- **Oxygen Administration**
- **Suction (Oral and Nasal)**
- **Resuscitation in Electric Shock**
- **Resuscitation in Drowning**
- **Noxious Gases**
- **Alternate Methods of Artificial Ventilation**
  Back Pressure—Arm Lift Method
- **Choking Emergencies**
  Heimlich Maneuver

Chapter IV

Cardiopulmonary Resuscitation (CPR)*

BASIC LIFE SUPPORT

BASIC LIFE SUPPORT is an emergency life-saving procedure that consists of recognizing and correcting failure of the respiratory or cardiovascular systems.

Oxygen, which is present in the atmosphere in a concentration of about 21%, is essential for the life of all cells. The brain, the principal organ for conscious living, starts to die if deprived of oxygen for as little as four minutes. In the delivery of oxygen from the atmosphere to the brain cells, there are two necessary actions, breathing and circulation. Breathing (taking in oxygen through the body's air passages) and the circulation of oxygen-enriched blood are both required. Any profound disturbance of the airway, breathing, or the circulation can promptly produce brain death.

Basic life support includes the ABC steps of cardiopulmonary resuscitation: Airway, Breathing, and Circulation (Fig. 4–1). Prompt application of basic life support is indicated for:

A—Airway obstruction
B—Breathing (respiratory) arrest
C—Circulatory or Cardiac (heart) arrest

Basic life support requires no instruments or supplies, and the correct application of the steps of cardiopulmonary resuscitation can maintain life until the patient recovers sufficiently to be transported to a hospital or until advanced life support can be delivered to the patient.

Basic life support is not the same as advanced life support. The latter consists of the use of equipment, cardiac monitoring, defibrillation, the maintenance of an intravenous lifeline, and the infusion of appropriate drugs.

Urgency

There must be a maximal sense of urgency in starting basic life support. The outstanding advantage of cardiopulmonary resuscitation (CPR) is that it permits the earliest possible treatment of airway obstruction, respiratory arrest, or cardiac arrest by properly trained persons.

Ideally, only seconds should intervene between recognizing the need and starting the treatment. The inadequacy or absence of breathing or circulation must be determined immediately.

If breathing alone is inadequate or absent, either opening the airway or *artificial ventilation* is all that is necessary. If circulation is also absent, artificial circulation must be instituted in combination with the artificial ventilation. If breathing stops before the heart stops, enough oxygen will be available in the lungs to maintain life for several minutes. But if

* Derived from American Heart Association: Standards and Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). JAMA, 244; 453–509, August 1, 1980 (by permission from the American Heart Association) and Emergency Care and Transportation of the Sick and Injured, 1981; AAOS Chicago, Illinois.

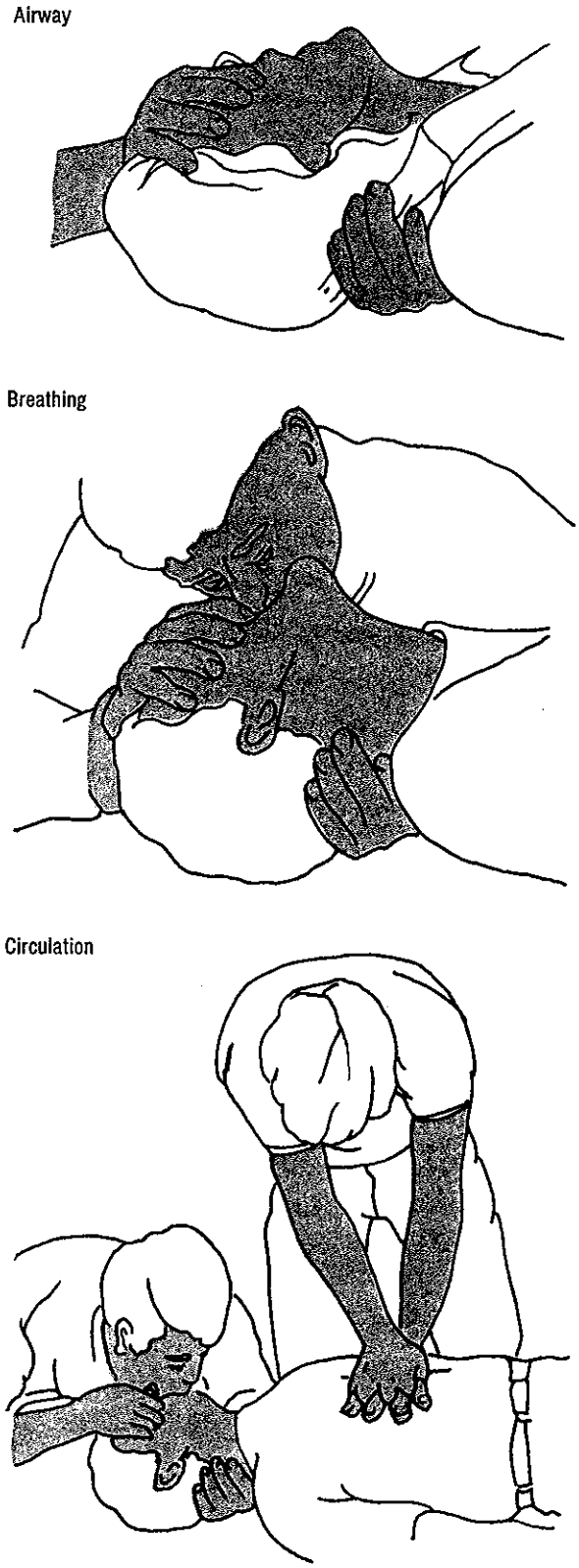


Fig. 4–1. The ABC steps of cardiopulmonary resuscitation — Airway, Breathing, Circulation — are the essential components of basic life support.

heart arrest occurs first, delivery of oxygen to the brain ceases immediately. Brain damage is possible if the brain is deprived of oxygen for four to six minutes. Beyond six minutes without oxygen, brain damage is very likely (Fig. 4–2). Speed is essential in determining the need for and beginnning the procedures of basic life support.

Unconsciousness

An unconscious patient must be carefully checked to determine which steps of basic life support are needed. Unconsciousness is established by observing the responses of the patient to verbal or painful stimuli. In addition, to exclude the possibility of a head injury as the cause of unconsciousness and also to determine the possibility of spinal injuries, the EMT,* while checking breathing and circulation, asks witnesses if the patient had a fall or looks for evidence of an accident or fall. If no evidence of such injuries is present, the EMT may start life support without concern for spinal damage. Conversely, if spinal injury is suspected, care must be taken to protect the spinal cords. Unconscious states and spinal and head injuries are each treated in separate chapters in this text.

Positioning the patient

For cardiopulmonary resuscitation to be effective, the patient must be horizontal, *supine* (lying down face up), and on a firm surface, for even when flawlessly performed, external chest compression will produce no blood flow to the brain if the body is in a vertical position. Airway management and artificial ventilation are more easily achieved when the patient is supine.

Beginning and Terminating Basic Life Support

Cardiopulmonary resuscitation is most effective when started immediately after cardiac arrest. If there is any question how long the arrest has lasted, the patient should be given

* The use of the initials, EMT, does not limit the provision of CPR to only qualified emergency medical technicians. However, all persons should receive specialized training and be qualified in CPR.

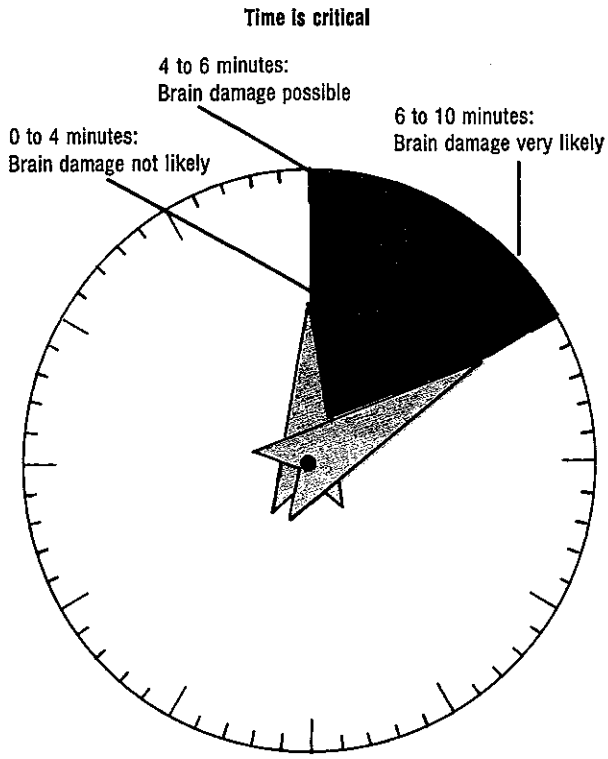


Fig. 4–2. Time is critical. If the brain is deprived of oxygen for four to six minutes, brain damage is likely to occur. After six minutes without oxygen, brain damage is extremely likely.

the benefit of the doubt and resuscitation started at once.

When resuscitation is indicated and is started in the absence of a physician, it should be continued until one of the following events occurs:

1. Effective spontaneous circulation and ventilation restored
2. Resuscitation efforts are transferred to another responsible person who continues basic life support
3. A physician assumes responsibility
4. The EMT is exhausted and unable to continue resuscitation efforts.

It is imperative, therefore, to place the unconscious patient in a supine position as quickly as possible in situations where the patient is found in a vertical position. Also, if the patient is lying crumpled up or face down, repositioning is necessary. Considerable caution must be taken, particularly if a neck or back injury is suspected. The patient must be rolled as a single unit of head, neck, and back. Elevating the lower extremities about 12 inches while keeping the rest of the body horizontal may promote venous blood return and assist artificial circulation if external chest compression is required.

The EMT kneels by the patient, but not in bodily contact, and sufficiently far away so that when the patient is rolled, the patient does not end up in the EMT's lap. The EMT rapidly straightens the patient's legs and moves the nearer arm above the head (Fig. 4–3a), then places one hand behind the back of the head and neck of the patient and the other hand on the distant shoulder (Fig. 4–3b). The patient is then turned toward the EMT by pulling on the shoulder, and the head and neck are controlled so that they turn with the rest of the torso as a unit (Fig. 4–3c). In this way, the head and neck remain in the same vertical plane as the back, and aggravation of any spinal injury is prevented. When the patient is flat on the back, the EMT brings the patient's arm back to the side (Fig. 4–3d). Now airway, breathing, and circulation can be assessed and treated.

Artificial Ventilation

Respiratory inadequacy may result from an obstruction of the airway or from respiratory failure. An obstructed airway is sometimes difficult to recognize until the initial steps of airway management have been attempted. At other times, a partially obstructed airway can be recognized by labored breathing, by excessive respiration, and by retraction of the intercostal, supraclavicular, and suprasternal spaces. Respiratory failure or arrest is characterized by minimal or absent respiratory efforts, failure of the chest or upper abdomen to move, and no detectable air movement through the nose or mouth.

Opening the airway and restoring breathing are the basic steps of artificial ventilation. The steps can be performed quickly under almost any circumstances, *without* equipment, and without help from another person. They constitute emergency medical care for airway obstruction, respiratory failure, or respiratory arrest.

