

Weakness, Syncope, and Sudden Death

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Episodic Weakness

Diagnostic challenge

Many Differential diagnoses

- Non-cardiac
 - Muscular weakness
 - Orthopedic
 - Neurological
 - Metabolic
 - Hypovolemia (blood loss, esp. internal)
 - Thromboembolic disease
- Cardiac – reduced cardiac output due to
 - Arrhythmia (bradycardia or tachycardia)
 - Obstructive lesions (PS or SAS or HOCM)
 - Poor contractile function
 - Pericardial disease



Episodic Weakness

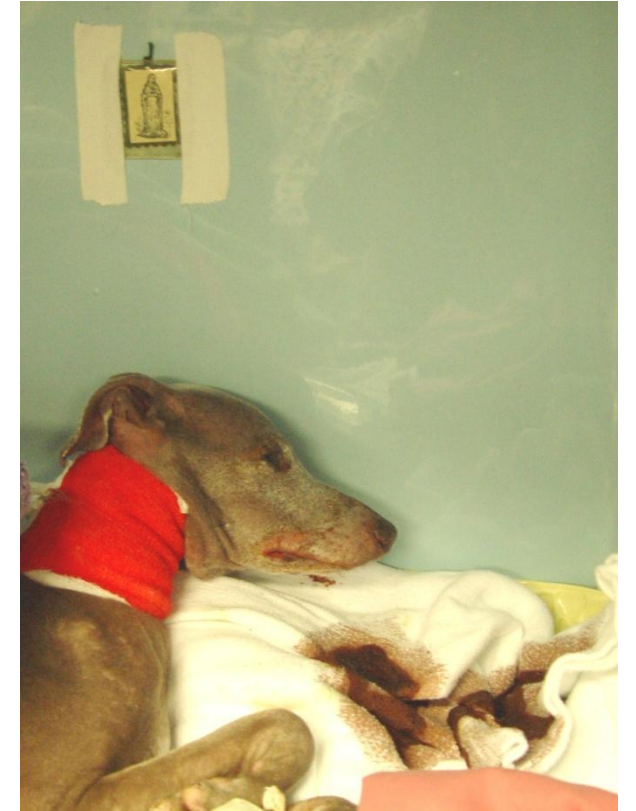
Key historical details

- Back limbs or all 4 limbs?
- Altered consciousness?
- Duration of weakness?
- Recurrence or frequency?
- Exercise related?
- Rate of onset?
- Is there metabolic or systemic disease?
- Shortness of breath?



Episodic Weakness

- PE findings are key!
 - Neurologic, orthopedic, cardiac, respiratory
- Diagnostic testing
 - CBC, chemistry profile, urinalysis
 - Thoracic radiographs
 - Limb or spine radiographs, MRI, CT
 - Blood pressure, ECG +/- Echo
 - Abdominal ultrasound
 - Abdominocentesis if fluid



Syncope

- Sudden, transient loss of consciousness with spontaneous recovery
- Syncope can be a precursor to sudden death
- Pre-syncope is akin to episodic weakness





Syncope



- Common in dogs with cardiac disease, +/- systemic diseases
- Less common in cats
- Uncommon in horses



Syncope

- Syncope is a clinical event, not a diagnosis
- The cause of syncope should be sought aggressively
- Some animals have single episode of syncope before sudden death
- Others have single (or repeated) syncope and no progression



Collapse or Syncope in Dogs

Diagnoses and Outcome

- 42% - Resolved without intervention
- 11% - A firm diagnosis was established
- Cause of syncope was the cause for death in 16% of cases
- Of the dogs that died (37), 49% of them succumbed to the disease causing collapse

Barnett L JSAP 2011



Syncope

Causes of syncope

- Hypoglycemia
- Hypoxemia
- Mild to severe anemia
- Hyperviscosity syndromes
- Hypotension
 - Hypovolemia
 - Inadequate vascular tone (e.g., vasodilating drugs)
 - Cardiovascular causes



Cardiovascular Causes of Syncope

- Bradycardia
- Tachycardia
- Low cardiac output (PS, SAS, myocardial failure)
- Cardiac restriction (pericardial tamponade or tension pneumothorax)
- Vasovagal or neurocardiogenic syncope
- Cough (tussive) syncope



Neurocardiogenic Syncope

AKA Vasovagal Syncope

- Common cause for syncope in people
 - Occurs in dogs but more difficult to prove
- Cardiac mechanoreceptors and aortic baroreceptors sense “overstimulation”
- Messages to brain: “Too much cardiovascular tone and CV stress”
- CNS output:
 - Less sympathetic tone
 - Increased parasympathetic tone
 - Result is reduced heart rate, low cardiac output, and loss of vasomotor tone
- CV effect:
 - Profound bradycardia and plummeting blood pressure
 - Reduced CNS perfusion causes syncope
- Triggers of vasovagal syncope: Anemia, hypovolemia, CHF (dogs), being a Boxer, not enough sleep, too much alcohol, emotional stimulation



Syncope

Differential diagnoses:

- Seizure
- Narcolepsy
- Catalepsy
- Collapse from muscular or orthopedic weakness



Findings from the History: Syncope vs. Seizure

- Owner Hx is typically seizure
- Loss of consciousness
- Collapse and on side
- May urinate or defecate
 - Less often than seizure
- +/- Head/neck may extend back or flaccid

- Owner Hx is typically seizure
- Loss of consciousness
- Collapse and on side
- May urinate or defecate
- +/- Head/neck may extend back or tonic and flexed



