Strumentazione Biomedica - Defibrillator

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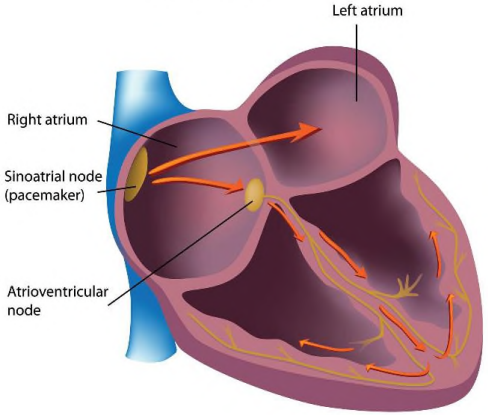
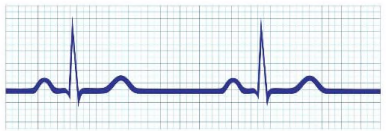
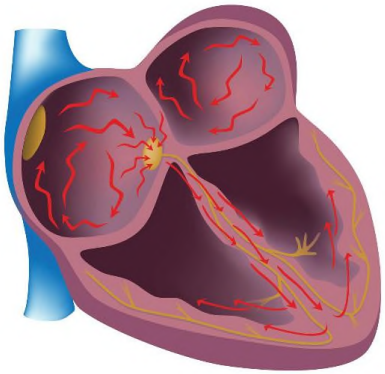
Treasurer, *IFMBE CED* (2018-21)

