Defibrillation Updates

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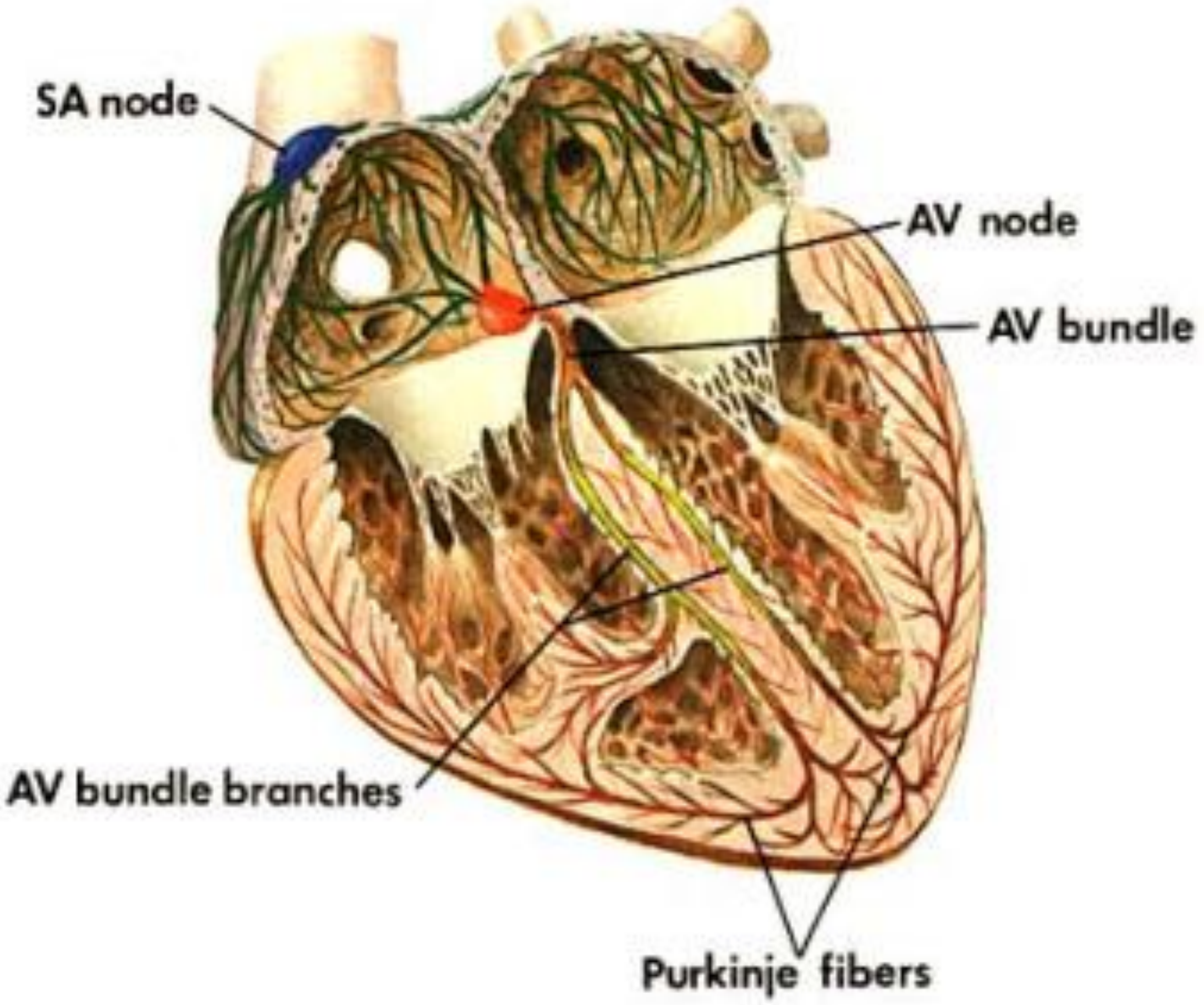
Disclosures