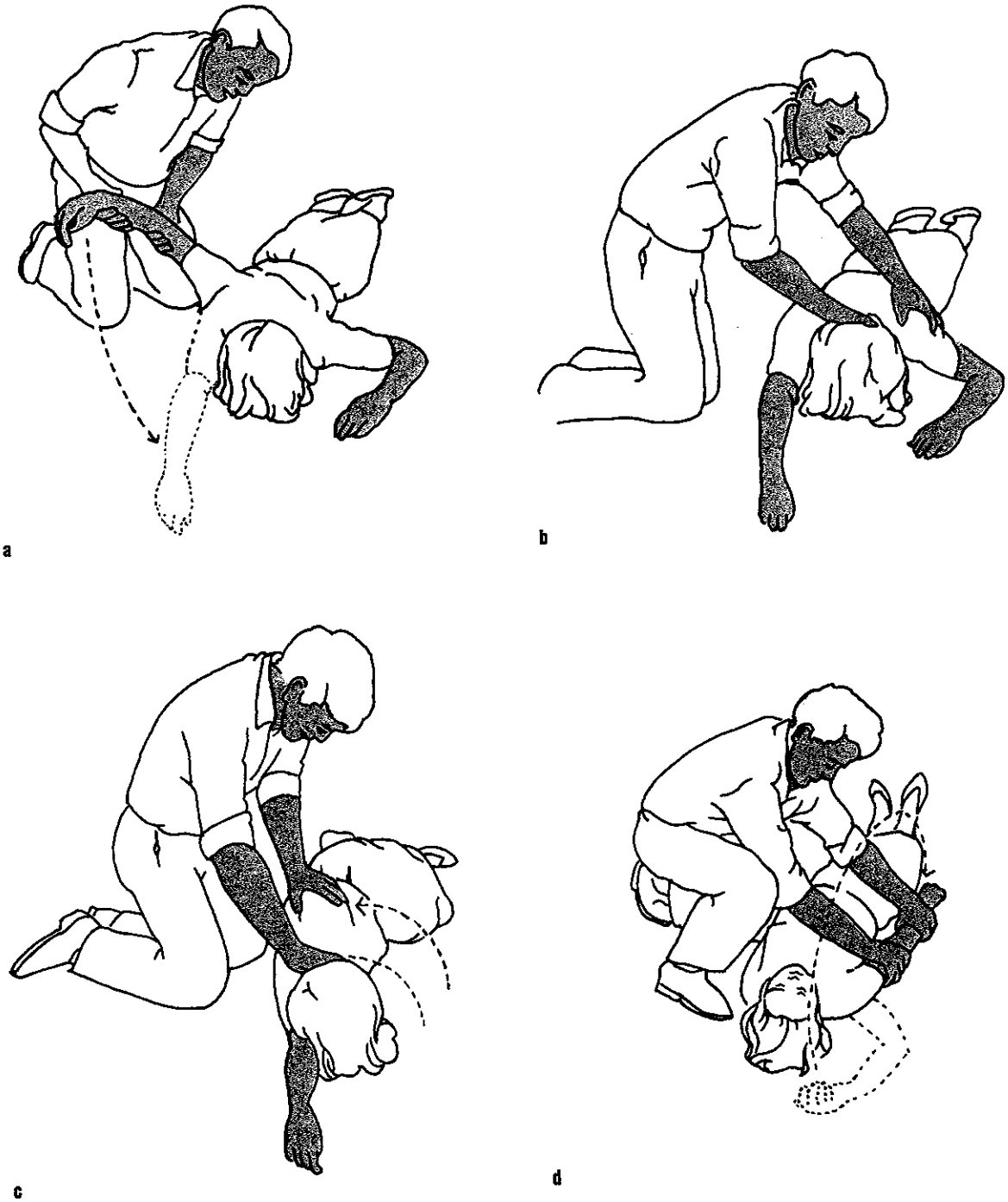


Fig. 4–3. The steps for rolling the patient into a supine position are shown. **a,** The EMT brings the patient's nearer arm above the head; **b,** places one hand behind the patient's head and neck and the other hand on the distant shoulder; **c,** rolls the patient toward the EMT by pulling the shoulder. **d,** Once the patient is flat, the extended arm is brought back to the side.

Opening the airway

Immediate opening of the airway is the most important factor in successful artificial ventilation. The airway may be blocked by the patient's own tongue or by foreign material in the mouth or throat.

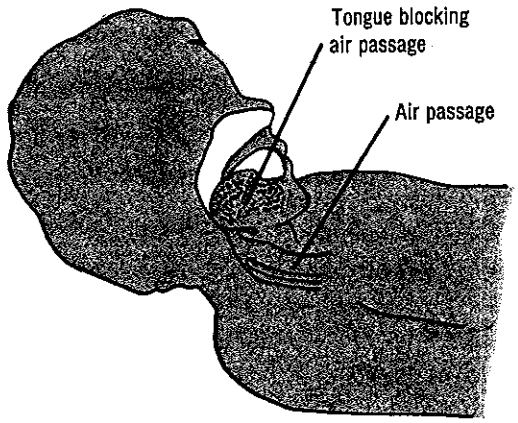


Fig. 4–4. When the neck is in flexion (chin down on chest) the tongue falls back into the throat and obstructs the airway.

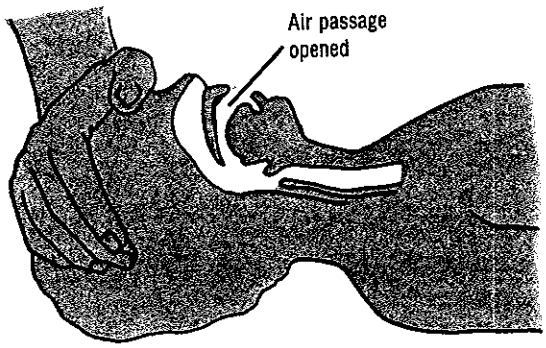


Fig. 4–5. The head-tilt maneuver. The airway is opened by extending the neck with firm pressure applied to the forehead.

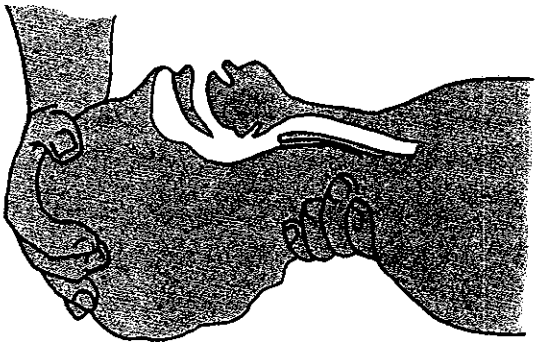


Fig. 4–6. The head tilt-neck lift, further opening the airway.

Head-tilt maneuver. When consciousness is lost, muscles relax. The result is that an unconscious patient's tongue can fall back into the pharynx, blocking it and obstructing the upper airway (Fig. 4–4).

Opening the airway to relieve the obstruction caused by the tongue is accomplished easily and quickly by tilting the patient's head backward as far as possible (Fig. 4–5). This procedure is known as the *head-tilt maneuver.* Sometimes this simple maneuver is all that is required to cause the patient to resume breathing spontaneously. For the head-tilt to be performed, the patient must be lying on the back. Kneeling close to the patient the EMT places a hand on the patient's forehead and applies firm backward pressure with the palm. This results in a movement of the patient's head as far backward as possible. Since effective head tilt may be difficult to obtain with one hand on the forehead, the other hand can be used to apply either a neck-lift or a chin-lift. The head-tilt is the initial and most important step in opening the airway.

Head tilt-neck lift. Having achieved head tilt by placing one hand on the forehead and applying backward pressure, the EMT places the other hand beneath the neck and lifts and/or supports it upward (Fig. 4–6). Excess force in performing this maneuver may cause cervical spine injury. Since the specific movement used is extension of the head at the junction of the neck rather than hyperextension of the cervical vertebrae, the hand lifting the neck should be placed close to the back of the head to lessen extension of the cervical spine. Emphasis should be placed on gentleness but firmness when lifting the neck. If loose dentures are a problem, they may be managed with the head tilt-chin lift or can be removed.

Head tilt-chin lift. In the conscious patient making spontaneous respiratory effort, chin-lift combined with head-tilt is highly effective in opening the airway when used initially. In addition, head tilt-chin lift may open the airway in some individuals in whom head tilt-neck lift is not effective. For this reason, EMT's should be familiar with the chin-lift technique and able to perform it as well as the neck-lift. Support of the lower jaw may be accomplished by lifting the chin. The tips of the fingers of one hand are placed under the lower jaw on

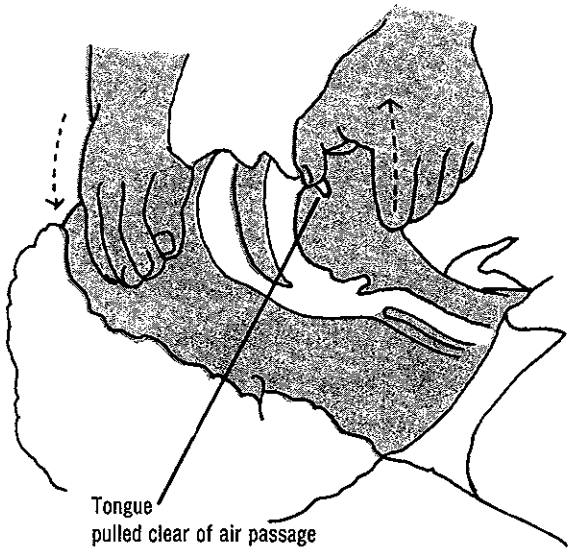


Fig. 4–7. The head tilt-chin lift technique. While the head is tilted backward with one hand, the fingers on the other hand lift the chin forward, as indicated by the arrow.

the bony part near the chin, bringing the chin forward, supporting the jaw, and helping to tilt the head back (Fig. 4–7). The fingers must not compress the soft tissues under the chin, which might obstruct the airway. The other hand continues to press on the patient's forehead to tilt the head back. The chin should be lifted so the teeth are nearly brought together, but the EMT should avoid closing the mouth completely. The thumb is used rarely when lifting the chin and then only to depress the lower lip slightly so the mouth will remain open. If the patient has loose dentures, they can be held in position, making obstruction by the lips less likely. If artificial ventilation is needed, the mouth-to-mouth seal is easier when the dentures are in place. If dentures cannot be managed in place, they should be removed.

In summary, either the head tilt-neck lift or the head tilt-chin lift can be used by EMT's to open the airway. While the traditional head tilt-neck lift has proved effective from experience, the chin lift may be needed if the neck lift does not restore airway patency. From field experiences EMTs will be able to identfy usefulness of both methods.

Hyperextension of the neck should not be done in patients who have suffered an actual or suspected injury to the cervical spine, as it may cause permanent paralysis. It is imperative that the possiblity of a cervical spine injury be considered at all times, especially in those patients who have suffered a fall or have been involved in an accident.

Jaw-thrust maneuver. The methods just described are effective for most patients. If not, an additional forward movement of the lower jaw (the *jaw-thrust)* may be required. The thrust is a triple maneuver in which the EMT places the fingers behind the angle of the patient's lower jaw, and then

1. Forcefully brings the jaw forward
2. Tilts the head backward
3. Uses the thumb to pull the patient's lower lip down, which allows breathing through the mouth as well as through the nose.

The jaw-thrust is performed best with the EMT kneeling by the patient's head (Fig. 4–8).

If a cervical spine injury is suspected, this triple maneuver can be modified by keeping the head in a neutral position and thrusting the jaw forward and opening the mouth as described. This may permit opening the airway without need to move the head from a neutral position.

