

Chapter 23: Defibrillation and Cardioversion

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PURPOSE OF PROCEDURE

Defibrillation is the therapeutic use of electricity to depolarize the myocardium so coordinated contractions can occur. The term *defibrillation* is usually applied to an attempt to terminate a nonperfusing rhythm (e.g., ventricular fibrillation or pulseless ventricular tachycardia).

Cardioversion is the application of electricity to terminate a still perfusing rhythm (e.g., ventricular tachycardia with a pulse, supraventricular tachycardias including atrial arrhythmias) to allow a normal sinus rhythm to restart. By this definition, cardioversion is a less urgent procedure compared to defibrillation, although the patient requiring cardioversion may be hypotensive or hemodynamically unstable, rather than in cardiac arrest.

PATIENT SELECTION

Indications for defibrillation include ventricular fibrillation (VF) ([Figure 23-1](#)) and pulseless ventricular tachycardia (VT) ([Figure 23-2](#)). Defibrillation is not indicated for asystole and pulseless electrical activity and is contraindicated for sinus rhythm, a conscious patient with a pulse, or when there is danger to the operator or others (e.g., from a wet patient or wet surroundings).

FIGURE 23-1.

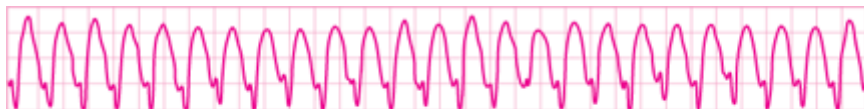
Ventricular fibrillation.



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FIGURE 23-2.

Ventricular tachycardia.



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Cardioversion is indicated for a hemodynamically unstable patient with VT, supraventricular tachycardia, atrial flutter, or atrial fibrillation. It is also possibly indicated after failed pharmacologic therapy for the previously mentioned arrhythmias, especially if the patient becomes hemodynamically unstable. **Cardioversion should be synchronized, which means the electric current will be timed with the patient's intrinsic QRS complexes**, to minimize the risk of inducing VF.

RISKS AND PRECAUTIONS

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Electrical energy can terminate an abnormal rhythm, but if inappropriately delivered, it can also induce VF. This can happen if the electric shock is delivered during the relative refractory portion of the cardiac electrical activity.¹

When preparing for defibrillation, check the patient and rhythm to ensure that a shock is truly indicated. Movement artifacts or loose leads may look like VF. New defibrillator technology is available that can filter compression or movement artifacts to "see through" the underlying rhythm. **However, when using automated external defibrillators (AEDs), all manufacturers currently still recommend stopping all compressions and patient movement (e.g., during transport) before initiating analysis mode.**

Make sure that no rescuer is inadvertently in contact with the patient when a shock is delivered. Neither single nor double gloves provide the rescuer with complete safety from current,² so we still recommend "stand clear" drills during defibrillator training, "stand clear" practice during actual defibrillation, and minimizing rather than eliminating the pause in compressions for defibrillation. **If the patient is on a wet or conducting surface, move the patient to a safe area and dry the body before delivering the shock.** When using manual defibrillation paddles, make sure that the paddles are either on the defibrillator cradle or on the patient's chest, with minimal time in transit from one position to the other. To prevent inadvertent discharges, always point the paddles downward and never wave the paddles around or face them toward each other, especially when charged. This is to prevent inadvertent discharges or "sparking."

To avoid skin burns, remove all metallic objects and [nitroglycerin](#) patches from the patient. Ensure correct placement of defibrillation paddles/pads and **remove all direct sources of [oxygen](#) to avoid fire.**^{3,4} If paddles are used, do not allow the conducting gel to spread to within 5 cm of the other paddle. In patients with an internal pacemaker requiring defibrillation, ensure that the paddles/pads are placed well away (12.5 cm or 5 inches) from the pacemaker before discharging.

Avoid prolonged pauses (>10 seconds) to CPR when performing defibrillation.^{5,6} Thus, the emphasis is on minimal interruptions to CPR for analysis, a single shock instead of three "stacked" shocks, and immediate resumption of CPR without a pulse or rhythm check immediately after defibrillation. In addition, if a mechanical CPR device is being used, defibrillation can be safely performed without stopping ongoing mechanical compressions to reduce unnecessary pauses.