Findings from the History: Syncope vs. Seizure

- Often precipitated by exercise or cough
- No (or brief) pre-ictal period
- Duration shorter (30 sec)
- Limbs flaccid or extended
- Limb motion when trying to recover
- Recovery fast (30 sec to 2 min)
- No hypersalivation or facial chomping

- No relationship to activity
- Often pre-ictal period
- Duration of ictus is often 1-2 min
- Tonic/clonic limb motion during ictus
- Post-ictal phase - minutes to hours
- Hypersalivation or facial chomping are common



Syncope- Diagnostics

- History critically important!
- PE is often normal
 - CV signs such as arrhythmia, gallop, murmurs, signs of CHF, etc.
 - Membrane pallor
 - Abdominal distension
 - Lack of neurological deficits



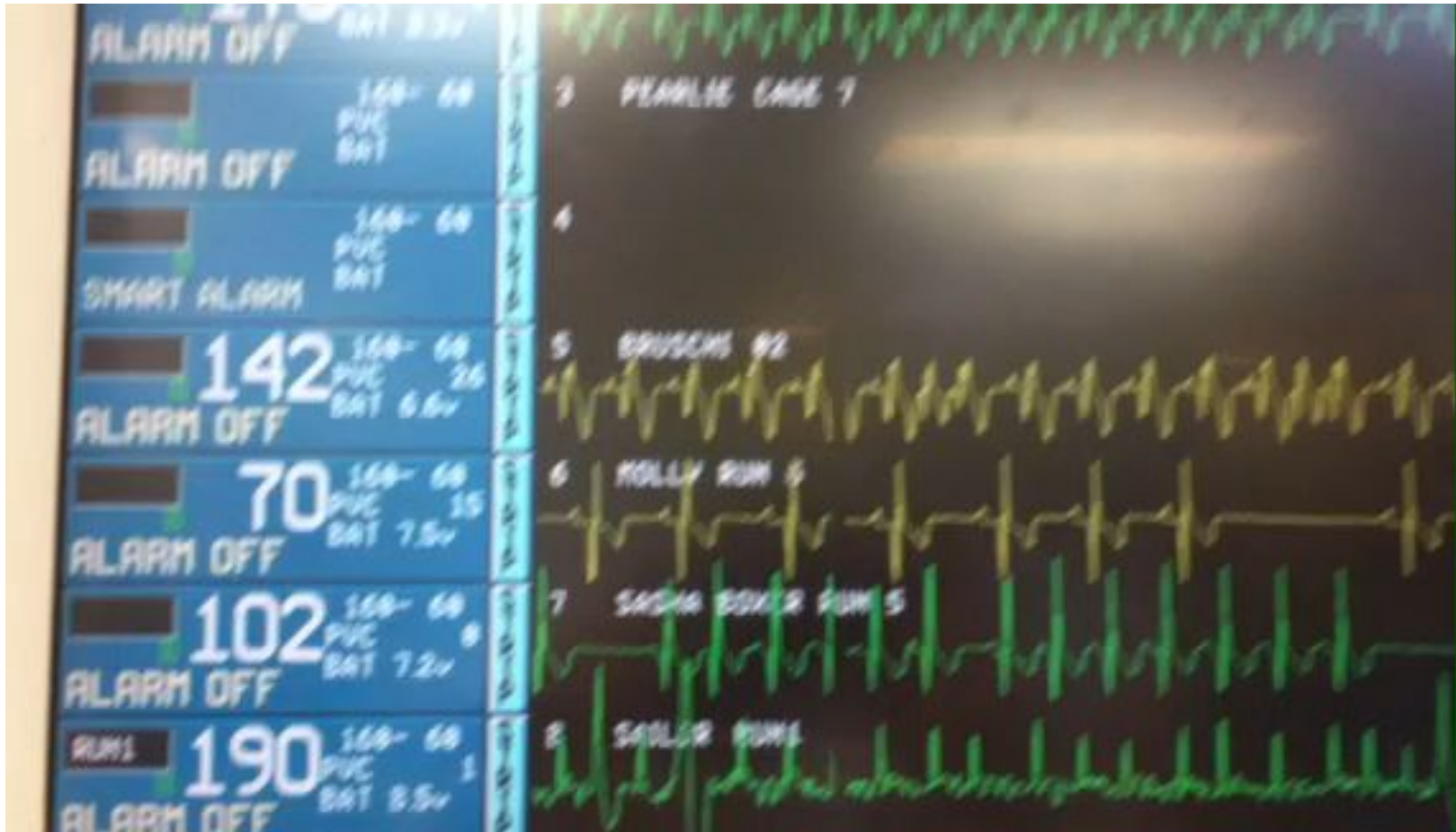
Syncope- Diagnostics

- ECG – Sometimes misses transient arrhythmias
- Echo – Identify underlying cardiac disease
- Thoracic radiographs
- CBC, Chemistry profile, urinalysis
- Arterial blood gas or pulse oximetry
- Event monitor recording
- Holter monitor recording
- ECG recording during hospitalization
- Blood pressure
- Abdominal ultrasound