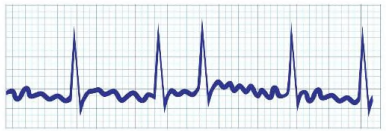
Normal



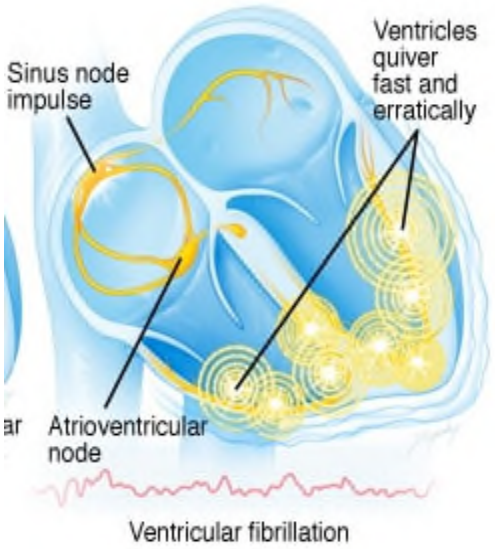


Atrial Fibrillation



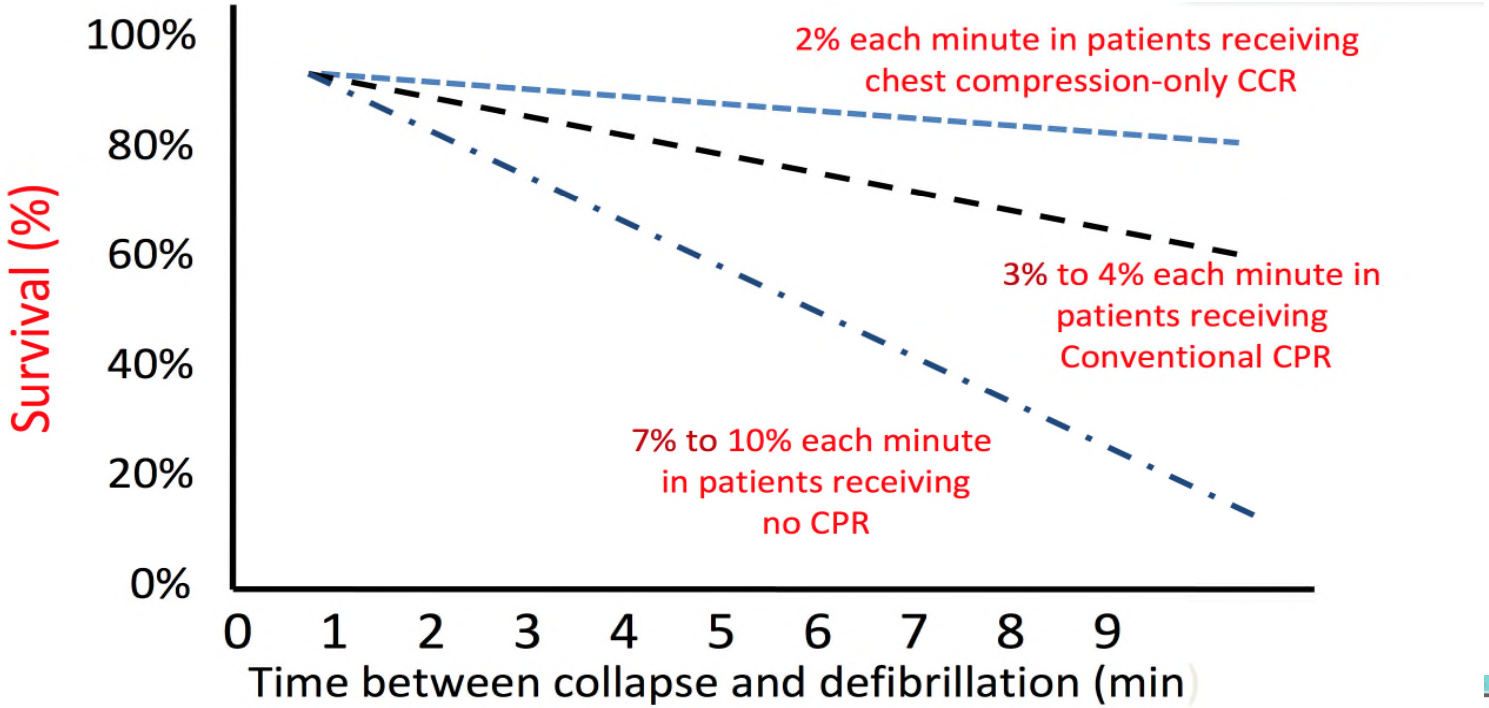


Ventricular Fibrillation

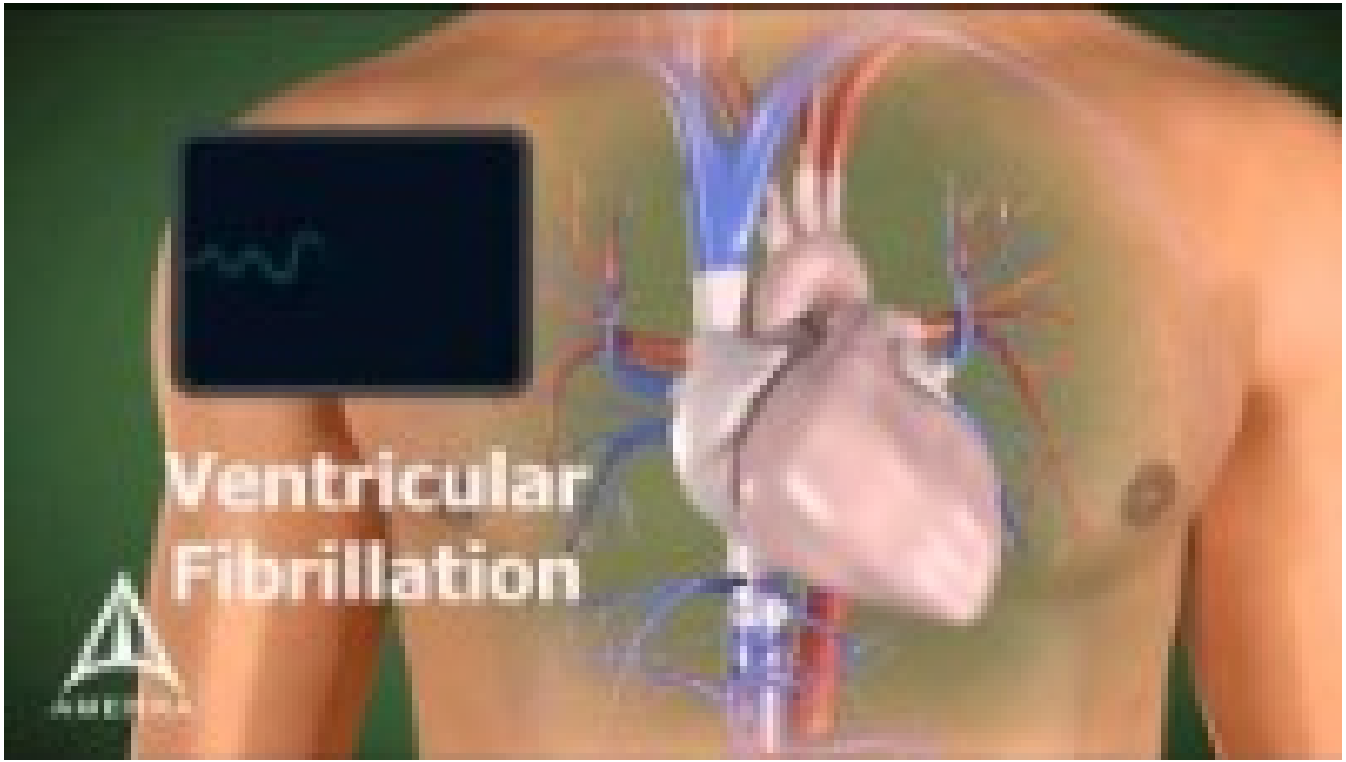


Prompt intervention is key

The intervention should take place within the first 2-4 min. The heart could restart working even after 15 min. but with serious damages to the patient.

