

BRIGHAM HEALTH



BRIGHAM AND
WOMEN'S HOSPITAL

Life-Threatening Cardiac Arrhythmias in the ICU

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HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

MAGNET
RECOGNIZED



AMERICAN NURSES
CREDENTIALING CENTER

Disclosures

None

Overview

- Bradycardias
 - Sinus arrest
 - AV Block
- Tachycardias
 - Ventricular Tachycardia
 - Unspecified Wide Complex Tachycardia
- Cardiac Arrest
 - Shockable rhythms
 - VF
 - Pulseless VT
 - Non-shockable rhythms
 - Asystole
 - Pulseless electrical activity (PEA)



Critical Care Medicine

Certification Examination Blueprint

Medical Content Category	% of Exam
Renal, Endocrine, and Metabolic Disorders	15.0%
Cardiovascular Disorders	17.5%
Pulmonary Disease	20.0%
Infectious Disease	12.0%
Gastrointestinal Disorders	5.0%
Neurologic Disorders	9.5%
Hematologic and Oncologic Disorders	5.5%
Surgery, Trauma, and Transplantation	7.0%
Pharmacology and Toxicology	4.5%
Research, Administration, and Ethics	2.0%
Critical Care Ultrasound Scanning	2.0%
	100%

Arrhythmias

<2%

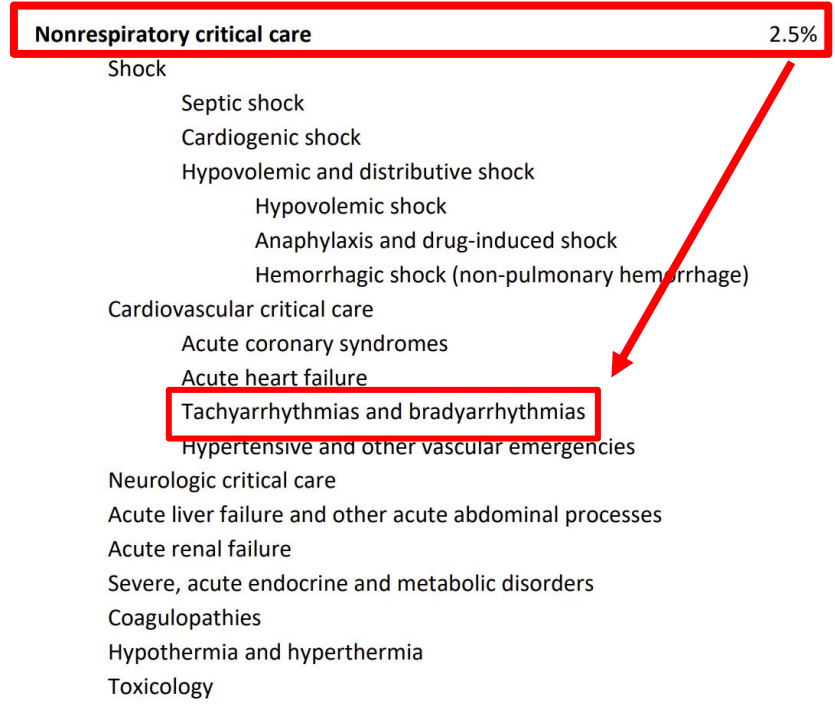
- Supraventricular tachycardia
 - Atrial fibrillation
 - Atrial flutter
 - Multifocal atrial tachycardia
 - Pre-excitation syndromes
 - Paroxysmal supraventricular tachycardia
 - (atrioventricular [AV] nodal reentrant tachycardia)
- Ventricular arrhythmias
 - Nonsustained ventricular tachycardia
 - Monomorphic ventricular tachycardia
 - Polymorphic ventricular tachycardia
 - Ventricular fibrillation
 - Accelerated idioventricular rhythm
 - Long QT syndrome
 - Brugada syndrome
- Bradycardias
 - Sinus bradycardia
 - Sinoatrial exit block
 - Atrioventricular block
- Pacemakers and defibrillators



Pulmonary Disease

Certification Examination Blueprint

Medical Content Category	% of Exam
Obstructive Lung Disease	17.5%
Critical Care Medicine	15%
Diffuse Parenchymal Lung Disease (DPLD)	10%
Sleep Medicine, Neuromuscular and Skeletal	10%
Epidemiology	2%
Infections	12%
Neoplasia	9.5%
Pleural Disease	5%
Quality, Safety, and Complications	5%
Transplantation	2%
Vascular Diseases	6%
Respiratory Physiology and Pulmonary Symptoms	4%
Occupational and Environmental Diseases	2%
	100%



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Case #1

A 79 year old woman with persistent atrial fibrillation and type 2 diabetes presented to the emergency room with malaise and dyspnea. She was diagnosed with bacterial endocarditis based upon fever, positive blood cultures with Gram positive cocci, and mitral valve vegetation on echocardiogram. Echocardiogram otherwise had no significant abnormality. EKG revealed atrial fibrillation with complete heart block and regular wide complex escape rhythm 38 bpm. Blood pressure was 96/48 mmHg. She was moderately ill-appearing and tachypneic with bibasilar crackles. Antibiotics were initiated, and the patient was started on a dopamine drip, without significant change in her heart rate or dyspnea.