Continuous ECG Monitoring in an ICU Environment

- No report, no quantification
- Watching for ECG abnormalities

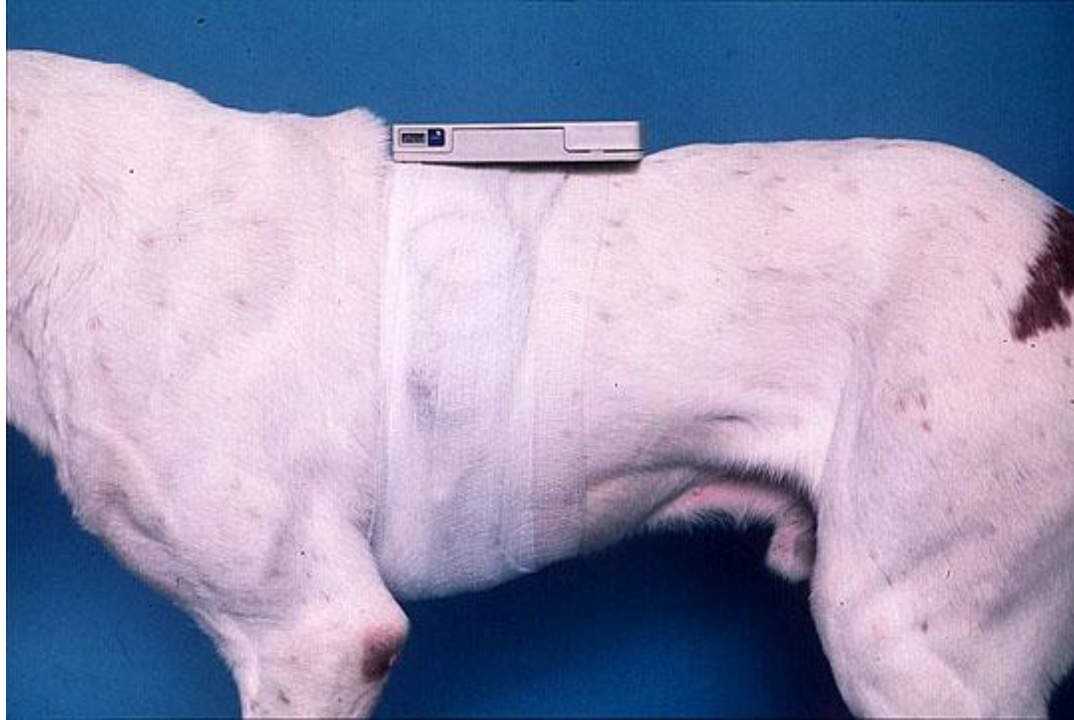


Holter Recorder

24 hour Continuous Ambulatory ECG Recording

- Records multiple ECG channels for 24 to 48 hours
- Gives accurate count of:
 - Number of QRS complexes in 24 hours
 - Number of VPCs in 24 hours
 - Frequency/length of repetitive ventricular or supraventricular arrhythmia
 - Minimum HR, maximum HR, length of pauses, etc.
- Useful for frequent syncope
- Often suggestive of arrhythmic cause even if syncope does not occur during recording









95706	QRS complexes		
4433	Ventricular	ectopics which represent	4 % of total QRS complexes
382	Supraventricular	ectopics which represent	<1 % of total QRS complexes
	Paced QRS complexes	which represent	% of total QRS complexes

VENTRICULAR ECTOPY

4075	Isolated		
1268	Bigeminal Cycles		
82	Couplets		
5	Runs		
194	Beats in Runs		
97	Beats LONGEST at	240 BPM at 12:38:53	14-AUG-87
3	Beats FASTEST at	251 BPM at 00:20:37	14-AUG-87

SUPRAVENTRICULAR ECTOPY

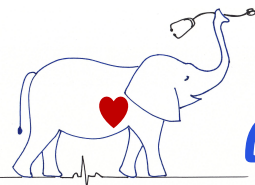
382	Isolated
0	Couplets
0	Runs
0	Beats in Runs
0	Beats LONGEST at
0	Beats FASTEST at

HEART RATES

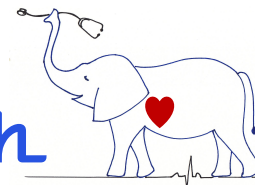
76	MIN at 11:45:47	14-AUG-87
126	AVG	
163	MAX at 07:22:31	14-AUG-87

S-T LEVELS Channel

mm at
mm at



CardioRush



Event Recorder

- Continuous loop recording
- Saves approximately 30 sec to 30 min of ECG
 - 20 sec before and 10 sec after button is depressed
- Implantable devices also available
- Some studies suggest better diagnostic yield than Holter recorder
(48% positive diagnosis rate in 1 study)



Management of Syncope

- Depends upon underlying cause
- High grade AV block and sinus arrest (SSS)
 - Rx with pacemaker or drug therapy
- Tachyarrhythmias treated with antiarrhythmic drugs
- CHF and baroreceptor dysfunction – digoxin, theophylline, Rx CHF, etc.
- Cough syncope – cough suppressants
- Vasovagal syncope – Beta-blockers? Digoxin?
- No therapy if cause uncertain.....



Sudden Death (Sudden Cardiac Death)

- Defined as an unexpected death (from cardiac cause) generally occurring within 1 hour of the onset of signs



