Management of Rhythm and Conduction Disorders

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Management of Rhythm and Conduction Disorders

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

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

  (- Hoffman TM, et al. Ped Cardiol 2002; 23: 598-560
  - Lan YT, et al. Curr Opin Cardiol 2003; 18: 73-78)

- **Incidence: 15-48%**

  (- Delaney JW, et al. J Thorac Cardiovascu Surg 2006; 131: 1296-1300
  - Valsangiacomo E, et al.Ann Thorac Surg 2002; 74: 792-796
  - Pfammatter JP, et al. Ped Crit Care Med 2001; 2: 217-222
  - Rekawek J, et al. J Thorac Cardiovasc Surg 2007; 133:900-904)

- **Definition of hemodynamically significant arrhythmias vs "benign" rhythm variations**

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Management of Rhythm and Conduction Disorders

WHEN TO CARE
AND
HOW TO TREAT SIGNIFICANT ARRHYTHMIAS?

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

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- **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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Management of Rhythm and Conduction Disorders
Objectives

- Anticipation and identification ot 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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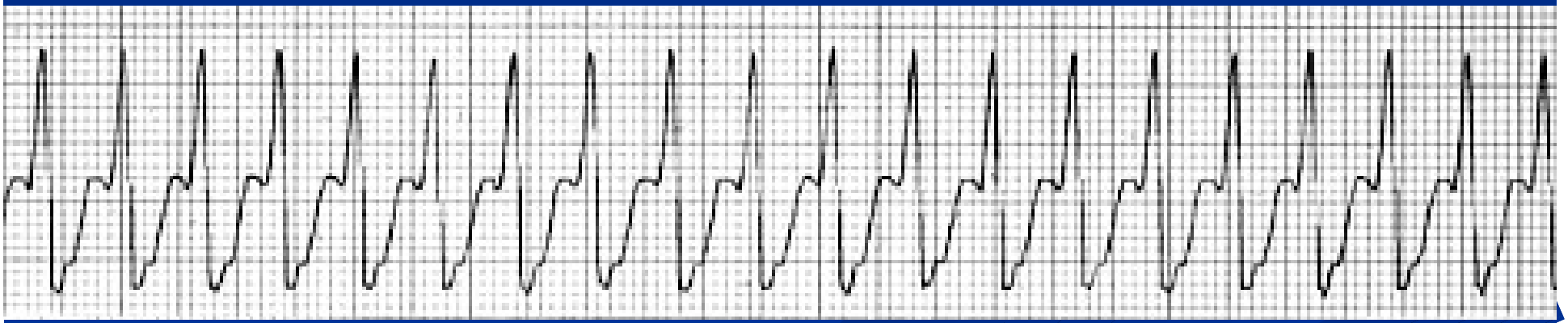
Diagnosis



Sinus tachycardia?

SVT?

Atrial flutter?

Ventricular tachycardia?

Junctional Ectopic Tachycardia?

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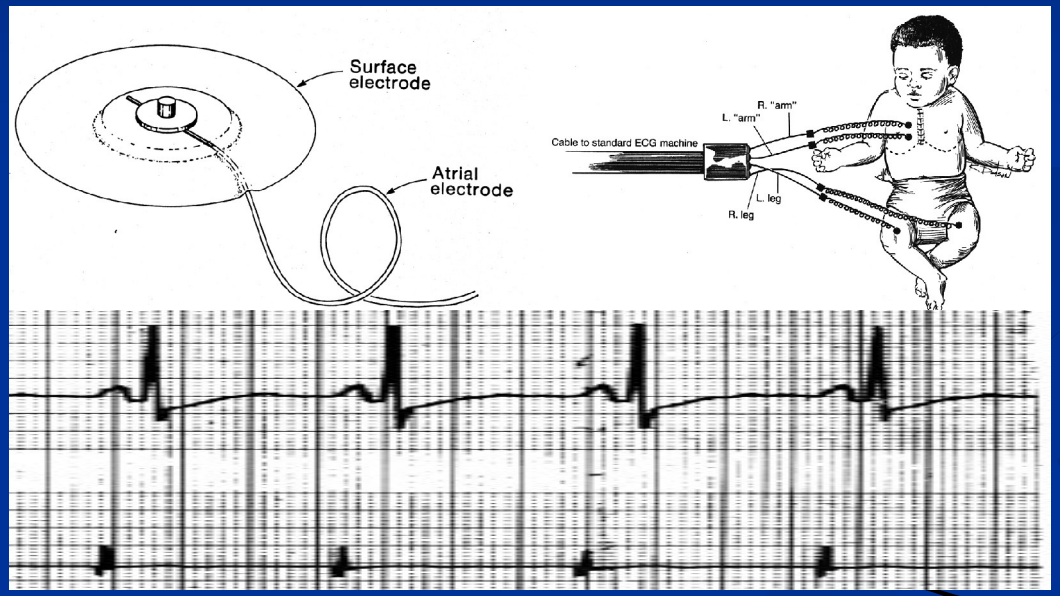
Diagnosis

ATRIAL/ EPICARDIAL EKG



LEAD II

ADENOSINE

Management of Rhythm and Conduction Disorders
Diagnosis

LEAD II

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Diagnosis

LEAD II

AEKG

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Diagnosis

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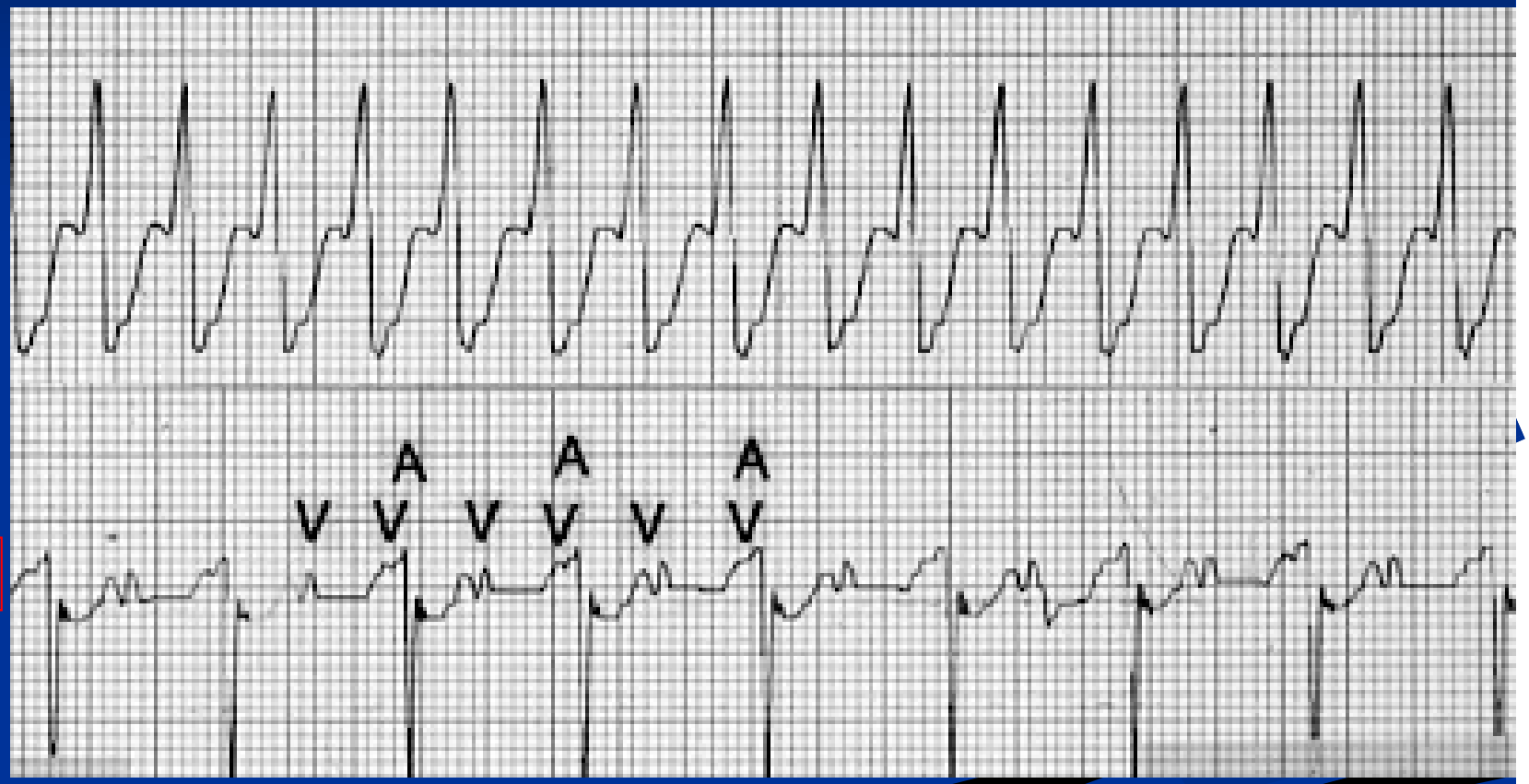
Diagnosis