Which of the following is the most appropriate next step in management of the bradycardia?

- A. Insertion of temporary transvenous pacemaker.
- B. Insertion of semipermanent pacemaker the following morning.
- C. Insertion of permanent pacemaker the following morning.
- D. Sedation and transcutaneous pacing.
- E. Administration of intravenous atropine.

Case #2

A 55 year old woman with morbid obesity is post-operative day 0 after laparoscopic cholecystectomy. She is left intubated for airway support due to suspected airway edema, and admitted to the surgical ICU. Throughout the afternoon, she has 3 episodes of abrupt onset sinus bradycardia and transient AV block with asystolic pauses up to 6 seconds triggered by positioning in the bed and by airway suctioning. EKG revealed normal sinus rhythm with normal intervals and no evidence of ischemia. She was otherwise hemodynamically stable.

What is the most appropriate next step?

- A) Insert a temporary transvenous pacemaker
- B) Insert a semi-permanent pacemaker the following morning
- C) Insert a permanent pacemaker the following morning
- D) Watchful waiting
- E) Start dobutamine infusion

Case #3

A 76 year old man with longstanding persistent atrial fibrillation treated with digoxin was admitted to the ICU after presenting with 1 week of diarrhea, generalized weakness, and confusion. EKG revealed atrial fibrillation with regular narrow complex rhythm 40 bpm. Blood pressure was stable. Laboratory workup revealed elevated digoxin level, elevated BUN and creatinine, and hyperkalemia 5.0 mEq/L.

In addition to IV fluid resuscitation, which of the following should be part of the initial management strategy?

- A) Temporary transvenous pacemaker
- B) Digoxin-specific antibody
- C) Kayexalate
- D) Intravenous insulin and glucose
- E) Intravenous furosemide

Digoxin toxicity

- Can cause various arrhythmias
 - Asystole; Sinus bradycardia; AV block; atrial tachycardia; junctional tachycardia; ventricular tachycardia; VF
- Dig toxicity can occur with normal dig levels (especially in patients with heart failure, ischemia, hypokalemia, hypomagnesemia, hypercalcemia)
- Digoxin inhibits muscle Na-K-ATPase resulting in hyperkalemia
- Hyperkalemia in dig toxicity is a predictor of mortality
- Administer digoxin-specific antibody (Fab fragments)
- After Fab fragments, hyperkalemia is rapidly corrected

Bradycardia: Etiologies

- Myocardial ischemia or infarction
- Hypoxia
- Electrolyte abnormalities
- Intracranial hypertension
- Vasovagal
- Medications

Bradycardia: Treatment

- Atropine
 - Effective for sinus bradycardia, AV nodal block, vasovagal
 - Not effective for Mobitz II second degree AV block, complete heart block, or for heart transplant patients
- Dopamine
- Epinephrine
- Isoproterenol
- Transvenous or percutaneous pacing
- If digoxin toxicity: Administer digoxin-specific antibody (Fab) fragments
- If calcium channel blocker toxicity: Administer glucagon

Bradycardia: Indications for pharmacological or pacing support

- Hypotension
- Acutely altered mental status
- Signs of shock
- Ischemic chest discomfort
- Acute heart failure