Once the airway has been opened, the patient may or may not start to breathe again. To assess whether breathing has returned, the EMT's head must be turned and an ear placed about one inch above the nose and mouth of the patient (Fig. 4–9). If the EMT can feel and hear movement of air and can see the pa-

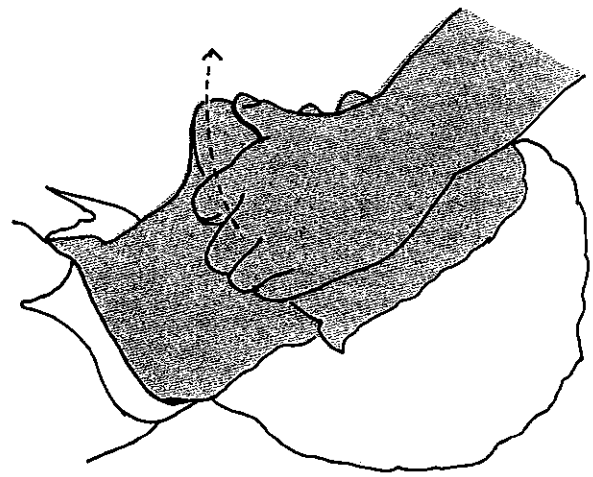


Fig. 4–8. In the jaw-thrust maneuver, the EMT places the fingers behind the angle of the patient's jaw and forcefully brings it forward.

Fig. 4–9. Respiration is determined by feeling the movement of air on the cheek, by hearing it, and by seeing the chest and abdomen move with each breath.

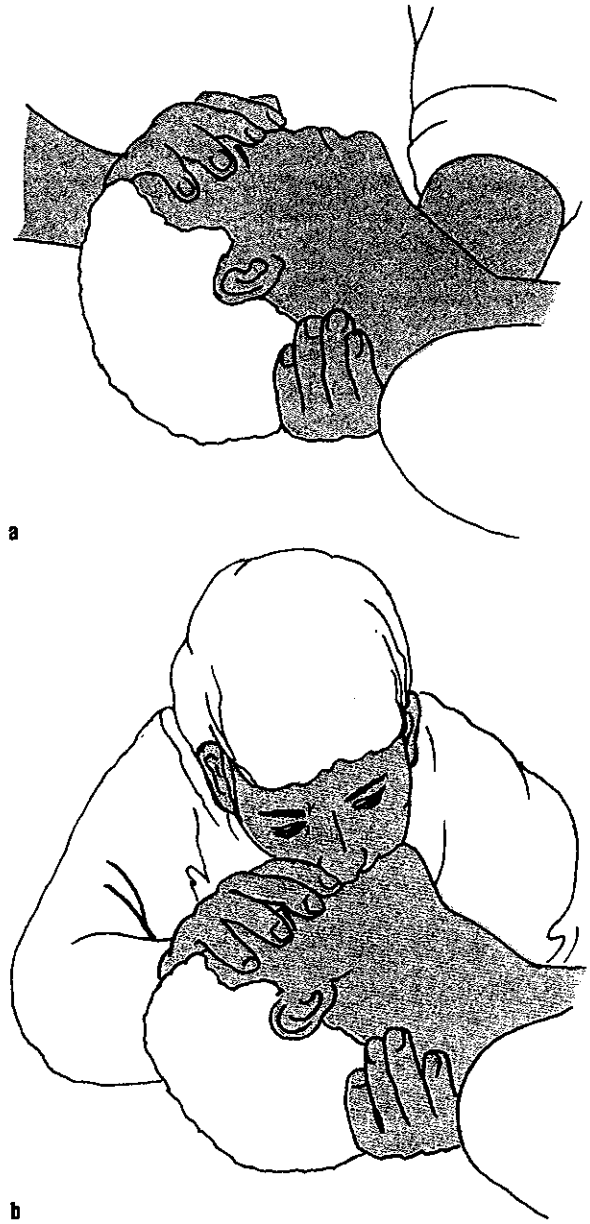
tient's chest and abdomen move, breathing has returned. Feeling and hearing are far more important than seeing. With airway obstruction, it is possible there will be no air movement even though the chest and abdomen rise and fall with the patient's attempts to breathe. Also, observing chest and abdominal movement is difficult in a fully clothed patient. Finally, there may be no chest movement even with normal breathing in patients who have chronic obstructive pulmonary disease.

Restoring breathing

No equipment is required to give effective artificial ventilation. It should never be delayed while the EMT obtains or applies devices for ventilatory assistance. Artificial ventlation, whether mouth-to-mouth, mouth-to-nose, or mouth-to-stoma, should deliver at least twelve breaths per minute in the adult.

Mouth-to-mouth. If the patient does not promptly resume adequate breathing after the airway is opened, artficial ventilation must be started. The exhaled air used in artificial ventilation contains about 16% oxygen; this is sufficent to sustain the patient's life.

To perform *mouth-to-mouth ventilation,* the EMT keeps or places one hand under the patient's neck and, with the other hand, pinches the patient's nostrils together, using the thumb and index finger. At the same time, with the heel of the hand the EMT continues to exert pressure on the forehead to maintain the backward tilt of the head (Fig. 4–10a). Alternatively, the EMT can use the head tilt-chin lift technique for keeping the airway open during mouth-to-mouth ventilation. The EMT then opens the mouth widely, takes a deep breath,



a

b

Fig. 4–10. Mouth-to-mouth ventilation is achieved, **a**, by the EMT's sealing off the patient's nose, and **b**, by encircling the patient's open mouth with the EMT's own and exhaling deeply into it.

makes a tight seal with the mouth around the patient's mouth and exhales into the patient's mouth (Fig. 4–10b). The EMT then removes his mouth and allows the patient to exhale passively, turning slightly to watch the patient's chest fall. The first four breaths must be given in rapid succession without waiting for the patient's lungs to deflate completely between breaths. This succession of breaths helps to reexpand the collapsed lungs.

Adequate ventilation is ensured if on every breath the EMT does the following:

1. Sees the patient's chest rise and fall
2. Feels the resistance of the patient's lungs as they expand
3. Hears and feels the air escape during exhalation

If the head tilt-chin lift technique is used, the thumb of the hand lifting the chin can be used to depress the lower lip and thus keep the mouth open during mouth-to-mouth ventilation.

When using the jaw-thrust for-mouth-to-mouth ventilation, the EMT must move to the patient's side, keep the patient's mouth open with both thumbs, and seal the nose by placing a cheek against the nostrils.

Mouth-to-nose. In some cases, mouth-to-nose ventilation is more effective than mouth-to-mouth ventilation. It is recommended when it is impossible to open the patient's mouth; when it is impossible to ventilate the patient through the mouth because of severe facial injuries; when it is difficult to achieve a tight seal around the mouth in a patient without teeth, or when, for some other reason, the EMT prefers the nasal route.

For the mouth-to-nose technique, the EMT keeps the patient's head tilted back with one hand on the forehead and uses the other hand to lift the patient's lower jaw (Fig. 4–11). This maneuver seals the lips. The EMT then takes a deep breath, seals the lips around the patient's nose, and blows in until the lungs are felt to expand. Then the EMT's mouth is removed, and the patient is allowed to exhale passively. The EMT can see the chest fall when the patient exhales. It may be necessary to open the patient's mouth or separate the patient's lips to allow air to escape during exhalation because the soft palate may block the nasopharynx and prevent air from exiting through the nose. When using the jaw-thrust for mouth-to-nose ventilation, the EMT uses his cheek to seal the patient's mouth and does not use his thumb to retract the lower lip.

Fig. 4–11. The technique of mouth-to-nose ventilation.

Gastric distention

Artificial ventilation frequently causes distention of the stomach. This occurs most often in children, but it is also common in adults. It is most likely to occur when excessive pressures are used for ventilation or when the airway is obstructed. Slight gastric distention may be disregarded, but marked inflation of the stomach is dangerous because it promotes regurgitation and reduces lung volume by elevating the diaphragm. Gastric distention that interferes with adequate ventilation should be relieved promptly. Frequently one can do so by exerting moderate pressure on the patient's abdomen between the umbilicus and the rib cage with the flat of the hand. To prevent aspiration of gastric contents during this maneuver, the patient's head and shoulders should be turned to one side and a suction device kept ready for immediate use.

Airway Obstruction

Upper airway obstruction can cause unconsciousness and cardiopulmonary arrest, or

it can be the result of the arrest itself. Either event can be fatal.

Sudden airway obstruction by a foreign body in an adult usually occurs during eating; in a child it occurs during eating or at play (sucking small objects).

There can be other causes of airway obstruction. A patient who becomes unconscious can suffer airway obstruction because the tongue falls back into the pharynx, blocking it and obstructing the upper airway. Regurgitation of gastric contents into the pharynx can occur during cardiopulmonary arrest or during CPR and thereby block the airway. Also, in head and facial injuries, blood clots, tooth and bone fragments, and loose tissue may obstruct the upper airway, particularly if the patient is unconscious.

Recognition of foreign body obstruction

Early recognition of airway obstruction is the key to successful management. The EMT must learn to differentiate between primary airway obstruction and other conditions resulting in respiratory failure or arrest, such as fainting, stroke, or heart attack.

The EMT may be faced with two situations in which upper airway obstruction is present:

1. The patient may be conscious when discovered but become unconscious
2. The patient may be unconscious when discovered.

Conscious patient

Sudden upper airway obstruction is usually recognized when a patient who is eating or has just finished eating is suddenly unable to speak or cough, grasps the throat, appears cyanotic, or shows exaggerated breathing efforts. Air movement is either absent or not detectable. Initially the patient will remain conscious, but if the obstruction is not removed in a short period of time, the oxygen in the lungs will be used up because the obstructed airway prevents the entry of air into the lungs. Unconsciousness and death will follow.

Patient found unconscious

When a patient is discovered unconscious, the cause is initially unknown. The unconsciousness may have been caused by airway obstruction or cardiopulmonary arrest. Any patient found unconscious must be managed as a patient with cardiopulmonary arrest, and the obstructed airway should be dealt with only as it becomes apparent during the correct sequence of resuscitative maneuvers.

Maneuvers to Relieve Upper Airway Obstruction

Three manual maneuvers are recommended for relieving foreign-body airway obstruction: back blows, manual thrusts, and finger sweeps.

Back blows

A series of four back blows should be delivered in rapid succession. These consist of sharp blows delivered with the EMT's hand over the patient's spine between the scapulae. The technique should be applied whether the patient is sitting, standing, or lying down.

With the patient sitting or standing:

1. The EMT is positioned at the side of and slightly behind the patient
2. The EMT delivers sharp blows with the hand to the patient's spine between the scapulae
3. The other hand may be placed in front of the patient's chest for support.

With the patient lying down:

1. The EMT kneels down and rolls the patient so that the patient's chest rests against the EMT's knees
2. The EMT delivers sharp blows with the hand to the patient's spine between the scapulae.

Manual thrusts

A rapid series of up to four thrusts is delivered to the upper abdomen (abdominal thrust) or lower chest (chest thrust).

Abdominal thrust. With the patient sitting or standing:

1. The EMT stands behind the patient, with arms wrapped about the patient's waist
2. The EMT grasps one fist with the other hand and places the thumb side of the fist against the patient's abdomen, between the xiphoid and umbilicus
3. The EMT presses the fist into the patient's abdomen with a quick upward thrust (Fig.

Fig. 4–12. Proper positioning of the hands for applying abdominal thrusts in the erect adult.

4–12). This is then repeated three more times.

For the abdominal thrust with the patient lying down, the EMT should modify the technique as follows:

1. Positioning the patient supine, the EMT kneels close to the patient's hips or straddles either the hips or one leg of the patient
2. The EMT places the heel of one hand against the patient's abdomen between the xiphoid and umbilicus. The second hand is placed on top of the first.