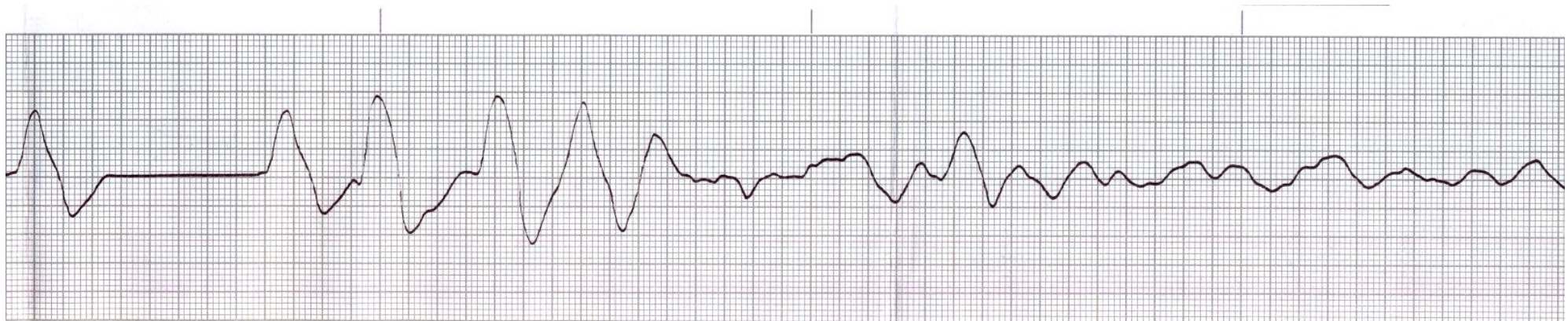
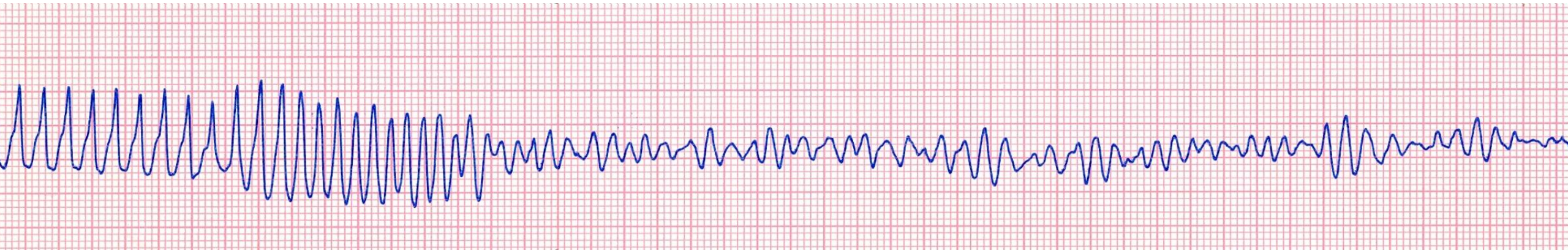
Sudden Death

- Cardiac causes
 - Arrhythmias, cardiomyopathy, myocardial infarction, pericardial hemorrhage
- Thromboembolism
- Pulmonary hemorrhage
- CNS event (stroke or hemorrhage)
- Aortic rupture or anomalous coronary artery
- “Found dead at home” – GDV, splenic mass, usually not a toxin



Sudden Death

- Ventricular fibrillation
- Bradycardia – AV block



Cardiac Rhythm Diagnosis at Time of Arrest for Hospitalized Cases

- Ventricular fibrillation
- Sinus bradycardia or sinus tachycardia
- Pulseless electrical activity, (AKA electromechanical dissociation)
- Asystole
- Ventricular tachycardia, atrial fibrillation, AV block, etc.



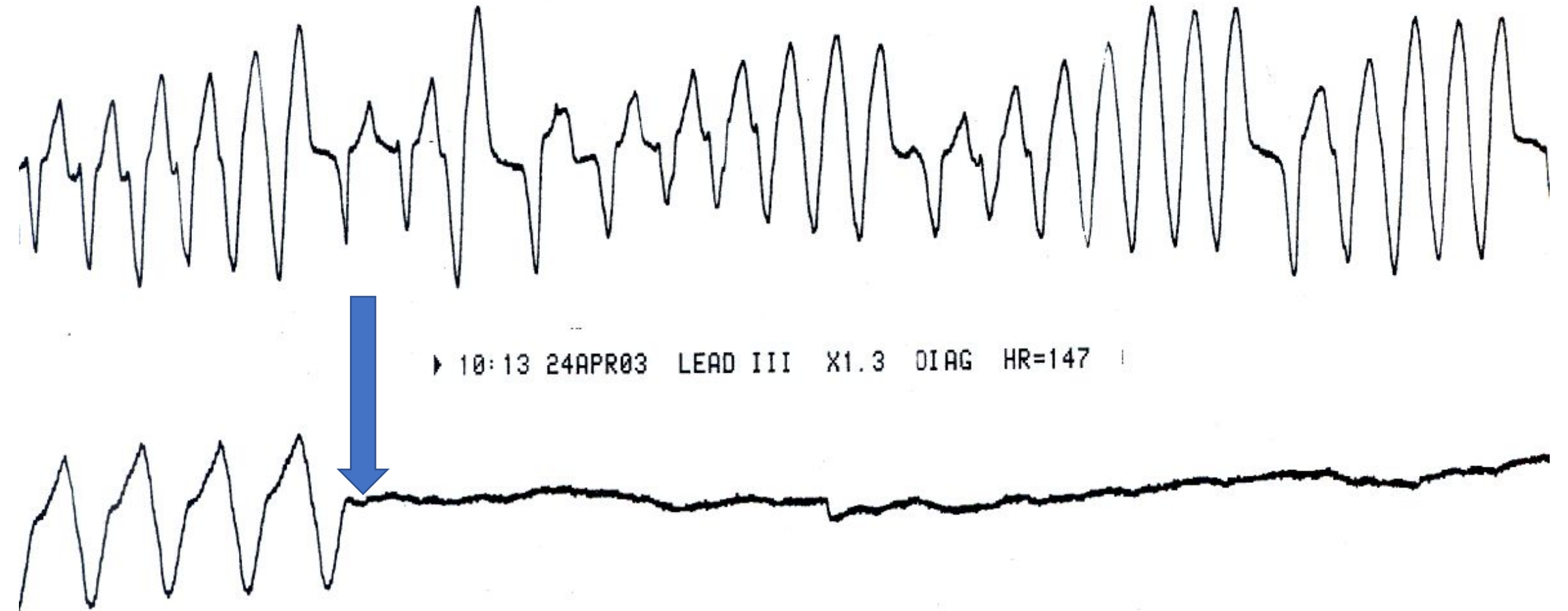
Cardiac Rhythms associated with Syncope or Sudden Death

- Asystole
- Pulseless electrical activity
- Advanced AV block
- Ventricular tachycardia
- Ventricular fibrillation
- Supraventricular tachycardia (syncope only)

How would you treat each of the above rhythms?