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Case #4

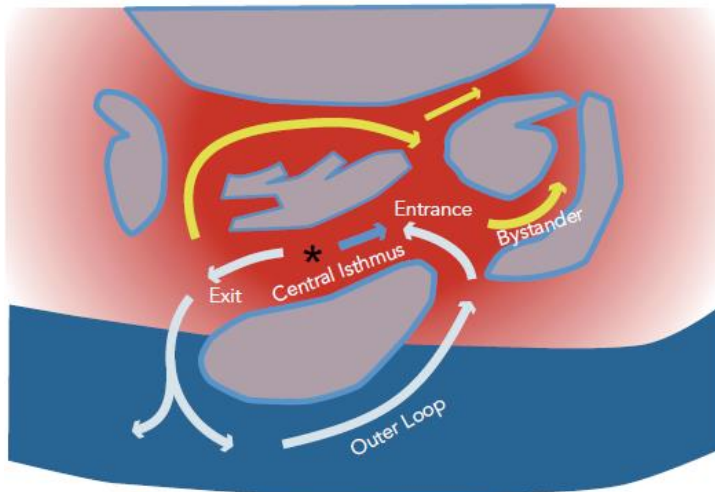
A 72 year old woman with ischemic cardiomyopathy, LVEF 30%, ventricular tachycardia treated with ablation 3 years ago plus continued amiodarone, presented to the ER with near syncope and 3 ICD shocks earlier in the day. Physical exam was unremarkable. EKG revealed normal sinus rhythm with normal intervals and no ischemic changes. Labs revealed normal electrolytes and cardiac enzymes. In the ER the patient had 2 additional runs of monomorphic ventricular tachycardia 180 bpm, terminated with anti-tachycardia pacing (ATP) on 1 occasion, and ICD shock on the second occasion. Amiodarone bolus was administered, and she was admitted to the ICU for further management. She continued to have recurrent episodes of monomorphic VT resulting in ATP and ICD shocks.

What is the most appropriate next step in management of her VT?

- A) Adjust the settings on the ICD to avoid ICD shocks
- B) Intubate and sedate with propofol
- C) Urgent coronary angiogram
- D) Procainamide infusion
- E) Urgent anesthesia consult for stellate ganglion block

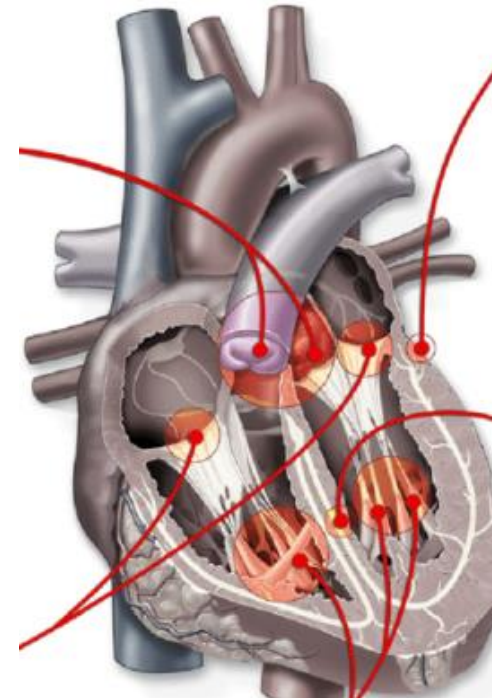
Monomorphic VT

Reentry



Nof. *Arrhythm Electrophysiol Rev.* 2013
Stevenson. *Trans Am Clin Climatol Assoc.* 2009;120:403

Automatic/Triggered



Calkins. *Eur Heart J.* 2015

Polymorphic VT

- Ischemia
- Electrolyte abnormalities
- Heritable channelopathy/cardiomyopathy
 - Long QT syndrome
 - Catecholaminergic polymorphic VT
 - Brugada syndrome
 - Arrhythmogenic cardiomyopathy
- QT prolongation secondary to medications

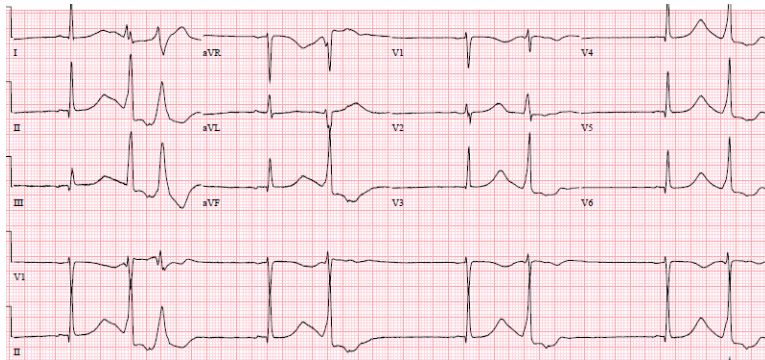
Hemodynamically Stable VT

What To do . . .

- Amiodarone
- Sotalol
- Lidocaine
 - Neurotoxicity: tremor; hypoactive delirium; dysarthria; seizures.
 - Monitor lidocaine levels.
- Procainamide
 - Toxicity: PR/QRS/QT prolongation; negative inotropy.
 - Hepatic metabolism to N-acetyl procainamide (NAPA).
 - NAPA active metabolite that is >80% renally cleared/not dialyzable.
 - Monitor procainamide and NAPA concentrations.

Case #5

- 32 year old female with uterine rhabdomyosarcoma, ESRD on hemodialysis, anxiety treated with citalopram and quetiapine.
- She presented with fever and cough, found to have COVID-19 infection, with oxygen desaturation and elevated inflammatory markers.
- She was treated with remdesivir and prednisone.
- On hospital day #4, she developed sinus bradycardia and ventricular arrhythmia . . .