- I have no relevant financial disclosures

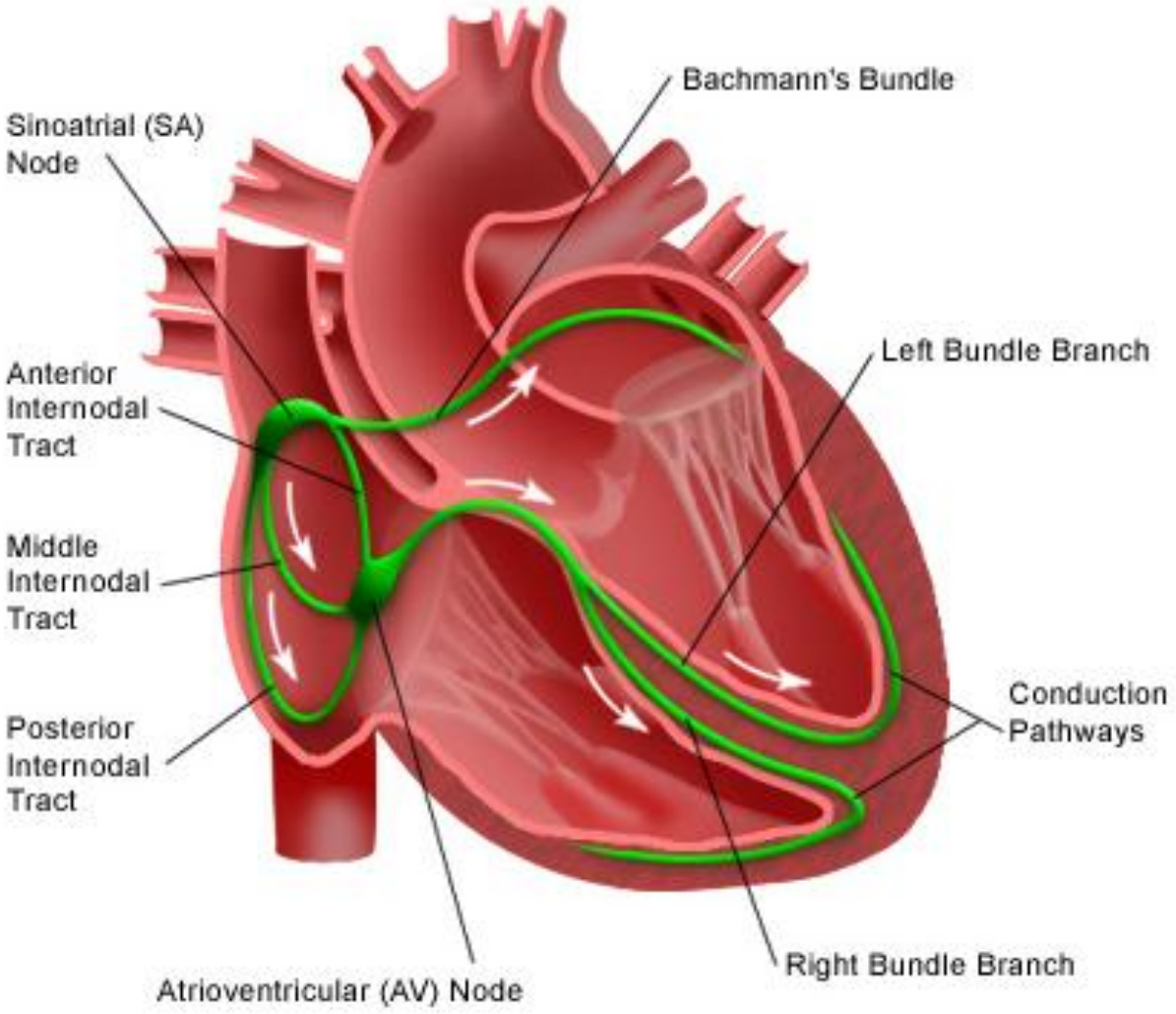
Objective

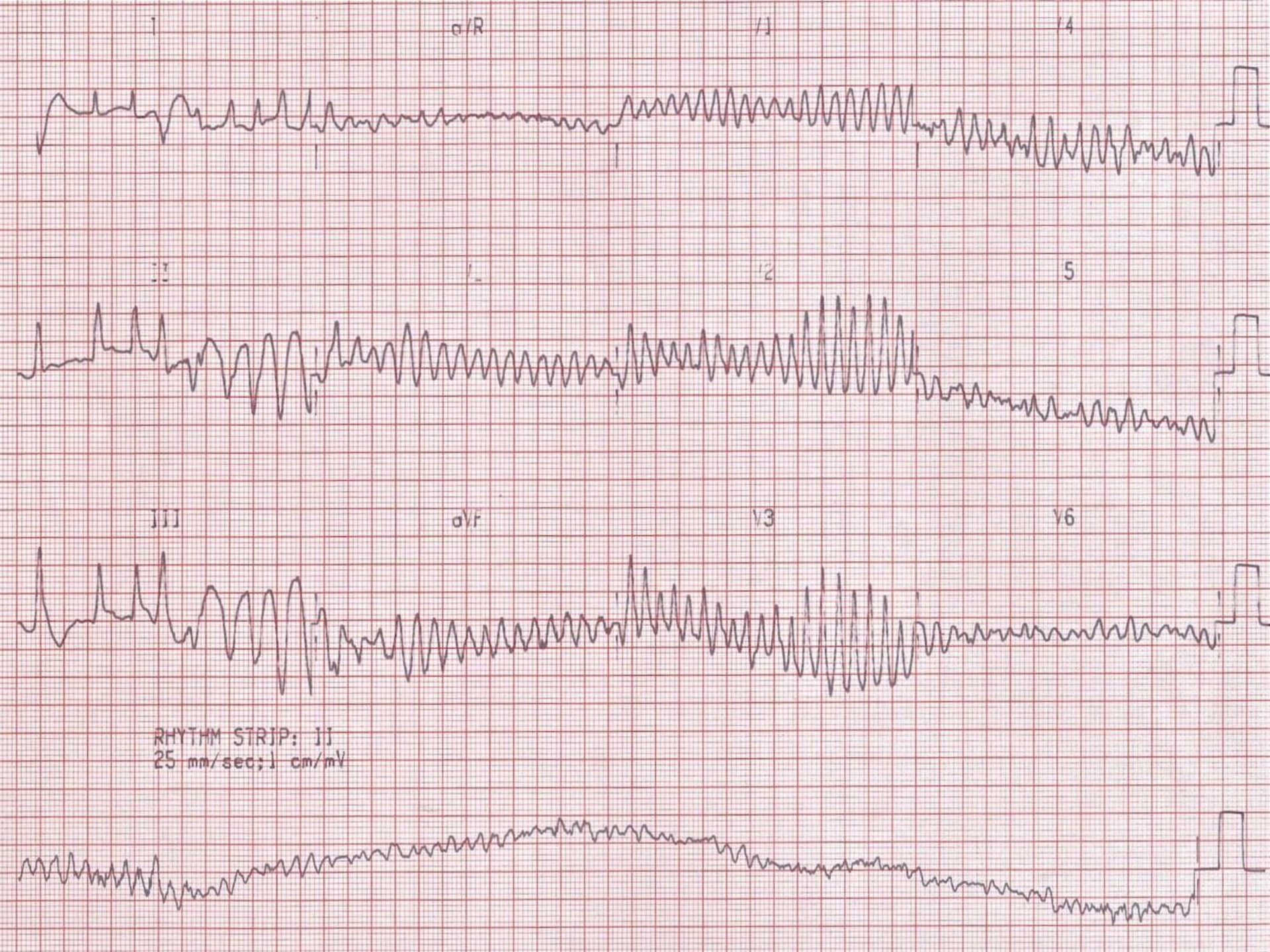
- To discuss the role of defibrillation in the management of cardiac arrest as it pertains to the practice of emergency medicine