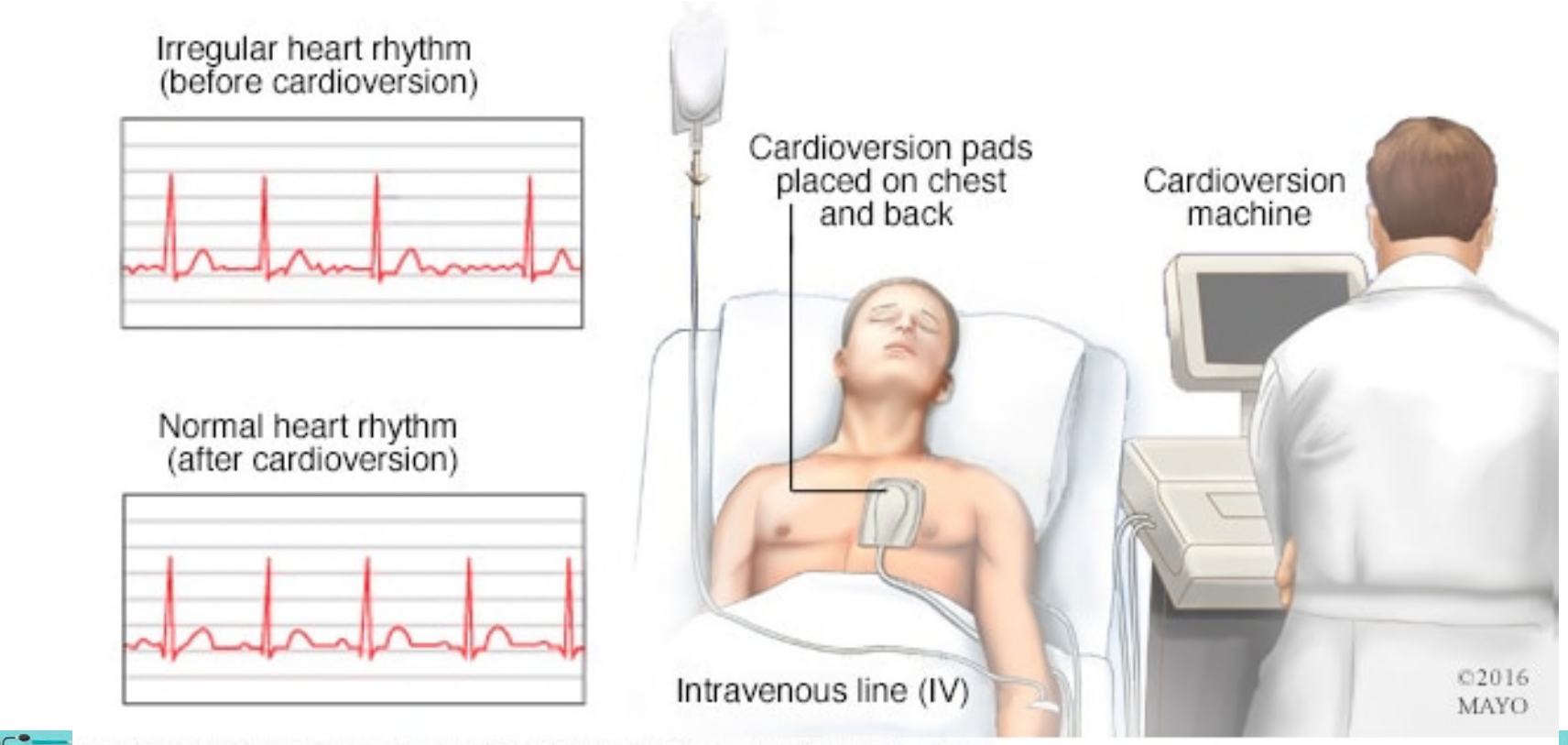


Nagao, K *Current Opinions in Critical Care* 2009



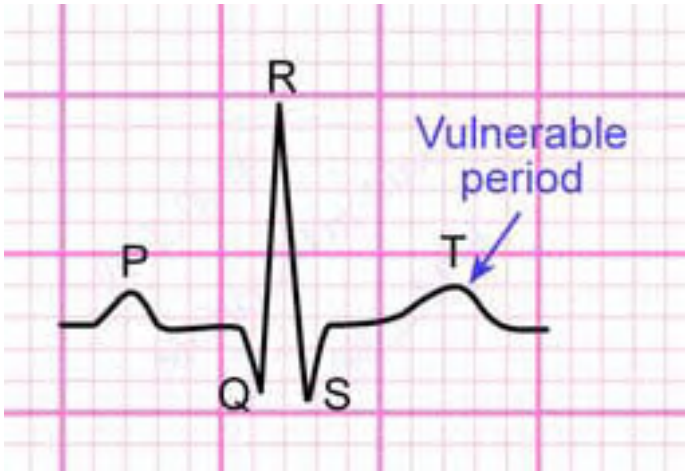
https://www.youtube.com/watch?v=6BobSS-bmFc (Last access 15/02/2021)

A particular application: cardioversion



A particular application: cardioversion

In the case of cardioversion, it is important that the