Cardiac Arrest

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During the management of any or all of the emergency situations discussed in this symposium, cardiac arrest is a distinct possibility. Arrest may occur during evaluation of the patient, as in cases of cardiac tamponade or tension pneumothorax. It may occur during relatively minor procedures such as bronchoscopy or insertion of chest tubes, and it is an ever present threat during definitive procedures under general anesthesia. It does not seem important to enumerate these separate situations, but it is essential that persons managing trauma patients be alert to the increased possibility of cardiac arrest which is present from the time of wounding until the beginning of convalescence.

DIAGNOSIS

Absence of pulsation in major arteries remains the most reliable method of detecting circulatory arrest. In patients with multiple injuries and in patients in shock, arterial palpation is not always simple, but it is almost always possible. In patients in whom doubt exists, resuscitative measures should be instituted.

CANDIDATES FOR RESUSCITATION

One of the major problems in circulatory arrest is definition of the group of patients in whom resuscitative procedures should be attempted. There are no precise rules, but it can be generally stated that patients with treatable lesions and circulatory arrest of less than five minutes duration should be resuscitated. When neither treatability nor duration of arrest can be readily determined, a common situation in treating trauma patients, resuscitation should be attempted.

TECHNICS OF RESUSCITATION

Time is the most critical controllable factor in determining the outcome in patients with cardiac arrest. The diagnosis and decision regarding resuscitation take only a few seconds. Resuscitation must be begun by persons who are immediately available, although more experienced personnel can be summoned to continue the treatment. The approach to actual resuscitative measures should be toward (1) establishing ventilation and (2) establishing circulation.

Establishing Ventilation. Before support of circulation or (if enough persons are present) concomitant with beginning circulatory support, an adequate airway and adequate ventilation of the lungs must be achieved. Initial mouth to mouth, or mouth to nose ventilation is continued until more elaborate equipment is available. If ventilation is being performed at the time arrest occurs, the airway is carefully inspected and its patency and proper position assured. If arrest occurs during an operation, in addition to inspection of the airway, ventilation with pure oxygen and discontinuance of all anesthetic agents should be immediate. The problem of mechanical ventilation during closed chest cardiac massage will be mentioned subsequently.

Establishing Circulation. There are two established methods of maintaining circulation artificially. In the last few years the splendid contribution by Kouwenhoven, Jude and Knickerbocker, the technic of closed chest cardiac massage has become well established; and in most instances, is the first method used to establish circulation after circulatory arrest [1]. This technic has been well substantiated and the essential points are as follows:

1. The patient must be on a firm surface, such as a floor, operating table or

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1.rollable factors in patients with a few seconds, by persons who though more experienced to continue actual resuscitation (1) establishing circulation, (2) support of the chest are present. Initial circulatory supple, adequate ventilation is achieved. Initial nose ventilation equipment is performed at the properly positioned airway, ventilation of immediate. The ventilation during will be mentioned.

There are two main circulation: the splendid ven, Jude and of closed chest wall established; first method used circulatory arrest will substantiated follows:

- on a firm supporting table or stretcher. Resuscitation in a yielding bed is difficult if not impossible.

2. The person applying closed chest massage should be positioned enough above the patient to permit use of the stiffened elbows in applying massage.

3. The hands should be placed as shown in the accompanying diagram. (Fig. 1.) The operator stands on either side of the patient, the hand toward the patient's head is placed on the lower sternum with the heel of the palm in the depression formed by the lower sternum. The second hand is placed on top with the fingers pointing towards the suprasternal notch.

4. Massage is performed by downward pressure in the straight anteroposterior plane. The lower end of the sternum should be depressed approximately 2 inches in the adult patient. Release should be prompt and complete. The rate of massage depends upon the availability of other persons to continue the effort. If sufficient other persons are available, a relatively rapid rate of about 90 to 100 per minute is employed, otherwise a lower rate of 60 to 80 per minute is begun. It is important that the hands stay in the central position.

5. The criteria for adequate closed chest massage is the ability to feel a peripheral pulse. Ordinarily this is a carotid or femoral artery and this pulse should not be equivocal.

6. If a peripheral pulse cannot be palpated, circulation is not adequate and steps in the technic should be reviewed as well as quickly reviewing the nature of the underlying problem. If circulation cannot be established within 1 minute, open cardiac massage is instituted. It should be emphasized that in most instances, this will not be necessary.

7. This method provides some, but not adequate artificial ventilation. Using a mask or tube and bag, respiratory efforts can be continued during closed chest massage or a rhythmic pause in massage to allow respiration can be used.
Open Cardiac Massage. If the closed massage is not successful or for some reason is not feasible, open cardiac massage is instituted promptly. The chest is opened from the sternum outward in approximately the fourth interspace, though no time should be lost in counting ribs. The pericardium should be opened and cardiac compression begun. This is best done with the operator facing toward the patient's head with the hand grasping the heart so that the palm and fingers are on the upper or right ventricular surface and the thumb against the left ventricular surface. Rhythmic compression is performed at rates mentioned above, and it is important that the heart be allowed to fill between compression efforts. Peripheral arterial pulsation will be palpable when massage is properly performed.