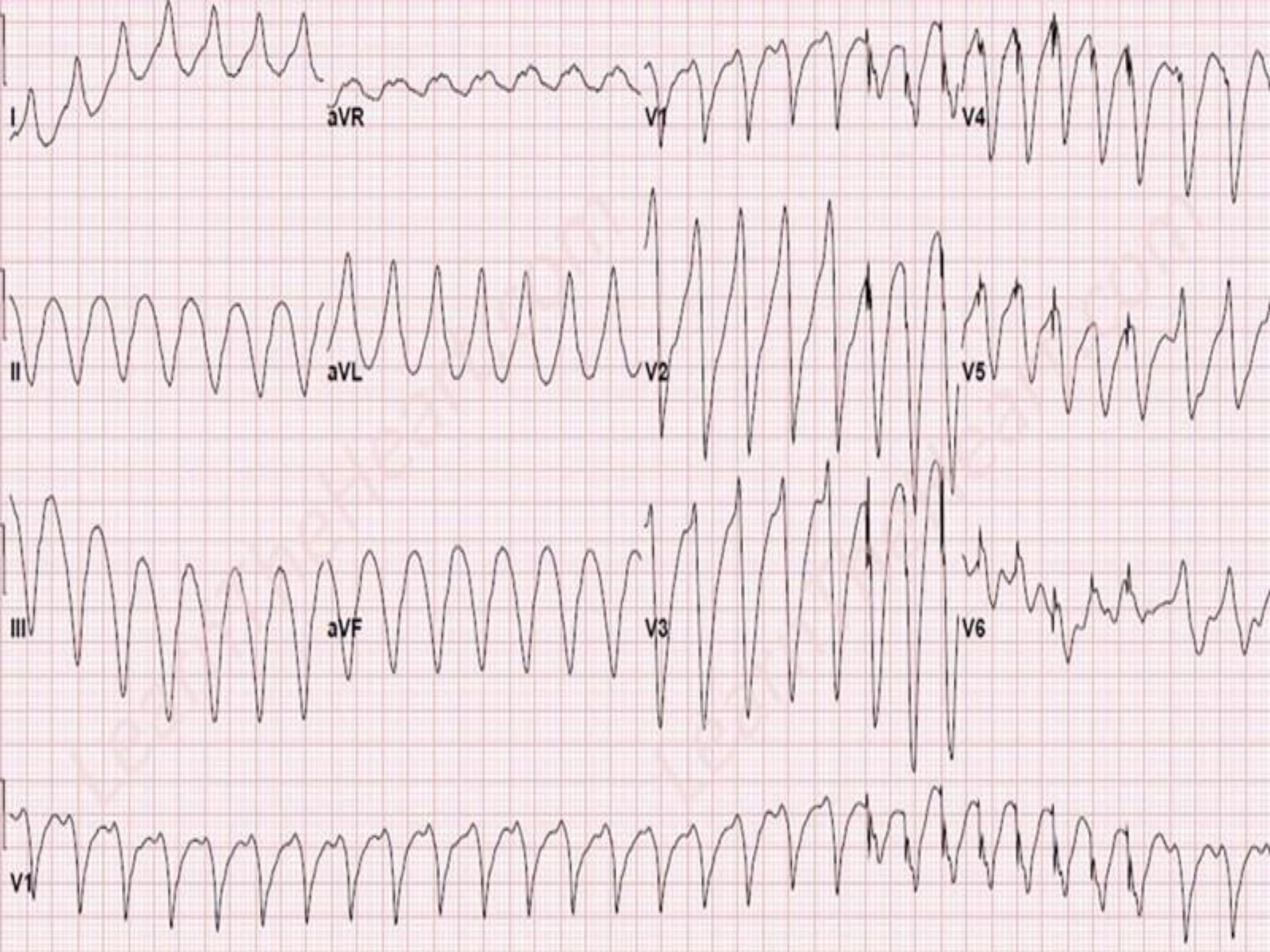
Normal Cardiac Conduction



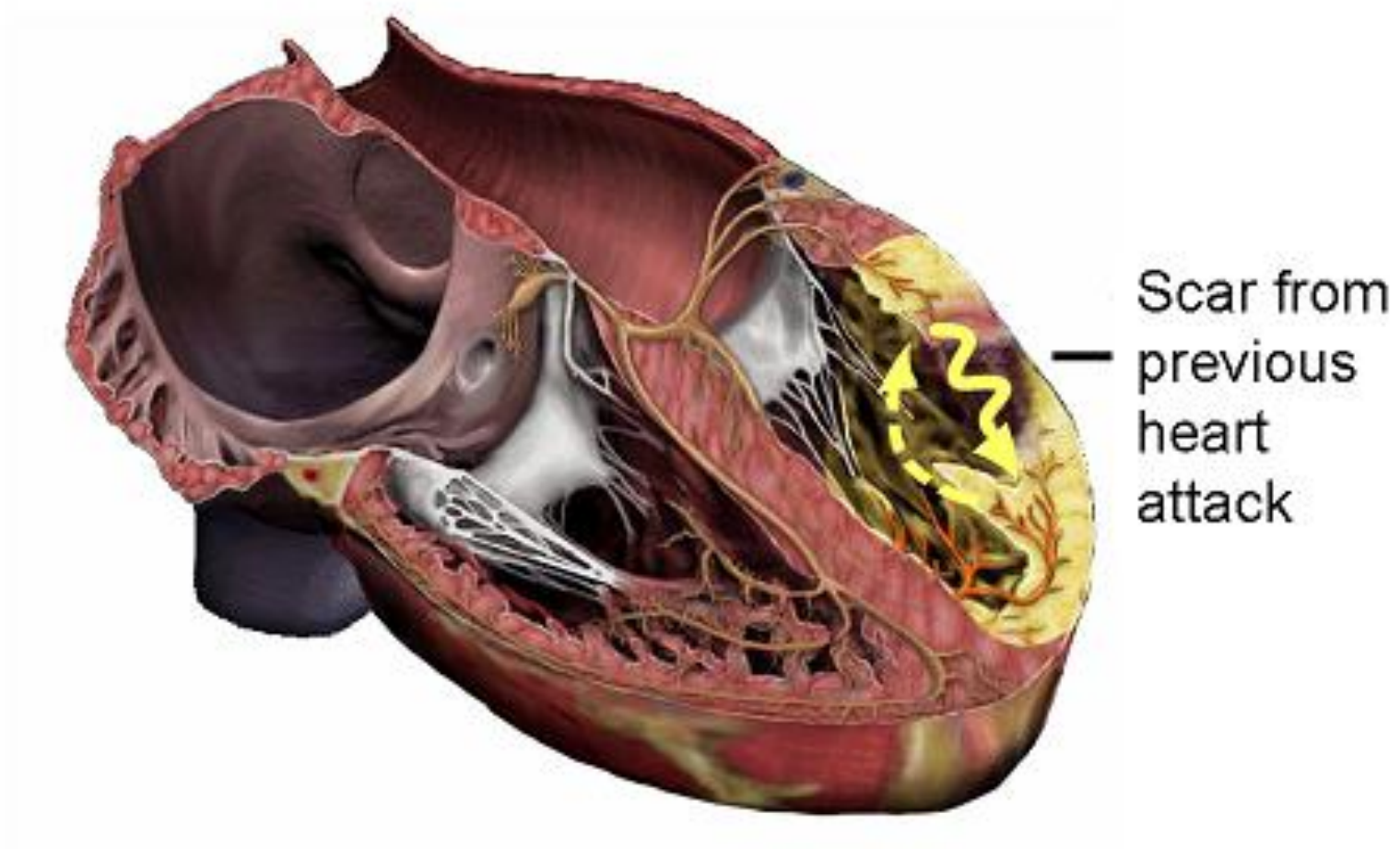
Normal Cardiac Conduction




I
aVR
V1
V4
II
V2
V5
III
aVF
V3
V6
RHYTHM STRIP: II
25 mm/sec; 1 cm/mV


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

Ventricular Origin of Cardiac Conduction



Defibrillation

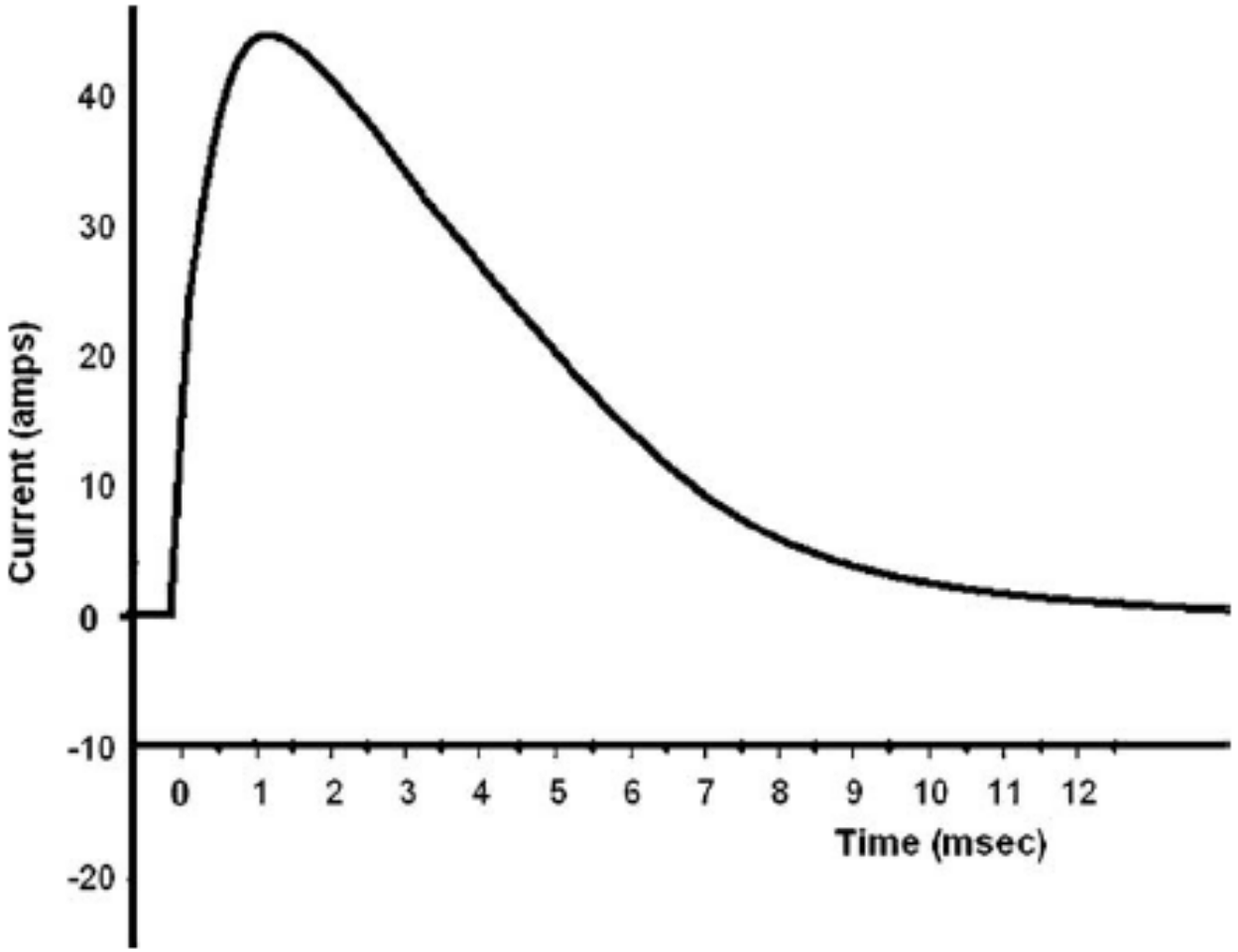
- Primary treatment for pulseless ventricular arrhythmias