defibrillation does not occur during the vulnerable period, as it could result in a non-pulse fibrillation.
For this reason, an electrical pulse should be delivered as close to the R-wave as possible (synchronised).



Different types of external defibrillators

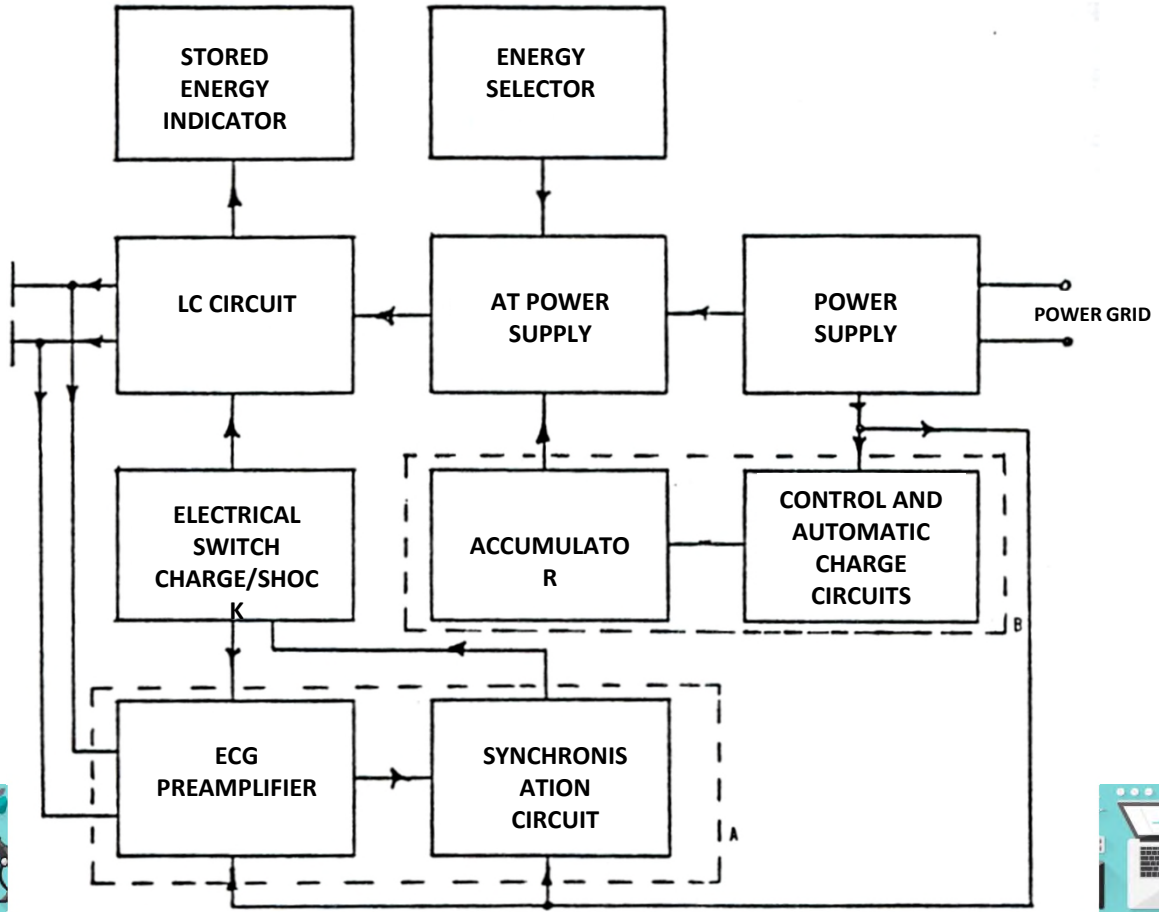
Advanced life support (ALS) – External defibrillators

