

EMERGENCY DEPARTMENT THORACOTOMY

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A Patients undergoing cardiopulmonary resuscitation (CPR) should be assessed for signs of life: respiratory or motor effort, electrical activity, or pupillary activity.

B Profound refractory shock includes patients with signs of life or systolic blood pressure < 60 mm Hg.

C Patients undergoing CPR upon arrival to the hospital should be stratified based on injury mechanism and transport time to determine the role for emergency department thoracotomy (EDT). With only 1% to 2% of blunt trauma patients surviving EDT, patients with greater than 10 minutes of prehospital CPR and no signs of life are pronounced dead. In patients with penetrating neck or extremity trauma, defined as non-torso trauma, EDT with aortic cross-clamping is a potential adjunct in the resuscitation if CPR requirements are less than 5 minutes in duration. Patients with penetrating torso injuries have the greatest survival after EDT; those with less than 15 minutes of prehospital CPR should undergo EDT. Patients with penetrating trauma to the head with CPR en route to the hospital are declared dead.

D The technique of EDT is described in detail in textbooks. In brief, an anterolateral thoracotomy is performed with the patient supine. If the patient has a penetrating wound to the right chest, a clamshell thoracotomy should be the initial incision. Pericardiotomy is performed anterior to the phrenic nerve, from the apex toward the aortic root, using scissors. In patients with cardiac activity and exsanguination from extrathoracic injury, aortic cross-clamp rather than pericardiotomy may be the first maneuver upon entry into the chest.

E Resuscitative endovascular balloon of the aorta (REBOA) may be an alternative if the appropriate equipment and clinical expertise exist.

F After the pericardial sac is opened, the patient's heart is evaluated. Patients in asystole without evidence of tamponade are declared dead. For those with a cardiac wound, tamponade, and asystole, cardiorrhaphy is performed before defibrillation because the non-beating heart is easier to repair. The initial repair does not need to be hemostatic; there must be enough injury approximation to permit internal massage of the heart without exsanguination through the cardiac opening. Internal massage permits circulation of intracardiac injection of epinephrine. After several rounds of cardiac massage, giving the epinephrine time to circulate, internal

paddles are used to defibrillate the heart; defibrillation is set at 30 joules.

G For patients with an intrinsic rhythm, the underlying pathology should be quickly assessed and treated. Patients diagnosed with cardiac injury undergo cardiac repair; if digital pressure on the ventricle or vascular clamps on the atria are effective at controlling bleeding, patients may be transported to the operating room for repair. Such local control, however, is not always feasible, and repair in the emergency department may be necessary. Ventricular cardiac injuries are best repaired with 3-0 nonabsorbable sutures, ideally buttressed with Teflon pledgets. If the injury is close to a coronary vessel, vertical mattress sutures should be used to exclude the coronary to avoid ischemia. For small linear stab wounds of the muscular left ventricle, bleeding may be temporized with a skin stapler. Atrial lacerations can be repaired with a simple running stitch or purse-string sutures for the appendage. Penetrating wounds to the great vessels or pulmonary hilum can cause intra-thoracic hemorrhage; rarely, blunt injuries to the descending thoracic aortic, pulmonary hilar, or azygous vein may be encountered at EDT. Pulmonary hilar cross-clamping, direct digital occlusion, or vascular clamping of the injury, or even packing of the apices for subclavian vessel injuries, may be needed to control hemorrhage. Patients with lung parenchymal injuries may develop bronchovenous air embolism; pulmonary hilar cross-clamping prevents further circulation of air in the venous system. To trap air that has already embolized to the left ventricle, the patient should be placed in Trendelenburg's position. Needle aspiration of the ventricular apex and aortic root can remove accumulated air. Cardiac massage, including direct digital strokes along the coronaries, may dissolve air already present.

H Thoracic aortic occlusion, either with digital control or with a Satinsky cross-clamp, is performed to (1) redistribute limited blood volume to the myocardium and brain in patients with hemorrhagic shock; (2) reduce subdiaphragmatic blood loss in patients with intraabdominal injury; and (3) increase coronary filling, which optimizes the return of spontaneous circulation after CPR. An aortic cross-clamp is typically placed inferior to the left pulmonary hilum. Removal of the aortic cross-clamp or moving the clamp to the infrarenal aorta should be performed within 30 minutes.

I Concurrent resuscitation of the patient in the emergency department should include packed red cells, calcium, and bicarbonate. Vasopressor agents such as epinephrine and vasopressin are given intravenously, and intracardiac epinephrine may be directly injected into the ventricle. Ventricular fibrillation is treated with defibrillation using internal paddles (i.e., placed directly on the surface of the heart) set at 30 J. After resuscitation and injury assessment, salvageability is assessed. The patient is transported to the operating room if the patient maintains a perfusing rhythm and is able to generate a systolic blood pressure > 70 mm Hg.