- Key factors for success
  - Duration
    - Likelihood of good outcome decreases 5-10% with each additional minute
  - Metabolic condition of the myocardium

Defibrillation

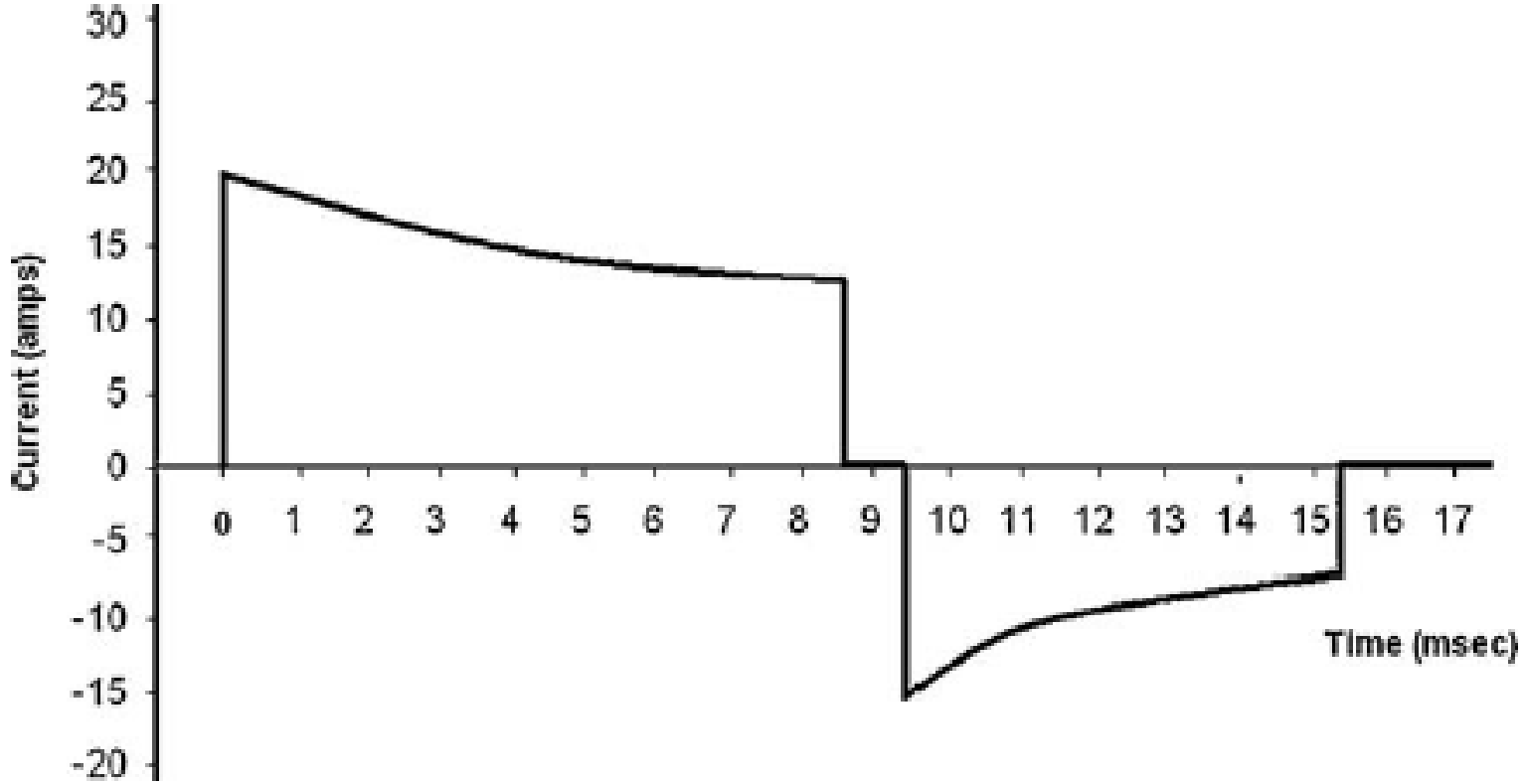
- External
  - Monophasic
  - Biphasic
- Internal
  - ICD
    - With or without pacer

Monophasic



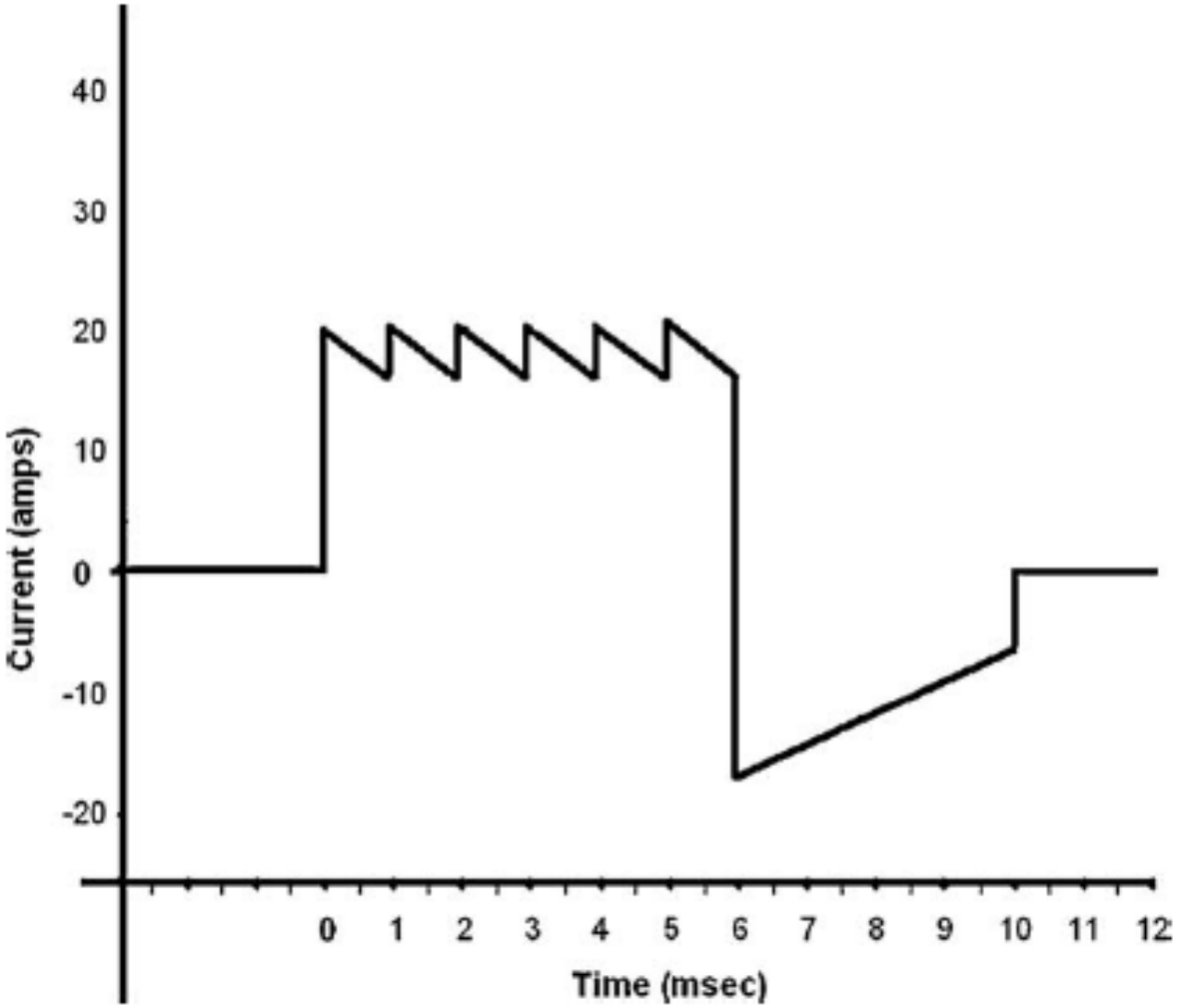
Deakin et al. Resuscitation 2010;81:1293–1304.