1) They are an all-in-one solution, and include pacing, vital signs monitoring, and diagnostic ECG monitoring
2) Used by skilled personnel

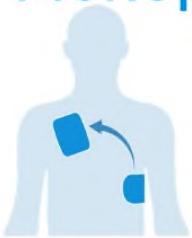
Basic life support (BLS) – Automated external defibrillators (AED)

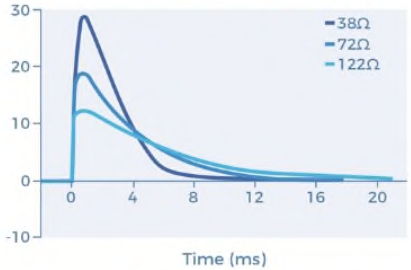
1) They have basic functions
2) They rely on algorithms that evaluate cardiac rhytms
3) Can be used by anyone

Block diagram of a defibrillator



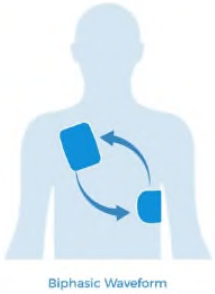
Monophasic vs Biphasic

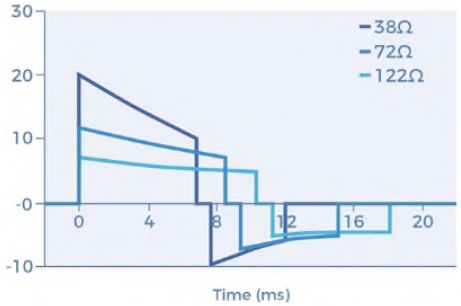




Monophasic

- Damped sine wave with a high peak current
- Current flows in one direction across the heart
- Current decreases as bodily impedance increases – the heart may not receive enough current to defibrillate if impedance is high



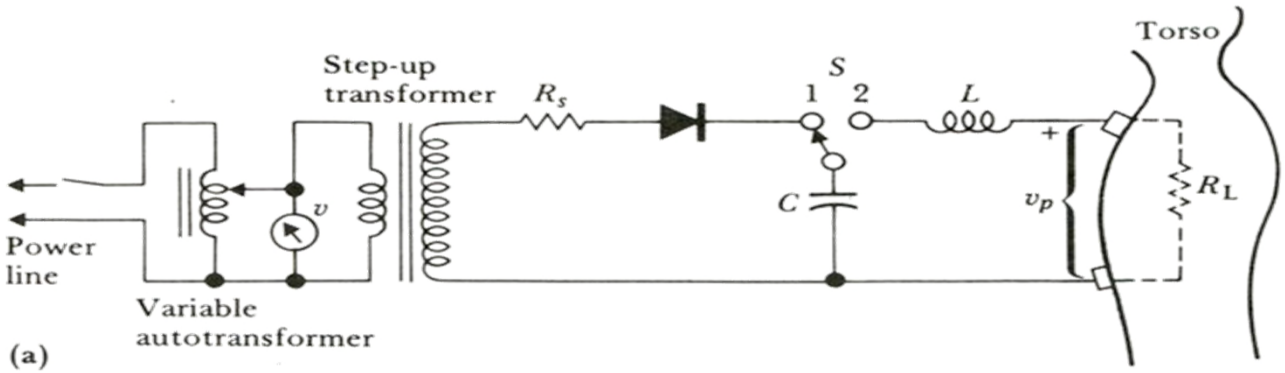


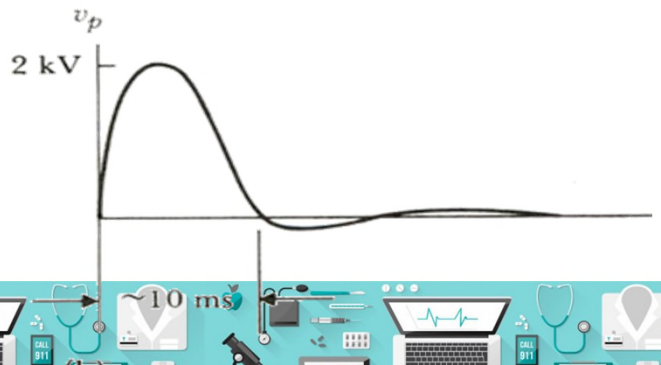
Biphasic

- Current flow is bidirectional
- Current waveforms adjust to maintain the delivered energy regardless of patient impedance - a patient will have equal chance of survival regardless of their impedance
- Lower energy delivered by biphasic devices can be as effective as higher energy monophasic devices
- Biphasic energy at 200 J or less can have equal or higher efficacy than monophasic energies of 200 to 360 J
- Using lower biphasic energy may result in less damage to the myocardium

