Perioperative arrhythmias
Content

• Definition
• Mechanisms of arrhythmia
• Contributing factors and causes
• Classification of arrhythmias
• Management of arrhythmias
• Drug therapy
• Case discussions
• Conclusion
Definition

*Arrhythmia is defined as "Abnormality of cardiac rate, rhythm or conduction."

- Cardiac arrhythmias are the most frequent perioperative cardiovascular abnormalities in patients undergoing both cardiac and non-cardiac surgery.
- The occurrence of arrhythmias have been reported in 70% of patients subjected to general anaesthesia for various surgical procedures.
<table>
<thead>
<tr>
<th></th>
<th>Polanczyk(^8)</th>
<th>Goldman(^7)</th>
<th>Brathwaite(^6)</th>
<th>Batra(^4)</th>
<th>Valentine(^1)</th>
<th>Bender(^1)</th>
<th>Walsh(^5)</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total patients</td>
<td>4181</td>
<td>916</td>
<td>462</td>
<td>226</td>
<td>211</td>
<td>206</td>
<td>51</td>
<td>6253</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>171</td>
<td>17</td>
<td>31</td>
<td>20</td>
<td>21</td>
<td>9</td>
<td>7</td>
<td>276 (4.41%)</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>51</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>–</td>
<td>3</td>
<td>0</td>
<td>59 (0.94%)</td>
</tr>
<tr>
<td>Paroxysmal atrial tachycardia</td>
<td>14</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>19 (0.3%)</td>
</tr>
<tr>
<td>Multifocal atrial tachycardia</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>21 (0.4%)</td>
</tr>
<tr>
<td>Paroxysmal supraventricular tachycardia</td>
<td>156</td>
<td>6</td>
<td>15</td>
<td>0</td>
<td>–</td>
<td>16</td>
<td>4</td>
<td>197 (3%)</td>
</tr>
<tr>
<td>Ventricular ectopics</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>18</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>19 (0.3%)</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>7</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>8 (0.13%)</td>
</tr>
<tr>
<td>Ventricular fibrillation</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>1 (0.02%)</td>
</tr>
<tr>
<td>Any dysrhythmia</td>
<td>317</td>
<td>35</td>
<td>47</td>
<td>29</td>
<td>21</td>
<td>28</td>
<td>13</td>
<td>490 (7.84%)</td>
</tr>
</tbody>
</table>
Mechanisms of Arrhythmia Production

- Automaticity
- Re-entry
- Triggered activity
Automaticity

**Enhanced Normal Automaticity**
(Occurs only within specialized pacemaker cells)
- Stimulation of sympathetic nervous system
- Inhibition of parasympathetic nervous system
- ATP depletion (e.g. hypoxemia, ischemia)
- Digoxin toxicity
- Hypokalemia

**Abnormal Automaticity**
(Occurs only within non-pacemaker cells)
- Acute Ischemia and/or reperfusion
- Congestive heart failure
Re-entry

- Normal Sinus Rhythm
- AV node Reentry Circuit

Diagram showing slow and fast pathways.
Triggered activity

- Normal Action Potential
- Action Potential with an EAD
- Action Potential with a DAD