Biphasic Truncated Exponential



Deakin et al. Resuscitation 2010;81:1293–1304.

Rectilinear Biphasic



Deakin et al. Resuscitation 2010;81:1293–1304.

Part 6: Defibrillation

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

Ian Jacobs, Co-Chair*; Kjetil Sunde, Co-Chair*; Charles D. Deakin; Mary Fran Hazinski; Richard E. Kerber; Rudolph W. Koster; Laurie J. Morrison; Jerry P. Nolan; Michael R. Sayre; on behalf of Defibrillation Chapter Collaborators

Biphasic waveforms are more effective in terminating VF when compared with monophasic waveforms. There is insufficient evidence to recommend any specific biphasic waveform. In the absence of biphasic defibrillators, monophasic defibrillators are acceptable.

Jacobs et al. Circulation. 2010;122 [suppl 2]:S325–37.

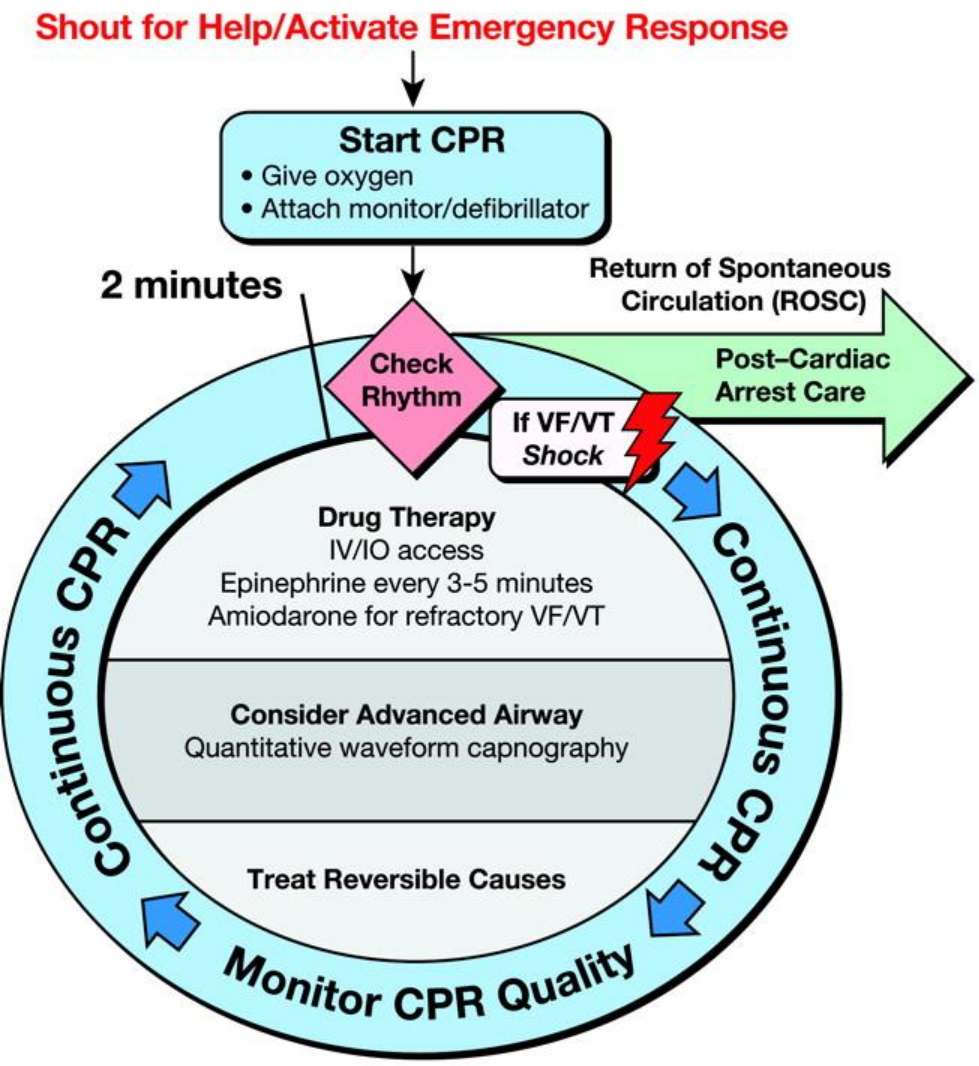
The Future?

- Pulsed wave biphasic
  - Rapidly oscillates between positive and baseline
- Multiphasic

Other Considerations?

- Single vs. stacked
  - Settled in the 2005 updates…
  - Reduced CPR interruption with single shock
- Fixed vs. escalating energy levels
  - Fixed preferred but data are limited
  - Start at highest setting if unsure

Adult Cardiac Arrest



CPR Quality
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Shock Energy
- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy
- **Epinephrine IV/IO Dose:** 1 mg every 3-5 minutes
- **Vasopressin IV/IO Dose:** 40 units can replace first or second dose of epinephrine
- **Amiodarone IV/IO Dose:** First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway
- Supraglottic advanced airway or endotracheal intubation
- Waveform capnography to confirm and monitor ET tube placement
- 8-10 breaths per minute with continuous chest compressions