After terminating the ventricular arrhythmia with electrical cardioversion, what is the best next step in management?

- A) Insert a temporary transvenous pacemaker
- B) Apply transcutaneous pacemaker
- C) Administer intravenous amiodarone
- D) Administer magnesium and isoproterenol
- E) Administer intravenous metoprolol

Torsades de Pointes

- Magnesium Sulfate
 - First line therapy, even if serum Mg concentration is normal
 - Stabilizes excitable membranes
 - Prevents long QT-related ventricular ectopic beats
- Isoproterenol drip
 - For TdP triggered by pauses or bradycardia
 - Titrate to heart rate 100 bpm
 - Beta-1 and beta-2 agonist. Chronotrope. Inotrope. Peripheral vasodilator.
 - Ensure no evidence of ischemia before administering
- Transvenous pacemaker
 - Overdrive pacing of the RA or RV at 100 bpm
 - If no response to Mg or isoproterenol

Wide Complex Tachycardia Differential Diagnosis

- Ventricular Tachycardia
- SVT with aberrancy
- SVT with preexcitation (WPW syndrome)

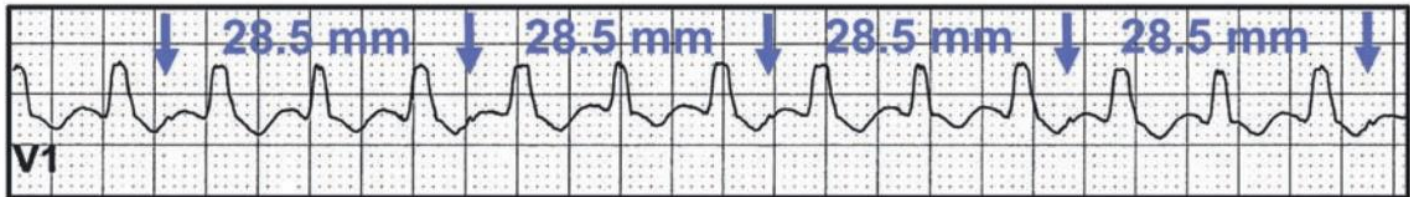
Wide Complex Tachycardia

- VT is approximately 4 times more common than SVT with aberrancy or preexcitation
- VT much more common than SVT if history of MI, CHF, or valvular heart disease
- Hemodynamic stability does not rule out VT
- AV dissociation is diagnostic for VT, but present in <50% of VT

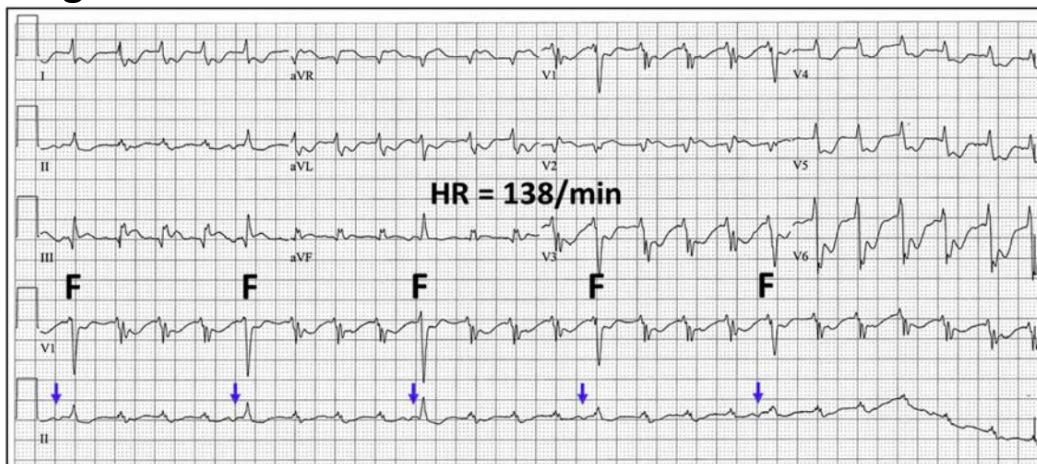
WCT: Tips for EKG Diagnosis

AV dissociation is diagnostic for VT

Dissociated P waves at slower rate than the QRS complexes:

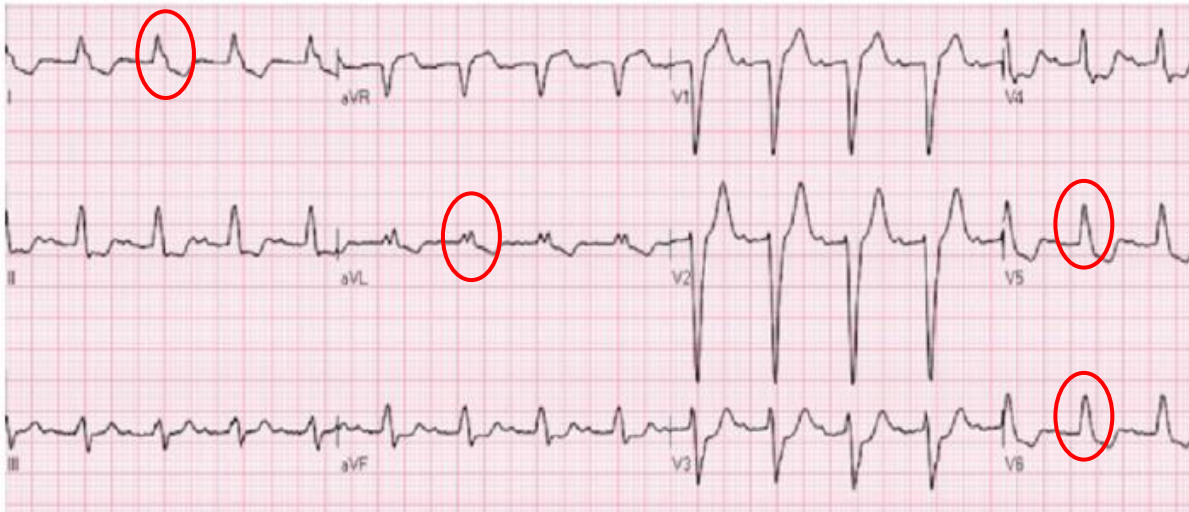


Regular WCT with fusion beats:



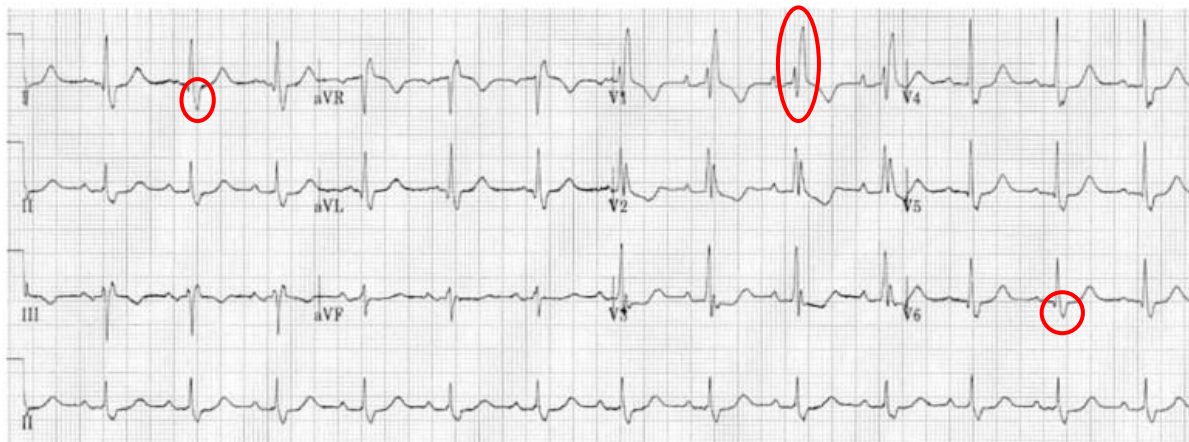
WCT: tips for EKG diagnosis

Know appearance of “typical” aberrancy



LBBB

- Broad or notched R waves I, aVL, V5, V6
- ST and T waves in opposite direction of QRS



