Management of Rhythm and Conduction Disorders

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Management of Rhythm and Conduction Disorders

- **Arrhythmias in the immediate postoperative course of pediatric cardiac surgery:** widely recognized complication

- **Related mortality documented between 0 and 1.2%**
  

- **Incidence: 15-48%**
  

- **Definition of hemodynamically significant arrhythmias vs “benign” rhythm variations**
WHEN TO CARE
AND
HOW TO TREAT SIGNIFICANT ARRHYTHMIAS?
Management of Rhythm and Conduction Disorders

- **Triggering factors:**
  - Postoperative cardiac dysfunction
  - Scar and sutures
  - Electrolyte disturbances
  - Stress response
  - Catecholamine stimulation
  - Pain, anxiety
  - Inflammatory process
Risk factors:

- Lower body weight
- Younger age
- Longer C.P.B.P. & aortic crossclamp times
- Use of deep hypothermia and circulatory arrest
- Type of intervention
- Residual lesions
- Higher Aristotle Basic Score
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Objectives

- Anticipation and identification of the type of arrhythmia/conductive disorder
- Identification of the causes for the arrhythmia
- Identification of the predisposing and triggering factors
- Rectification of all documented abnormalities taking into account the risk/benefit ratio:
  - Anti-arrhythmic drugs/watch for “pro-arrythmogenic” effect
  - Surgery (Maze)
  - Mapping/ablation
  - Pacemaker strategies
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Diagnosis

Sinus tachycardia?
SVT?
Atrial flutter?
Ventricular tachycardia?
Junctional Ectopic Tachycardia?
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Diagnosis

ATRIAL/ EPICARDIAL EKG

LEAD II

ADENOSINE
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Diagnosis

LEAD II
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Diagnosis

LEAD II

AEKG
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Diagnosis

LEAD II
Management of Rhythm and Conduction Disorders: Most common anomalies

- Supraventricular Tachycardia
  - Junctional re-entry Tachycardia
  - Intra-atrial re-entry Tachycardia

- Junctional Ectopic Tachycardia/JET

- Ventricular Tachycardia

- Atrio-Ventricular Block
Supraventricular Tachycardia
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SVT

- 95% of postoperative tachycardias
- Narrow QRS complexes
- 2 pathophysiological types:
  - Re-entry tachycardia (with/without accessory pathways)
  - Ectopic (automatic)
## Management of Rhythm and Conduction Disorders
### SVT

<table>
<thead>
<tr>
<th>Re-entry without accessory pathway</th>
<th>Re-entry with accessory pathway</th>
<th>Automatic</th>
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<td>Orthodromic/ Wolff-Parkinson-White</td>
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<td>Permanent junctional re-entry</td>
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*University of Colorado School of Medicine*

*Advancing Science Improving Care*
Re-entry Tachycardia:

- More frequent
- Abrupt start and conversion and are paroxysmal
- Little variation of the heart rate
- Converted by adenosine
- Converted by cardioversion and overdrive
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SVT

- Re-entry Tachycardia with accessory pathways:
  - Pre-excitation syndromes:
    - Short PR interval
    - Wide QRS
    - Delta wave
  - AV node re-entry:
    - Retrograde P’ wave within the QRS complex (invisible) or in the terminal portion of the QRS complex
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SVT/pre-excitation syndromes

- Short PR segment
- Wide QRS complex
- Delta wave

- Lown-Ganong-Levine
- Wolff-Parkinson-White
- Mahaim
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SVT
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SVT

JUNCTIONAL TACHYCARDIA

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SVT

- **Re-entry Tachycardia without accessory pathways: atrial flutter and fibrillation:**
  - Abrupt start
  - Atrial flutter: usually rather stable rate
  - Atrial fibrillation: irregular rate
  - Difficult diagnosis if “1:1” or “2:1” conduction
  - Usually poorly tolerated in the immediate postoperative period
  - May co-exist with a sinus node dysfunction (tachycardia-bradycardia syndrome)
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Atrial Flutter

- Regular rhythm
- F waves ("saw-tooth")
- Variable conduction; 2:1 (++)
- Vagal stimuli decrease the ventricular rate but do not convert to sinus rhythm
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Atrial fibrillation

- Multiples focci
- Irregular rate, variable wave forms
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Atrial fibrillation
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SVT

- **Automatic supraventricular tachycardia:**
  - Less frequent
  - Variable heart rate (autonomic status)
  - Unresponsive to cardioversion and overdrive
  - Unresponsive to adenosine/resistant to many anti-arrhythmic drugs
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SVT

- **Ectopic Tachycardia:**
  - 1. Atrial ectopic and chaotic Tachycardia
  - 2. JET:
    - 3 scenarios:
      - Early postoperative complication
      - Congenital
      - Paroxysmal type - adolescent/young adult
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SVT - TREATMENT

- SHOCK: cardioversion (0.5-1 J/kg)

