Arrhythmias in the critically ill ICU patients: Approach for rapid recognition & management
Objectives

- Be able to identify and manage:
  - Atrial fibrillation with a rapid ventricular response
  - Atrial flutter
  - Supraventricular tachycardia
  - Ventricular tachycardia
  - Torsade de pointe
  - Sinus bradycardia
  - Complete AV block
Atrial fibrillation

• The most common arrhythmia in hospitalized patients

• Associated with hypotension due to decreased diastolic filling time

• Rate control in ICU patients may be difficult as many drugs cause hypotension
Recognition

- Rapid, irregular and sudden onset
- Chaotic baseline
- May appear regular at very rapid rates
Treatment

• Rate control
  – Intravenous diltiazem
  – Intravenous beta blockers
  – Digoxin: Achieves rate control slowly and is less effective in ICU patients and thyrotoxicosis

• Acute conversion to sinus rhythm
  – Unstable patients (hypotension, chest pain, acute heart failure)
  – Inability to control rate
  – Desire to avoid anticoagulation
Rate control medications

- IV and oral Diltiazem
- IV and oral Verapamil
- IV and oral Metoprolol
- IV Esmolol
- IV and oral Amiodarone
Intravenous diltiazem

- Bolus, 0.25 mg/kg IV
- If inadequate, second bolus, 0.35 mg/kg
- Infusion rate: 5 mg/h.
- The infusion rate may be increased in 5 mg/h increments up to 15 mg/h
- The infusion may be maintained for up to 24 hours
Intravenous Metoprolol versus Diltiazem

Atrial Fibrillation
Rate: >120/min
Systolic BP: > 95 mm Hg

Metoprolol, 0.15 mg/kg IV (maximum 10 mg)
Diltiazem, 0.25 mg/kg IV (maximum 25 mg)

Success: HR <100 BPM
Diltiazem: 90%
Metoprolol: 80%

Diltiazem versus esmolol

Atrial fibrillation after CABG or valve, HR > 100 BPM & hemodynamically stable

<table>
<thead>
<tr>
<th>Diltiazem</th>
<th>Bolus: 0.25-.35 mg/kg</th>
<th>Drip: 5-15 mg/hr</th>
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<tbody>
<tr>
<td>Esmolol</td>
<td>Bolus: 500 µg/kg</td>
<td>Drip: 25-50 µg/kg/min</td>
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<td>Titrate up by 25-50 µg/kg/min/10 minutes</td>
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- At 12 hours, rate control was achieved:
  - Diltiazem: 100%
  - Esmolol: 40%

- At 24 hours, sinus rhythm was achieved:
  - Diltiazem: 67%
  - Esmolol: 80%

Acute conversion options

• DC cardioversion
  – Advantages: Nearly 100% successful
  – Disadvantages: Requires sedation

• Ibutilide
  – Advantage: Intravenous
  – Disadvantage: Less effective, risk of torsade de pointe in 4.1%

• Amiodarone
  – Conversion to NSR achieved in 83% of patients with recent onset AF (<12 hrs) vs 44% of placebo treated patients (Cybulski, et al. Clin Card, 2008)
Ibutilide vs. Procainamide

Atrial flutter

- Regular atrial macro-reentrant circuit
- Can be more difficult to control from a rate standpoint
**Special Circumstances: WPW**

- **In patients without WPW**
  - The AV node protects the ventricles from rapid conduction
  - The QRS complex is narrow

- **In patients with WPW**
  - The AV node no longer is conducting all the beats
  - The accessory connection has very rapid conduction
  - The QRS complex is wide
  - Agents that block the AV node preferentially allow conduction in the AC resulting in very rapid, wide atrial fibrillation
Special Circumstances: WPW
Diagnosis of Ventricular Tachycardia: Importance

- Akhtar, Annals of Internal Medicine, 1988
  - 150 Wide Complex Tachycardias
  - 122 (82%) diagnosed as VT
  - 39 (32%) initially diagnosed correctly
  - 43 (35%) diagnosed as SVT
  - 35 (29%) received intravenous verapamil
  - 34 had hemodynamic collapse
Clinical Data Can Be Misleading

- Morady, JAMA, 1985
  - Asked to make a diagnosis when given clinical scenarios and ECGs diagnostic for VT
  - 59% of house officers, internists and cardiologists were influenced by an adequate blood pressure and stable hemodynamic status when evaluating wide complex tachycardia.
A Case

- 71 year old man
- Coronary artery disease
  - CABG in 1987
  - Perioperative MI
  - Perioperative “arrhythmias”: Mexilitine
- Day prior to admission: syncope with head injury
- Day of admission: syncope in the kitchen
Subsequent Strips