Asystole

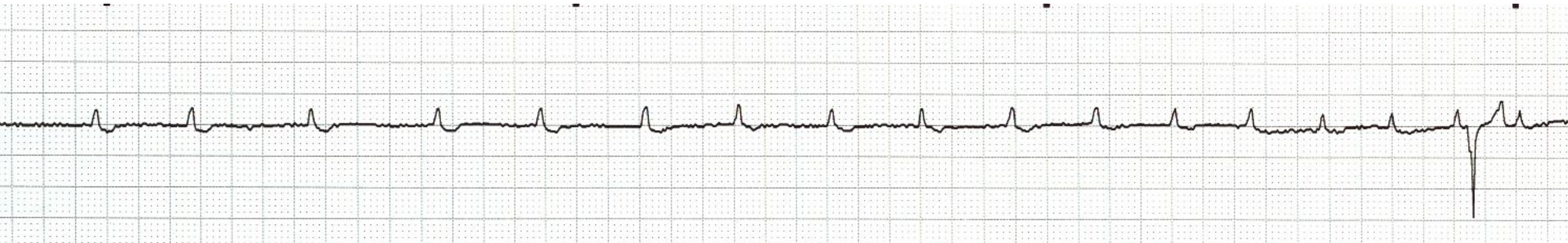
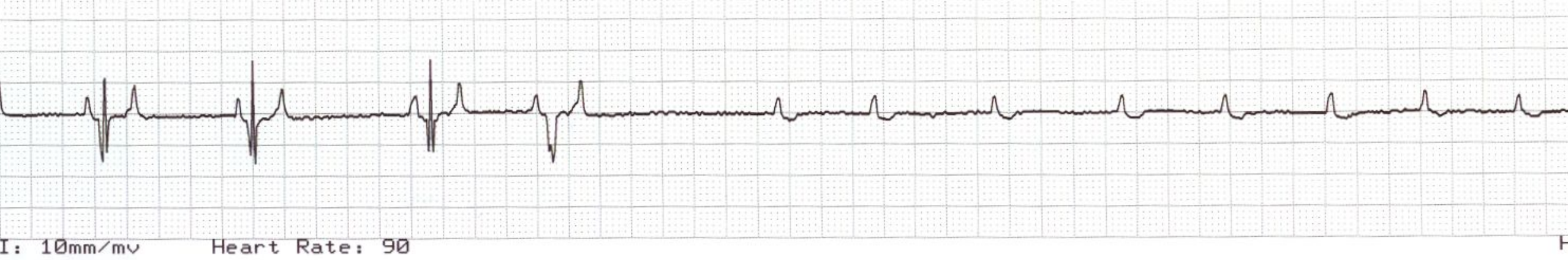


Pulseless Electrical Activity (Electromechanical Dissociation)



25 mm/sec, 1 cm/mv





History

< 12-lead ECG > < 12-lead ECG >



Advanced AV Block Dogs

- Preferred treatment:
 - Cardiac pacing
- Possible drug therapies (usually will not prevent sudden death):
 - Propranolol
 - Terbutaline
 - Theophylline