EQUIPMENT

1. Defibrillator: This can be a manual, semi-automated, or fully automated external defibrillator.

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3. Conductive gel or gel pads for defibrillation paddles.
4. Related resuscitation equipment (e.g., bag-valve mask device, airway devices, suction, IV cannulation, drugs).

Defibrillators should be properly maintained and in a constant state of readiness. We recommend the use of checklists⁷ to identify defibrillator malfunction and ensure proper maintenance of batteries. Users should be trained in the proper use of checklists, and checks should be performed frequently (as often as every shift). Perform cardioversion in a resuscitation area with appropriate monitoring and standby resuscitation equipment, in case the patient deteriorates or develops cardiac arrest.

PATIENT POSITIONING

Place the patient in the supine position. Expose the chest, and remove jewelry and medication patches. If the chest is very hairy in the areas where electrodes are to be placed, quickly shave the hair to ensure the electrodes stick onto the chest. If the chest is wet (because of sweat or because the patient has been in water), wipe dry immediately. Sweat or moisture on the chest will reduce adhesion of the electrodes.


ANESTHESIA AND PROCEDURAL MONITORING

For a patient in cardiac arrest, defibrillation is part of the immediate resuscitation process. However, for an elective or semi-elective cardioversion, procedural sedation and monitoring—before, during, and after the procedure—are essential. Provide cardiac, blood pressure, and pulse oximetry monitoring; place an IV line; and make sure airway equipment, suction, and [oxygen](#) are immediately available. Obtain informed consent when possible. Sedation is typically provided with an IV agent such as etomidate, propofol, or midazolam.

STEP-BY-STEP TECHNIQUE

PLACEMENT OF PADDLES/PADS

Regarding placement of defibrillation paddles or pads, there are several alternative positions:

1. **Antero-apical position:** Place one paddle/pad to the right of the upper half of the sternum (breastbone), just below the patient's right clavicle (collarbone), and place the other pad just below and to the left of the left nipple (in the axilla). With a female patient, place the paddle/pad  breast. Do not place it over the breast ([Figure 23-3](#)).

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This is the preferred position for a supine patient and when using defibrillation paddles. The idea is to maximize current flow through the cardiac chambers rather than along the chest wall.

2. **Anteroposterior position:** Place one pad/paddle at the left lower sternal border and the posterior pad/paddle below the left scapula ([Figure 23-4, A and B](#)).
3. **Apex-posterior position:** Place one pad/paddle at the apex, just below and to the left of the left nipple, and the posterior pad/paddle below the left scapula.

FIGURE 23-3.

Antero-apical positioning of defibrillation pads. [Image used with permission of Institute for Medical Simulation & Education.]



One pad on right upper half
of sternum (breastbone)
below right clavicle (collarbone)

One pad just
below and to the
left of the nipple

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FIGURE 23-4.

Anteroposterior positioning of defibrillation pads in an infant. [Reproduced, with permission, from Children's Emergency, KK Women's and Children's Hospital, Singapore.]



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When using paddles (**Figure 23-5**), apply conducting gel or a gel pad and firmly place the paddles onto the chest wall (25 lb/square inch or 2 cm² of pressure). When using defibrillation pads, ensure the electrodes are firmly attached and there is good contact by pressing gently with fingers over the center and around the edges to check for good adhesion. Good contact increases shock efficiency. In the AED mode, if contact is insufficient for the defibrillator to operate, the "Check Electrodes" message will also be heard. Outcomes are better with larger electrodes (12 cm) than with smaller electrodes (≤ 8 cm).

FIGURE 23-5.

Antero-apical positioning of defibrillation paddles in an adult.



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MANUAL DEFIBRILLATION

1. Prepare the patient and equipment as described earlier. CPR should be ongoing.
2. Check that the rhythm is VF or pulseless VT.
3. Check that the defibrillator is in *unsynchronized* mode.
4. Select the appropriate energy level. For biphasic machines, select according to the manufacturer's recommendation (150 to 200 J with biphasic truncated exponential waveforms and 120 J for rectilinear biphasic waveforms). For monophasic defibrillators, it is reasonable to begin with an initial 360-J shock.⁶
5. Apply the paddles or pads (may be applied beforehand) and charge.