https://www.youtube.com/watch?v=3X6u01xL5XA

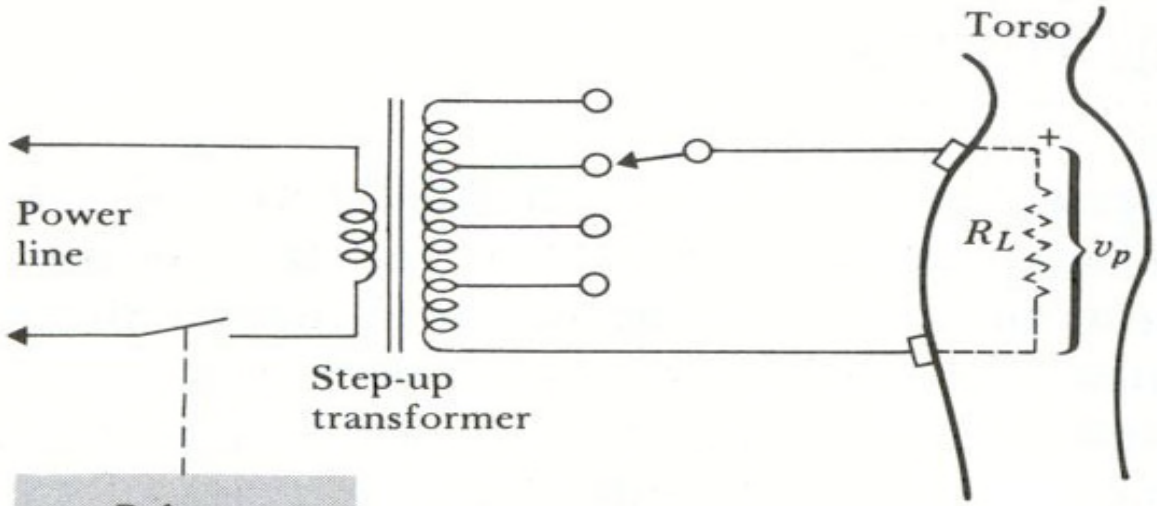
(a) Basic circuit diagram for a capacitive-discharge type of cardiac defibrillator.

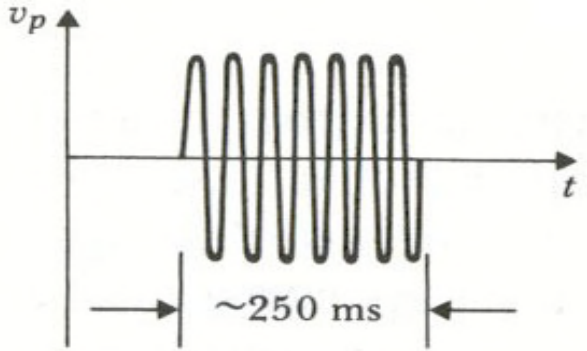




(b) A typical waveform of the discharge pulse. The actual wave-shape is strongly dependent on the values of L,C, and the torso resistance R_L.

Basic arrangement for an AC defibrillator





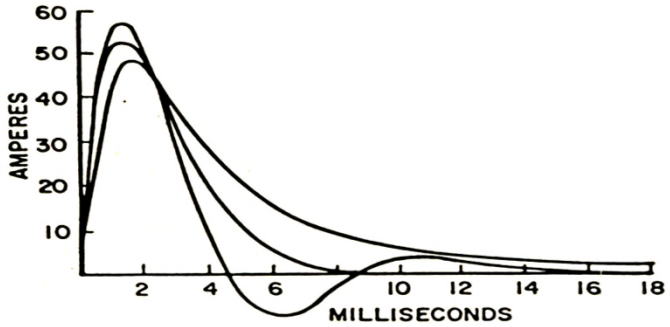


Figure 5. Waveforms from a damped sine wave defibrillator, showing underdamped (highest peak and negative current flow), critically damped (intermediate peak), and overdamped (lowest peak) conditions.