LEAD II

AEKG



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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

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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)

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SVT

Re-entry without accessory pathway	Re-entry with accessory pathway	Automatic
Sinus re-entry	Orthodromic/ Wolff-Parkinson-White	Atrial ectopic
Atrial fibrillation	Antidromic	Atrial chaotic
Atrial flutter	Permanent junctional re-entry	JET
AV re-entry		
Hisian re-entry	Mahaim	

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SVT

- **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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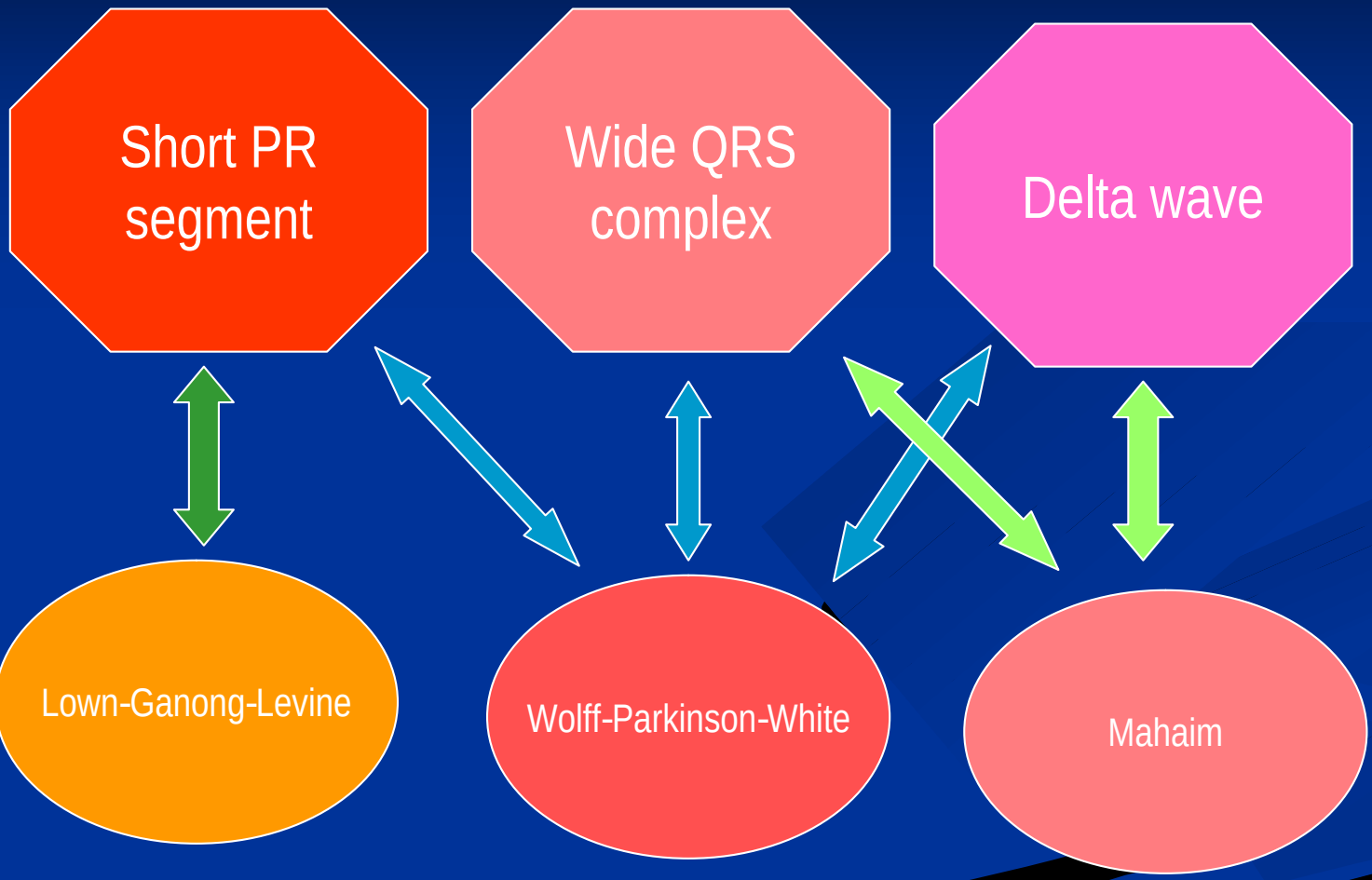
Management of Rhythm and Conduction Disorders
SVT/pre-excitation syndromes



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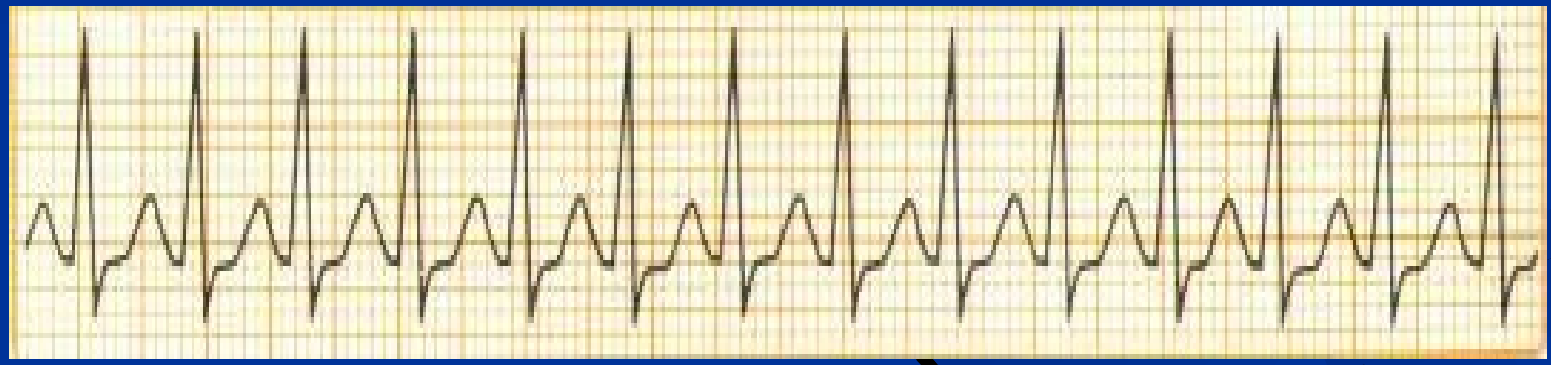
SVT



