defibrillation

general

- DC cardioversion is an important treatment option in tachyarrhythmias
- it is used in emergency treatment in cardiac arrest from VF or VT & is indicated in haemodynamically unstable VT and sustained SVT that precipitates angina, heart failure or hypotension

mechanism of action

- the exact mechanism of action is unknown. DC shocks need to produce a current density that depolarises a critical mass of myocardium, thereby leaving insufficient myocardium to maintain the re-entrant tachycardia and prevent re-initiation
- for VF & AF, the critical mass involves the entire ventricles or atria whereas VT and flutter involve specific re-entrant circuits and regional depolarisation in the path of their circulating wave fronts is all that is required
- DC shocks also prolong the refractoriness of the myocardium

electrical energy

- the goal is to achieve a certain current through the entire heart, atria or a region depending on the arrhythmia, DC shocks are prescribed as energy measured in joules.
- it would be preferable to be able to deliver a set current to prevent delivering inappropriately low currents in patients with high impedance and excessive current flow in causing myocardial damage in patients with low impedance; however, appropriate current dosages are not well defined (particularly for biphasic waveform)

current waveform

- modern defibrillators deliver current, the magnitude of which depends on the prescribed energy and thoracic impedance
- monophasic waveform defibrillators deliver current that is in a single direction or polarity. They can be further characterised by the rate at which the current pulse returns to zero. Damped sinusoidal monophasic waveforms return to zero gradually, whereas truncated exponential return instantaneously.
- biphasic waveform defibrillators generate a sequence of two current pulses are generated, the polarity of the second in the opposite direction of the first. Biphasic waveforms provide equal efficacy at lower electrical energies and the lower shock energies are associated with fewer ST segment changes & less post-resuscitation myocardial dysfunction

thoracic impedance

- the magnitude of current flow is dependent on the thoracic impedance
- the average adult thoracic impedance is 70-80 ohms
- factors which determine the thoracic impedance include:

(i) energy selection
(ii) electrode size
(iii) electrode composition
(iv) paddle to skin coupling
(v) number of previous shocks
(vi) distance between electrodes
(vii) time between previous shock and present shock
(viii) phase of ventilation
(ix) patients build
(x) recent sternotomy

paddle position & size

- standard placement is just to the right of the upper sternal border below the clavicle (sternal pad) & to the left of the nipple with the centre of the paddle in the mid-axillary line (apex)
- permanent pacemakers and ICD must be avoided as shock may cause malfunction; it is inevitable that some current is deliver & these devices should be checked after DC cardioversion or defibrillation
- the use of right parasternal & left posterior infrascapular positions has been advocated for AF because this configuration provides an optimal vector of current delivery to the atria.

- larger electrodes have less impedence; however, excessively large electrodes may result in less transmyocardial current flow
- the minimum recommended electrode size is 50cm2 with the sum of both electrodes exceeding 150cm2

synchronised cardioversion

- with cardiocersion of atrial tachyarrhythmias and VT, synchronisation of DC shock with the R-wave of the QRS complex is required to reduce the possibility of inducing VF by delivering the shock during the relative refractory portion of the T-wave
- synchronisation should not delay shock in unstable VT

DC shock dosage

- Multiple human clinical studies have described initial biphasic defibrillator energy levels ranging from 100 J to 200 J,and subsequent energy levels ranging from 150 J to 360 J, without clearly demonstrating an optimal energy level.
- It is recommended that the default energy level for biphasic waveforms in adults should be 200 J for all shocks (although other energy levels may be used providing there are relevant clinical data for a specific defibrillator suggesting that these energy levels provide adequate shock success).
- With a monophasic defibrillator, an initial shock of 360J is recommended.

- The initiation of a one shock strategy may improve outcome by reducing interruption of chest compressions. This strategy would be of benefit in scenarios where a significant time is required for rhythm recognition and recharging of the defibrillator (ie, > 10 seconds), but its benefits depend entirely on the quality of CPR performed between shocks.
- It is recommended that a single-shock strategy be used in patients in cardiac arrest requiring defibrillation for VF or pulseless VT. When using this strategy, CPR should be resumed immediately after shock delivery, and interruptions minimised.
- A stacked-shock strategy (using up to three shocks as necessary) is recommended in cases where the occurrence of the cardiac arrest (VF or VT) has been witnessed by the rescuer, and a manual defibrillator isimmediately available. If further shocks are indicated, a single-shock strategy is recommended.

sedation

- a separate doctor is required to manage sedation
- patients with poor myocardial function need not only reduced dose but also onset time is slower because of low cardiac output
- sensitive tachyarrhythmias such as flutter require only low doses whereas atrial flutter is likely to need higher energy & may require repeated shock

digoxin & cardioversion

- digoxin toxicity results in a significant reduction in the threshold for inducing ventricular arrhythmia with DC shock. If digoxin toxicity is a possibility then reconsideration of the need for cardioversion or at least careful titration of energy is required
- clinical experience would suggest starting with low energy such as 10J is safer in this setting

anticoagulation

- cardioversion of AF & to a lesser extent flutter is associated with a risk of thromboembolism and stroke
- it is accepted that the propensity of clots forming in the left atrium after 48 hours and for these to be dislodged when sinus rhythm is restored is so high that anticoagulation is indicated prior to cardioversion in AF (anticoagulation for 3-4 weeks reduces the risk of embolism be 80%)