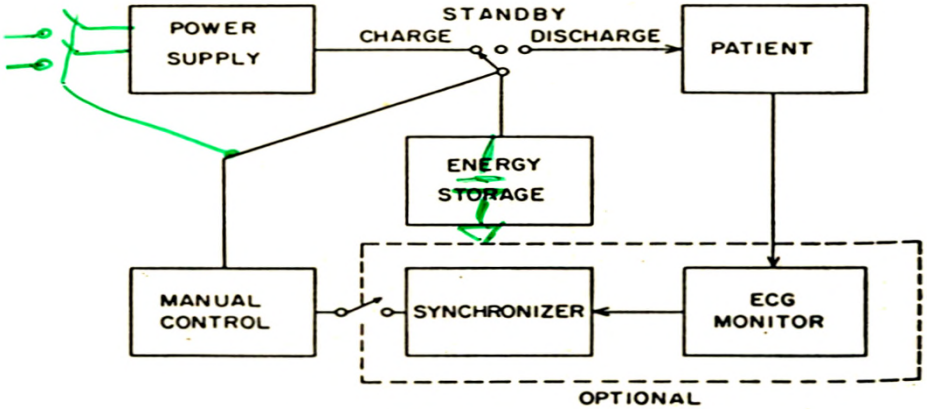


Figure 9. Block diagram of a defibrillator.

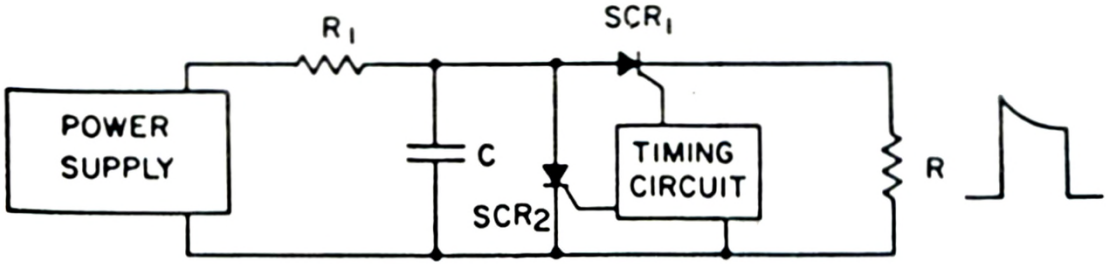
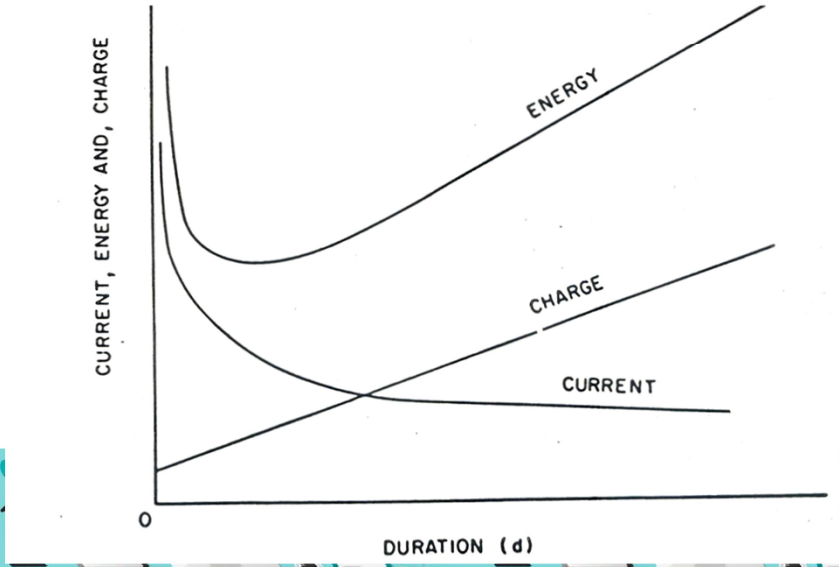
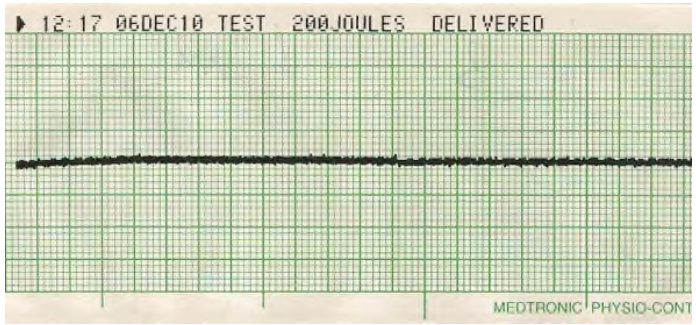


Figure 6. Basic circuit diagram of a truncated exponential decay defibrillator (sometimes called trapezoidal).