Fig. 4–13. Proper positioning of the hands for abdominal thrusts in the supine patient.

3. The EMT presses the hand into the patient's abdomen with a quick upward thrust and repeats the thrust as above if necessary (Fig. 4–13).

Chest thrust

When the patient is so large in the abdomen, as in advanced pregnancy or gross obesity,

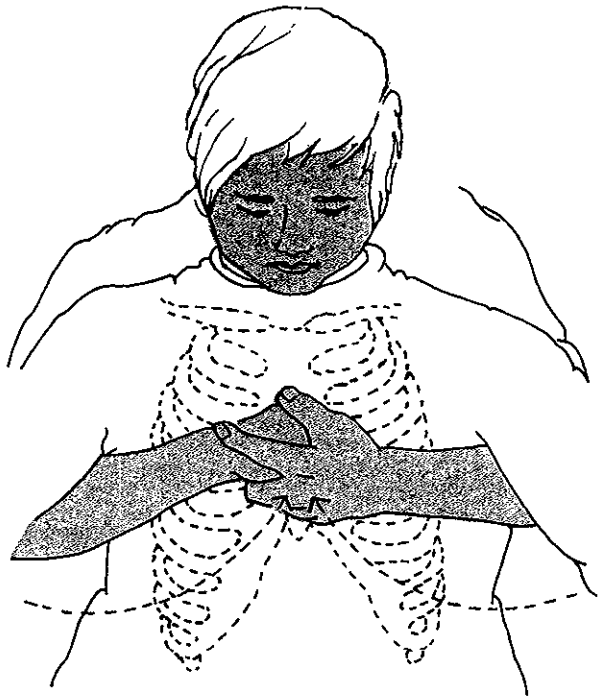


Fig. 4–14. Proper technique of the chest thrust in the erect patient.

and the EMT is unable to wrap the arms fully about it, an alternative technique, the *chest thrust*, can be appiled.

With the patient sitting or standing:

1. The EMT wraps his hands under the patient's arms to encircle the patient's lower chest
2. and grasps one fist with the other hand, with the thumb side of the fist on the lower sternum but clear of the xiphoid process.
3. The EMT presses the fist into the patient's chest with a quick backward thrust (Fig. 4–14). Up to four thrusts are delivered if necessary.

With the patient lying down:

1. The EMT positions the patient supine and kneels close to the side of the patient's body.
2. The EMT places his hands on the sternum in exactly the same manner as for external chest compression and applies compressions as would be performed for CPR. Four downward thrusts are applied.

Combined use of back blows and manual thrusts

Back blows produce an instantaneous increase in pressure in the respiratory passages, which may result in either partial or complete dislodgment of a foreign body. The manual thrusts produce a lower, though more sustained, increase in pressure in the respiratory passages and may further assist in the dislodgment of the foreign body. The combination of these two techniques appears to be a more effective method of clearing upper airway obstruction than the single use of one or the other. It is not clear, however, if one sequence is more effective than another, and thus either back blows followed by thrusts or thrusts followed by back blows can be used.

Manual removal of foreign body

If at any time the foreign body causing the airway obstruction appears in the mouth or is believed to be in the mouth, it should be removed cautiously by the EMT with his fingers. Back blows and manual thrusts may dislodge the foreign body but not expel it, for in unconsciousness, the patient's jaw muscles relax. The EMT can use either a *cross-finger technique* or a *tongue-jaw lift* to probe the mouth with a finger.

Cross-finger technique for opening the mouth

1. The thumb is crossed under the index finger.
2. The thumb and the index finger are braced against the patient's lower and upper teeth respectively.
3. As the fingers are pushed apart, the patient's jaw is forced open (Fig. 4–15).

Tongue-jaw lift for opening the mouth

1. The head is kept in the neutral position.
2. The patient's mouth is opened by grasping both the tongue and lower jaw between the thumb and fingers and lifting them forward. This action pulls the tongue away from the back of the throat and away from the foreign body that may be lodged there.

Finger probes

1. Hold the patient's mouth open with either the cross-finger or tongue-jaw lift technique.
2. Use the index finger of the other hand as a hook to sweep down the inside of the patient's cheek to the base of the tongue.
3. The index finger is then used as a hook to attempt to dislodge the impacted foreign body up into the mouth.
4. When the foreign body comes within reach, grasp and remove it.

Care should be taken when finger probes are attempted that a dislodged foreign body is not pushed back into the airway.

Fig. 4–15. The cross-finger technique to open the mouth.

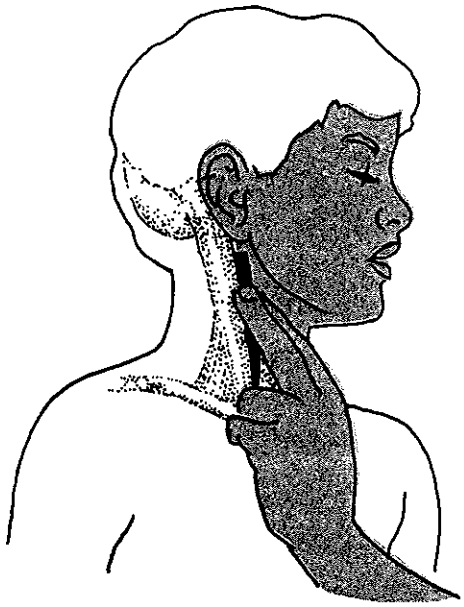


Fig. 4–16. The carotid pulse is felt in the groove between the larynx and the sternocleidomastoid muscle.

Artificial Circulation

A disturbance of the regular rhythm of the heart may prevent adequate cardiac contraction, resulting in failure to generate blood flow and produce a pulse. The absence of a strong, palpable central pulse, such as the carotid pulse in the neck, indicates no blood flow and hence cardiac arrest.

After determining unconsciousness, turning the patient if necessary, opening the airway, and giving four quick breaths, the EMT must assess the status of the patient's circulation. Cardiac arrest is determined by the absence of a palpable pulse in a large artery. The carotid is such an artery; it is close to the heart, large in diameter, and palpable in the neck. It is found most easily by locating the larynx at the front of the neck and then sliding two fingers toward either side of the neck. The carotid pulse is felt in the groove between the larynx and the sternocleidomastoid muscle with the pulp of the index and long fingers (Fig. 4–16). Light pressure is sufficient. Excessive pressure should not be applied because it can obstruct the circulation, dislodge blood clots, or produce marked cardiac slowing.

The hand on the forehead that had previously been maintaining backward head tilt can be left in position to maintain the airway, but it is not necessary to continue to pinch off the nostrils. The hand previously placed beneath the neck is used for locating the carotid pulse.

If the pulse is present but breathing is absent, the EMT should ventilate the patient once every five senconds until adequate breathing resumes.

If the pulse is absent, the EMT should start external chest compression, which adds artificial circulation to the already initiated artificial ventilation.

External Chest Compression

The heart lies slightly to the left of the middle of the chest between the sternum and the spine (Fig. 4–17). Rhythmic pressure and relaxation applied to the lower half of the sternum compresses the heart and produces artificial circulation. In a patient with cardiac arrest, the carotid artery flow resulting from external chest compression is only about one-quarter to one-third normal.

External chest compression must always be accompanied by artificial ventilation.

The patient must be on a firm, flat surface. This may be the ground, the floor, or a spine board on an ambulance litter. If in bed, the patient should be placed on the floor. This is

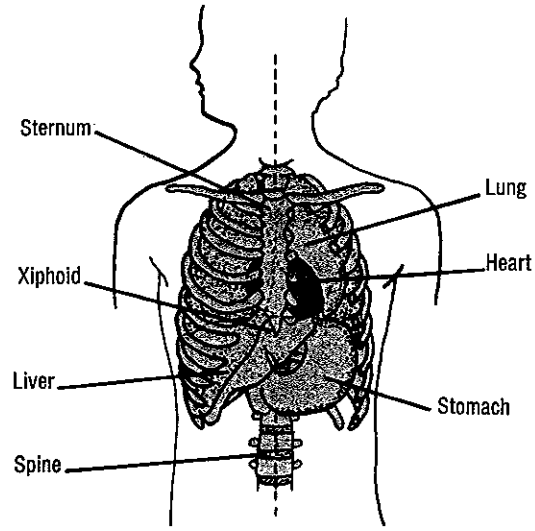


Fig. 4–17. The heart lies slightly to the left of the middle of the chest, between the sternum and the spine, with the lungs on either side and with the liver and stomach below.

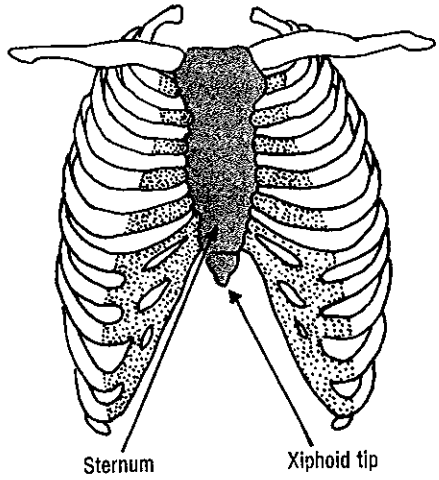


Fig. 4–18. The xiphoid process is at the lower tip of the sternum and extends downward over the upper abdomen.

quicker than looking for some type of support and thus does not delay cardiac compression.

Technique of external chest compression

The EMT kneels close to the patient's side, with one knee at the level of the head and the other at the level of the upper chest, and places the heel of one hand on the lower half of the sternum. Great care must be taken *not* to place the hand on the xiphoid process, which extends downward over the upper abdomen (Fig. 4–18), or beside the sternum onto the ribs. Correct positioning of the hands is achieved in the following manner: The index and long fingers of the hand nearer the patient's feet are slid along the edge of the rib cage until the fingers reach the notch in the center chest (Fig. 4–19a). The long finger is pushed as high as possible into the notch, and the index finger is then laid on the lower portion of the sternum with the two fingers touching (Fig. 4–19b).

The heel of the other hand is then placed on the lower half of the sternum (Fig. 4–19c) so that it touches the index finger of the first hand. The first hand is then removed from the notch in the center of the rib cage and applied over and parallel to the hand now resting on the patient's lower sternum (Fig. 4–19d).

Only the heel of one hand is in contact with the lower half of the sternum.

The technique may be improved or made more comfortable for the EMT if the fingers of the lower hand are interlocked with the fingers of the upper and pulled slightly away from the chest wall. Pressure is exerted vertically downward through both arms to depress the adult sternum 1½–2 inches. A rocking motion allows pressure to be delivered vertically downward from the shoulders while the arms are kept straight (Fig. 4–20). Vertical pressure downward produces a compression which should be immediately followed by a period of relaxation. The time spent in the compression phase is a crucial factor in determining blood flow. At least 50% of the compression-relaxation cycle should be spent in compression. Short, jabbing compressions are ineffective in producing blood flow. The heel of the EMT's hand should not be removed from the chest during relaxation, but pressure on the sternum should be completely released so it can return to its normal resting position between compressions. Compression and relaxation must be rhythmic. The EMT must not jab downward; neither should the EMT's hands bounce or come away from the patient's chest (Fig. 4–21).

Resuscitation

When two EMTs are performing CPR, the compression rate should be sixty per minuts, with a single breath given after each fifth compression (ratio 5:1). To help maintain a compression rate of sixty per minute, the EMT delivering the compression can count: "one thousand one, one thousand two, one thousand three," etc., as approximately one second is required to say this phrase. The two EMTs can provide more effective CPR than a single EMT because ventilation can be delivered without any pause in compression; and, since cardiac compression is not interrupted, blood pressure is never allowed to fall to zero.