Establishing Heart Beat. Until adequate artificial circulation, as indicated by good palpable peripheral pulses is demonstrated, the managing physician has only two considerations: (1) ventilation and (2) circulation, both to be established in the shortest possible period of time. When those are established the patient can be supported safely for a considerable period of time, and time per se becomes less important. The managing physician must then consider three problems. The first is evaluation of the underlying process or injury; are there correctable factors which have led to cardiac arrest such as hidden hemorrhage, undetected pneumothorax, drug overdose, and so forth? The second consideration is the nature of cardiac arrest, whether there is cardiac standstill or ventricular fibrillation. If the closed chest procedure is employed, an electrocardiogram is necessary in most instances to make a diagnosis of ventricular fibrillation. In a child, ventricular fibrillation can frequently be observed through the intact chest wall. In the open chest, the gross appearance of the heart is diagnostic. Electrocardiographic evidence of ventricular fibrillation should be reviewed carefully because in inexperienced hands a poor electrocardiogram with electrical interference may superficially resemble ventricular fibrillation. In any case, the equipment for defibrillating the heart should be called for as soon as the immediate urgency of establishing circulation has been relieved. A third consideration at this point in resuscitation is the use of drugs. Ordinarily, the course of cardiac arrest which is promptly recognized and promptly handled will be the resumption of an effective heart beat within 1 or 2 minutes of the establishment of artificial circulation. Artificial circulation should be interrupted for a few seconds at about one minute intervals in order to detect any spontaneous occurrence of resumed cardiac activity. Two drugs are most helpful and should be called for when the immediate acute situation has been resolved. These are intravenous preparation of sodium bicarbonate and epinephrine in 1:10,000 dilution. The intravenous injection of sodium bicarbonate should be begun as soon as it is available and ordinarily 40 mEq. are injected into a peripheral vein. This can be repeated at 10 minute intervals during resuscitative efforts. If the heart does not resume continuous beat within two minutes of the institution of massage, 2 cc. of diluted epinephrine should be injected intravenously and massage continued. This is true whether or not ventricular fibrillation is present. The injection of 2 cc. of dilute epinephrine should be repeated at 3 to 10 minute intervals until beat is established. Calcium chloride is helpful in instances in which beat is established but ineffectual [2]. It probably should not be used in patients taking digitalis. If ventricular fibrillation is proved to be present, cardiac massage is maintained for 2 to 3 minutes after the injection of epinephrine following which a defibrillator is employed. In using either the internal or external defibrillator, it is important that the electrodes be well applied to the heart or chest. This must be done rapidly in order to prevent interrupting massage for any longer than a few seconds and the initial current should be about 100 volts for the internal defibrillator and 300 volts for the external. A manual timer should be used and a single shock employed [3,4]. Massage should immediately be resumed following defibrillation until spontaneous beat occurs. If the heart is not defibrillated after a second period of massage, defibrillation is performed using three rapid shocks at the same voltage. Massage is again immediately re instituted; and if the heart is still fibrillating, the voltage regulator is advanced 10 volts for internal and 50 volts for external defibrillation. Ordinarily defibrillation is accomplished with three or less electrical shocks. Failure to defibrillate is frequently caused by a faulty defibrillator or improper application of the electrodes. When spontaneous beat is re-established, the chest is closed with absorbable suture material if the open
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When heart beat is re-established and circulation is satisfactorily maintained, the major consideration becomes evaluation of the central nervous system. If the patient was conscious prior to circulatory arrest and remains unconscious after circulation is re-established for more than 10 minutes, the central nervous system has been injured by the anoxic episode. At present there are no good parameters by which one can judge the severity of the injury early in its course. In the patient who is not conscious prior to the circulatory arrest, such as the patient with head injury, the problem is much more difficult and may be impossible to solve. If there is evidence of central nervous system injury the patient should be treated by the institution of hypothermia [5]. This decision should be made within a few minutes after cardiac resuscitation and the body temperature lowered as quickly as possible to 33°C. This level of hypothermia should be maintained until there is unequivocal evidence of neurologic improvement. Ordinarily this is twentyfour to forty-eight hours. The patient will require a tracheostomy; and in view of the evidence that hyperventilation reduces brain swelling, a respirator should be employed if spontaneous breathing does not appear to be entirely satisfactory. There is conflicting evidence and opinion regarding the use of urea to reduce brain swelling [6,7].

SUBSEQUENT MANAGEMENT

In a patient who sustains cardiac arrest following trauma, it is obviously necessary to deal with the other surgical problems associated with the original trauma despite reluctance to perform further procedures on a patient who has experienced circulatory arrest. The tendency to center attention on the circulatory arrest neglecting potentially fatal injury, must be avoided.

SUMMARY

Most patients with circulatory arrest can be resuscitated to their prearrest status. Although many situations will be encountered in which ultimate survival of the patient is not achieved, it is likely that considerable improvement in present results can be achieved by prompt and effective utilization of the regimen outlined above.

REFERENCES