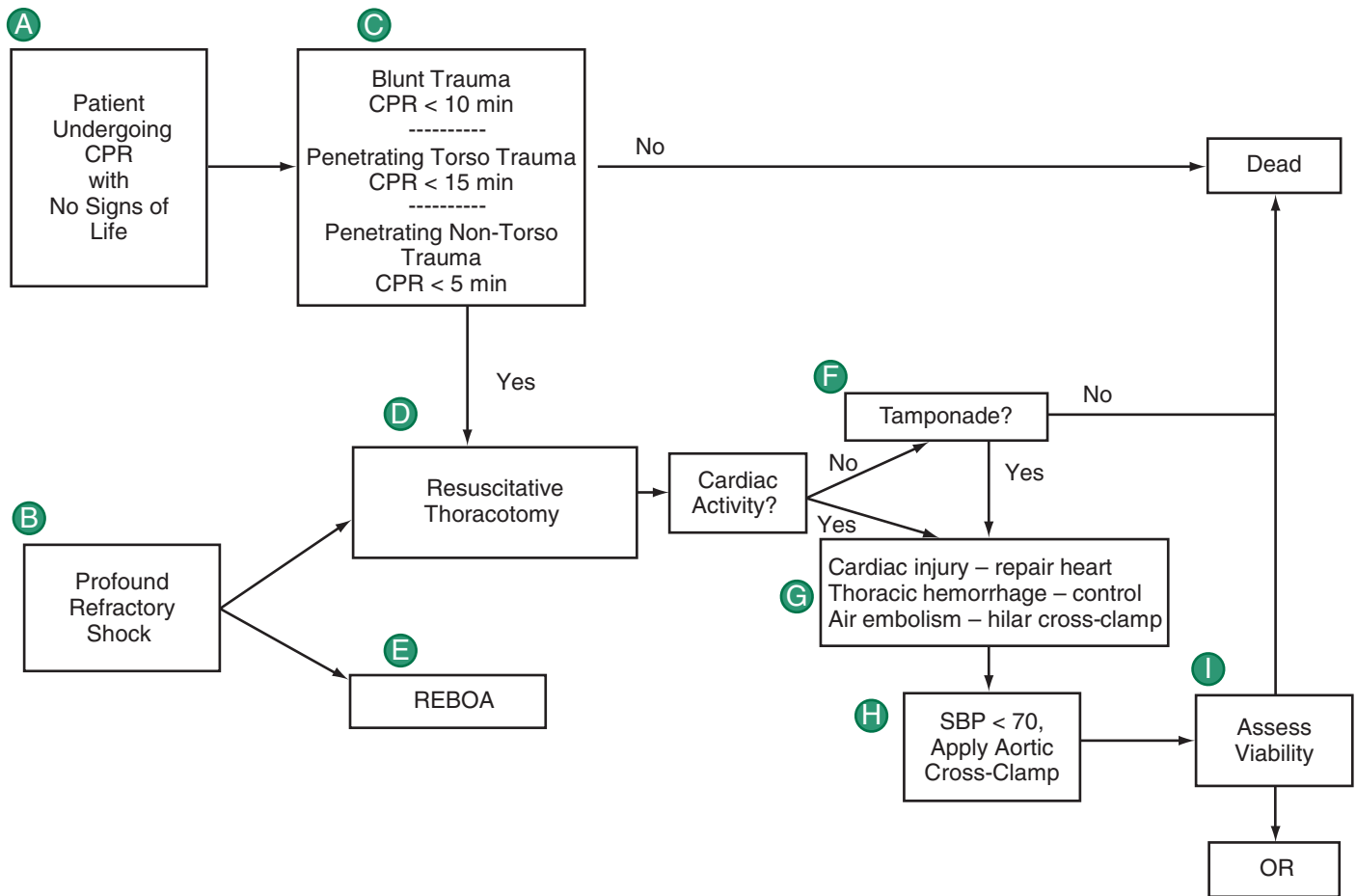
EDT has the highest survival rate after isolated cardiac injury, with 20% of patients salvaged despite presenting without vital signs. For patients with penetrating torso injuries, 14% of hypotensive patients and 8% of patients without vital signs but with signs of life are salvaged. For patients sustaining blunt trauma, historically only 1% to 3% of patients survive EDT, regardless of their presenting clinical indices.

Abstract

Patients with impending cardiac arrest or those undergoing cardiopulmonary resuscitation may be salvaged with immediate thoracotomy in the emergency department. Understanding the defined indications and the key components of the associated resuscitative efforts is crucial for the appropriate use of this procedure.

Keywords

emergency department thoracotomy
resuscitative thoracotomy
thoracic trauma
cardiac arrest



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