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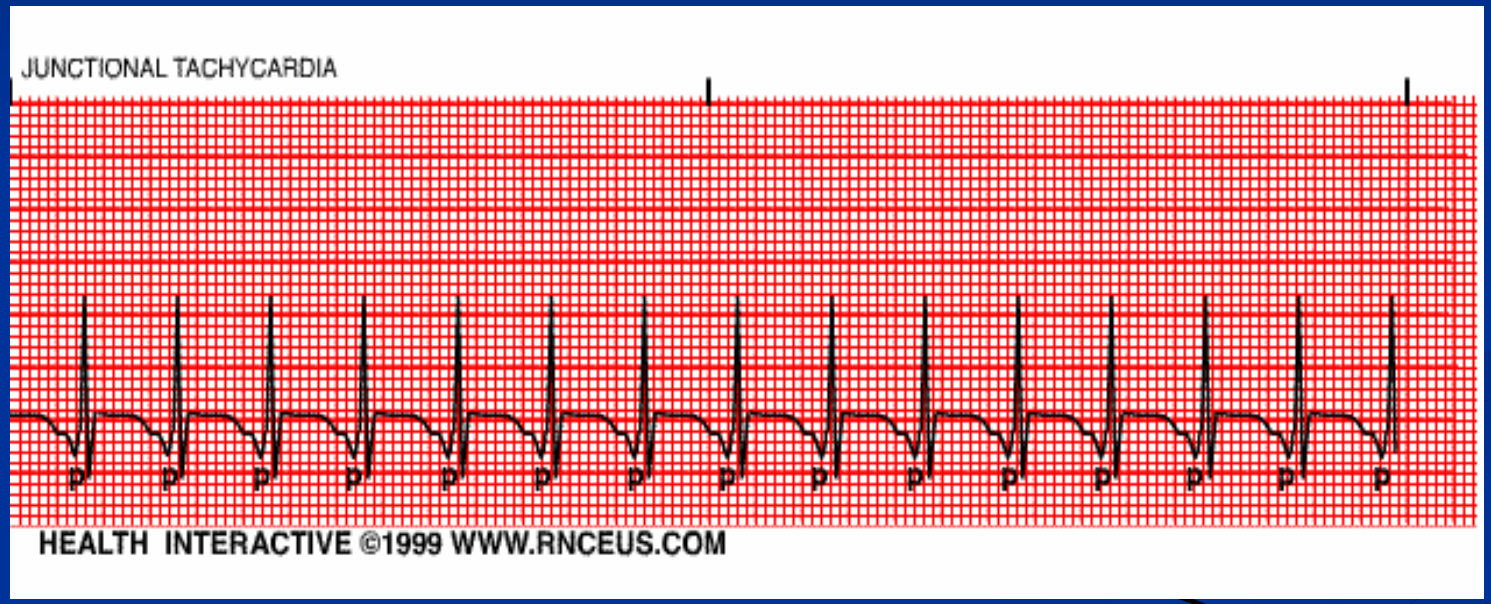
SVT



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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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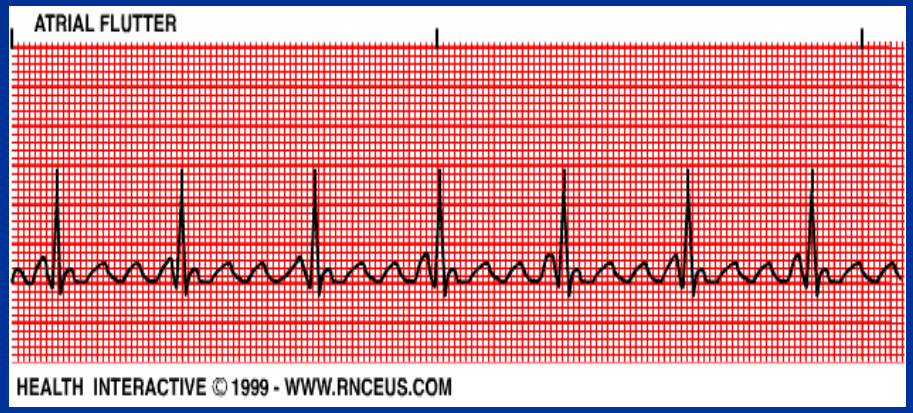
Management of Rhythm and Conduction Disorders
Atrial Flutter



- 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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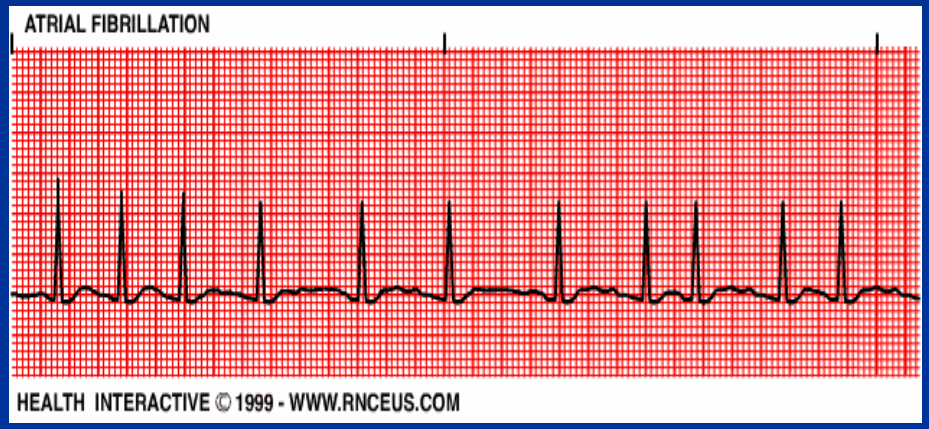
Atrial fibrillation



- Multiples focci
- Irregular rate, variable wave forms

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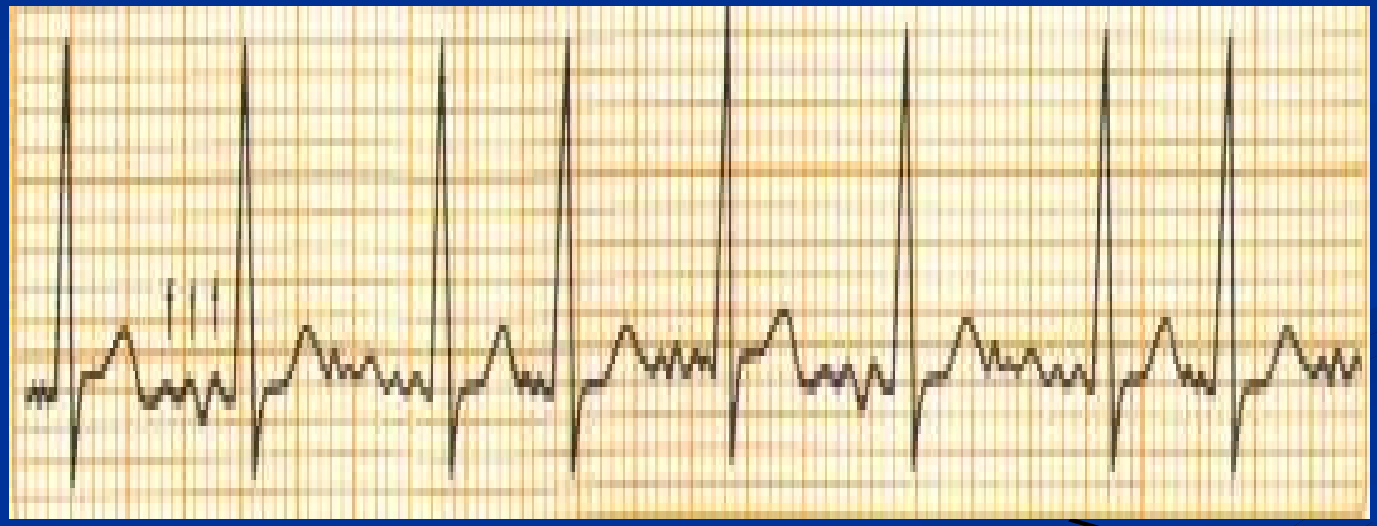
Atrial fibrillation