If a second EMT becomes available after single-EMT CPR has been started and is in progress, the recommended procedure for entry of the second EMT is as follows: Without stopping CPR, the original EMT lets the new EMT know that everything is ready for switch to two-EMT CPR. The new EMT should check the patient's pulse to make sure that the first EMT has correctly diagnosed the patient's condition. The new EMT should then kneel down on the side of the patient opposite the original EMT, in position for artificial ventilation, fing-

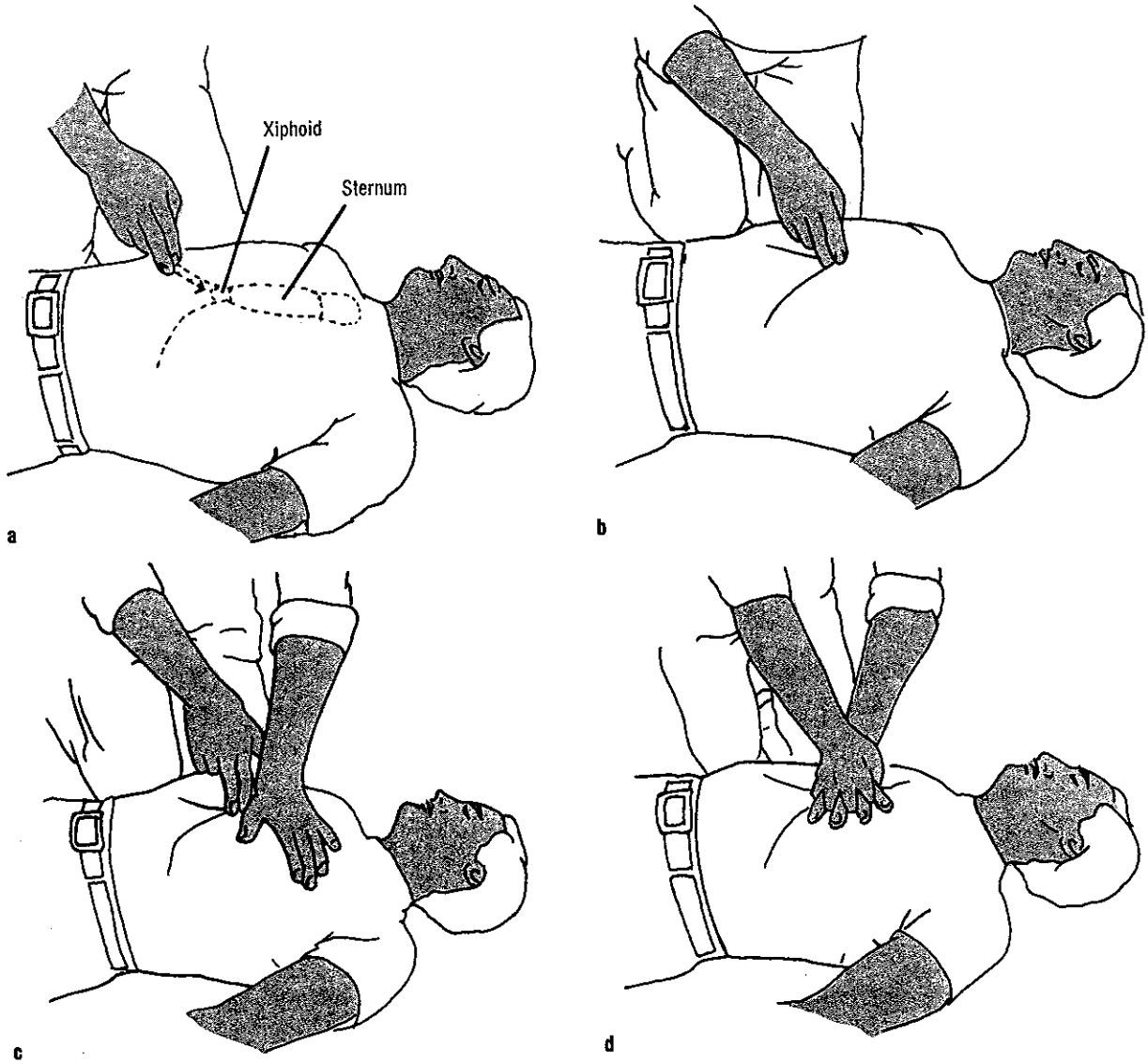


Fig. 4-19. The correct hand position for chest compression is shown. **a,** The index and long fingers of the EMT's hand nearer the patient's feet are slid along the center of the patient's rib cage to the notch in the center of the chest. **b,** The long finger is pushed high into the notch, and the index finger laid on the lower portion of the sternum. **c,** The heel of the second hand is then placed on the lower half of the sternum, touching the index finger of the first hand. **d,** The first hand is then removed from the notch and applied over and parallel to the hand on the sternum.

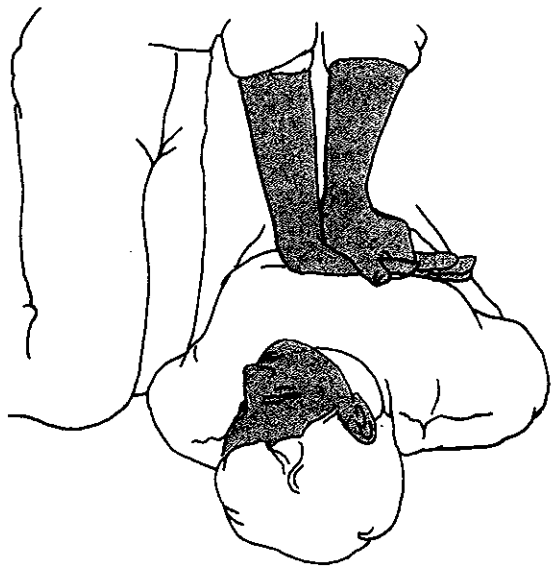


Fig. 4–20. External chest compression is produced by vertical downward pressure through both arms to depress the adult sternum 1½–2 inches.

ers in position to feel the carotid pulse. If compressions are adequate, a pulse should be present; if no pulse is felt, the compressor's technique should be evaluated. The new EMT should call out, after feeling a pulse with each compression, "Stop compression." The original EMT should stop compressiong for five seconds so the new EMT can check for a spontaneous pulse. If none is found, two-EMT CPR is begun. The new EMT should deliver a breath immediately after confirming pulselessness. This entire process, from the moment the new EMT arrives to the point when a breath is delivered, should be done in as little time as possible to ensure that CPR continues effectively. As soon as this breath is delivered, the original EMT changes to the two-person rate. Artificial ventilation is then interposed during the upstroke of each fifth cardiac compression.

Two-EMT CPR should be performed with the EMTs on opposite sides of the patient (Fig. 4–22). They can then switch positions when necessary without significant interruption in the 5:1 sequence. To switch, the EMT who is providing ventilation, after giving a breath, moves into position for compression. The EMT performing compression, after the fifth compression, moves to the patient's head and checks the pulse for five seconds but no longer. If no pulse is felt, the EMT at the head ventilates the patient and says, "continue CPR." Using this technique, sixty cardiac compressions can be provided per minute.

Effectiveness of CPR

The reaction of the pupils to light should be checked periodically during CPR, since constriction provides a good indication of the delivery of oxygenated blood to the patient's brain. Pupils that constrict when exposed to light indicate adequate oxygenation and blood flow to the brain. If the pupils remain widely

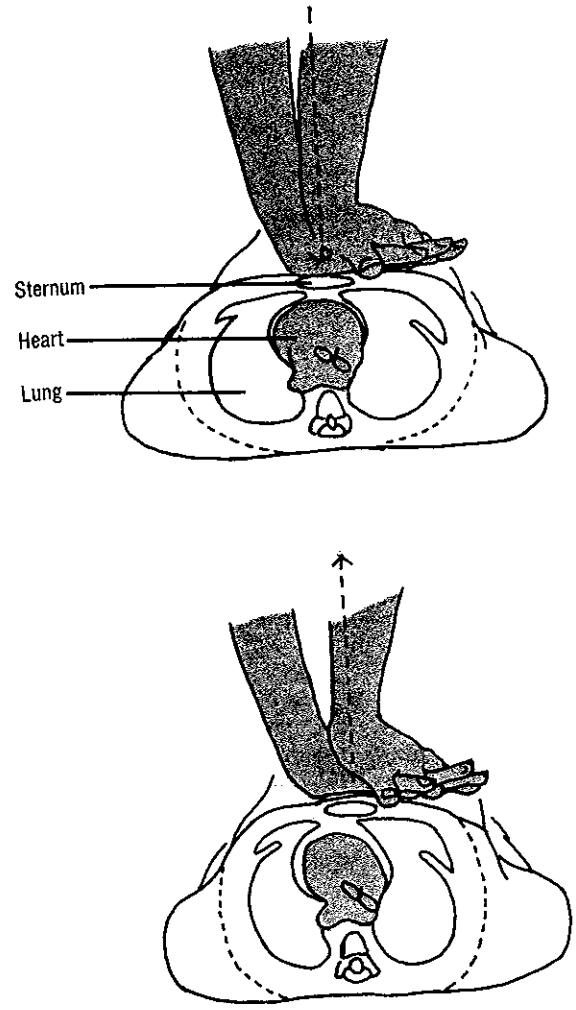


Fig. 4–21. Compression and relaxation should be rhythmic and of equal duration. The heel of the hand should not be removed from the sternum, but pressure on the sternum should be released so it can return to its normal resting position between compressions.

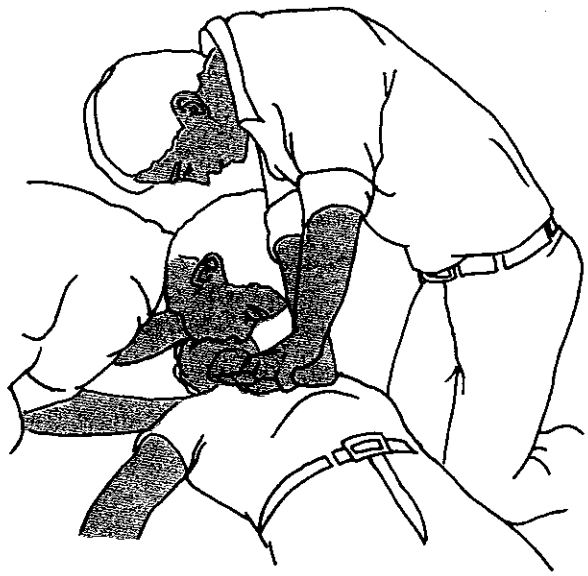


Fig. 4-22. When two EMTs perform CPR, one is on each side of the patient. Here, one EMT performs mouth-to-mouth ventilation while the other delivers external chest compression.

dilated and do not react to light, serious brain damage may be imminent or may have occurred (Fig. 4-23). Dilated but reactive pupils are a less ominous sign. However, it must be emphasized that normal pupillary reactions may be altered in the elderly and frequently are altered in any individual by the administration of drugs.

The carotid pulse should be palpated periodically during CPR to check the effectiveness of extrenal cardiac compression or the return of a spontaneous effective heartbeat. Palpation should be done after the first minute of CPR and every few minutes thereafter. Pupils and pulse should be checked by the EMT performing the ventilation, particularly just before the change of EMTs.