Atropine Response Test

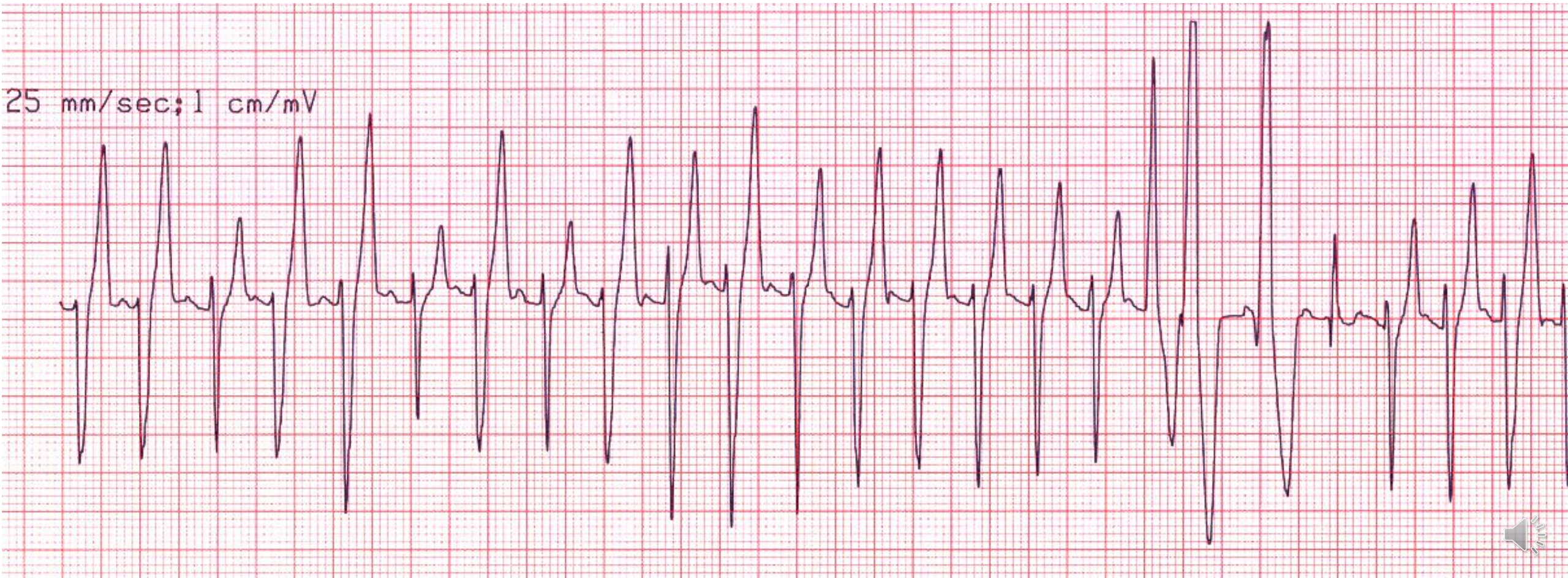
Pre-atropine



Post-atropine



Ventricular Tachycardia

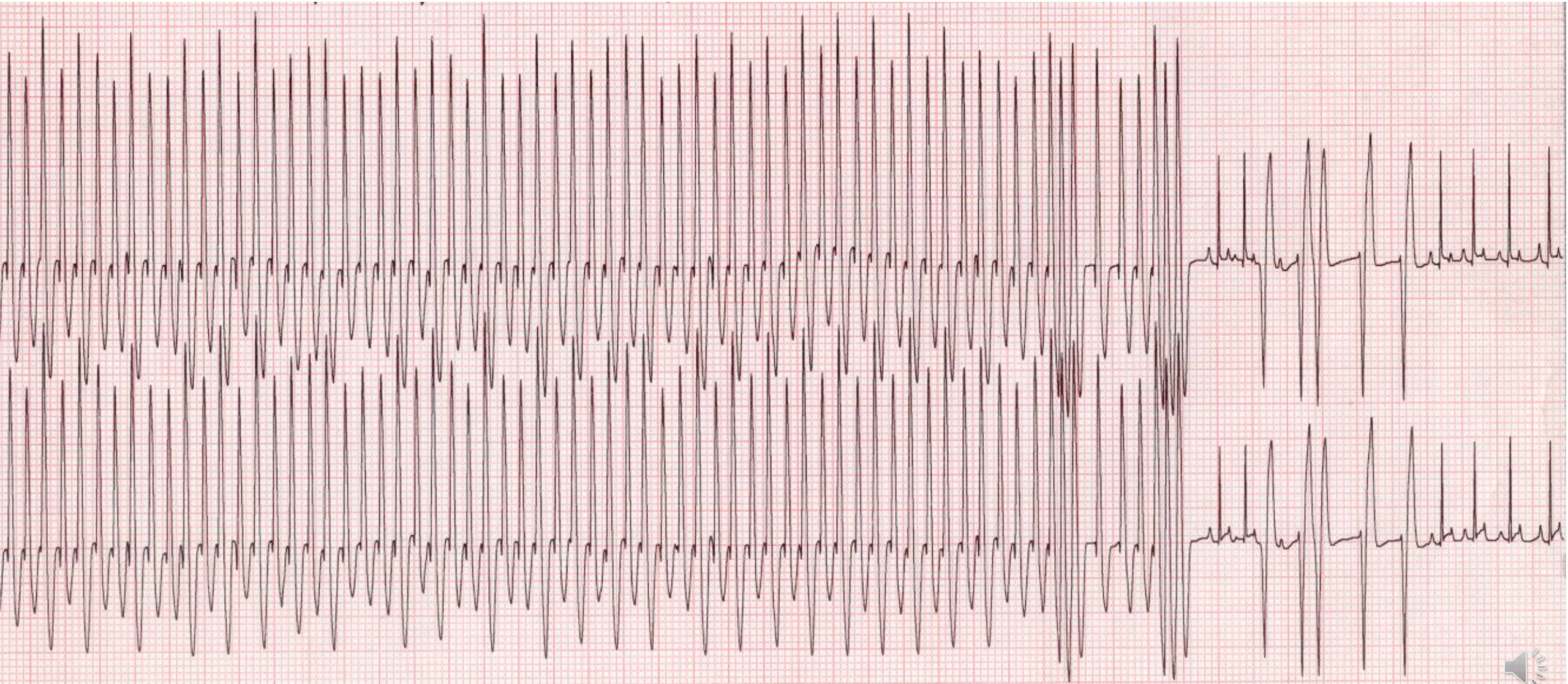


Management of Ventricular Arrhythmias

- Underlying cardiac disease?
 - Thoracic radiographs
 - Echocardiography
 - Troponin I concentration
- Systemic disease?
 - Acid-base status
 - Electrolytes
 - Hypoxemia
 - Anemia
 - Coagulopathy
 - Blood volume
 - Pain
 - Drug toxicity