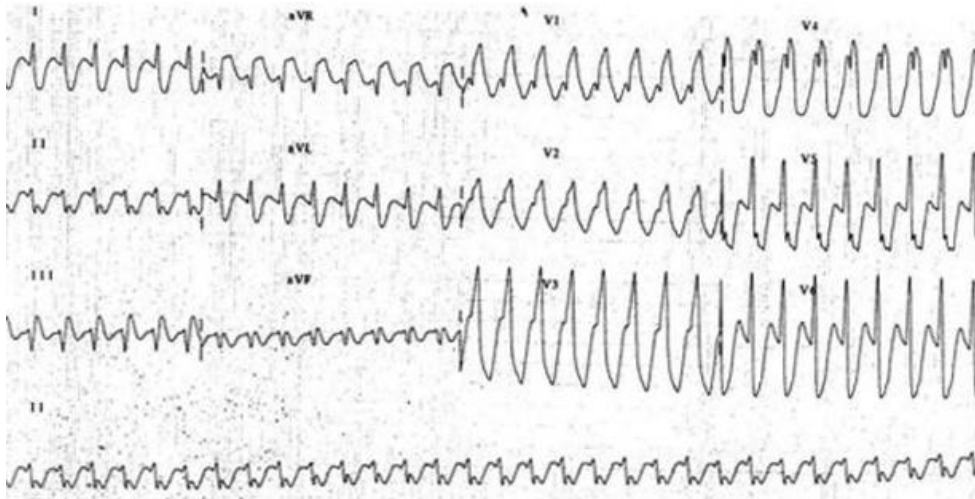
RBBB

- rsR' in V1
- Broad S wave in V6 and lead I

Case #6

A 56 year old man with no known heart disease except paroxysmal atrial fibrillation treated with flecainide and metoprolol was admitted to the ICU for community acquired pneumonia with hypoxic respiratory distress. He developed abrupt onset wide complex tachycardia 220 bpm. Blood pressure remained stable. The patient was alert, and noted palpitations but no chest discomfort or increased dyspnea. Prior baseline EKGs revealed no evidence of preexcitation.

Which of the following would NOT be an appropriate first step in management?



- A) Carotid sinus massage
- B) Adenosine bolus
- C) IV sotalol
- D) IV amiodarone
- E) Electrical cardioversion

Management of Stable Wide Complex Tachycardia

SPECIFIC ARRHYTHMIA MANAGEMENT

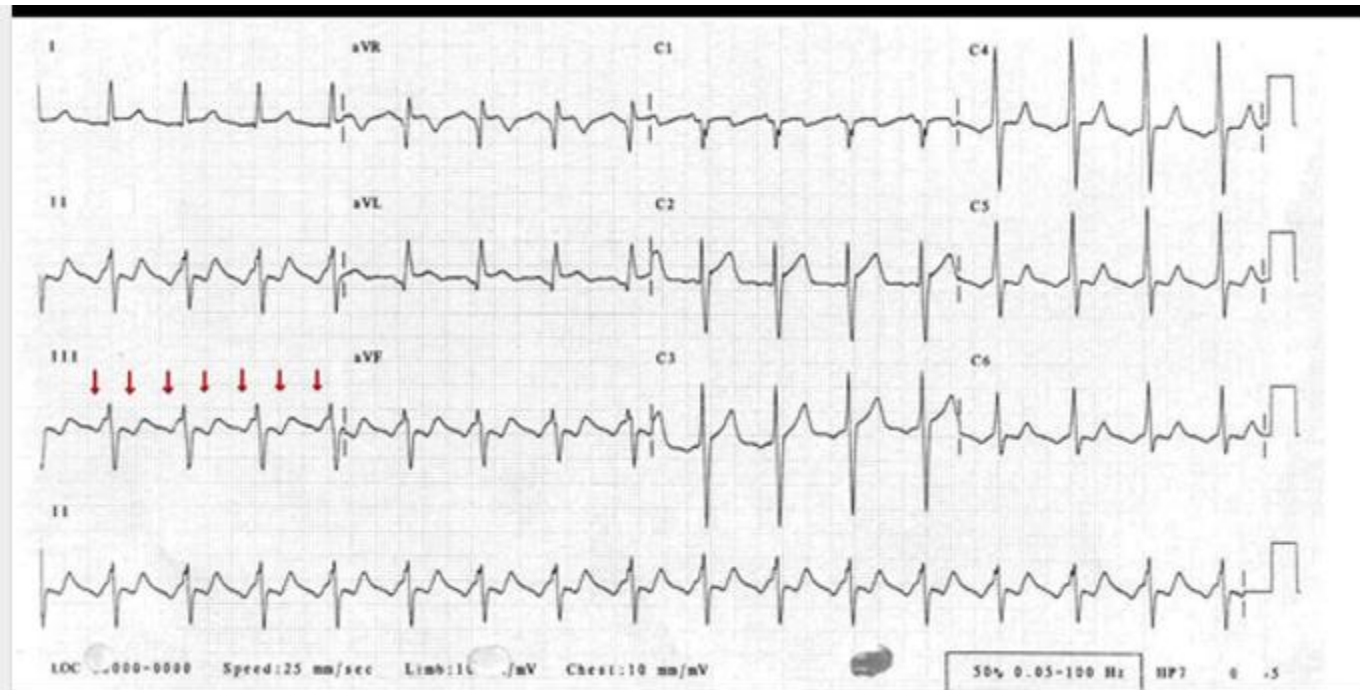
Wide-Complex Tachycardia

Recommendations for Pharmacological Management of Hemodynamically Stable Wide-Complex Tachycardia		
COR	LOE	Recommendations
2b	B-NR	1. In hemodynamically stable patients, IV adenosine may be considered for treatment and aiding rhythm diagnosis when the cause of the regular, monomorphic rhythm cannot be determined.
2b	B-R	2. Administration of IV amiodarone, procainamide, or sotalol may be considered for the treatment of wide-complex tachycardia.
3: Harm	B-NR	3. Verapamil should not be administered for any wide-complex tachycardia unless known to be of supraventricular origin and not being conducted by an accessory pathway.
3: Harm	C-LD	4. Adenosine should not be administered for hemodynamically unstable, irregularly irregular, or polymorphic wide-complex tachycardias.