DEFIBRILLATION
08 APR 95
SHOCK NO. 03  10:01:41
JOULES SELECTED 300
SYNC MODE
SUMMARY COMPLETE

NAME

PRESHOCK LEAD II X1.0

POSTSHOCK LEAD II X1.0

DEFIBRILLATION
01 01 09:51:56
JOULES SELECTED 200

PRESHOCK LEAD II X1.0

POSTSHOCK LEAD II X1.0
Diagnosing VT

• Brugada 1991: Four Questions:
  - Absence of RS Complex in Precordial Leads?
  - R to S Interval > 100 ms in 1 Precordial Lead?
  - Atrio-Ventricular Dissociation?
  - Morph Criteria for VT Present in both V1-2 & V6?
- Criteria were 99% sensitive for diagnosing VT and 96% specific

• Other methods:
  - VT usually occurs in patients with structural heart disease
  - VT is generally wider than sinus rhythm
  - Concordance
  - VA dissociation
No RS in any precordial lead
R to S in precordial lead > 100 ms
Absence of RS Complex in Precordial Leads?

No

R to S Interval > 100 ms in 1 Precordial Lead?

No

No

Yes

Atrio-Ventricular Dissociation?

No

Yes

Morph Criteria For VT Present in Both V1-2 & V6?

Yes

83 = VT  
SN = .21  
SP = 1.0

172 = VT  
SN = .66  
SP = .98

59 = VT  
SN = .82  
SP = .98
Morphology Criteria
For VT Present in
Both V1-2 & V6?

Yes
65 = VT, 3 = SVT
SN = .987, SP = .965

No
164 = SVT, 5 = VT
SN = .965, SP = .987
Treatment of Ventricular Tachycardia

• Lidocaine, 1 mg/kg load, 2 mg/min
  - Cleared by liver
  - Levels high in patients with CHF
  - Toxicity: Neurological

• Procainamide, 12.5 mg/kg load over 45 minutes, 2 mg/min
  - Cleared by kidney. Impaired clearance: NAPA accumulation: Torsade risk
  - Toxicity:
    • Torsade
    • Hypotension with infusion
    • Myocardial depression
Treatment of Ventricular Tachycardia

- Intravenous amiodarone: 150 mg bolus over 15 minutes, 1 mg/min for 6 hours, then 0.5 mg/min subsequently. Total 24 hour dose: 1050 mg.
- Cleared by ?
- Toxicity:
  - Acutely: Hypotension, bradycardia, possible Torsade risk
- Additional bolus’ may be required: In the initial, blinded dose titration study, patients receiving the 1000 mg daily dose needed 1.75 +/- 2.6 additional bolus’ to achieve control.

Torsade de Pointes

• Etiology
  – Hypokalemia, hypomagnesemia hypocalcemia
  – Congenital Long QT syndrome
  – Drugs
    • Antiarrhythmics
      – Dofetilide, Sotalol, Quinidine, Procainamide
    • Antibiotics
      – Ketoconazole, Erythromycin
    • Psychoactive drugs
      – Thioridazine, Haloperidol
  – Subarachnoid hemorrhage
  – Bradycardia
The key is recognition
The key is recognition
Complete AV block
Bradycardia induced Torsade
Treatment of Torsade

- Withdraw the offending agent
  - Dialysis in NAPA induced Torsade in renal failure

- Magnesium infusion
  - 1-6 grams of IV MgSO4 at rapid rates
  - Keep potassium level above 4.0

- Elevation of the heart rate
  - Atrial pacing to shorten the QT interval
Supraventricular Tachycardia

- AV Nodal Reentry Tachycardia
- Orthodromic AV Reciprocating Tachycardia
AV Nodal Reentry
Adenosine

- Adenosine is an endogenous nucleoside
- Administration results in high grade AV block
- Duration of action: 11 seconds
- 6-12 mg IV push over 1 second with flush
- 91% effective in terminating AV node dependent tachycardia
A V Nodal Reentry
Orthodromic AVRT
Indications for temporary pacing

• Third degree AV block
• Symptomatic second degree AV block
  - Especially if infranodal in origin
• Symptomatic sinus bradycardia
• In the setting of an acute MI
  - Third degree AV block
  - Infranodal second degree AV block
• In the treatment of pause dependent Torsade de pointe
Vagally mediated bradycardia
Determination of infranodal block

- Infranodal block carries a poorer prognosis
- QRS duration can help determine the level of block:
  - Narrow QRS: AV nodal level
  - Wide QRS: Infranodal level

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<thead>
<tr>
<th>Maneuver</th>
<th>Location of Block</th>
</tr>
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<tbody>
<tr>
<td>AVN</td>
<td>Infranodal</td>
</tr>
<tr>
<td>Atropine</td>
<td>Improve</td>
</tr>
<tr>
<td>Exercise</td>
<td>Improve</td>
</tr>
<tr>
<td>CSM</td>
<td>Worsen</td>
</tr>
<tr>
<td></td>
<td>Improve</td>
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Trancutaneous Pacing - Capture
Conclusions

- Control of atrial fibrillation is often difficult in ICU patients because of elevated sympathetic tone and associated hypotension
- Early recognition of cardiac arrhythmias is the most critical part of caring for these patients
- Accurate diagnosis is important as inappropriate therapy can result in decompensation