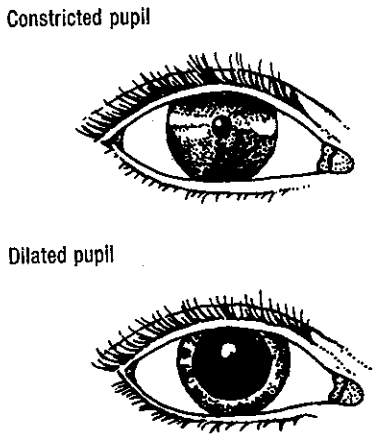


Fig. 4-23. A constricted pupil and a dilated pupil are shown for comparison.

CPR Interruption

Do not interrupt CPR for more than five seconds for any reason.

Without the addition of monitoring, lifeline, drugs, and defibrillation (advanced life support), basic life support will rarely be sufficient for patient survival, regardless of how well it is performed. If advanced life-support modalities cannot be brought to the scene, the patient must be moved promptly to the hospital.

OXYGEN ADMINISTRATION

Oxygen should be given as soon as it is available. If the patient is breathing without assistance but is unconscious or cyanotic (bluish skin), oxygen inhalation should be started. Also, oxygen should be given to all carbon monoxide and toxic gas patients even when conscious.

Because a mask provides the highest concentration (approaching 100%) of oxygen, it is the preferred method. A well-fitting mask made of clear plastic should be selected so the patient can be observed for vomiting. Some patients are afraid of the mask and it is important to overcome this fear. If able, the patient should be allowed to breathe a few times with it, and a few times without it. The instructions given with the mask and oxygen tank should be followed carefully. *No open flames or smoking should be allowed in the area where oxygen is administered.*

Relatively low concentrations of oxygen should be sufficient for many patients, but high concentrations may be required. Medical advice by radio should be obtained.

Oxygen administration—should this become necessary over prolonged periods of time the large size cylinder used in the machine shop could be considered for use, provided the necessary flow regulator and humidifier are specified. The Robert Shaw demand valve is very useful in extending the limited medicinal oxygen carried aboard in portable apparatus.

SUCTION (ORAL AND NASAL)

The air passages may be blocked by mucus, vomitus, or foreign material in the mouth or nose, or both. The head of the patient should be turned to one side to allow the fluids to drain away and the fingers of the rescuer should be swept through the mouth to remove the blockage. The rescuer's fingers may be wrapped in a piece of cloth or gauze to help remove the mucus and slippery objects. If these methods are not successful, suction will have to be used.

Suction is negative pressure (drawing pressure, vacuum) created by a mechanical or hand-operated apparatus (aspirator). When the suction tip (suction catheter or rigid pharyngeal suction tip) is placed in the mouth, the fluids are drawn through the tube into a catch jar. This jar is located between the patient and the source of the vacuum. While suction will remove fluids from the mouth and throat, fingers may have to be used to wipe out solid matter.

Either a suction catheter or a rigid pharyngeal tip can be used to suction the mouth. The following recommended suction catheter sizes* should be used:

Newborn	6 French
6 months to 3 years	8 French
5 years to 16 years	10 French
Adult (Female)	12 French
Adult (Male)	14 French

Oral Suction

When suctioning the mouth, this procedure should be followed:

- Use one hand to open the mouth for the insertion of the catheter or pharyngeal tip.
- Do *not* insert the catheter or pharyngeal tip too far into the mouth and throat as it may make the patient vomit or may produce a laryngospasm.
- Perform the suctioning quickly in a few seconds and repeat as needed.

Nasal Suction

- Do *not* attempt to suction the nose by inserting the catheter or pharyngeal tube into the nose. Serious bleeding may develop from nasal injury.
- If nasal suction is essential, place the suction tip at the opening of the nostrils.

When suctioning, the tubing must be rinsed frequently to avoid clogging. The tube should be immersed in a jar of water and a short spurt of water allowed to clear the tube. The suction equipment should be kept clean by washing it with hot water and soap; and if possible, sterilize it after use.

RESUSCITATION IN ELECTRIC SHOCK

The type and the extent of an injury from electric shock will depend upon the amount and frequency of the current, the duration of contact with the current, and the pathway through the tissue. The resistance of the body primarily is centered on the skin. A dry, well-keratinized, intact skin provides a higher resistance to electricity than moist thin skin and electrical contact is more easily established.

The resulting injuries from electric shock may range from benign to fatal ones. Other than burns and injuries from falls, the possible emergency conditions include:

Tetany (painful spasms) of the musculature of breathing. This usually is limited to the duration of the shock. However, it may cause secondary cardiac arrest to occur when the shock is a prolonged one.

Prolonged paralysis of respiration. This may last for minutes after the shock as a result of massive convulsions.

Heart flutter (ventricular fibrillation) or other serious disturbances of heart rhythm (arrhythmias).

The *cardiopulmonary status* of the patient should be determined as soon as the electrical object has been cleared. Cardiopulmonary resuscitation should be started immediately if spontaneous respirations or circulation are absent. The procedure for CPR is given on p. IV–1+.

Effective CPR only can be performed with the patient in a horizontal position on a hard surface. In cases where the patient cannot be placed immediately into a horizontal position,

* One size smaller or larger should be allowed for individual variations.

but where the rescuer can reach the victim within one minute after the accident, a precordial thump should be delivered and mouth-to-mouth ventilation started immediately. The *precordial thump* is a sharp, quick single blow delivered over the midportion of the sternum, hitting with the bottom, fleshy portion of the fist, 8 to 12 inches from the victim's chest. *Then* the patient should be moved quickly to a flat surface and CPR started. If more than 60 seconds elapse between electric shock and rescue, the precordial thump should not be given. Instead, the victim should receive artificial ventilation and be moved as quickly as possible to a horizontal position, prior to initiating CPR.

RESUSCITATION IN DROWNING

Drowning is a type of suffocation caused by a breathing in of fluids or a spasm of the voice box (larynx). Basic life support resuscitation principles are the same as presented previously on p. IV–1+, and should be performed immediately.

A drowning victim must be rescued as quickly as possible. Most incidents occur within reach of the rescuer, thus, even a non-swimmer can be of assistance. If the drowning occurs near a dock, pool side, shore, or a boat, the rescuer should lie down and extend a hand, foot, piece of clothing, towel, fishing pole, rope, stick, or other objects to the victim. (See Fig. 4–9.) A ring buoy also may be used to pull the victim to safety, if available. If the drowning occurs too far from shore to extend an object, a boat or surfboard should be used to rescue the victim. The life of the rescuer should *not* be endangered while attempting to rescue a drowning person.

Artificial ventilation should be started *immediately*. Although mouth-to-mouth ventilation may be performed while in the water, it may be difficult or impossible because of the depth of the water. In such situations, a flotation device may be used to support the head of the victim, while performing mouth-to-mouth ventilation. The rescuer may have to postpone artificial ventilation until he can stand in shallow water. *Effective cardiac compression cannot be performed in the water.*

Whenever a neck or back injury is suspected, the victim *must* be removed from the water on a back support. If available, a backboard should be slipped under water and allowed to float up to the victim. (See Fig. 4–10.) If a backboard is not available, such items as a wide board or door may be used. The victim should be secured to the support with any available material to prevent sliding or rolling. (See Fig. 4–11.) The victim should be kept as level as possible while being removed from the water. When materials or assistance are not available, the victim should remain in the water until they do arrive. If removal is urgent because of excessive bleeding, cardiac arrest, or very cold water, the victim's back should be kept as level as possible. See p. IV–1, for *modified jaw thrust* that should be used in cases of suspected neck injuries.

Stomachs of drowning victims usually become distended due to the large amount of water swallowed. The water may be forced out and distention relieved by turning the victim on the side and compressing the upper abdomen. Also, the victim may be turned into a prone (face downward) position and lifted under the stomach with the rescuer's hands to force the water out.

All patients saved from drowning should be evacuated to a medical facility for additional care.

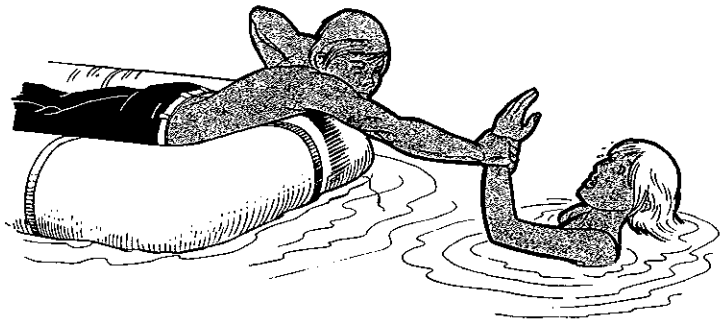


Fig. 4–24.
Rescuing a drowning victim.

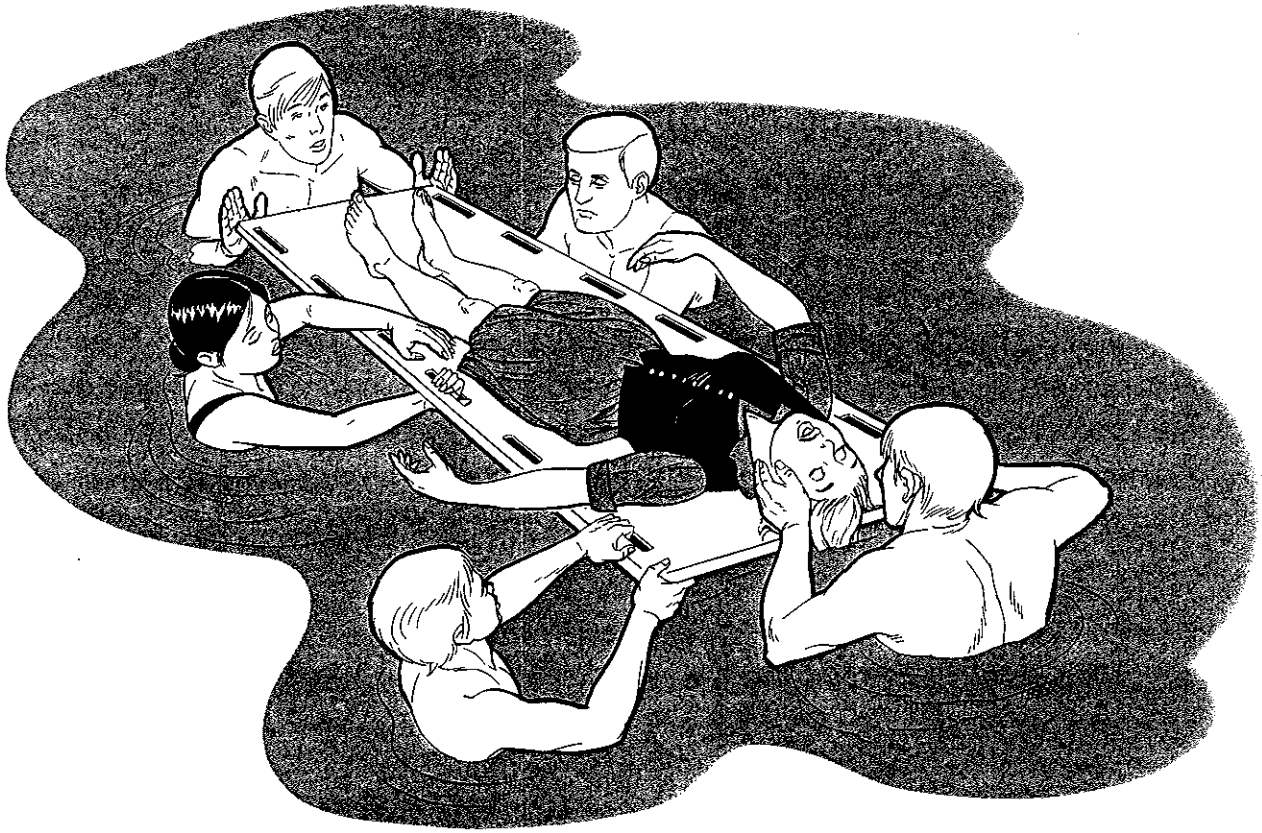


Fig. 4–25. Placing a backboard under a drowning victim.