- Adenosine
 - May be administered for treatment or diagnosis for regular monomorphic WCT
 - Should not be use for irregular/polymorphic WCT
- Amiodarone, procainamide, or sotalol
 - May be used to treat WCT of unknown etiology
- Verapamil
 - Avoid if etiology of WCT is unknown

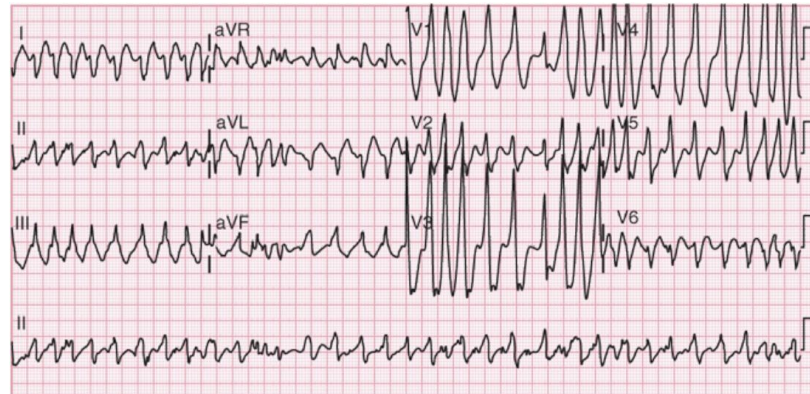
Case #6

Patient was hemodynamically stable, so IV sotalol was administered, revealing typical atrial flutter. He was subsequently treated with external cardioversion.



Case #7

A 43 year old man with Wolff-Parkinson-White syndrome was admitted to the surgical ICU after a motor vehicle crash with concussion but no evidence of skull fracture or intracranial hemorrhage. He developed abrupt onset tachycardia 200 bpm. He remained hemodynamically stable.

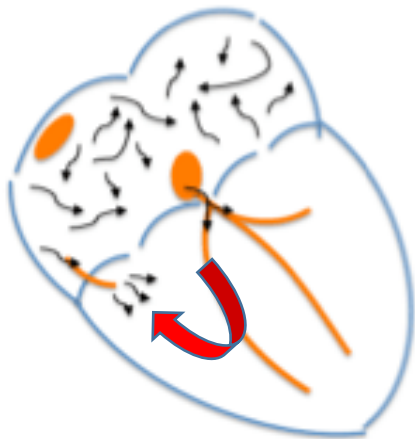


Which of the following would be the most appropriate next step in management?

- A) Intravenous metoprolol
- B) Intravenous verapamil
- C) Intravenous procainamide
- D) Intravenous digoxin
- E) Intravenous amiodarone

Atrial fibrillation with Wolff Parkinson White Syndrome

- Avoid AV Nodal Blockers
 - Beta blockers
 - Calcium blockers
 - Digoxin
 - Adenosine
 - Amiodarone
- Treatment Options
 - Procainamide
 - Ibutilide
 - Electrical cardioversion



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Case #8

A 70 year old woman with history of CAD and remote CABG was admitted to the hospital with acute decompensated heart failure and newly noted reduced LVEF 40% and global hypokinesis. There was no sign of acute coronary syndrome based upon EKG and laboratory evaluation. She was intubated for acute respiratory distress, started on dobutamine for cardiogenic shock, and admitted to the ICU. In the ICU, she developed pulseless ventricular tachycardia. CPR was started, and external shock was delivered, but failed to maintain sinus rhythm for more than few seconds. Epinephrine, additional shocks, and CPR were continued, but the patient remained in pulseless ventricular tachycardia.

What is the best next step in management?