Depolarization

Hyperpolarization
<table>
<thead>
<tr>
<th>Acute anaesthetic factors</th>
<th>Acute surgical factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthesia-induced cardiac depression</td>
<td>Pain</td>
</tr>
<tr>
<td>Inotropes</td>
<td>Trauma</td>
</tr>
<tr>
<td>Hypervolaemia $\rightarrow$ acute atrial stretch</td>
<td>Anaemia</td>
</tr>
<tr>
<td>Auto-PEEP</td>
<td>Local and systemic inflammation (elevated IL-6 and CRP)</td>
</tr>
<tr>
<td>Shock</td>
<td>Mediastinal manipulation</td>
</tr>
<tr>
<td>Pulmonary artery catheter/misplaced central line</td>
<td></td>
</tr>
<tr>
<td>Local anaesthetic toxicity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acute medical factors</th>
<th>Chronic medical factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoxia</td>
<td>Ageing (fibrosis and inflammation)</td>
</tr>
<tr>
<td>Hypovolaemia</td>
<td>Atrial distension (heart failure, valvular disease)</td>
</tr>
<tr>
<td>Electrolyte disturbances</td>
<td>Ischaemic heart disease</td>
</tr>
<tr>
<td>Acute myocardial infarction</td>
<td>Congestive cardiac failure</td>
</tr>
<tr>
<td>Metabolic/respiratory acidosis</td>
<td>Chronic hypoxia, e.g. COPD, OSA</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Hypertension</td>
</tr>
<tr>
<td>Sepsis</td>
<td>Cardiomyopathy</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>Persistent tachycardia-induced atrial remodelling</td>
</tr>
<tr>
<td>Hypoglycaemia/hyperglycaemia</td>
<td>Accessory pathways</td>
</tr>
<tr>
<td>Hypothermia/hyperthermia</td>
<td>Congenital heart disease</td>
</tr>
<tr>
<td>Myocarditis/pericarditis</td>
<td>Scarring post-cardiac surgery</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>Pulmonary hypertension</td>
</tr>
<tr>
<td>Excessive alcohol and caffeine intake</td>
<td>Hyper/hypothyroidism</td>
</tr>
<tr>
<td>Recreational drugs</td>
<td>Malignancy</td>
</tr>
<tr>
<td>REVERSIBLE CAUSES</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Hypoxemie, hypercarbia, acidosis, electrolyte imbalance</td>
<td></td>
</tr>
<tr>
<td>Hypotension</td>
<td></td>
</tr>
<tr>
<td>Light anesthesia/ adrenergic stimulation</td>
<td></td>
</tr>
<tr>
<td>Proarrhythmic drugs</td>
<td></td>
</tr>
<tr>
<td>Hypothermia</td>
<td></td>
</tr>
<tr>
<td>Mechanical irritation: PAC, CVC, ETT</td>
<td></td>
</tr>
<tr>
<td>Cardiac ischemia</td>
<td></td>
</tr>
</tbody>
</table>
Classification of Cardiac Arrhythmias

- **Heart rate**: increased $> <$ decreased
- **Heart rhythm**: regular $> <$ irregular
- **Complexes on ECG**: narrow $> <$ broad
- **Site of origin**: supraventricular $> <$ ventricular
<table>
<thead>
<tr>
<th>Bradyarrhythmia</th>
<th>Tachyarrhythmia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart block</td>
<td>Supraventricular</td>
</tr>
<tr>
<td>• Sinoatrial block / Sinusarrest</td>
<td>• Sinustachycardia</td>
</tr>
<tr>
<td>• Atrioventricular block</td>
<td>• Atrial fibrillation</td>
</tr>
<tr>
<td>• Bundle branch block</td>
<td>• Atrial flutter</td>
</tr>
<tr>
<td></td>
<td>• AVNRT</td>
</tr>
<tr>
<td></td>
<td>• AVRT</td>
</tr>
<tr>
<td>Escape ritme</td>
<td>Ventricular</td>
</tr>
<tr>
<td></td>
<td>• Ventricular tachycardia (VT) :</td>
</tr>
<tr>
<td></td>
<td>- Monomorphic vs Polymorphic</td>
</tr>
<tr>
<td></td>
<td>- Sustained vs Non-sustained</td>
</tr>
<tr>
<td></td>
<td>• Ventricular fibrillation (VF)</td>
</tr>
</tbody>
</table>
Management of arrhythmias
Tachycardia Algorithm (with pulse)

- Assess using the ABCDE approach
- Give oxygen if appropriate and obtain IV access
- Monitor ECG, BP, SpO2, record 12-lead ECG
- Identify and treat reversible causes (e.g., electrolyte abnormality)