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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 terme: ablation

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Junctional Ectopic Tachycardia

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- Transient, potentially letal arrhythmia
- EKG criteria:
- 1) Narrow QRS complexes
- 2) HR between 170-260 b.p.m.
- 3) A-V disociation periods with $HR_v > HR_a$
- 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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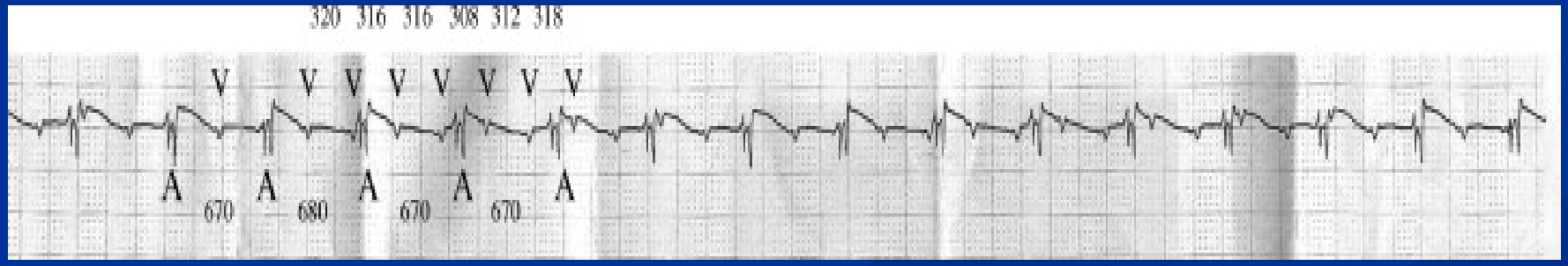
Management of Rhythm and Conduction Disorders

JET



Management of Rhythm and Conduction Disorders
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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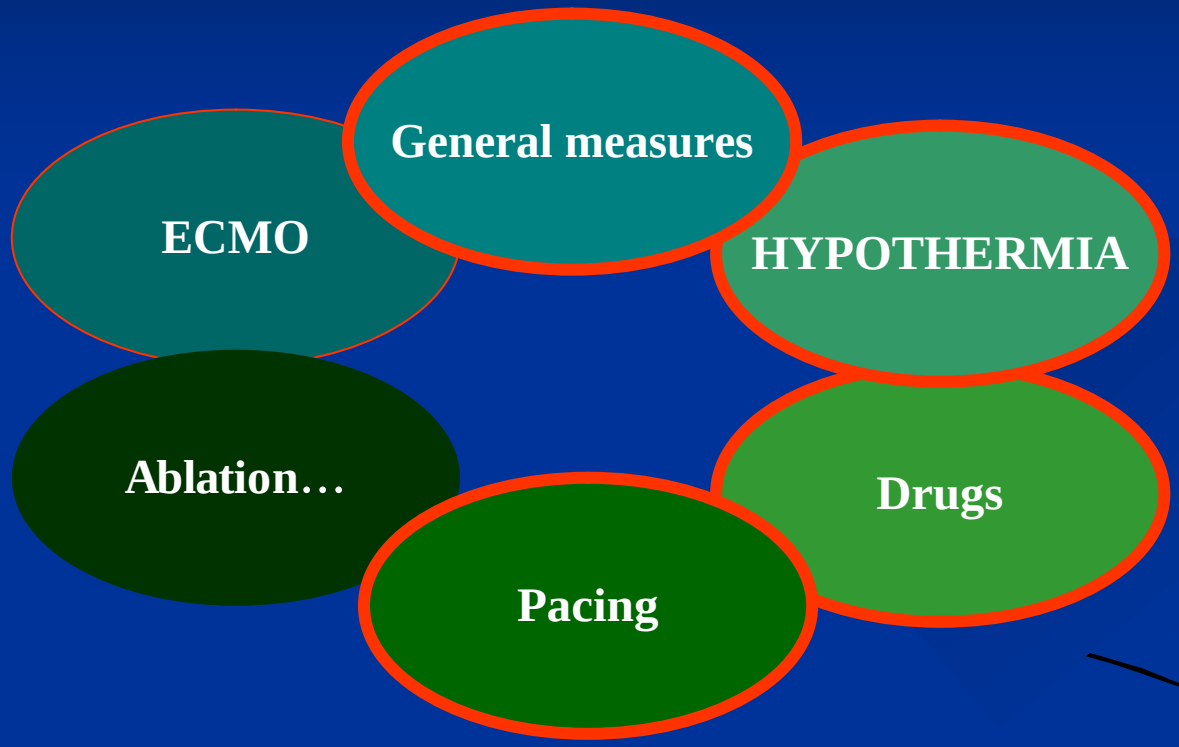
JET



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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**

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Management of Rhythm and Conduction Disorders
JET

- **Controlled hypothermia/ cooling:**

- **Objectives:**

(- Hoffman TM, et al. Ann Thorac Surg 2002; 74: 1607-1611
- Deakin CD, et al. Anaesthesia 1998; 53: 848-853
- Bash SE, et al. J AM Coll Cardiol 1987; 10: 1095-1099
- Guccione P, et al. G Ital Cardiol 1990; 20: 415-418)

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

- **Inconvenients:**

  - Vasoconstriction and metabolic acidosis
  - Increased morbidity-sepsis
  - Increased lenght of stay in the ICU