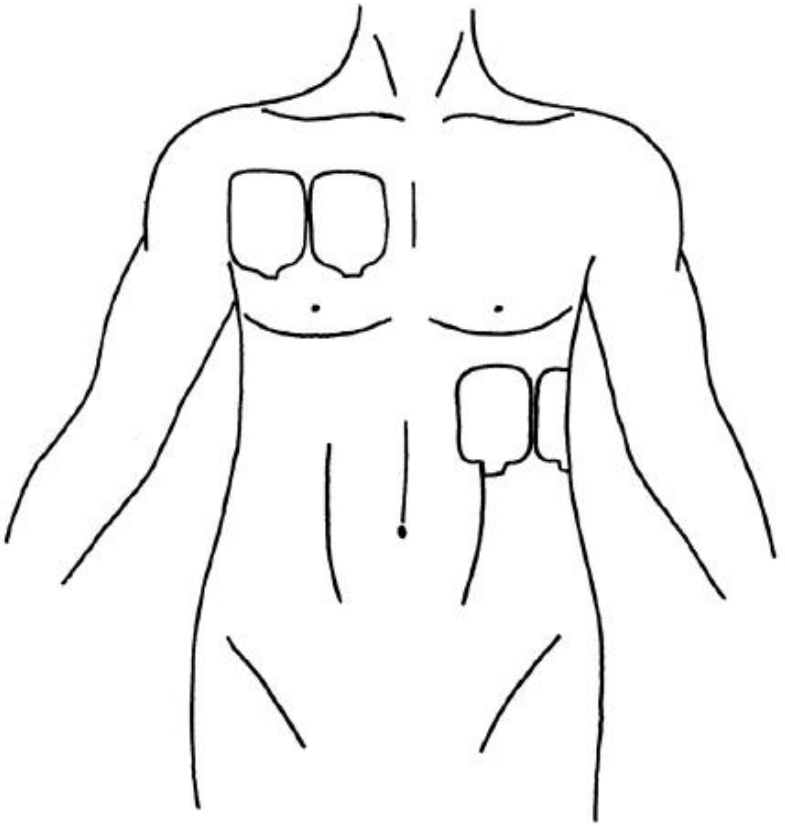
Reversible Causes
- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

Neumar et al. Circulation. 2010;122[suppl 3]:S729–67.

DOUBLE SIMULTANEOUS DEFIBRILLATORS FOR REFRACTORY VENTRICULAR FIBRILLATION

Benjamin W. Leacock, MD

To our knowledge, this is the first case report of an OHCA patient with intractable VF to be successfully defibrillated by the simultaneous use of two biphasic defibrillators. There is reasonable evidence for the use of higher energies for patients in VF requiring more than one defibrillation. The 2010 guidelines recommend an initial energy of 150 to 200 J, but state that it is reasonable to increase the energy for subsequent shocks when available (27). Given that commercial biphasic defibrillators have an upper limit of 200 J, it may be reasonable to attempt cardioversion with the simultaneous use of two defibrillators in select patients.



Leacock B. J Emerg Med 2014;46:472-4.

Other Considerations

- Automated external defibrillators
- Life Vest

Automated External Defibrillators and Survival After In-Hospital Cardiac Arrest

Paul S. Chan, MD, MSc
Harlan M. Krumholz, MD, SM
John A. Spertus, MD, MPH
Philip G. Jones, MS
Peter Cram, MD
Robert A. Berg, MD
Mary Ann Peberdy, MD
Vinay Nadkarni, MD
Mary E. Mancini, RN, PhD
Brahmajee K. Nallamothu, MD, MPH
for the American Heart Association National Registry of Cardiopulmonary Resuscitation (NRCPR) Investigators

Context Automated external defibrillators (AEDs) improve survival from out-of-hospital cardiac arrests, but data on their effectiveness in hospitalized patients are limited.

Objective To evaluate the association between AED use and survival for in-hospital cardiac arrest.

Design, Setting, and Patients Cohort study of 11 695 hospitalized patients with cardiac arrests between January 1, 2000, and August 26, 2008, at 204 US hospitals following the introduction of AEDs on general hospital wards.

Main Outcome Measure Survival to hospital discharge by AED use, using multivariable hierarchical regression analyses to adjust for patient factors and hospital site.

Results Of 11 695 patients, 9616 (82.2%) had nonshockable rhythms (asystole and pulseless electrical activity) and 2079 (17.8%) had shockable rhythms (ventricular fibrillation and pulseless ventricular tachycardia). AEDs were used in 4515 patients (38.6%). Overall, 2117 patients (18.1%) survived to hospital discharge. Within the entire study population, AED use was associated with a lower rate of survival after in-hospital cardiac arrest compared with no AED use (16.3% vs 19.3%; adjusted rate ratio [RR], 0.85; 95% confidence interval [CI], 0.78-0.92; $P<.001$). Among cardiac arrests due to nonshockable rhythms, AED use was associated with lower survival (10.4% vs 15.4%; adjusted RR, 0.74; 95% CI, 0.65-0.83; $P<.001$). In contrast, for cardiac arrests due to shockable rhythms, AED use was not associated with survival (38.4% vs 39.8%; adjusted RR, 1.00; 95% CI, 0.88-1.13; $P=.99$). These patterns were consistently observed in both monitored and nonmonitored hospital units where AEDs were used, after matching patients to the individual units in each hospital where the cardiac arrest occurred, and with a propensity score analysis.

Conclusion Among hospitalized patients with cardiac arrest, use of AEDs was not associated with improved survival.

JAMA. 2010;304(19):2129-2136 www.jama.com

USE OF AUTOMATED EXTERnal defibrillators (AEDs) has been proposed as a strategy to reduce times to defibrillation and improve survival from cardiac arrests that occur in the hospital setting.[1,2] However, current evidence to support the use of AEDs in hospitals has been mixed and limited to single-center studies.[3,4] Although some stud-

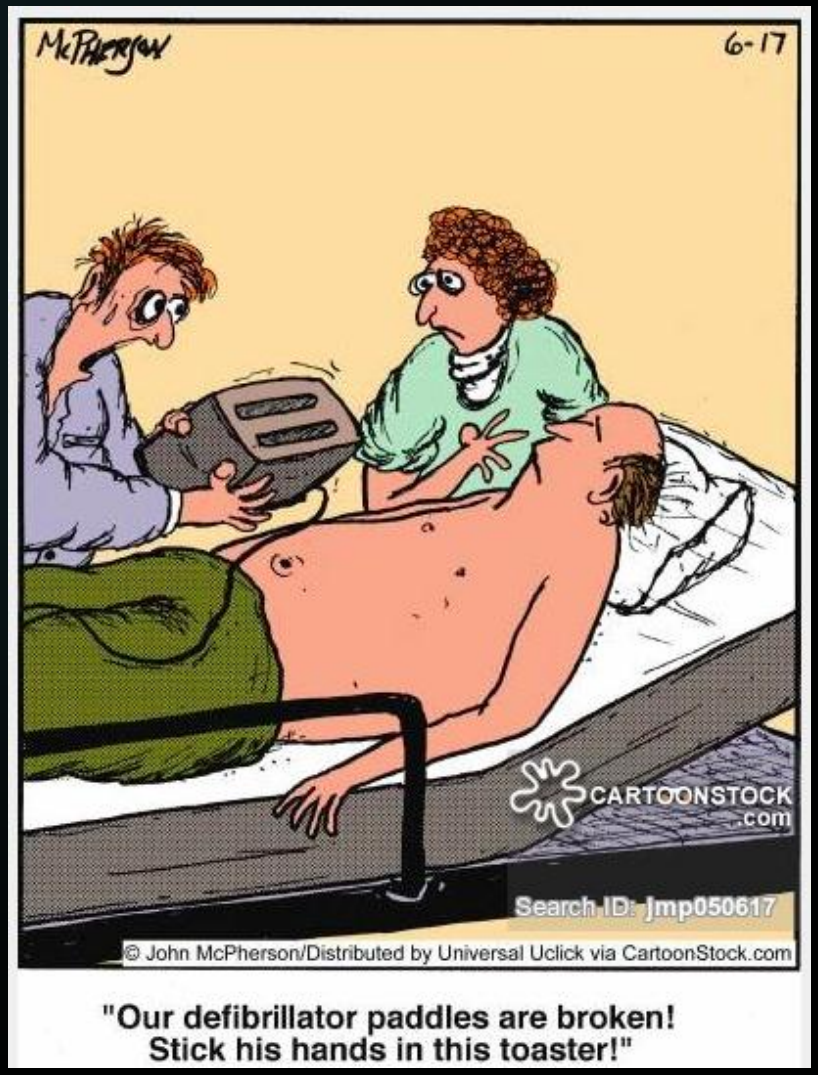
Other Considerations

- Automated external defibrillators

- Life Vest

Other Considerations?