Synchronised DC Shock
- Up to 3 attempts

Stable
- Is QRS narrow (< 0.12 sec)?
  - Narrow
    - Is rhythm regular?
      - Regular
        - Regular Narrow Complex Tachycardia
          - Probable atrial fibrillation
          - Control rate with:
            - β-Blocker or digitalis
          - Consider digoxin or amiodarone
          - Atrial fibrillation if duration > 48 h
          - Anticoagulate
      - Irregular
        - Irregular Narrow Complex Tachycardia
          - Probable re-entry PSVT
          - Record 12-lead ECG in sinus rhythm
          - If recurs, give adenosine again & consider choice of anti-arrhythmic prophylaxis

Broad
- Is QRS regular?
  - Regular
    - Use vagal manoeuvres
    - Adenosine 6 mg rapid IV bolus; if unsuccessful give 12 mg; if unsuccessful give further 12 mg
    - Monitor ECG continuously

Broad QRS
- Amiodarone 200 mg IV over 10-20 mins and repeat shock if failed by:
  - Amiodarone 900 mg over 24 h

Unstable
- 1. Shock
- 2. Syncope
- 3. Myocardial ischaemia
- 4. Heart failure

Irregular
- Seek expert help

Irregular Ventricular Tachycardia for uncertain rhythm:
- Amiodarone 300 mg IV over 20-50 mins; then 900 mg over 24 h
- If previously confirmed SVT with bundle branch block:
  - Give adenosine as for regular narrow complex tachycardia

Irregular Narrow Complex Tachycardia

Possibilities include:
- AF with bundle branch block
- Treat as for narrow complex
- Polymorphic VT (e.g., torsades de pointes:
  - Give magnesium 1 g over 10 min)

*Attention: Electrical cardioversion on conscious patients is always undertaken under sedation or general anaesthesia
Bradycardia Algorithm

- Assess using the ABCDE approach
- Give oxygen if appropriate and obtain IV access
- Monitor ECG, BP, SpO₂, record 12-lead ECG
- Identify and treat reversible causes (e.g., electrolyte abnormalities)

Assess for evidence of adverse signs
1. Shock  3. Myocardial ischaemia
2. Syncope  4. Heart failure

- Atropine 500 mcg IV

Satisfactory response?

Risk of asystole?
- Recent asystole
- Mobitz II AV block
- Complete heart block with broad QRS
- Ventricular pause > 3s

- Interim measures:
  - Atropine 0.5 mg IV repeat to maximum of 3 mg
  - Isoprenaline 5 mcg min⁻¹ IV
  - Adrenaline 2-10 mcg min⁻¹ IV
  - Alternative drugs* OR
  - Transcutaneous pacing

- Seek expert help
- Arrange transvenous pacing

Observe

* Alternatives include:
- Aminophylline
- Dopamine
- Glucagon (if beta-blocker or calcium channel blocker overdose)
- Glycopyrrolate can be used instead of atropine
Drug therapy
- The Action Potential

![Diagram of the action potential with ECG signal and ion changes](image-url)
Antiarrhythmic drugs

**Classification of Vaughan Williams**

**Class I**: Sodium Channel Blockers: lidocaine, flecainide
- SVT’s eg VKF, WPW

**Class II**: Beta-Blockers: metoprolol, atenolol
- SVT’s en VT

**Class III**: Potassium Channel Blockers: amiodarone, sotalol
- SVT’s en VT
- Cave LQT!

**Class IV**: Calcium Channel Blockers: verapamil en diltiazem
- SVT

**Others drugs**: eg adenosine, digoxine

*Fig. 13.54 Vaughan Williams’ classification of antiarrhythmic drugs based on their effect on cardiac action potentials. 0, = 0 mV. The dotted curves indicate the effects of the drugs.*
Class IB: Lidocaine

- **Indication**: Lidocaine is indicated in refractory VF/pVT

- **Myocard depression** R/ fluids/vasopression

- **CNS toxicity**: Confusion; delirium; grand mal seizures

- **Dose**: 100 mg (1–1.5 mg kg−1) of lidocaine ( +50 mg if necessary). Max 3 mg kg−1 during the 1st hour
  - Cave: metabolised by the liver

Therefore… Lidocaine Binds Preferentially in Ischemic Tissue
Class II: Betablockers

- Esmolol (Breviblock ®) and Metoprolol (Seloken ®)
- Block adrenergic tone -> Primarily SA-node, AV-node
- Indication: SVT with preserved ventricular function
- **Side-effects:** Hypotension, Bradycardia
- **CI:** 2nd or 3rd heart block, hypotension, severe congestive heart failure and lung disease associated with bronchospasm.