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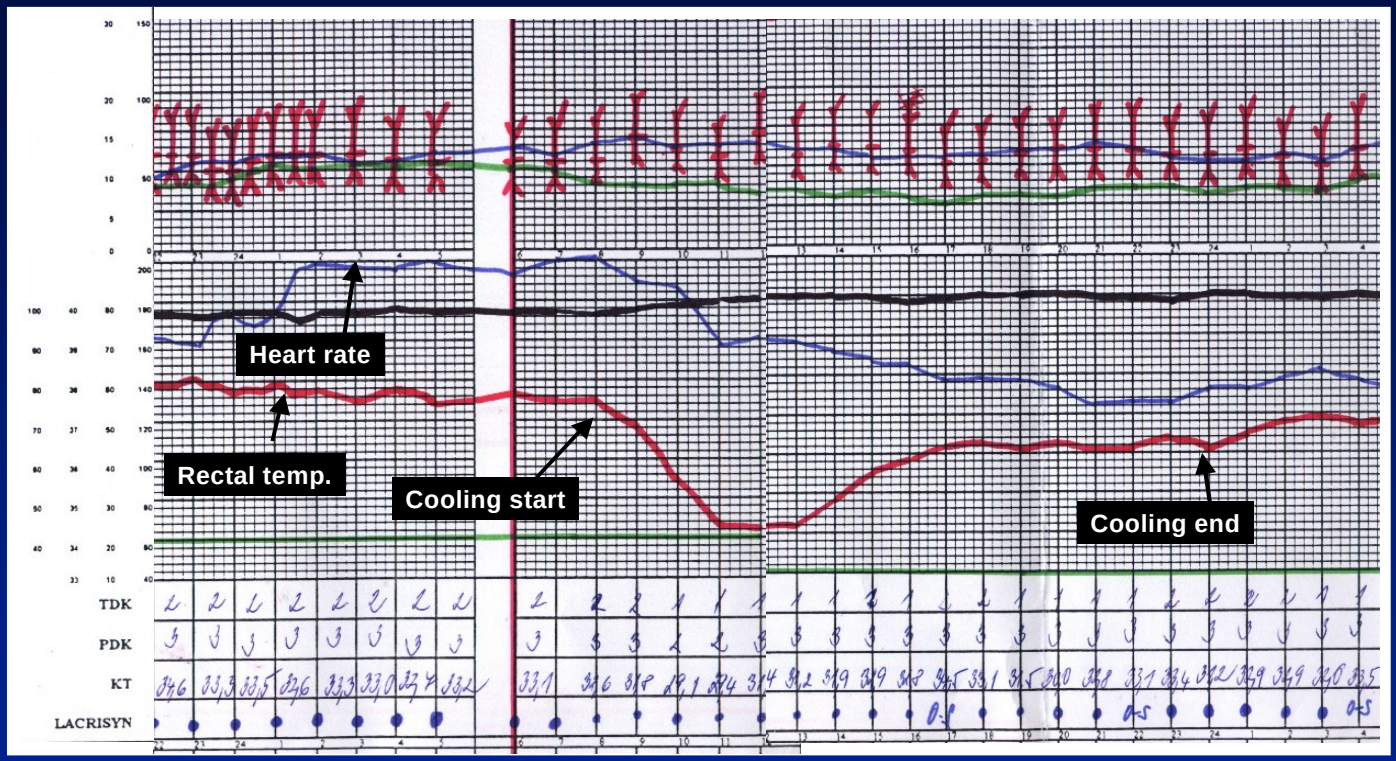

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JET

- **Drugs:**

- **1) Magnesium:** conflicting data in literature

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

  (- Munoz R, et al. J Thorac Cardiovasc Surg 2000; 119: 891-898
  - Hoshino K, et al. Pediatr Int 2003; 45: 39-44
  - Satur CM, et al. Ann Thorac Surg 1995; 59: 921-927)

- **Maintenance of normal/supra-normal Mg^{+} levels is a favorable factor…**

  (- Dittrich S, et al. Int Care Med 2003; 29: 1141-1144
  - Fow ML, et al. Anesth Analg 1997; 84: 497-500
  - Wilkes NJ, et al. Anesth Analg 2002; 95: 828-834)

- **Systematic prophylactic or therapeutic IV $MgSO4^{-}$**

  (- Dormann BH, et al. Am Heart J 2000; 139: 522-528
  - Dittrich S, et al. Int Care Med 2003; 29: 1141-1144)

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JET

- **Drugs:**
- **2) Amiodarone:**
- **Drug of choice**

(- McKee MR, Curr Opin Pediatr 2003; 15: 193-199
- Dormann BH, et al. Am Heart J 2000; 139: 522-528
- Luedtke SA, et al. Ann Pharmacother 1997; 31: 1347-1359
- Shah MJ, et al. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu 1998; 1: 91-102)

- **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**

(- Laird WP, et al. Pediatr Cardiol 2003; 24: 133-137
- McKee MR, Curr Opin Pediatr 2003; 15: 193-199
- 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**

(- Perry JC, et al. J Am Coll Cardiol 1996; 27: 1246-1250
- Yap SC, et al. Int J Cardiol 2000; 76: 245-247
- Gandy J, et al. Can J Cardiol 1998; 14:855-858
- Raja P, et al. Br Heart J 1994; 72: 261-265)

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JET

- **Drugs:**

- **3) Digoxin:**

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

  (- Dormann BH, et al. Am Heart J 2000; 139: 522-528
  - Luedtke SA, et al. Ann Pharmacother 1997; 31: 1347-1359
  - Walsh EP, et al. J Am Coll Cardiol 1997; 29: 1046-1053)

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

- **Digoxin may increase cardiac automaticity**

  (- Karapawich PP, Am Heart J 1985; 109: 159-160)

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Management of Rhythm and Conduction Disorders
JET

- **Drugs:**

- **4) Propafenone:**

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

(- Cabrera A, et al. An Esp Pediatr 2002; 56: 505-509
- Garson A, et al. Am J Cardiol 1987; 59: 1422-1444
- Heusch A, et al. Eur Heart J 1994; 15: 1050-1056
- Janousek J, et al. Am J Cardiol 1998; 81: 1121-1124
- Sarubbi B, et al. Heart 2002; 88: 188-190)

- **Dose: 300-500 mg/m^2/ day po, or 10-20 µg/kg/min IV**

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JET

- **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**

(Janousek J, et al. Pacing Clin Electrophysiol 2003; 26: 579-586)

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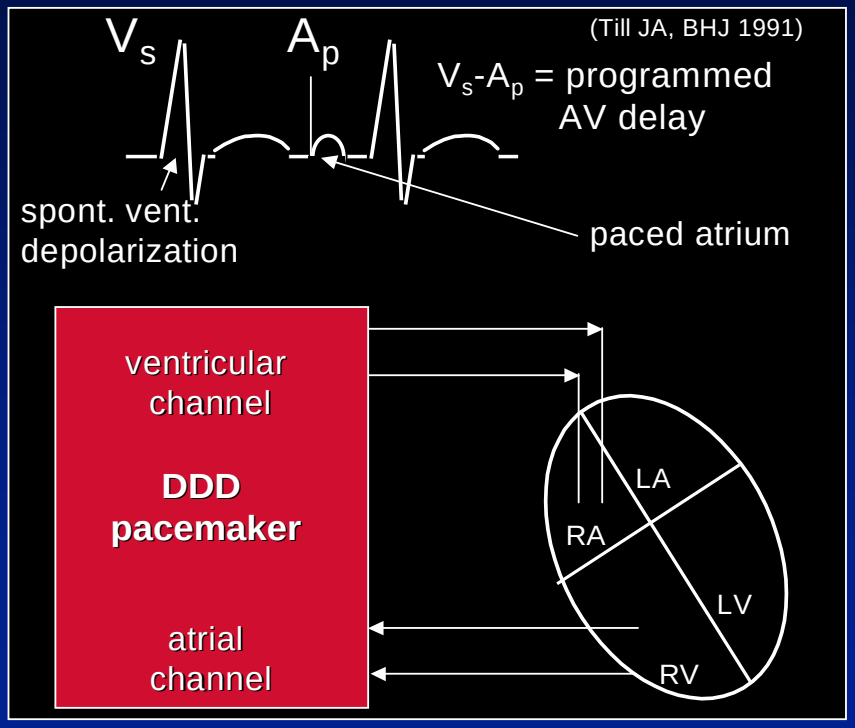
JET