- Hemodynamically stable:
  - a) Vagal stimuli
  - b) Adenosine: 100-200 μg/ kg IV “push”
  - c) Overdrive: trans-esophageal/atrial epicardial leads
  - d) MgSO4⁻; rectify all metabolic disorders (K⁺, Ca⁺)
  - e) Drugs: sotalol, amiodarone, procainamide, propafenone, digoxin...
  - f) In the long term: ablation
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Junctional Ectopic Tachycardia
Transient, potentially lethal arrhythmia

EKG criteria:

1) Narrow QRS complexes
2) HR between 170-260 b.p.m.
3) A-V dissociation periods with $HR_y > HR_a$

AEKG is crucial to establish diagnosis

Adenosine trial:
- No response
- Blocks the retrograde AV conduction
- Does not modify ventricular rate

Resistant to overdrive pacing and to cardioversion
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JET
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JET
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JET
Objectives:

1) Conversion to sinus rhythm
2) Decrease of the ventricular rate
3) A-V synchrony

Markers of «success»:

1) Stable ventricular rate <140 - 150 b.p.m.
2) Ability to establish an adequate A-V synchrony
3) Hemodynamic status improvement
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JET

ECMO

Ablation...

General measures

HYPOTHERMIA

Drugs

Pacing
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JET

- **General measures:**
  - **1) Control of the «stress-response»:**
    - Sedation
    - Optimization of the analgesia
  - **2) Control of exogenous amines:**
    - Decrease inotropic drugs, vagolytic drugs, inodilators to the minimal efficient doses
  - **3) Optimization of the metabolic and acid-basic status**
  - **4) Muscular relaxants**
Controlled hypothermia/ cooling:

Objectives:


- Decrease cardiac automaticity
- Decrease cardiac rate
- Also useful in the context of concomitant LCOS

Inconveniences:

- Vasoconstriction and metabolic acidosis
- Increased morbidity-sepsis
- Increased length of stay in the ICU
Cooling start

Rectal temp.

Heart rate

Cooling end
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JET

Drugs:

1) Magnesium: conflicting data in literature

Hypomagnesemia is a consequence of surgery involving C.P.B.P.


Maintenance of normal/ supra-normal Mg+ levels is a favorable factor...


Systematic prophylactic or therapeutic IV MgSO4

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JET

**Drugs:**

2) Amiodarone:

**Drug of choice**


**Efficient at the dose of 5 mg/kg IV over 60', or 25 µg/kg/min IV over 4h, followed by 10-20 mg/kg/d or 5-15 µg/kg/min**

- Rossi AF, In: Chang AC, Burke RP (eds). The Second International Symposium on Pediatric Cardiac Intensive Care, Miami, Fla, 1997; pp 67-70)

**Few significant published side-effects**

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JET

- **Drugs:**

- **3) Digoxin:**

  - Multiple studies show little or no effect in decreasing the ventricular rate in case of JET

  - No evidence-based data demonstrating benefits of digoxin on both the ventricular rate and the length of the JET

  - Digoxin may increase cardiac automaticity
    - Karapawich PP, Am Heart J 1985; 109: 159-160
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JET

**Drugs:**

**4) Propafenone:**

Scarce literature about this drug but favorable data supporting its beneficial effect in decreasing cardiac automaticity


**Dose:** 300-500 mg/m²/ day po, or 10-20 µg/kg/min IV
Pacing:

- Main objective: re-establish AV synchrony

- 1) Atrial pacing (AOO) 5-10 b.p.m. > ventricular rate

- 2) A-V sequential pacing (DDD)

- 3) R wave synchronized atrial pacing
R wave synchronized atrial (AVT) pacing

(V_s - A_p = programmed AV delay)

spont. vent. depolarization

paced atrium

ventricular channel

DDD pacemaker

atrial channel

(Till JA, BHJ 1991)
R wave synchronized atrial pacing

(JET slowed by cooling, 2nd° AV block during AAI pacing)

R wave synchronized atrial pacing (VA int. = 260 ms)  Spont. rhythm (JET)
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**E.C.M.O.:**

- Multiple publications describing the virtues of ECMO in case of refractory JET

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Ventricular Tachycardia
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Ventricular tachycardia

- 5% of postoperative arrhythmias
- More frequent in the adolescent and young adult (Fallot’s tetralogy, cardiomyopathy, aortic stenosis...)
- Young child: long QT syndrome, cardiac tumors
- POSTOPERATIVE COURSE: high suspicion of ischemia or significant residual lesions
- Types:
  - Monomorph VVT
  - Torsades de pointe
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Ventricular tachycardia

Ventricular ectopy:

- Usually transient and caused by electrolyte and oxygenation abnormalities
- Does not require anti-arrhythmic drugs
- Rectify all documented metabolic disorders
- Beta-blockers useful in some cases
1. Monomorphic VT:
   - Large QRS complexes, regular rate and morphology
   - Differential diagnosis with SVT and right bundle-brunch block: adenosine