- Pads vs. paddles
  - No difference
- Type of gel
  - No difference
- Lead placement
  - Anterior-lateral
  - ≥ 8 cm from ICD or pacer generator



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Important deadlines

10 May 2015 - Peter Baskett Bursary

31 May 2015 - Abstract Submission

15 August 2015 - Early registration

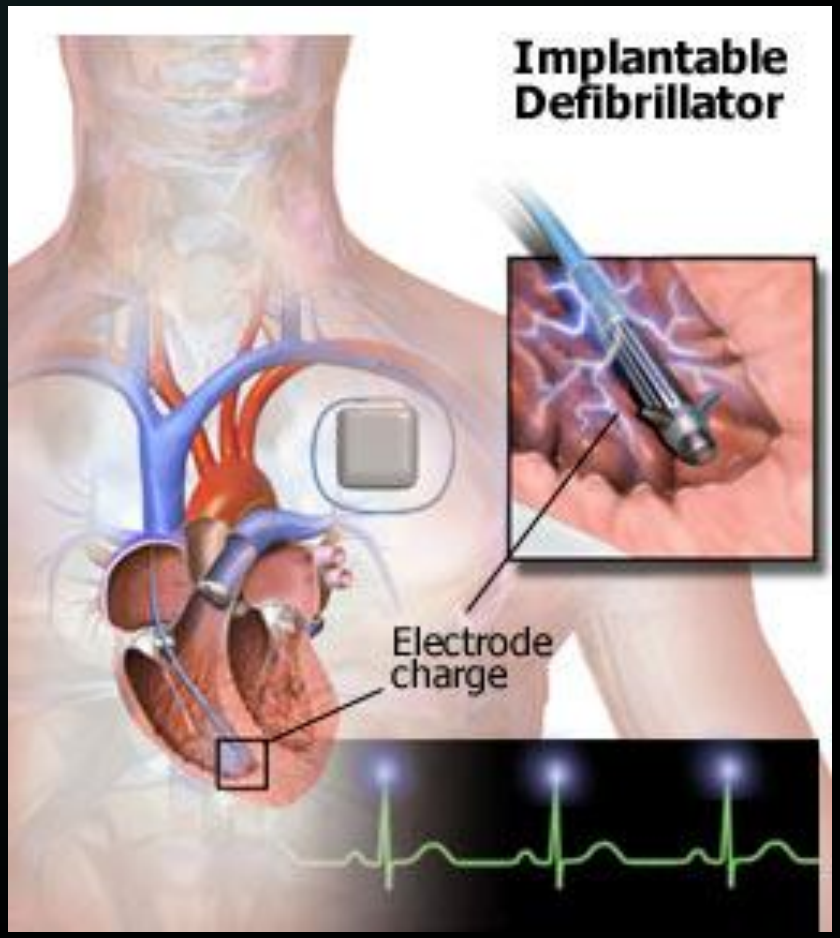
15 October 2015 - Late registration

15 October 2015 - Release of the new Resuscitation Guidelines

Defibrillation

- External
  - Monophasic
  - Biphasic

- Internal
  - ICD
    - With or without pacer



Internal

- Single shock
  - Level of concern depends on associated features
    - Chest pain, SOB, palpitations, or syncope
  - Interrogate device
  - Consult cardiology

Inappropriate Implantable Cardioverter-Defibrillator Shocks

Incidence, Predictors, and Impact on Mortality

Johannes B. van Rees, MD,* C. Jan Willem Borleffs, MD,* Mihály K. de Bie, MD,* Theo Stijnen, PhD,† Lieselot van Erven, MD, PhD,* Jeroen J. Bax, MD, PhD,* Martin J. Schalij, MD, PhD*

Leiden, the Netherlands

Objectives The purpose of this study was to assess the incidence, predictors, and outcome of inappropriate shocks in implantable cardioverter-defibrillator (ICD) patients.

Background Despite the benefits of ICD therapy, inappropriate defibrillator shocks continue to be a significant drawback. The prognostic importance of inappropriate shocks outside the setting of a clinical trial remains unclear.

Methods From 1996 to 2006, all recipients of defibrillator devices equipped with intracardiac electrogram storage were included in the current analysis and clinically assessed at implantation. During follow-up, the occurrence of inappropriate ICD shocks and all-cause mortality was noted.

Results A total of 1,544 ICD patients (79% male, age 61 ± 13 years) were included in the analysis. During the follow-up period of 41 ± 18 months, 13% experienced ≥1 inappropriate shocks. The cumulative incidence steadily increased to 18% at 5-year follow-up. Independent predictors of the occurrence of inappropriate shocks included a history of atrial fibrillation (hazard ratio [HR]: 2.0, $p < 0.01$) and age younger than 70 years (HR: 1.8, $p = 0.01$). Experiencing a single inappropriate shock resulted in an increased risk of all-cause mortality (HR: 1.6, $p = 0.01$). Mortality risk increased with every subsequent shock, up to an HR of 3.7 after 5 inappropriate shocks.

Conclusions In a large cohort of ICD patients, inappropriate shocks were common. The most important finding is the association between inappropriate shocks and mortality, independent of interim appropriate shocks. (J Am Coll Cardiol 2011;57:556–62)

Internal

- Multiple shocks
  - More concerning
  - Cardiac monitor and keep external defibrillator close by…
  - Work up
    - CXR
    - ECG
    - Electrolytes and cardiac biomarkers
    - Antiarrhythmic levels if available
  - Interrogate device

Internal

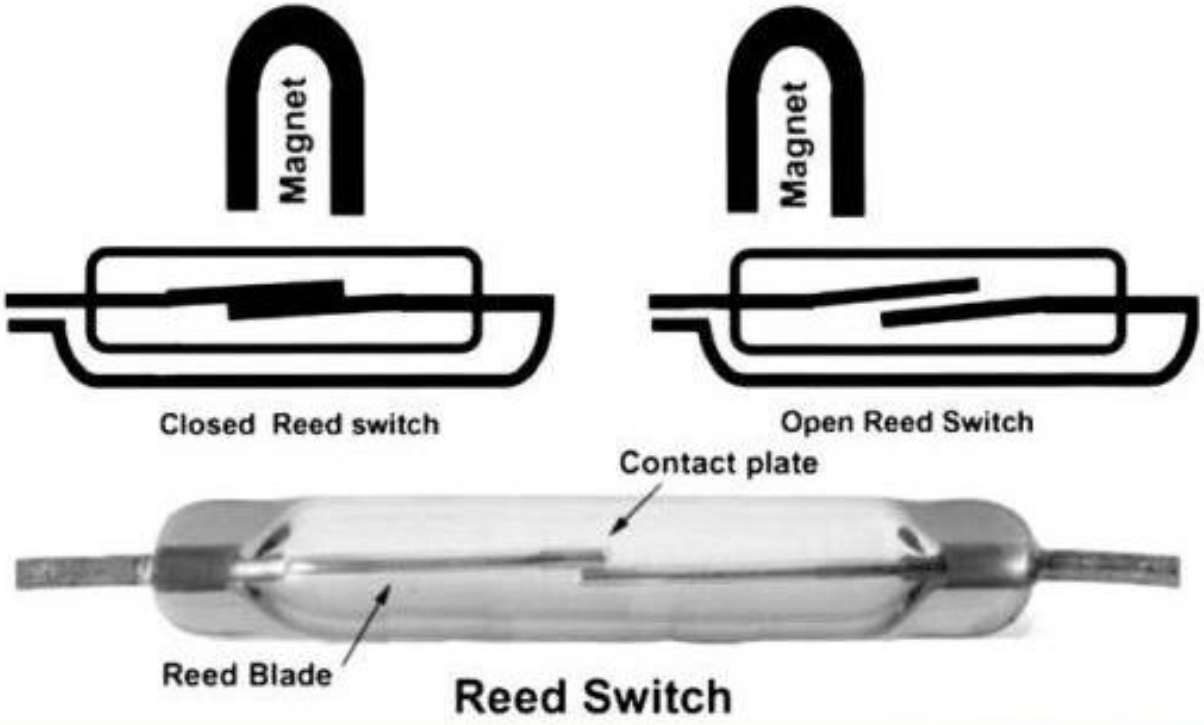
- Expect
  - ST elevation or depression for ~ 15 minutes
  - Elevated cardiac biomarkers in up to 1/3
  - Post-shock bradycardia
    - May see pacing activity