R wave synchronized atrial (AVT) pacing



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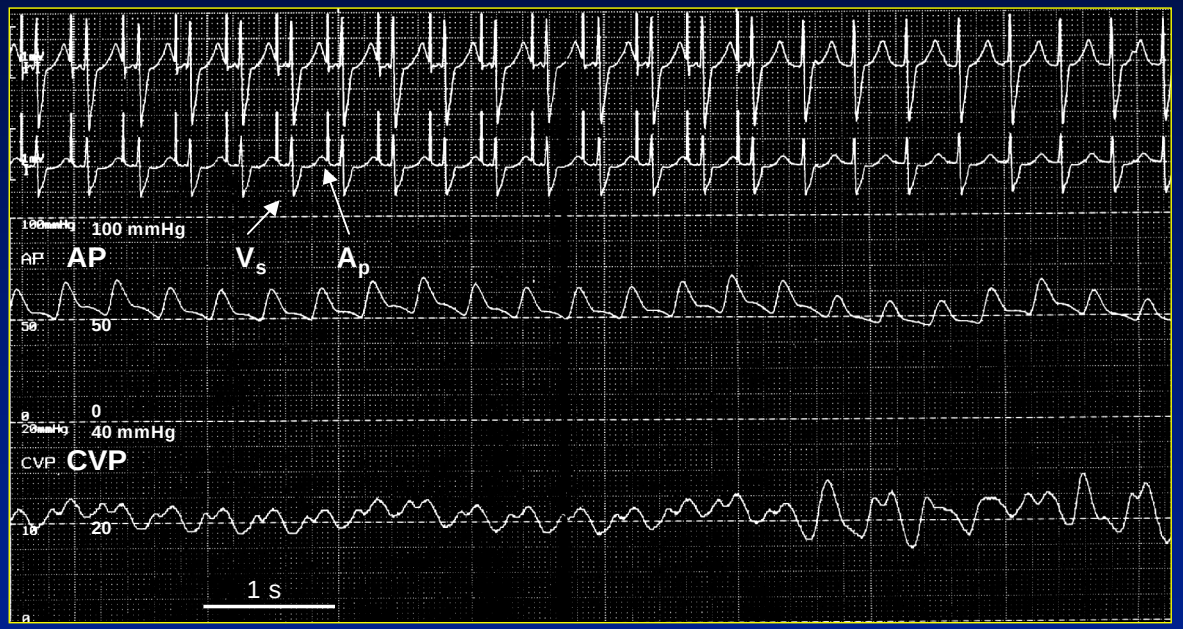
JET

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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JET

- **E.C.M.O.:**

- **Multiple publications describing the vertues of ECMO in case of refractory JET**

(- Walker GM, et al. Pediatr Crit Care Med 2003; 4: 52-54

- Cohen ML, et al. J Thorac Cardiovasc Surg 1999; 118: 961-963
- Azzam FJ, et al. Can J anesth 1998; 45: 898-902)

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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:
  - Monomorphic VT
  - Torsades de pointe

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Ventricular tachycardia

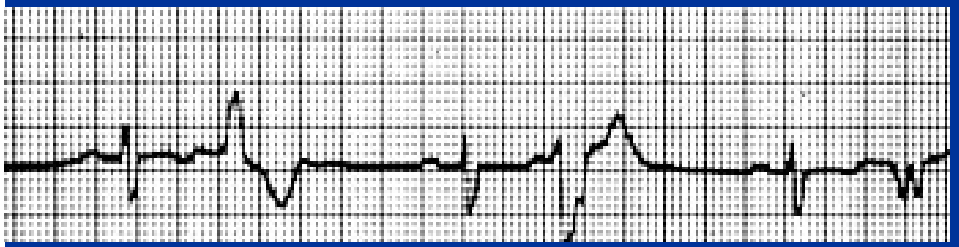
Ventricular ectopy:

- 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



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Ventricular tachycardia

- **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 ligne
  - Related to long QT syndrome , cranial traumatism, intoxication by anti-arrhythmic drugs
  - Triggered by hypoK^+, hypoMg^+, hypoCa^+

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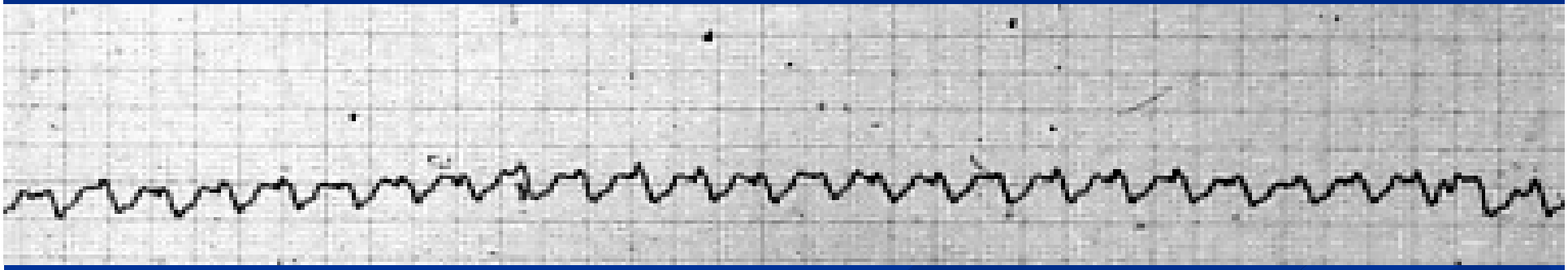
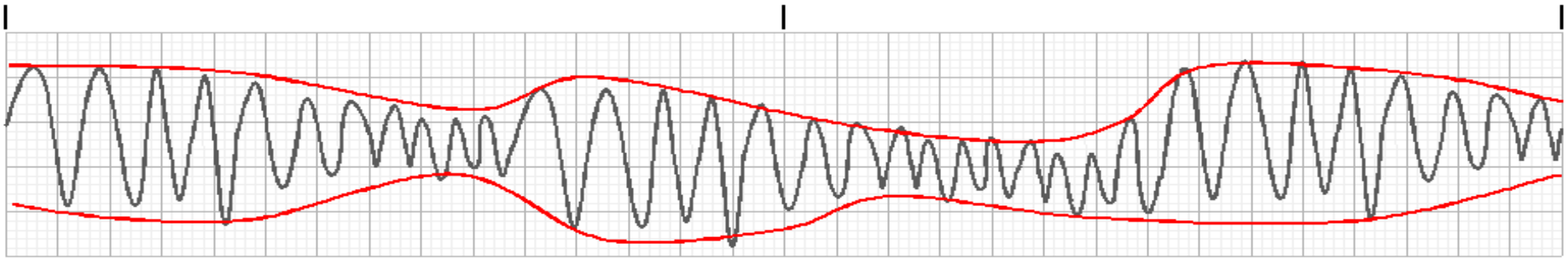
Management of Rhythm and Conduction Disorders
Ventricular tachycardia

Monomorphic Ventricular Tachycardia



Polimorphic Ventricular Tachycardia



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Management of Rhythm and Conduction Disorders
Ventricular tachycardia- TREATMENT

- **MONOMORPHIC VT:**

- **HEMODYNAMIC COMPROMISING:**

  - **Cardioversion 1→2→4 J/kg**
  - **IV Amiodarone**
  - **Alternatives: lidocaïne, procainamide, ß-blockers, bretylium**
  - **Rectify all metabolic and acid-base disorders and any anatomic substract leading to ischemia**

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Management of Rhythm and Conduction Disorders
Ventricular tachycardia- TREATMENT

- **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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Management of Rhythm and Conduction Disorders
Ventricular tachycardia- TREATMENT

- **TORSADE DE POINTE:**
- **SUSTAINED:**
  - **Cardioversion 1→2→4 J/ kg**
  - **$MgSO_4^-$: 25-50 mg/kg slow IV**

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Management of Rhythm and Conduction Disorders
Ventricular tachycardia- TREATMENT

- **TORSADE DE POINTE:**
- **NON-SUSTAINED:**
  - **$MgSO_4^-$: 25-50 mg/kg slow IV**
  - **LQTS : ß-blockers**
  - **Anti-arrhythmic intoxication : isoproterenol, pacemaker**