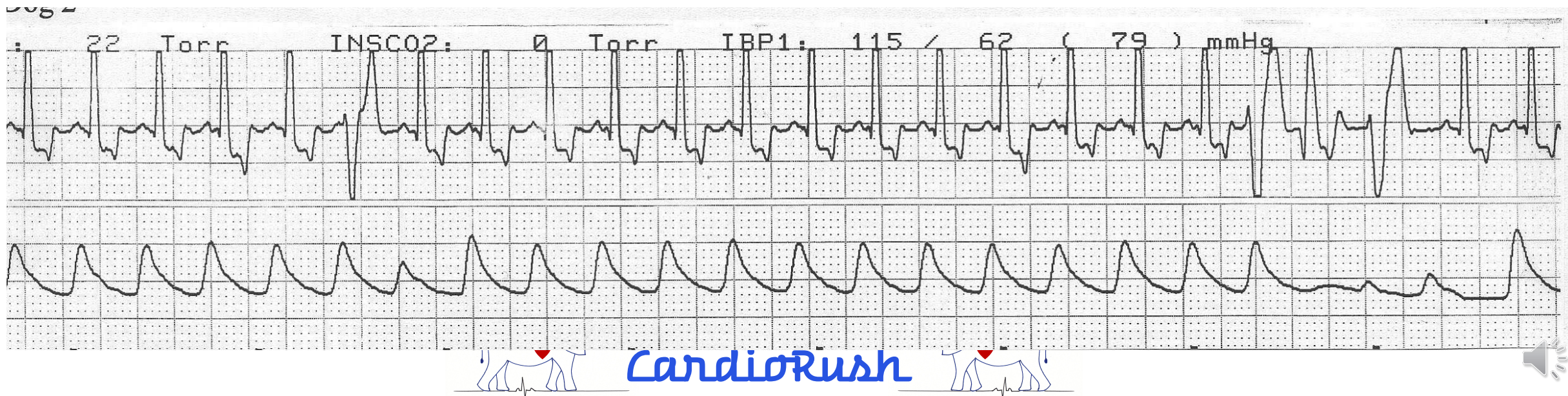
Lidocaine Bolus



Prevention of Sudden Death in Dogs with Serious Ventricular Arrhythmias

Longterm treatment appropriate?

- Sotalol – 1-3.5 mg/kg BID
- Mexiletine – 5-8 mg/kg TID
- Beta-blockers
- Amiodarone



Sudden Death Prevention Trials (People with Coronary Disease or DCM)

- Beta-blockers – Improved survival
- Class I drugs – Worse survival than placebo
- Sotalol – +/- Worse survival than placebo
- Amiodarone – Survival equal to or no better than placebo for chronic Rx
- Implantable cardioverter-defibrillator – Survival improved (people)



Ventricular Fibrillation



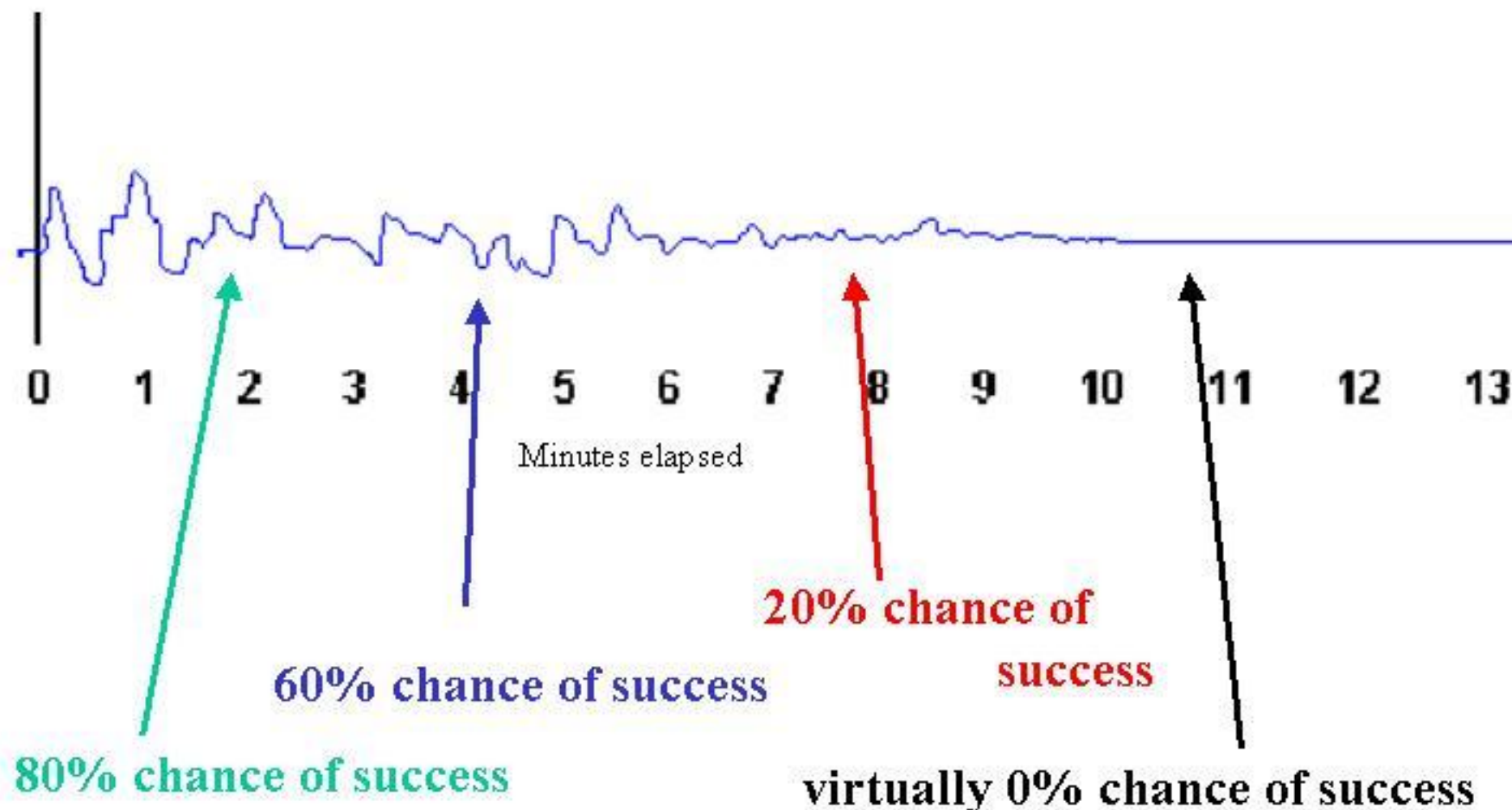
Defibrillation

- Definition: Termination of ventricular (or atrial) fibrillation, usually by electroshock
- Also called DC countershock
- Time to defibrillation is the most important factor in human survival from cardiac arrest