- Dose: Metoprolol 2–5 mg at 5-min intervals to a total of 15 mg. Esmolol intravenous loading dose of 500 µg kg⁻¹ over 1 min, followed by an infusion of 50–200 g kg⁻¹ min⁻¹.
Class III: Amiodarone

- Also has Class I, II, IV effects
- Improve response to defibrillation VF or unstable VT
- **Side effects:** Neg inotrope, vasodilatation, Bradycardia, Heart Block
- **Prolongs QT** (TdP rare)

Therapeutic → Arrhythmogenic

Prolong APD
Class IV: Calcium Channel Blocker

- Verapamil (Isoptine®) and Diltiazem (Tildiem®)
- Slows SA-node and AV-node

Indications:
- Stable regular SVT uncontrolled by adenosine/vagal manoeuvres
- AF or Aflutter
- Proarrhythmic effect: Bradycardia and heart block; Negative inotrope
- CI: heart block and heart failure, WPW

Dose: Diltiazem 250µg/kg IV; 2nd dose 350 µg/kg
Other drugs: Adenosine (Adenocor ®)

- Slows transmission AV node
- Indication: AVNRT/AVRT; AF/Aflutter
- Dose: 6mg (eventually + 12mg every 1-2min)
- Half-life: 10-15s
- Side effect: flushing, nausea and chest discomfort
Other drugs: Digoxine

- Positive inotropic, negative chronotropic, negative dromotropic
- Correct K+ and Mg+
- Pro-arrhythmic effect +++

- Narrow therapeutic window, cardiotoxiciteit
- Toxicity: Yellow vision; nausea, diarrhoea
- Antidote: anti-digoxin Fab fragments
Case discussions
Case 1: PSOS clavicula

- Female, 20yo; ASA 1
- 73kg/172cm, no known allergies
- Medical history:
  - 2013: wisdom teeth
  - Tonsillectomy
  - PONV
- Clinical exam: no particulars
• ASA monitoring: SR 60 bpm, 112/67 mmHg, Sat 100% FiO2 21%

• Induction:
  • 15µg Sufentany; Lidocaine 40mg; Propofol 200mg; Rocuronium 30mg
  • ETT + sevoflurane (1,1 MAC)
  • Cefazoline 2g, Ketorolac 30mg, Dexamethasone 5mg, DHBP 0,625mg
  • 20min before end of surgery: Paracetamol 1g; Ondansetron 4mg
Treatment Torsade de Pointes

• Stable:
  • Stop all drugs known to prolong the QT interval
  • Correct electrolyte abnormalities, especially hypoK+
  • Magnesium sulphate 2g (IV over 10’)
  • Increase heart rate: Atropine, Isoprenolol (Isuprel®), Overdrive pacing

• Unstable: Shock!
Treatment VT

- **Stable:**
  - Amiodarone 300mg (iv over 20-60’) + 900mg over 24h

- **Unstable:**
  - Shock: 120-150J biphasic
Drug selection for acute management of unstable VT and VF

• VF intraoperatively: rapid defibrillation and correction of reversible etiologies

• Lidocaine? No human clinical studies that it promotes conversion of VT/VF

• ALIVE: Amiodarone (5mg/kg) vs lidocaine (1,5mg/kg)
  • VF resistent to 3 shocks, epinephrine and a fourth shock or recurrent VF
  • 347pt: Survival to hospital admission Amiodarone 22,8% vs lidocaine 12% (P=0.008)