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Conductive disorders

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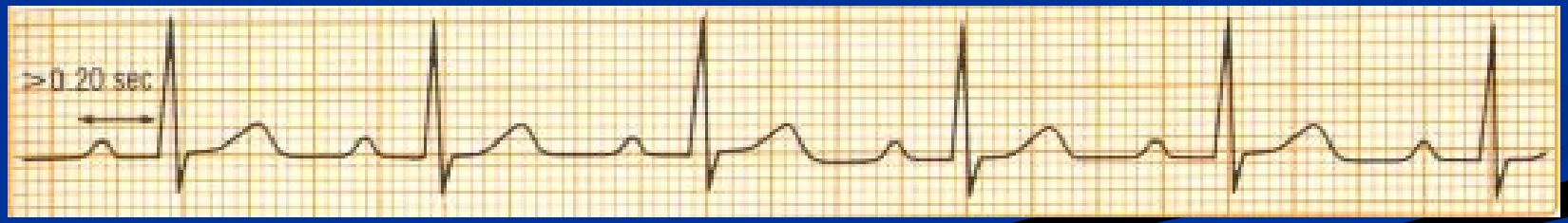
Management of Rhythm and Conduction Disorders
Conductive disorders

- **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**



Management of Rhythm and Conduction Disorders
Conductive disorders

- **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

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Wenckebach/ Mobitz I 2nd degree A-V Block

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Mobitz II 2nd degree A-V Block

Management of Rhythm and Conduction Disorders
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**

  (Weindling SN, et al.Am J Cardiol 1998; 15: 525-527)

- **Treatment: pacemaker; isoprenaline**

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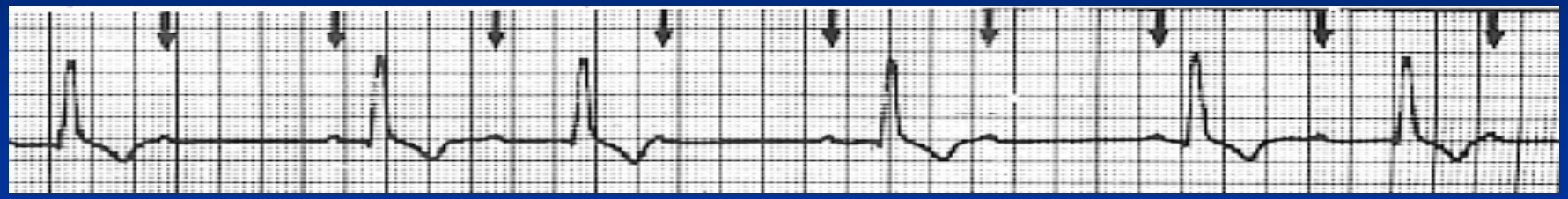
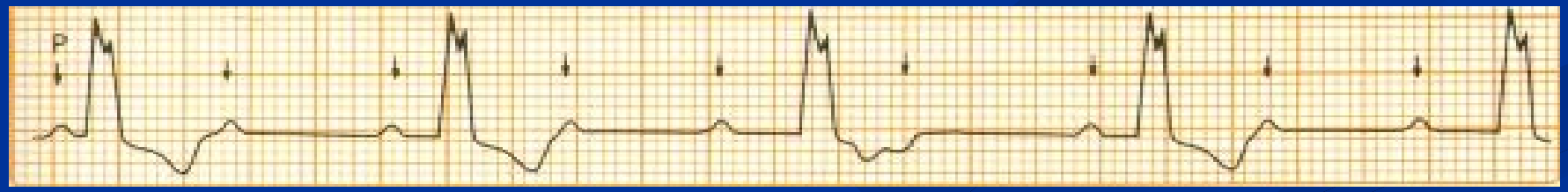
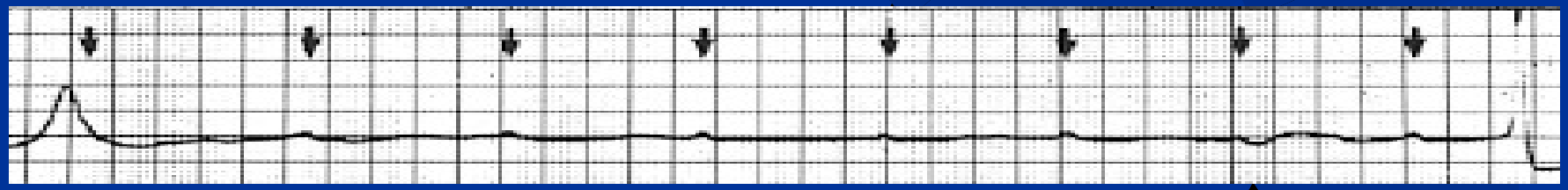
3rd degree A-V Block







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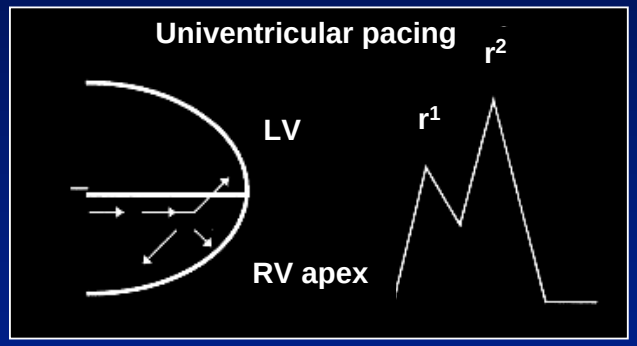
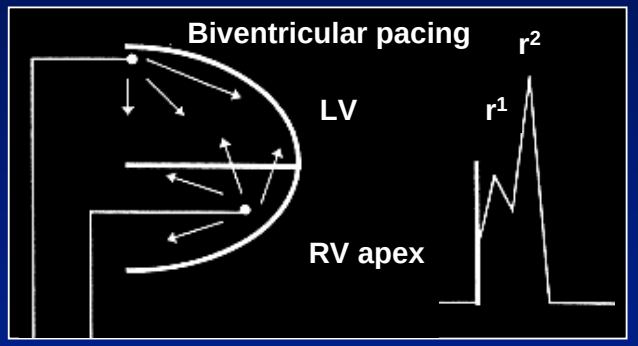
Management of Rhythm and Conduction Disorders
Indications for definitive Pacemaker insertion

- Persistent, symptomatic Mobitz type II 2nd degree or 3rd degree A-V block (>7 days)
- Transient post operative block reverting to normal sinus rhythm with bifascicular block, or Mobitz type II 2nd 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