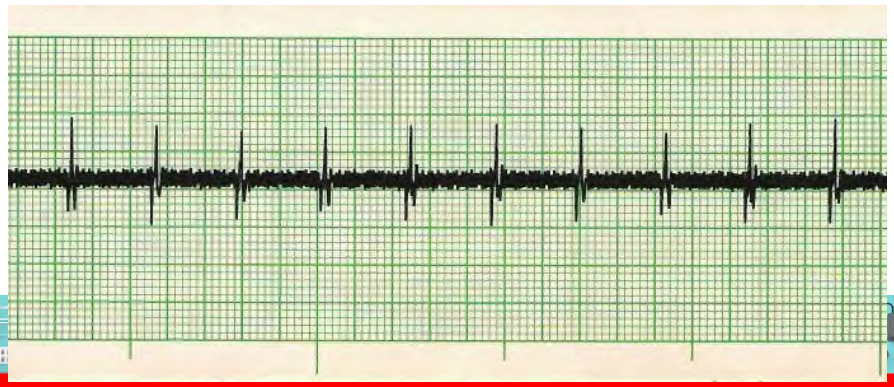


EMI risk: WiFi transmitter

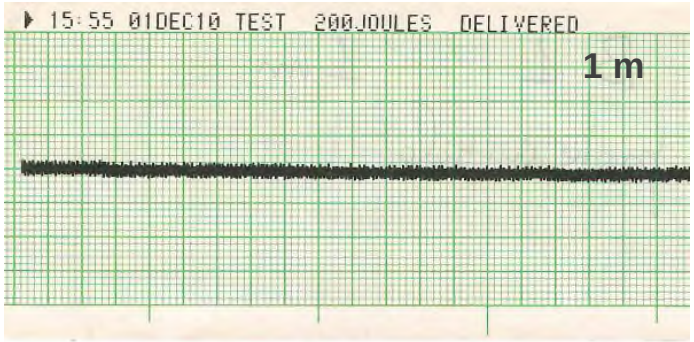


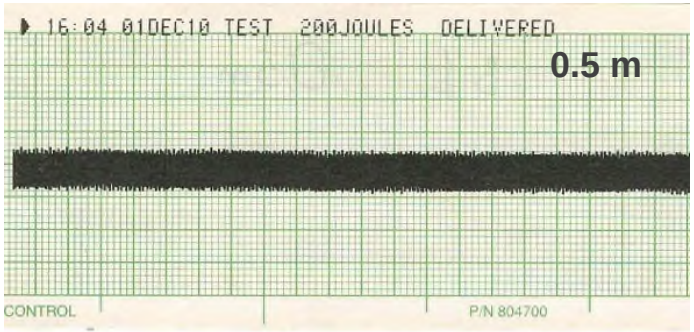
NO interference

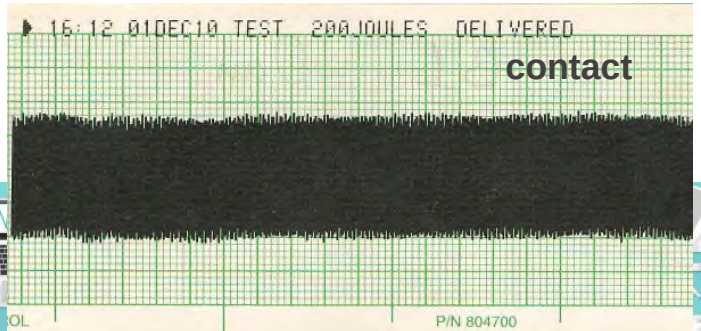
CRITICAL



omitted alarm: CARDIAC FREQUENCY







Safety measures

1) Check the accumulator (it has to be changed every 2-3 years): try to fire the defibrillator on a certain load (the device has to be able to supply the number of shocks given by the manufacturers before the accumulator is empty).
2) Check the conductive rubber holders that hold the pads and the internal resistance.
3) Check the low-frequency leakage currents (with a leakage current meter)
4) Measure the waveform and the supplied energy during the shock (with the specific tester).
5) Measure the ability of synchronisation.
6) Check the pads and the insulation of the cables daily
7) Check the ECG performance and the other vital signs (e.g., SPO2)
8) Check the alarms

Deepening Podcasts:
https://www.youtube.com/watch?v=3X6u01xE5XA