• ARREST: prospective trial: IV amiodarone vs placebo in cardiac arrest out of hospital,
  • 504 pt with survival to hospital 44% vs 34% (P= .0,03)
  THERE WAS NO SIGNIFICANT ADVANTAGE TO AMIODARONE IN SURVIVAL TO HOSPITAL DISCHARGE
  - No placebo controlled trials available in the surgical venue
Case 2: VED

- Man 71yo, 76kg; 176cm, ASA 3
- No known allergies
- Medical history
  - AHT, NIDDM
  - Multinodular goiter
  - Appendectomy
  - 2010: AdenoCa of the left kidney -> nephrectomy
• Medication:
  • Co-enalapril® 20-12,5 mg
  • L-thyroxine® 50 µg
  • Tamsulosine® 0.4 mg
  • Glucophage® 850 mg 2x1/d

• Clinical exam: No particulars, NEU: cfr indication

• Labo: No particulars

• ECG...
Treatment AF

• Stable
  • Rate control
    • Beta-blockers
    • Calcium channel blockers: Diltiazem, Verapamil
    • Digoxin, Amiodarone in case of heart failure
  
  • Rhythm control
    • Electrical cardioversion
    • Chemical cardioversion: Amiodarone 300mg (IV over 20-60’) + 900mg over 24h; Flecainide, Propafenone, Ibutilide
    • CAVE: If AF>48h: No cardioversion without full anticoagulation or TEE

• Unstable: shock!
  
• WPW: Avoid Diltiazem, Verapamil or Digoxin
Management of Perioperative Atrial Tachyarrhythmias

PSVT or AF < 24 h duration

- Hemodynamic instability, angina, or preexcitation syndrome

  - Urgent DC cardioversion

  - AF = 24-48 h duration

    - Consider IV unfractionated or subcutaneous low-molecular weight heparin

      - Evidence of structural heart disease* → Amiodarone

      - No evidence of structural heart disease* → IV ibutilide; single-dose oral flecainide or propafenone; amiodarone

  - AF > 48 h duration

    - Consider DC cardioversion after 3-12 weeks of warfarin therapy

- Heart rate control with IV diltiazem or beta-blocker (<100 bpm)

  - Spontaneous conversion

- Not a candidate for anticoagulation

  - Anticoagulate with IV heparin, begin warfarin

  - Consider TEE guided DC cardioversion ("fast-track")
A comparison of rate control and rhythm control in patients with atrial fibrillation.

Wyse DG\textsuperscript{1}, Waldo AL, DiMarco JP, Domanski MJ, Rosenberg Y, Schron EB, Kellen JC, Greene HL, Mickel MC, Dalquist JE, Corley SD; Atrial Fibrillation Follow-up Investigation of Rhythm Management (AFFIRM) Investigators.

\textbf{Abstract}

\textbf{BACKGROUND:} There are two approaches to the treatment of atrial fibrillation: one is cardioversion and treatment with antiarrhythmic drugs to maintain sinus rhythm, and the other is the use of rate-controlling drugs, allowing atrial fibrillation to persist. In both approaches, the use of anticoagulant drugs is recommended.

\textbf{METHODS:} We conducted a randomized, multicenter comparison of these two treatment strategies in patients with atrial fibrillation and a high risk of stroke or death. The primary end point was overall mortality.

\textbf{RESULTS:} A total of 4050 patients (mean +/- SD age, 69.7 +/- 9.0 years) were enrolled in the study; 70.8 percent had a history of hypertension, and 38.2 percent had coronary artery disease. Of the 3311 patients with echocardiograms, the left atrium was enlarged in 64.7 percent and left ventricular function was depressed in 26.0 percent. There were 356 deaths among the patients assigned to rhythm-control therapy and 310 deaths among those assigned to rate-control therapy (mortality at five years, 23.8 percent and 21.3 percent, respectively; hazard ratio, 1.15 [95 percent confidence interval, 0.99 to 1.34]; P=0.08). More patients in the rhythm-control group than in the rate-control group were hospitalized, and there were more adverse drug effects in the rhythm-control group as well. In both groups, the majority of strokes occurred after warfarin had been stopped or when the international normalized ratio was subtherapeutic.