2. Torsade de pointe:
   - Large QRS complexes with variable morphology, “turns around” the iso-electric line
   - Related to long QT syndrome, cranial traumatism, intoxication by anti-arrhythmic drugs
   - Triggered by hypoK⁺, hypoMg⁺, hypoCa⁺
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Ventricular tachycardia

Monomorphic Ventricular Tachycardia

Polimorphic Ventricular Tachycardia
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Ventricular tachycardia- TREATMENT

- MONOMORPHIC VT:

- HEMODYNAMIC COMPROMISING:
  - Cardioversion 1→2→4 J/kg
  - IV Amiodarone
  - Alternatives: lidocaïne, procainamide, β-blockers, bretylium
  - Rectify all metabolic and acid-base disorders and any anatomic substrat leading to ischemia
MONOMORPHIC VT:

HEMODYNAMIC STABILITY:

Burst overdrive pacing:
- On the temporary ventricular epicardial pacing leads
- 10% faster than the tachycardia rate for 1-3 seconds
- Defibrillator ready...

IV Amiodarone
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Ventricular tachycardia - TREATMENT

- TORSADE DE POINTE:

- SUSTAINED:
  - Cardioversion 1 → 2 → 4 J/kg
  - MgSO4: 25-50 mg/kg slow IV
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Ventricular tachycardia - TREATMENT

- TORSADE DE POINTE:

- NON-SUSTAINED:
  - MgSO4: 25-50 mg/kg slow IV
  - LQTS: β-blockers
  - Anti-arrhythmic intoxication: isoproterenol, pacemaker
Conductive disorders
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Conductive disorders

1st degree A-V Block:

- Pre-operative: rheumatic fever, digoxin, cardiomyopathy, ASD, TAPVR, tricuspid atresia, Ebstein’s disease, l-TGA, anti-arrhythmic drugs

- Post-operative: complex atrial surgery, inlet VSD

- No treatment required
**2nd degree A-V Block:**

1. Wenckebach/ Mobitz type I:
   - Progressive prolongation of the PR segment
   - Tricuspid valve surgery, ASD closure, myocarditis, Duchenne, drugs, tumors, sickle cell disease
   - Treatment is required if poor tolerance: treat the underlying cause, isoprenaline, pacemaker

2. Mobitz type II:
   - “tout ou rien” AV conduction
   - May evolve towards 3rd degree A-V Block
   - Treatment: prophylactic pacemaker?

3. BAV II 2:1/3:1/4:1
Wenckebach/ Mobitz I 2\textsuperscript{nd} degree A-V Block
Mobitz II 2\textsuperscript{nd} degree A-V Block
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Conductive disorders

- **3rd degree A-V Block:**
  - Congenital: l-TGA, maternal collagen disease, heterotaxy
  - Post-operative (2%): VSD, l-TGA, sub-aortic obstruction, Konno, Rastelli, AVSD, Fallot's tetralogy
  - Post-operative: transient in 63% of cases; normal sinus rhythm within 10 days
    

- Treatment: pacemaker; isoprenaline
3rd degree A-V Block
Indications for definitive Pacemaker insertion

- Persistent, symptomatic Mobitz type II 2\textsuperscript{nd} degree or 3\textsuperscript{rd} degree A-V block (>7 days)
- Transient post operative block reverting to normal sinus rhythm with bifascicular block, or Mobitz type II 2\textsuperscript{nd} degree A-V Block
- Symptomatic sinus bradycardia
- Bradycardia-Tachycardia Syndrome
- Symptomatic LQTS
- Cardiomyopathies (re-synchronization)

(modified from ACC/AHA/NASPE Guidelines 2002)
EP concept of multisite ventricular pacing

- improves ventricular contraction
- allows for optimal AV synchrony for both ventricles
Hemodynamic concept of AV and IV dyssynchronization

1st\textdegree AV block, LBBB

ECG

PQ 180 ms

QRS 230 ms

ECHO/Doppler:

Mitral flow

Presystolic MR

Pulmonary flow

Lung filling period

RV contraction

LV contraction

Isovolumetric Relaxation

Aortic flow

330 ms

Medtronic InSync Trial
Hemodynamic concept of AV and IV resynchronization

Attrial synchronous bivent. pacing

ECG
SVD=100 ms

ECHO/Doppler:
Mitral flow
E A

Pulmonary flow

Aortic flow

LV filling period maximum

QRS=120 ms

Scale: 100 ms

Medtronic InSync Trial
Management of Rhythm and Conduction Disorders
Re-synchronization

Arterial pressure changes following AV and IV resynchronization

Systolic pressure

Pulse pressure

N = 20
N = 18

* p < 0.01
# p < 0.001

* p NS
# p < 0.01

N = 13
N = 14

N = 12
N = 13

Baseline
AV resynchr.
(N = 13)
IV resynchr.
(N = 14)

Baseline
AV resynchr.
(N = 12)
IV resynchr.
(N = 13)
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THANK YOU!

The Children’s Hospital
Denver, Colorado