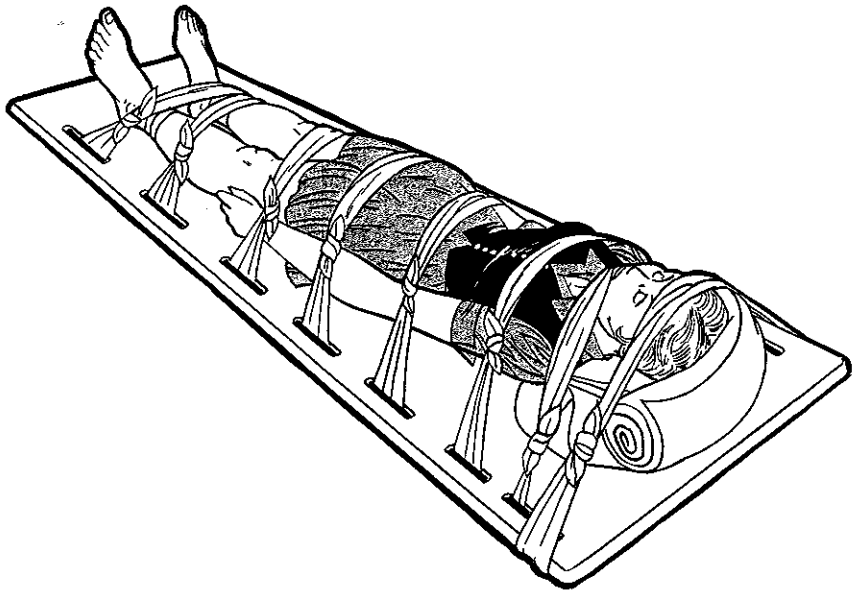


Fig. 4–26. Drowning victim secured to a backboard.

NOXIOUS GASES

Suffocation (asphyxia) may occur when the air we breathe contains noxious (harmful or poisonous) gases as carbon monoxide; carbon dioxide; carbon tetrachloride; petroleum products (as gasoline, kerosene, benzene, ether); and refrigerants (as Freon®, ammonia, carbon dioxide, methyl chloride). These and other noxious gases cause asphyxiation because they block the air passageway to the lungs, or unite with the hemoglobin in red blood cells so that insufficient oxygen is carried to the brain.

General Treatment

When smoke or noxious gases are inhaled, some general rules for first aid are: (1) remove the victim as quickly as possible from the contaminated area of the vessel to a section that has plenty of fresh air; (2) administer oxygen if the person is breathing; (3) if breathing has stopped, give mouth-to-mouth resuscitation (see p. IV–1+); (4) if both spontaneous circulation and respiration are absent, apply cardiopulmonary resuscitation (see p. IV–1+); (5) treat for shock (see p. III–9+); (6) remove clothing that absorbed the gas; and (7) keep the patient lying down, covered, and quiet.

Caution: *For a victim of toxic gas inhalation, as hydrogen cyanide, mouth-to-mouth resuscitation is not recommended because of the potential danger to the rescuer. Instead, a manual resuscitation procedure should be used. (See p. IV–23+ for a description of the Back Pressure-Arm Lift Technique.)*

Medical advice by radio should be obtained. As a general rule, medications other than oxygen should be administered only upon competent medical advice.

Rescue Precautions

Many noxious gases (as carbon monoxide, carbon dioxide, hydrogen, Freon®) have no odor to warn anyone of their presence. Also, safety measures against fire and explosion must be made for combustible gases as hydrogen, carbon monoxide, and methyl chloride, among others.

If the victim of gassing is in a closed compartment or at the bottom of a hold, *a rescuer should go down only if he has a lifeline attached around his chest and under the armpits.* Another lifeline should be taken to be attached in a similar manner to the casualty. Also where victims are exposed to gas or lack of oxygen, rescuers should use a breathing apparatus, smoke helmet, or smoke mask with a tube attached to open air. Nothing should be done that will jeopardize the safety of the rescuer or victim. If the victim will not be rescued quickly, a breathing appartus should be taken down to him.

When no breathing apparatus is carried aboard ship, extreme care must be taken if a rescuer goes below to bring up a victim. The rescuer should be pulled up immediately if contact is lost by voice or by line and the lifeline goes taut. *A gas mask gives little or no protection and is of no value as a breathing apparatus.*

Ammonia Gas in Air

Ammonia is an alkali. It is used as a refrigerant.

Breathing ammonia vapor in low concentrations will cause watering and irritation of the eyes and catching of the breath or coughing. Highly concentrated ammonia vapor causes choking, and intense irritation and corrosion of the air passageway. Collapse, respiratory arrest and death can result. Other symptoms may be excessive salivations, nausea, vomiting, diarrhea, abdominal pain, shock, and convulsions.

Treatment

Remove the victim to a well-ventilated space. Flush the eyes with water for at least five minutes. Give a dilute solution of citrus fruit juice or vinegar diluted with equal parts of water to act on gastrointestinal irritation. Apply artificial respiration. If the patient is breathing, have oxygen inhaled under positive pressure to prevent excessive accumulation of fluid in the lungs. Respiratory depressant narcotics as morphine sulfate and codeine sulfate should *not* be given. *Medical advice by radio should be obtained* on ammonia inhalation.

Carbon Dioxide

This colorless, odorless gas is heavier than air and may collect in holds and compartments

of vessels. Suffocation from carbon dioxide may occur while fighting a fire in a hold. The gas may be used as a refrigerant. Grain in the hold that ferments and refrigerated cargoes of certain foods may produce the gas. Exposure to carbon dioxide causes giddiness, headache, breathing difficulties, and loss of consciousness.

Treatment

The victim should be removed to fresh air and oxygen inhalation administered. If respiration has ceased, mouth-to-mouth resuscitation should be given. (See p. IV–1+.) *Medical advice by radio should be obtained* on handling exposure to carbon dioxide gas.

Carbon Monoxide

This gas is colorless, odorless, lighter than air, and combustible. Carbon monoxide is produced from incomplete combustion of organic matter in fires that may occur in the hold of a vessel, from some explosions, and the exhaust gases of gasoline and oil-driven engines. It can form in ill-ventilated stokeholds when refrigerated meat cargoes decompose. Carbon monoxide reacts with the hemoglobin of the red blood cells to cut off the body's oxygen supply. Exposure to this gas produces dizziness, intense headache, muscular weakness, throbbing in temples, dilated pupils, and breathing difficulty that results in unconsciousness. In severe cases the lips may be bright red, and the skin of the face and body has a pink color. In high concentrations of carbon monoxide, a person will die in a few minutes.

Treatment

The patient should be removed from the contaminated air as quickly as possible with little or no exertion on his part. Artificial respiration by mouth-to-mouth should be applied. If the patient is breathing, inhalations of 100% oxygen should be given. He should be kept in bed and chilling avoided. *Medical advice by radio should be obtained on caring for those exposed to carbon monoxide.*

Cyanides

Hydrogen cyanide or hydrocyanic acid is used to fumigate ships. Both the solid cyanides and the gaseous form are extremely poisonous. Refer to p. III–64+ for detailed information. *Medical advice by radio should be obtained.*

Carbon Tetrachloride

Other Chlorinated Hydrocarbons

Carbon tetrachloride is a poison that affects the nervous system. Prolonged exposure causes loss of consciousness. Low level exposure causes headache, dizziness, and a feeling of depression and confusion with loss of coordination. Extensive liver and kidney damage can follow one high-level exposure or repeated exposures to low level concentrations. The symptoms of poisoning often are delayed. A victim exposed to a toxic concentration of the vapor often does not realize his condition, until he becomes dangerously ill several hours later. Signs of poisoning include nausea, headache, mental confusion, and occasionally drunken behavior like that caused by alcohol. Eyes, nose, throat, and lungs will show considerable irritation.

The chlorinated hydrocarbons have had wide usage as solvents for dissolving oils, fats, and waxes. They have been used for dry cleaning, degreasing metal articles, and cleaning electric and electronic equipment. However, this type of usage is being restricted because of the poisoning potential of these chemicals.

Carbon tetrachloride in the past has been used in some fire extinguishers, but this use is not widespread now. Not only is inhalation of its vapor poisonous, but fire and heat will decompose it to form phosgene gas—a deadly irritant that has been used as a chemical warfare agent.

Treatment

For inhalation of carbon tetrachloride (and other chlorinated hydrocarbons) move the victim from the toxic area. Remove contaminated clothing. If he is breathing, give oxygen. If necessary, apply artificial respiration. Keep the patient lying down, quiet, and warm. (*Caution:* DO NOT USE ALCOHOL OR STIMULANTS!) Wash the body with soap and water to remove the contaminant.

Freon ®

Freon is a colorless, odorless gas that has extensive use as a refrigerant. It is a registered

trademark for selected halogenated compounds containing fluoride. The trademark is used only with compounds that are nonflammable and low in toxicity. Although generally classed as nonpoisonous, it is toxic in high concentrations. Dangerous conditions may be created in closed space areas aboard ship when large quantities of Freon gases leak from refrigeration units.

In confined or unventilated sections, Freon may displace the air and produce asphyxiation in anyone caught in the areas. After prolonged inhalation of Freon gases, a patient may have serious disruption of normal heartbeat if subjected to fear or excitement, which causes the body to release adrenalin. The liquid form of some types of Freon in contact with eyes and skin may cause frostbite or freezing of tissues.

In a fire aboard ship, Freon gases in contact with an open flame or hot metal surfaces may undergo chemical change to produce poisonous gases that tend to collect in low places. These toxic gases are easily detected by their intensely irritating effect on the nose and eyes.

Rescue: There should be forced air ventilation of the areas where Freon gas is present. Those who must enter the danger area should use mechanical breathing apparatus with an independent air supply and a lifeline. Gloves, protective clothing, and special eyeglasses also should be worn to prevent frostbite.

Treatment

Remove a patient from the toxic atmosphere. Take off the contaminated clothing. Give artificial respiration, if necessary. Pay special attention to the victim's eyes because Freon is a powerful freezing agent that can freeze delicate eye tissues. Flush the eyes for several minutes with running water. Keep the patient at rest for several hours to avoid excitement or emotional stress. *Do not give any medication that contains epinephrine or similar heart-stimulating drugs. Medical advice by radio should be obtained.*

Methyl Chloride

Methyl chloride is a colorless, combustible gas with an ether-like odor. It has been used as a refrigerant. It is a dangerous substance which may cause drowsiness, nausea, vomiting, mental confusion, convulsions, coma, and death. The gas is absorbed rapidly through the skin, adding to its toxicity. Accumulation of fluid in the lungs and bronchial pneumonia are most often the cause of death from methyl chloride.

Because of its explosive nature, the gas is dangerous in low concentrations. Therefore, no naked flame or light should be exposed to its vapor. If an accident occurs that involves methyl chloride, electric motors should be stopped to avoid risk of sparking.

Treatment

The victim exposed to methyl chloride should be removed from the contaminated area. Take off the patient's clothing, and administer oxygen and/or artificial respiration. Restrain an overactive patient. Medical advice by radio should be obtained at once on further treatment or evacuation.