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6. Check that no one is in contact with the patient or trolley and call out, "Stand clear."

7. Discharge the shock.
8. Continue CPR and manage according to the local resuscitation protocol. The advanced cardiac life support universal cardiac arrest algorithm is shown in [Figure 23-2](#).

AUTOMATED EXTERNAL DEFIBRILLATION

1. Prepare the patient and equipment as described earlier. **CPR should be ongoing.**
2. Open the package containing the defibrillation pads with attached cable and connector. With the chest prepared, carefully pull off the protective backing from the pads. Attach the pads.
3. Turn on the device (follow the voice prompts according to your device).
4. Initiate analysis of the rhythm, and ensure there is no movement during analysis. If a shock is indicated, the device will automatically charge up to a preset level.
5. Check that no one is in contact with the patient or trolley and call out, "Stand clear."
6. Discharge the shock (note that fully automated defibrillators do not require the operator's input to discharge a shock).
7. Continue CPR and manage according to the local resuscitation protocol. The advanced cardiac life support universal cardiac arrest algorithm is shown in [Figure 23-2](#).

CARDIOVERSION

1. Prepare the patient and equipment as described earlier. Ensure the patient has adequate monitoring and that there is resuscitation equipment on standby.
2. Check the patient and the rhythm.
3. Check that the defibrillator is in *synchronized* mode.

4. Select the appropriate energy level. For monophasic defibrillators, start at 50 J for paroxysmal supraventricular tachycardia and atrial flutter and at 100 J for VT and atrial fibrillation. For biphasic defibrillators, follow the manufacturer's recommendations.
5. Provide sedation with an appropriate agent when ready.
6. Apply the paddles or pads (may be applied beforehand) and charge.
7. Check that no one is in contact with the patient or trolley and call out, "Stand clear."
8. Discharge the shock.
9. Continue to monitor and manage according to local protocols.

INTERNAL DEFIBRILLATION

Internal defibrillation is indicated in a patient with VF or pulseless VT with an open thoracotomy. This could be in a patient with traumatic cardiac arrest, for example, or during open heart surgery. The procedure requires a special set of internal defibrillator paddles ([Figure 23-6](#)), which should be connected to the defibrillator.

FIGURE 23-6.

Internal defibrillation paddles.



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Moisten the internal defibrillator paddles with saline, and then place one paddle posteriorly over the left ventricle and the other anteriorly over the right ventricle. Hold the paddles firmly against the myocardium to ensure good contact. Begin with 10 J for defibrillation and increase as needed.

PEDIATRIC DEFIBRILLATION

VF in children is relatively uncommon, and the most frequent cause of cardiac arrest is usually respiratory. Thus, treatment should be directed toward preventing cardiac arrest by supporting ventilation and respiration. In the event of VF, use a weight-related dose of 4 J/kg body weight for the first and any subsequent shocks. For VT with a pulse, cardiovert with 1 J/kg synchronized. This can be increased to 4 J/kg subsequently if needed. Special pediatric paddles (**Figure 23-7, A and B**) or pads are available. Some AEDs also come with pediatric attenuator pads. In an infant, it is possible to defibrillate with the patient propped on the side using anteroposterior paddle placement.

FIGURE 23-7.

(A) Pediatric defibrillation paddles. (B) Antero-apical positioning of defibrillation paddles in an infant. [Reproduced, with permission, from
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OUTCOMES ASSESSMENT

The aim of defibrillation or cardioversion is termination of the abnormal rhythm and restoration of a normal perfusing rhythm.

COMPLICATIONS

Possible complications include skin burns, inadvertent electric shock to others, and defibrillation-induced myocardial damage. However, these complications are minimal compared to the ultimate complication of patient death if defibrillation is unsuccessful or not attempted.

FOLLOW-UP

Patients requiring defibrillation or cardioversion will require intensive monitoring and close postresuscitation care.

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