ELECTROCUTION

PATHOPHYSIOLOGY: The danger of cardiac arrest is related principally to the magnitude and duration of the electrical current. The voltage of the electrical source and the electrical resistance of the body tissues through which the electricity passes are only important in that they determine the magnitude of the current flow. Alternating current at 60 Hertz (the frequency used by power companies) is generally more dangerous to humans than direct current at any given voltage because it is more likely to induce **ventricular fibrillation**.

When a low current intensity (1 milliampere, or mA) is applied from the body surface, there is little danger of harm and the electrical current is usually felt as a tingling sensation in the area of contact. Progressively higher currents cause increasingly unpleasant and painful sensations. At approximately 10 mA, tetanic muscular contractions may occur, which may make it difficult or impossible for a hand grasping an object with an electrical current to let go. The current at which it is not possible to release an energized object varies considerably from person to person within the range of 30 mA. At 40-50 mA the tetanic contractions may involve all muscles, including the diaphragm and the intercostals, causing respiratory arrest until the current flow stops. With contact of short duration at this current level normal respiration usually resumes immediately after the current flow ceases. Longer contact can cause prolonged apnea with resultant hypoxemia, tissue hypoxia, secondary cardiac arrest, and death.

Higher currents (100 mA to several amperes), even of brief duration, can directly induce ventricular fibrillation. Brief duration shocks at or just above 10 mA may result in a current flow of sufficient strength that the heart holds its contraction in systole until release of the current. This is thought to protect against or reverse ventricular fibrillation in some circumstances. Defibrillators used in resuscitation deliver current in this range.

Higher current flow (several tens of amperes) may cause prolonged respiratory arrest. Massive currents of several hundred amperes can induce both respiratory and cardiac **arrhythmia**, including ventricular fibrillation.

The victim of such a massive electrical shock rarely remains conscious. Electrical power linemen receiving such injuries have been reported to climb down the utility pole before collapsing in cardiac arrest, presumably due to a ventricular arrhythmia.

The passage of electrical current through body tissue generates heat and may produce injuries similar to that of a **burn** or **crush injury**. Current often flows along nerves and blood vessels where there is disruption of the vascular endothelium and thrombosis. The resulting thermal injury may be of sufficient severity to require debridement, escharotomy, fasciotomy, or amputation.

Secondary injuries, caused when the victim is thrown by contact with an electrical source, may include cervical spine or other bony fractures, closed **head injury**, and peripheral nerve damage. Myoglobinuria may occur due to muscular injury.

LIGHTNING: Acts as a massive DC countershock, depolarizing the entire myocardium at once, following which the hearts normal rhythm may resume. In one published series, death occurred in 45% (30 of 66) victims struck by lightning. The patients who died were those who suffered an immediate **cardiac arrest**. Respiratory arrest often lasts longer than **asystole** and the victim may die from hypoxia if CPR is not started promptly. Patients who do not arrest immediately have an excellent chance of recovery.

MANAGEMENT OF THE VICTIM OF SEVERE ELECTRIC SHOCK: The rescuer must be certain that the current is off before attempting to touch the victim or move the victim from the electrical source. If possible, the current should be switched off at its source. Rescuers should not touch a victim who is still in contact with an active current source. If unconscious, the victim should be assessed for the presence of adequate breathing and circulation. Rescue breathing and chest compressions should be started when indicated, taking care to protect the cervical spine from further motion or injury if there is any likelihood that the victim was thrown or suffered a fall. In such a case the chin-lift or jaw-thrust, without head-tilt, should be used to open the airway. A cervical collar or its equivalent should be used if available. Any obvious orthopedic injury should be immobilized.

When a power lineman on a utility pole is electrocuted, rescue breathing can often be initiated by rescuers on the pole, with chest compressions, if needed, as soon as the victim can be lowered to the ground. Even with no loss of consciousness, a victim of high-voltage electrical shock should receive cardiac monitoring and transport to the hospital due to the danger of delayed cardiac arrest from a life-threatening arrhythmia.

Since virtually all victims of lightning injury who do not go into immediate arrest survive, when multiple victims are simultaneously struck by lightning, individuals who appear clinically dead immediately following the strike should be treated before other victims showing signs of life. Most patients who are successfully resuscitated from cardiac arrest due to lightning or other high voltage electrical shock injury will have return of spontaneous respirations within 30 minutes. Complete recovery has been reported after resuscitation of up to several hours in some patients. The victim of cardiac arrest due to electrical shock may warrant prolonged aggressive efforts in certain circumstances. The decision to terminate resuscitation should be made by a physician well versed in the treatment of electrical injuries based on all the factors unique to the specific incident.

When significant crush or burn injury is suspected, IV fluids (NS) should be administered at a rate sufficient to maintain the urine output at 50-100 ml/hr, to minimize the likelihood of renal shutdown due to myoglobinuria and/or dehydration from third space fluid loss.