Defibrillation Statistics:

Defibrillation's chances of restoring a pulse decrease rapidly with time



Ventricular Fibrillation

- Electrical DC countershock (defibrillation)
- Current must traverse the heart
- Many cells depolarized at once (>28%)
- “New” rhythm is hopefully a pulse generating rhythm
- Repeated shocks (2-3 in a row)
- Continue CPR, epinephrine, amiodarone (?), magnesium



Indications for Defibrillation

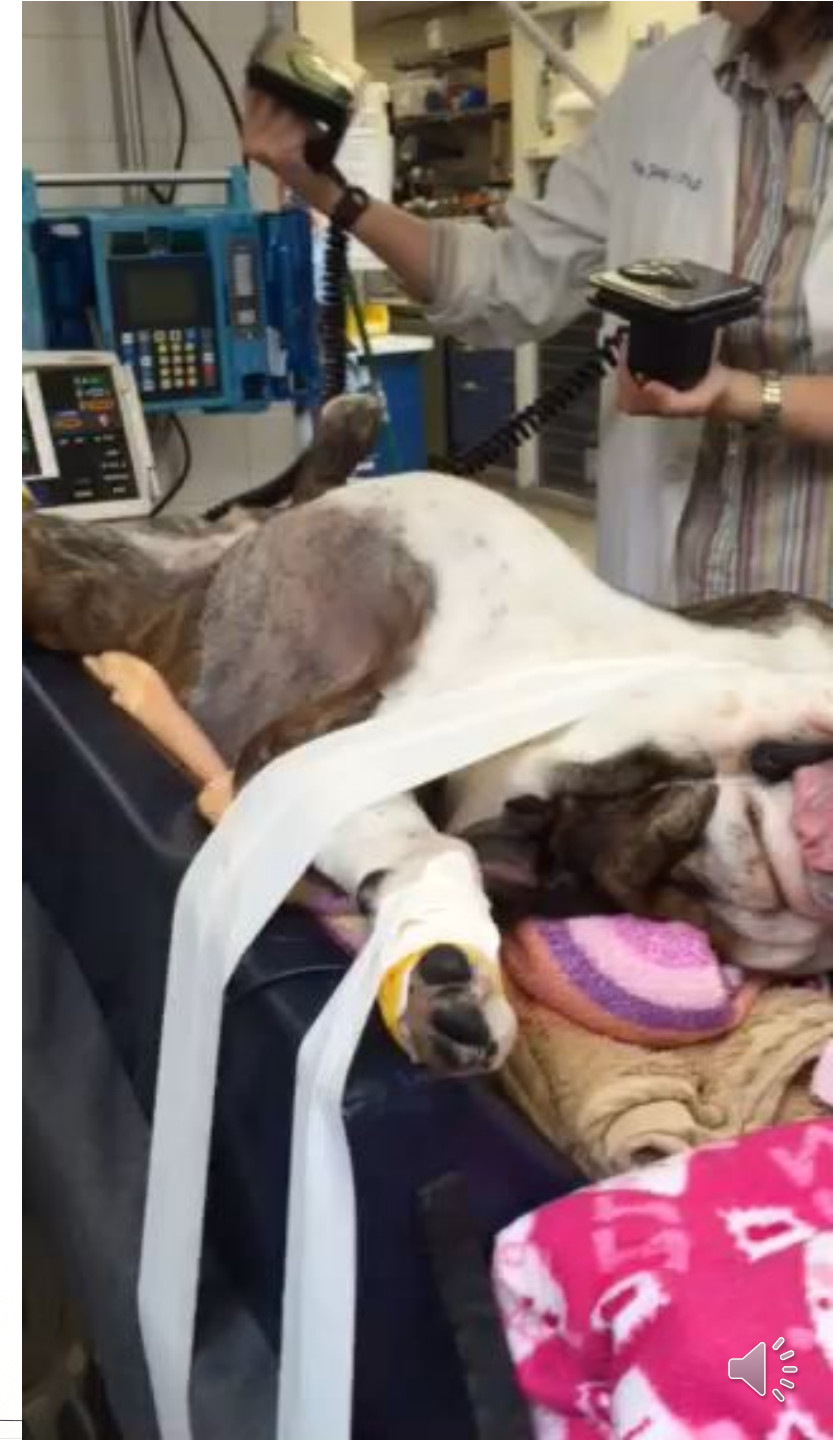
- Ventricular fibrillation
- Ventricular flutter
- Torsades de pointes
- Pulseless ventricular tachycardia

- Most sources do not recommend defibrillation for asystole or for pulseless electrical activity (electromechanical dissociation)



Energy for Defibrillation

- Dose 2-4 Joules/kg
- 2 J/kg (under 7 kg)
- 5 J/kg (8 to 40 kg)
- 5-10 J/kg (above 40 kg)



Intrathoracic Defibrillation

- Lower energy requirements so lower energy selection
- 0.2 J/kg initial energy selection
- Saline used on paddles
- “Squeeze” the heart between the paddles



Ventricular Waveforms During VF

- Coarser waveforms easier to defibrillate
- Higher frequency waveforms are easier to defibrillate than lower frequency
- Epinephrine and vasopressin can coarsen and increase the frequency of waveforms