Petroleum Gases

Extremely dangerous concentrations of fumes or gases from various petroleum products may be encountered aboard vessels carrying these cargoes. In addition to being on the alert for possible suffocation or poisoning, strict precautionary measures against fire and explosion are necessary.

Gasoline, benzene, naphtha, and other petroleum products are poisonous if swallowed or inhaled, or if there is prolonged contact with the skin. If gasoline is swallowed, see p. III–63 for treatment.

Inhalation of gasoline fumes produces a kind of intoxication like that caused by alcohol. At first, the victim has a false sense of well-being and security. Then his ability to think is lessened, giddiness sets in with uncoordinated and unsteady movements. Because he is likely to fall, he should be kept away from moving machinery. The face becomes flushed or mucous membranes develop a bluish tint because of reduced hemoglobin in the capillaries. Exposure to concentrated fumes causes dilated pupils, labored breathing, followed by coma and death from asphyxiation.

Treatment

Assist the victim to a well-ventilated area and remove contaminated clothing. If he is

breathing, give oxygen or an oxygen-carbon dioxide mixture. If breathing is not evident, give artificial respiration.

Medical advice by radio should be obtained before administering any medications. The patient should be kept in bed, warm, and quiet. When he begins to recover, he may become violent and almost uncontrollable. He should be carefully guarded to prevent self-injury or harm to others.

ALTERNATE METHOD OF ARTIFICIAL VENTILATION

In some instances mouth-to-mouth resuscitation cannot be used. For instance, certain toxic and caustic materials create a hazard to the rescuer. Also, facial injuries may prohibit the use of mouth-to-mouth or mouth-to-nose resuscitation. This section describes an effective alternate method of artificial respiration, the *Back Pressure—Arm Lift Technique.* However, a rescuer must remember that this method should be used only when circumstances prohibit the use of the more desirable exhaled air technique.

Back Pressure—Arm Lift Method

The rescuer should place the victim who has stopped breathing in the position shown in Fig. 4–12, clear the patient's mouth and throat, and begin artificial respiration at once.

Step 1. Position of the Victim

Place the victim in a face-down position. Bend his elbows, placing one hand on the other. Turn his face to one side and place his cheek on his hands, with his chin jutting out. If there is a second rescuer available to assist, have him hold the victim's chin in the jutting-out position. Remove foreign matter from the mouth and pull his tongue forward. Always make sure that the tongue does not block the air passage.

Step 2. Position of the Rescuer

The rescuer should kneel on either the right or left knee at the head of the victim, facing him. Place the knee at the side of the victim's head, close to his forearm. Place the opposite foot near the victim's elbow. If it is more comfortable, the rescuer can kneel on both knees, one on each side of the victim's head.

Next, the rescuer should place his hands on the flat of the victim's back in such a way that the heels of the hands lie just below a line running between the armpits. With the tips of the thumbs just touching, the rescuer's fingers should be spread downward and outward.

Step 3. Compression Phase

The rescuer rocks forward until his arms are about vertical, and allows the upper part of his body to exert slow, steady, even pressure downward upon the hands in contact with the victim's back. This forces air out of the lungs. The rescuer's elbows should be kept straight and the pressure exerted almost directly downward on the victim's back. Do not exert sudden or too heavy pressure. The rescuer's hands should not be placed high on the victim's back or shoulder blades.

Step. 4. Position for Expansion Phase

The rescuer should release the pressure by "peeling" his hands from the victim's back without giving any extra push with the release. The rescuer should rock slowly backward while gliding his hands along the victim's arms, until he is able to grasp the arms with each hand, just above the elbows.

Step 5. Expansion Phase

The victim's arms should be drawn upward toward the rescuer. While doing this, the rescuer should keep his arms straight. Just enough lift should be applied on the victim's arms by the rescuer so that resistance and tension can be felt at the victim's shoulders. The arm lift pulls on the victim's chest muscles, arches his back, and relieves the weight on his chest. The victim's arms are placed gently on the floor to complete the cycle.

Step 6. Repeat Previous Five Steps

The above cycle should be repeated about 12 times per minute at a steady rate to the rhythm of (*a*) *press,* (*b*) *release,* (*c*) *lift,* (*d*) *release.* The counts for *press* (*compression*) and *lift* (*expansion*) should occupy about equal time, with the *release* periods being of minimum duration. The emphasis is placed on *press*

and *lift* because these are the action steps. *Artificial respiration should be continued for two hours; longer if there are signs of life.*

The rescuer may use either or both knees, and the knees may be shifted during the procedure with no break in the steady rhythm. Remember to rock *forward* with the back pressure and *backward* with the arm lift. The rocking motion helps to sustain the rhythm and adds to the ease of operation. If the rescuer gets tired and another person is available, take turns with him. In making the change, be sure that the rhythm is not broken.

a. Position of the Subject

b. Position of the Operator

c. Compression Phase

d. Position for Expansion Phase

e. Expansion Phase

Fig. 4-27. Back pressure—arm lift method of resuscitation.

CHOKING EMERGENCIES

An estimated 4,000 people in the United States today choke to death from food and other materials that lodge in the windpipe (trachea).

The middle-aged and the elderly have been found to be prone to choking on food, especially if they have had several alcoholic drinks, or have ill-fitting artificial teeth. However, choking incidents can strike people at all ages, it commonly occurs among children who swallow small toys and other objects.

Usually the incident occurs at the dinner table from meat or other food that the victim cannot swallow. *The person chokes suddenly and cannot breathe, turns blue or black, cannot speak, and dies in 4 or 5 minutes.* Usually those who witness the incident stand by helplessly and often think that the victim is having a heart attack. Thus the choking incident has become known as a *cafe coronary.* Artificial respiration and slapping the victim's back have been found to be futile motions for this type of emergency.

A physician at the scene could cut an opening into the throat to reach the trachea, or he could insert a large-caliber hypodermic needle to provide a temporary airway. Such expertise seldom is available to provide the immediate action required. Dr. Henry J. Heimlich at the University of Cincinnati College of Medicine developed a procedure that anyone can perform to save a choking victim's life.

Heimlich Maneuver*

The Heimlich procedure is performed as follows: The rescuer stands behind the choking victim and puts both arms around him just above the belt line. The victim's head, arms, and upper torso are allowed to hang forward. Then the rescuer grasps his fist with his other hand, and presses upward quickly into the victim's abdomen. This action below the rib cage forces the diaphragm upward to compress the lungs and expel air that removes the obstructing food mass. (See Fig. 4–13.) When the choking victim is sitting, the rescuer kneels behind the chair and wraps his arms around the back of the chair and the victim, then performs the Heimlich maneuver in the same manner.

The same effect can be obtained with the victim lying face up on the floor and the rescuer kneeling astride the victim's hips or thighs. The rescuer presses quickly with both hands—one on top of the other—into the navel and below the rib cage). (See Fig. 4–14.)

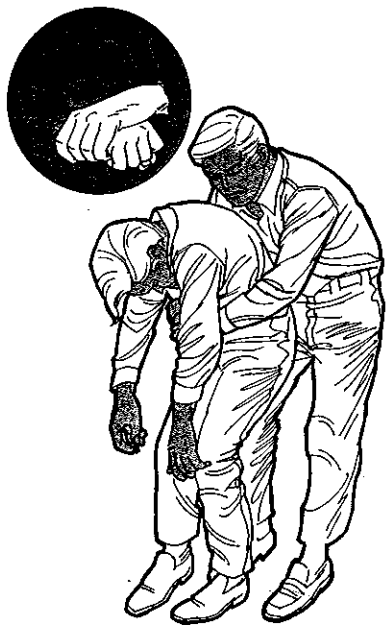


Fig. 4–28. Heimlich maneuver (rescuer standing and victim standing or sitting). Standing behind the victim, wrap your arms around his waist. Grasp your fist with your other hand and place the fist against the victim's abdomen. Press the abdomen with a quick upward thrust.

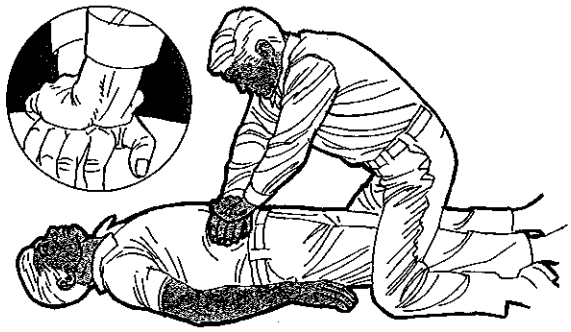


Fig. 4–29. Heimlich maneuver (rescuer kneeling and victim lying on his back). Kneel astride the victim's hips. Put one hand on top of the other and place the heel of the bottom hand on the abdomen. Press in with a quick upward thrust. Repeat, if necessary.

* Adapted from "Pop Goes The Cafe Coronary," by Henry J. Heimlich, M.D. *Emergency Medicine,* Vol. 6. No. 6, pp. 154–5, June 1974.

In both situations described above, the rescuer must remove the food from the victim's mouth with his fingers—especially if the victim is on his back.

It has been reported there have been incidents when it was necessary to perform the procedure eight or nine times to dislodge the foreign body. Once or twice was not enough. In a few instances, a poorly informed rescuer did not succeed, only to be followed by a second rescuer whose efforts expelled the offending food mass. Also, there have been many occasions when choking victims have self-administered the Heimlich maneuver—punching the upper abdomen with the fists, or pressing the abdomen against the edge of a sink or table, or the back of a chair.

Misapplication of the maneuver has resulted in several cases of cracked ribs caused by crushing embraces applied by overzealous rescuers. Such injuries may be avoided if the rescuer remembers to press INWARD and UPWARD with his HANDS—he should not squeeze with his arms.

Near-Drowning Victims

Dr. Heimlich states that the Heimlich maneuver has been successful in saving the lives of near-drowning victims, after usual resuscitative efforts failed. The maneuver forced water out of the lungs to gush forth from the mouth. As one rescuer stated: "You can't get air into the lungs, until you get the water out."

WHEN PATIENTS NEED OXYGEN

Delay Can Be Fatal!

When breathing is impaired during medical emergencies, the patient usually requires some method of artificial ventilation. (See p. IV–3.) However, some patients may have illnesses or accidents that require highly concentrated oxygen—as in heart attacks, shock, severe burns, heavy loss of blood, or extreme breathing difficulties. To save a person's life, it may be necessary to use a resuscitator or mask to supply oxygen.

To administer oxygen effectively, medical attendants aboard ship should have received prior training in resuscitation and the care and use of oxygen apparatus or equipment. Ship owners and Masters of vessels should consult with State and local health departments and emergency medical care units on (1) the training of all concerned; and (2) the purchase and maintenance of reliable oxygen therapy equipment.

CARDIOPULMONARY RESUSCITATION (CPR)

Lifesaving Procedure!

Cardiopulmonary resuscitation (CPR) is a lifesaving technical procedure, which requires exactness and good physical coordination. *Book knowledge only* on how to administer CPR is not enough. Correct practice at frequent intervals is required. A mannikin—not a healthy person—should be used during practice sessions on CPR. Personnel should receive supervised training in a formal course of instruction, certified by either the American Heart Association or the American National Red Cross.

Thus aboard ship, it is desirable that several people will have received training in first aid and be certified to apply CPR. Also, it is essential that retraining and recertification be carried out periodically.

All text on cardiopulmonary resuscitation (CPR), stated previously in Chapter IV, should be used primarily to refresh the memories of personnel who are certified to apply CPR.