- A) Intravenous amiodarone
- B) Intravenous calcium
- C) Sodium bicarbonate
- D) Intravenous magnesium
- E) Intravenous metoprolol

Part 3: Adult Basic and Advanced Life Support

2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Nonvasopressor Medications During Cardiac Arrest

Recommendations for Nonvasopressor Medications		
COR	LOE	Recommendations
2b	B-R	1. Amiodarone or lidocaine may be considered for VF/pVT that is unresponsive to defibrillation.
2b	C-LD	2. For patients with OHCA, use of steroids during CPR is of uncertain benefit.
3: No Benefit	B-NR	3. Routine administration of calcium for treatment of cardiac arrest is not recommended.
3: No Benefit	B-R	4. Routine use of sodium bicarbonate is not recommended for patients in cardiac arrest.
3: No Benefit	B-R	5. The routine use of magnesium for cardiac arrest is not recommended.

- Amiodarone or lidocaine may be considered for VF/pulseless VT

Cardiac Arrest – Vasopressors

Vasopressor Medications During Cardiac Arrest

Recommendations for Vasopressor Management in Cardiac Arrest		
COR	LOE	Recommendations
1	B-R	1. We recommend that epinephrine be administered for patients in cardiac arrest.
2a	B-R	2. Based on the protocols used in clinical trials, it is reasonable to administer epinephrine 1 mg every 3 to 5 min for cardiac arrest.
2a	C-LD	3. With respect to timing, for cardiac arrest with a nonshockable rhythm, it is reasonable to administer epinephrine as soon as feasible.
2b	C-LD	4. With respect to timing, for cardiac arrest with a shockable rhythm, it may be reasonable to administer epinephrine after initial defibrillation attempts have failed.
2b	C-LD	5. Vasopressin alone or vasopressin in combination with epinephrine may be considered in cardiac arrest but offers no advantage as a substitute for epinephrine in cardiac arrest.
3: No Benefit	B-R	6. High-dose epinephrine is not recommended for routine use in cardiac arrest.

- Epinephrine
 - Indicated for all cardiac arrest types
- Vasopressin
 - May be considered in combination with epinephrine

Cardiac Arrest Resuscitation

- Insufficient evidence to support or refute use
 - Atropine
 - Corticosteroids
- Not recommended for routine use:
 - Calcium
 - Sodium bicarbonate
 - fibrinolytics

Cardiac Arrest – Reversible Etiologies

5 “H”s

- Hypovolemia
- Hypoxia
- Hydrogen ions (Acidosis)
- Hypo-/Hyperkalemia
- Hypothermia

5 “T”s

- Tension Pneumothorax
- Tamponade
- Toxins
- Thrombosis (Pulmonary)
- Thrombosis (Coronary)

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Summary Take Home Points - Bradycardia

- There is no specific heart rate or length of pause that warrants urgent pacing.
- Indication for intervention is based upon symptoms and/or instability.
- Interventions: Medications or pacing

Summary Take Home Points - Tachycardia

- Wide complex tachycardia → Most often VT
- Unstable tachyarrhythmia → Cardiovert
- Stable VT → Procainamide; amiodarone; lidocaine; sotalol; beta blocker
- Torsades de Pointes → Mg and isoproterenol
- WPW → Avoid AV nodal blocking agents

Summary Take Home Points – Cardiac Arrest

- CPR
- Epinephrine
- VF/pulseless VT → Electrical cardioversion +/- amiodarone or lidocaine
- Look for reversible causes (5 “H”s and 5 “T”s)

Further Resources

Part 8: Advanced Life Support

**2010 International Consensus on Cardiopulmonary Resuscitation and
Emergency Cardiovascular Care Science With
Treatment Recommendations**

Morrison. *Circulation*. 2010; 122(suppl 2): S345
Focus on pages S351-S354

AHA FOCUSED UPDATE

**2019 American Heart Association Focused Update on
Advanced Cardiovascular Life Support: Use of Advanced
Airways, Vasopressors, and Extracorporeal Cardiopulmonary
Resuscitation During Cardiac Arrest**

An Update to the American Heart Association Guidelines for Cardiopulmonary
Resuscitation and Emergency Cardiovascular Care

Panchal. *Circulation*. 2019; 140: e881
Focus on pages e885-e888

Part 3: Adult Basic and Advanced Life Support

**2020 American Heart Association Guidelines for Cardiopulmonary
Resuscitation and Emergency Cardiovascular Care**

Panchal. *Circulation*. 2020;142 (suppl 2): S366

Review

Initial evaluation and management of wide-complex tachycardia: A
simplified and practical approach

Littmann. *Am J Emerg Med*. 2019; 37: 1340

**The Society of Thoracic Surgeons Expert
Consensus for the Resuscitation of Patients
Who Arrest After Cardiac Surgery**



Dunning. *Ann Thorac Surg*. 2017; 103: 1005
Focus on pages 1007-1014

The Society of Thoracic Surgeons Task Force on Resuscitation After Cardiac Surgery*

BRIGHAM HEALTH



BRIGHAM AND
WOMEN'S HOSPITAL

Thank You! Questions?

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