetry)
- DCCV
Supraventricular Tachycardia (SVT)

AVNRT

AVRT
AV Node Reentry & PSVT

A  Normal Sinus Rhythm

B  Critically Timed Atrial Premature Beat

- ERP effective refractory period
C  AV Node Reentry Established

Atrial depolarization – inverted P wave (commonly lost under QRS)

Vagal
ACh
↑ ERP

Sympathetic
Norepi
↓ ERP

Ventricular depolarization

D  PSVT Signs & Symptoms

- Narrow QRS complex tachycardia
- 140-200 beats/min
- Sudden onset
  - Palpitations (98%)
  - Dizziness (78%)
  - Dyspnea (47%)
  - Chest pain (38%)
Ablation of SVT
AVRT

(accessory pathway-mediated SVT)
WPW
WPW syndrome

- WPW may be described as type A or B.
- Type A (left) has a positive delta wave in $V_1$
- Type B (right) has a negative delta wave in $V_1$
  - Arrhythmia: 80% tachycardia is AVRT, 15-30% is A Fib, 5% is A Flutter,
  - May induce ventricular fibrillation
Caution

*DO NOT use verapamil, digoxin or (AV node block) in patients with WPW*

may lead to rapid ventricular response and cause VF in case of AF
Pre-Excited AF

[ECG Image]
Case 5

- 35 year old male with a history of nonischemic cardiomyopathy
- Presents with palpitations
What is the diagnosis?

1. Atrial fibrillation
2. Atrial flutter
3. Sinus Tachycardia
4. Monomorphic Ventricular Tachycardia
VT - Reentry

[Diagram of the heart with annotations for Normal Sinus Rhythm and Ventricular Tachycardia]
VT - Reentry

Reentry in the Border Zone of a Myocardial Infarction

- Coronary Occlusion
- Left Ventricle
- Heterogeneous Border Zone
- Central Fibrosis
Features of VT

- Very broad complexes (>160ms).
- Absence of typical RBBB or LBBB morphology.
- Extreme axis deviation
- **AV dissociation** (Independent P waves).
- **Capture beats** — occur when the sinoatrial node transiently ‘captures’ the ventricles, in the midst of AV dissociation, to produce a QRS complex of normal duration.
- **Fusion beats** — occur when a sinus and ventricular beat coincide to produce a hybrid complex of intermediate morphology.
- **Positive or negative concordance** throughout the chest leads, i.e. leads V1-6 show entirely positive (R) or entirely negative (QS) complexes, with no RS complexes seen.
Independent P waves
Fusion beat
Capture Beat
VT – Chest Lead concordance

Ventricular Tachycardia with negative concordance

Ventricular Tachycardia with positive concordance
Monomorphic Ventricular Tachycardia

- Hypotension, AMS, signs of shock, AHF
- Prior EKG to suggest prolonged QT

- Lidocaine (optional)
  - Consider 1 - 1.5 mg/kg rapid IV push while preparing procainamide

- Procainamide
  - Infusion 20 - 50 mg/min with max dose of 17 mg/kg
  - 100 mg over 2 min given every 5 min
  - Stop when cardioversion achieved

- Amiodarone
  - 150 mg IV load over 10 min followed by infusion of 1 mg/min x 6 hours

Shock
- 100 - 360J

AMS - altered mental status; AHF - acute heart failure
Polymorphic VT

Polymorphic VT (PVT)

Long QT (Tdp*)
- Congenital (Adrenergic)
- Acquired (Pause dependent)
- Acquired Ischemic* (Rare?)
  *Haikins, JACC 2001
  * Non Tdp possible

Normal QT (Non Tdp)
- Brugada CMVT*
- Ischemic
  1. Primary VT (Common)
  2. Late scar mediated PVT (uncommon)

Is it Tdp or VF?

VTs in Transition
- Monomorphic to PVT
- Any Pulseless PVT
- Tdp to transition to VF
No way to differentiate!

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Prolonged QT
Long QT syndrome

QT interval: total duration of ventricular activity.

- Need for QTc Interval: The QT interval varies with RR interval. False high values may be noted in Bradycardias.
- BAZETT’s Formula: QTc = QT / √(RR) (RR in seconds)
- A useful rule of thumb is that, with a normal heart rate (60 - 100 bpm), the QT interval SHOULD NOT exceed half the RR interval.

- D/D for long QT:
  - Electrolytes (low K, low Mg, low Ca) (+other: hypothyroidism)
  - Drugs (antiarrhythmics class I, III; macrolide or quinolone antibiotics; antipsychotics...)
  - Ischemia
  - Congenital long QT syndrome (LQT 1,2,3)
Torsades de Pointes

- From the French ‘twisting of points’. This describes a form of VT where the cardiac axis twists round the isoelectric line.
- The rhythm may be intermittent and self-terminating. If it lasts more than a few seconds the patient will become symptomatic.
- Common causes are electrical imbalance - i.e K+ and/or Mg++ depletion or prolonged Q-T interval frequently caused by drugs such as Sotalol/Amiodarone or tricyclic antidepressants.
PVC -> VT -> Torsade -> VF
Adult Cardiac Arrest Algorithm — 2015 Update

1. Start CPR
   - Give oxygen
   - Attach monitor/defibrillator

2. Rhythm shockable?
   - Yes
   - VF/pVT
   - Shock

3. Shock
   - CPR 2 min
     - IV/IO access

4. CPR 2 min
   - IV/IO access
   - Epinephrine every 3-5 min
   - Consider advanced airway, capnography

5. Shock
   - Rhythm shockable?
     - No
     - CPR 2 min
       - IV/IO access
       - Epinephrine every 3-5 min
       - Consider advanced airway, capnography

6. Shock
   - Rhythm shockable?
     - No
     - CPR 2 min
       - IV/IO access
       - Epinephrine every 3-5 min
       - Consider advanced airway, capnography

7. Shock
   - CPR 2 min
     - IV/IO access
     - Epinephrine every 3-5 min
     - Consider advanced airway, capnography

8. CPR 2 min
   - Amiodarone
   - Treat reversible causes

9. Asystole/PEA

10. CPR 2 min
    - IV/IO access
    - Epinephrine every 3-5 min
    - Consider advanced airway, capnography

11. CPR 2 min
    - Treat reversible causes

12. Rhythm shockable?
    - No
    - CPR 2 min
      - Treat reversible causes

- If no signs of return of spontaneous circulation (ROSC), go to 10 or 11
- If ROSC, go to Post-Cardiac Arrest Care

CPR Quality
- Push hard (at least 2 inches [5 cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Rotate compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If PetCO2 <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation
- Biphasic: Manufacturer recommendation (eg, initial dose of 120-200 J; if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- Monophasic: 360 J

Drug Therapy
- Epinephrine IV/IO dose: 1 mg every 3-5 minutes
- Amiodarone IV/IO dose: First dose: 300 mg bolus. Second dose: 150 mg

Advanced Airway
- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abrupt sustained increase in PetCO2 (typically >40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes
- Hypovolemia
- Hypoxia
- Hyperion (acidosis)
- Hypo-hyperkalemia
- Hyperthermia
- Tension pneumothorax
- Temporomandicular, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

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Summary

- Atrial Fibrillation and atrial flutter
- Supraventricular tachycardia
- WPW
- Ventricular ectopics
- Ventricular tachycardia