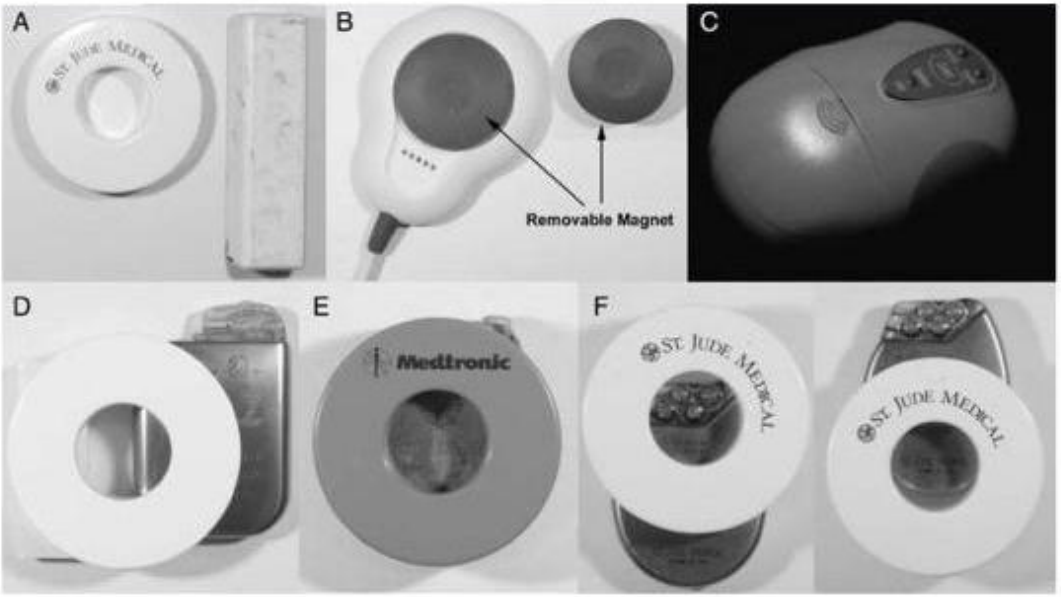
Internal

- Electrical storm
  - High number of successive shocks in 24 hour period
  - Appropriate or inappropriate?
  - V fib vs. A fib with RVR

Internal

- Electrical storm
  - Consider
    - External cardioversion if unstable rhythm
    - IV amiodarone
    - Donut magnet
      - Use only if life threatening causes ruled out


Magnet
Magnet
Closed Reed switch
Open Reed Switch
Contact plate
Reed Blade
Reed Switch


A
B
C
Removable Magnet
D
E
F
Medtronic


before donut
donut
after donut


MATT GROENING

Internal

- Device malfunction
  - Lead fractures
  - Electromagnetic interference
    - Razors, large speakers, slot machines, etc…
- Must interrogate after magnet use

Interrogation in the ED?

- Read only (no programming capability)
  - Step 1: interrogate device
  - Step 2: transmit data to call center
  - Step 3: interpreted by company
  - Step 4: info sent back to the ED

The Benefit of Interrogating Defibrillators by Emergency Department Personnel

Neuenschwander JF, Hiestand BC, *Peacock IV WF, Sondrup LC, Hummel JD, Daoud EG, Abraham WT

*The Ohio State University, Columbus, OH; *Cleveland Clinic Foundation, Cleveland, OH*

Background

Implantable cardiac defibrillators (ICD) are recommended as first line therapy in patients with congestive heart failure (CHF) and left ventricular ejection fraction of <30%.

These devices provide considerable diagnostic information, typically accessed by cardiologists for diagnostic purposes and to direct management.

Objective

The purpose of this pilot study is to assess the feasibility and impact of early ICD interrogation in the Emergency Department (ED), and to evaluate potential risks of ED interrogation.

Methods

Academic, urban tertiary referral center with 60,000 annual visits

All ED patients with a Medtronic ICD, regardless of presenting complaint, were eligible if -

- Age > 18 years
- Able to provide informed consent
- ED physician who had completed training in device interrogation was present.

ICD Data collected included :

- underlying rhythm
- patient activity
- heart rate variability
- mode switches
- fluid impedance trends
- shock delivery

The ED physician interpreted the ICD interrogation independently and used the data to direct the patient's care.

Adverse outcomes were defined as those events that could occur as a result of pacer/ICD interrogation

- Death
- Hospitalization due to pacer/ICD failure
- Inappropriate discontinuation of cardiac pacing/ICD function
- Alteration of arrhythmia sensing detected at the time of device follow up

Follow up of event occurrence was measured through phone calls to the patient, review of hospital records, and search of the Social Security Death Index.

Results

26 patients enrolled

- 20 (77%) males
- Mean age 58.5 ± 13.5 years.

Sixteen (62%) patients with cardiovascular complaints

- 6 (23%) were directly related to rhythm / ICD issues

ICD interrogation successfully provided data in all patients,

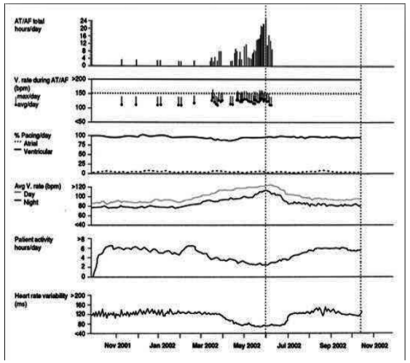
- <10 minutes to complete in 22 (85%) patients.

Suspected diagnosis confirmed in 15 of 16 patients (94%) with cardiac complaints

Suspected diagnosis excluded in 2 patients with cardiac complaints, who were then able to be discharged.

Seventeen patients (65%) were admitted from the ED,12 with cardiac complaints and 5 with non-cardiac disease.

Figure: Standard output from pacemaker interrogation



There were no adverse events noted immediately or during follow up.

Limitations

- Convenience sample
- Small sample size
- Single academic center
- Motivated physicians

Conclusions

In this proof-of-concept study, we have demonstrated the feasibility of ICD interrogation by ED physicians and a potential role of ICD diagnostics to aid in the implementation of care in the ED

Formal time savings analysis, cost benefit studies, and feasibility in community EDs should be investigated

Final Thoughts

- Not a lot of new data on external defibrillation
  - Updated guidelines anticipated for 2015
  - 2010 algorithms still apply

- Management of ICD in the emergency department is an issue of growing importance
  - Life-saving but potentially problematic