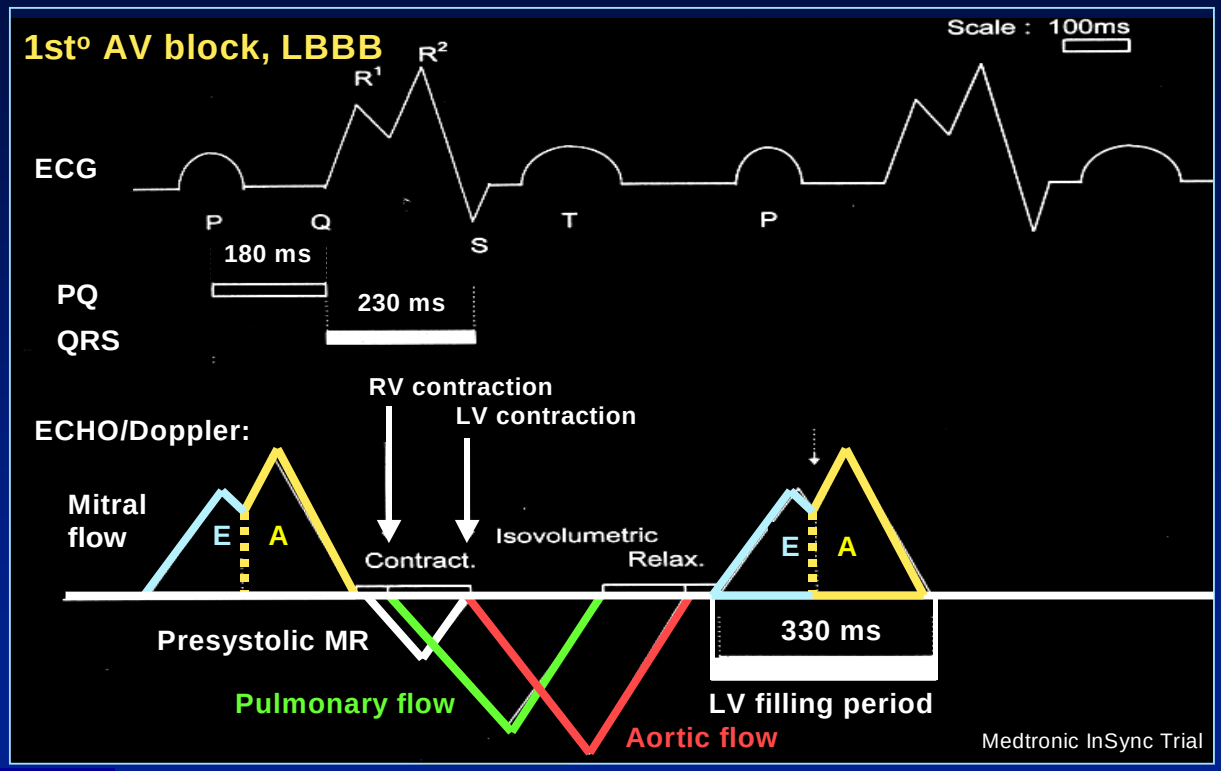




- improves ventricular contraction
- allows for optimal AV synchrony for both ventricles

Management of Rhythm and Conduction Disorders
Re-synchronization

Hemodynamic concept of AV and IV dyssynchronization



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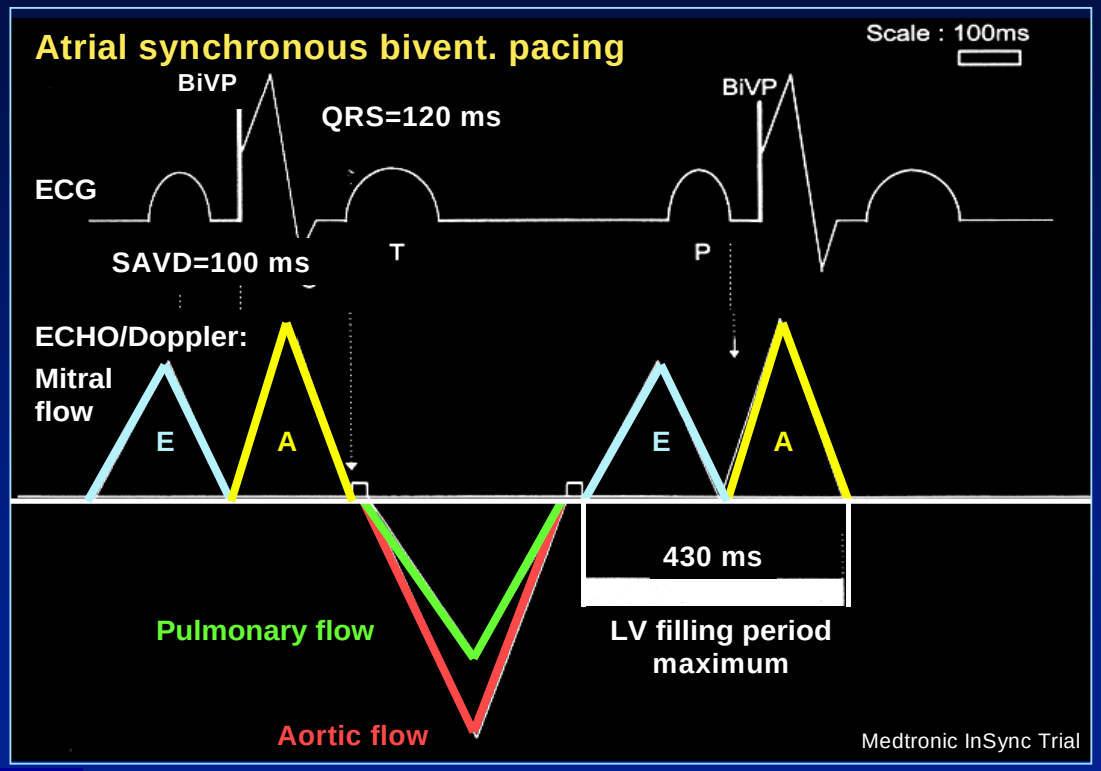
Management of Rhythm and Conduction Disorders
Re-synchronization

Hemodynamic concept of AV and IV resynchronization



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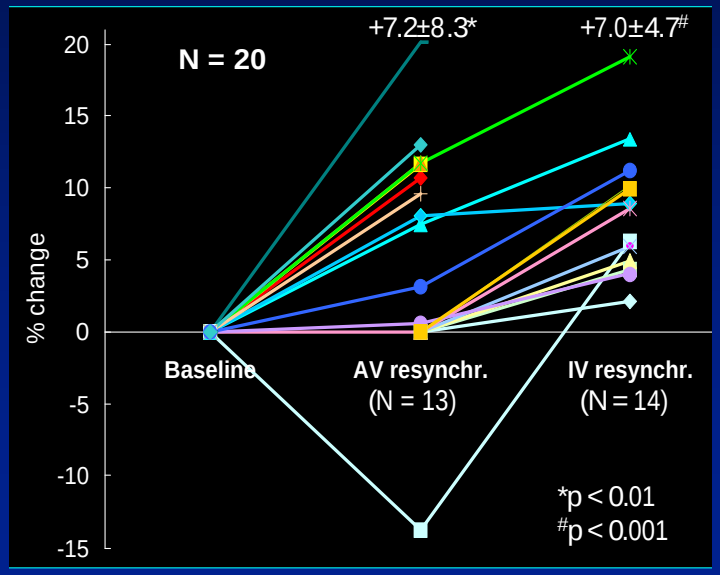
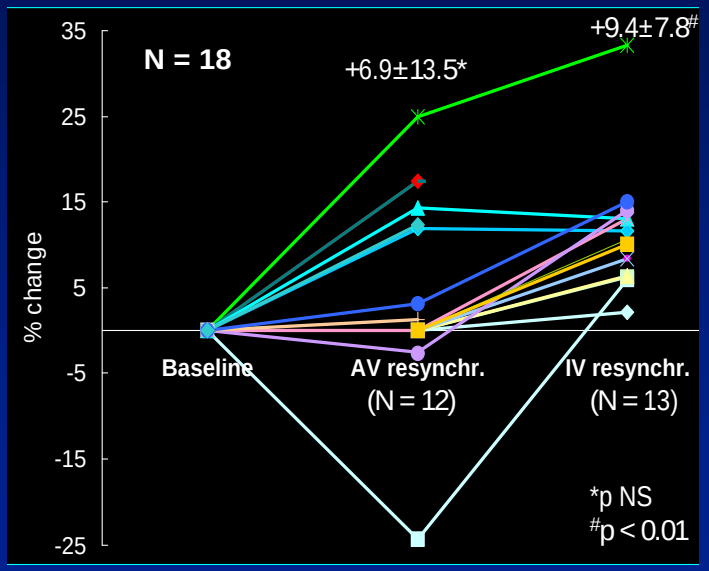
Management of Rhythm and Conduction Disorders
Re-synchronization

Arterial pressure changes following AV and IV resynchronization

Systolic pressure



Pulse pressure



Management of Rhythm and Conduction Disorders

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