\textbf{CONCLUSIONS:} Management of atrial fibrillation with the rhythm-control strategy offers no survival advantage over the rate-control strategy, and there are potential advantages, such as a lower risk of adverse drug effects, with the rate-control strategy. Anticoagulation should be continued in this group of high-risk patients.
Intravenous amiodarone in treatment of recent-onset atrial fibrillation: results of a randomized, controlled study.

100 patients with recent onset AF (<1w)

- **Group 1**
  - 5mg/kg within 30’, 1200mg over 24 Amiodarone
  - Digoxin if HR>100bpm
  - 68% reconversion to SR

- **Group 2**
  - Saline
  - Digoxin if HR>100bpm
  - 60% reconversion to SR

Conclusion: Only a modest benefit of amiodarone in converting acute AF to SR.
Case 3: Laparoscopy for subobstruction

- Female 56yo, 80kg/162cm, ASA 3

- Medical history:
  - AHT, hyperlipidemia, obesity (BMI 30)
  - Hysterectomy, Diagnostic laparoscopy, gastric bypass, abdominoplasty
  - Palpitations during 1 minute, rarely

- Medication:
  - Bisoprolol 5mg 1xd
  - Asaflow® 80mg 1xd
  - Lipitor® 40mg 1xd
Treatment AVNRT

• Stable
  • Vagal manoeuvres: carotid sinus massage (5”), Valsalva
  • Adenosine 6mg + 12mg + 12mg
  • Recurrence: Adenosine, Diltiazem, Verapamil

• Unstable: Shock (70-120J)
Casus 4: Belsey Mark IV

- Man, 75yo, ASA 3
- 165cm, 85kg, no known allergies
- Medical history
  - Polyarthritis
  - Hiatus hernia, Barrett slokdarm
  - Light coronay atheromathosis
  - 05.2015 AF -> reconversie
  - 2012 RCC -> Partial nephrectomy
  - 2014 Tumor RUL -> thoracoscopic resection
  - Bilateral THP
  - Prostatectomy
• Medication:
  • Apocard Retard® 150mg 1/d
  • Emconcor® 2.5mg 1/d
  • Omeprazole 40mg 1/d
  • Tofranil® 25mg 1/d
  • Xarelto® 15mg 1/d (Stop 1m ago)
• RX thorax: hypoplasia, atelectasis LLL
• TEE: Atria dilated, light MI
• Labo: eGFR 51, no particulars
• ECG: nl SR, RBTB, LAFB (bifasciculair block)
Treatment bradycardia

• Stable:
  • Observe

• In case of risk of asystole, treat as unstable:
  ◦ Recent asystole
  ◦ Mobitz II AV block
  ◦ Complete heart block with broad QRS
  ◦ Ventricular pause > 3s
Treatment bradycardia

- Unstable:
  - Atropine 500µg, repeat every 3-5min (max 3mg), CAVE ischaemia or myocardial infarction
  - Isoprenaline 5µg/min
  - Adrenaline 2-10µg/min
  - Dopamine 2-10µg/min

- Theophylline 100-200mg (slow iv): inferior MI, Cardiac transplant, spinal cord injury
- Glucagon: Overdose with beta-blockers or calciumchannelblockers

- Pacing: transcutaneous, fist, transvenous
Conclusion

• Cardiac arrhythmia carries the potential of haemodynamic instability/cardiovascular collapse
• Increased morbidity, ICU stay, length of hospitalization and hospital costs
• Precipitating causes should be treated or removed immediately
• Know your patient, know your drugs
• Expert advice
Referenties

1. ATOTW 279 – Peri-operative Cardiac Arrhythmias – Part 1, 04/02/2013


All Arrythmias Straighten Themselves Out in THE END