# Cardiopulmonary Resuscitation in Practice

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CARDIOPULMONARY arrest or cardiac arrest is the unexpected cessation of effective functional respiration and circulation. Heart attack, drowning, electrical shock, asphyxiation, or a wide variety of other circumstances may cause heart stoppage.

The closed-chest method of cardiopulmonary resuscitation is an effective technique for treatment of such arrest, as Jude and others (*1*) demonstrated in 1960. Since it is not a surgical procedure, many serious complications affecting the survival of a patient after open-chest resuscitation are eliminated (*2–4*). Further, resuscitation by the closed-chest technique provides adequate circulatory and respiratory support for application of newer therapeutic procedures. Most clinical experience, catheterization studies, and animal research indicate that this method is as physiologically effective as open-chest resuscitation, if not more so (*5–8*), although some studies conclude that the open-chest method may be somewhat better (*9*, *10*). In any event, it is clear that closed-chest resuscitation can be applied by persons with less skill and without the facilities required for open-chest resuscitation. Moreover, among victims of cardiopulmonary arrest treated by this method, survival is frequent and less complicated.

Complete application of the closed-chest method encompasses two distinct phases, each including several steps. The emergency phase requires that the operator be skilled in three techniques: adequate opening of the air passages, mouth-to-airway respiration, and manual compression of the heart through the intact chest wall. The definitive phase of resuscitation requires application and interpretation of the electrocardiogram and proper use of drugs, defibrillators, or pacemakers, as necessary. Each phase requires an organized approach to resuscitation, both inside hospitals and on a communitywide basis outside of hospitals.

Whether such an organized approach is successfully implemented depends primarily on whether policies for emergency resuscitation have been carefully and thoughtfully developed. Proper use of these basic principles for action in both phases of resuscitation requires through organization of personnel and rapid application of resuscitation techniques. Serious consideration must be given to the selection, distribution, and location of needed equipment. Methods of performance can vary considerably according to the professional abilities of the persons involved and the problem to be solved.

There have been several approaches to the practical application of the current principles of resuscitation. The purpose of this report is to review them.

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## Policy Development

From 1958, when the expired-air method of artificial ventilation was found to be superior to previously accepted manual methods (*11*), the method has been widely adopted both by professional and lay groups. The technique can be easily taught, even to children (*12–14*). There is seldom any hesitancy in proceeding, possibly because 70 to 90 percent of all respiratory ca-

tastrophes outside the hospital occur in the presence of friends, family, or neighbors (*15*). True, the operator has to cope with problems of esthetics and boredom: the victim may regurgitate, and 30 to 40 minutes of sustained effort may be required to revive him. But these potential difficulties and also hypocarbia in the rescuer are more than offset by the clinical effectiveness of the mouth-to-airway method (*16*). Mouth-to-airway resuscitation has therefore been quickly adopted in the United States, Switzerland, England, New Zealand, Canada, Australia, and Scandinavia (*13*), and nearly all Red Cross societies have incorporated the technique into their manuals (*17*).

The development of closed-chest cardiac compression in 1960 received less immediate acceptance. Although clearly shown to be physiologically effective, the method was at first designated a "medical procedure," to be performed only after a physician had confirmed the diagnosis (*18*). Nevertheless, careful training of dentists, nurses, and rescue workers in the method was encouraged even though the difficulties of diagnosis remained and the possibility of inadvertent injury was apparent (*5, 19, 20*).

In 1962, the American Nurses' Association's Committee on Nursing Practice urged nurses only to assist physicians in closed-chest cardiopulmonary resuscitation, not to initiate the procedure (*21*). Committee members pointed out the professional and legal implications of having nurses initiate resuscitation. In 1963, however, the association suggested that individual nursing associations initiate policy statements to clarify the nurse's role in resuscitation (*22*). In an earlier paper (*8*), the author has pointed out the value of such policy statements, in which other professional groups may join.

A policy statement permitting nurses to initiate closed-chest resuscitation in the absence of a physician was issued in 1962 by the nurses' association in California, and other programs designed especially to train nurses in these emergency procedures were described (*23*). Similar policy statements for nurses are now under development in Wisconsin and New York (*24*).

The rapid accumulation of experience with the new closed-chest method, plus the prevalence of cardiac-arrest emergencies, made it obvious that not only physicians, but also dentists and nurses, rescue workers, electricians, and others in high-risk occupations could, and should, be able to initiate closed-chest cardiopulmonary resuscitation. Thus, Dr. Peter Safar, professor and chairman, department of anesthesiology, University of Pittsburgh School of Medicine, and others proposed a plan for training appropriate segments of the population in a systematic way (*25*). The committee on pulmonary surgery of the American College of Chest Physicians endorsed the use of the closed-chest technique by medical and nonmedical rescue groups (*4*).

The growing opinion that the closed-chest technique should be considered an emergency procedure was endorsed at the Second National Conference on Cardiovascular Diseases held in November 1964 (*26*). The conference recommended that, as an emergency procedure, the technique be taught to dentists, nurses, and specialized occupational groups. An editorial presenting the concept of emergency application, outlining the basic considerations of organizing training and comparing the acceptable risk involved with the great good to be achieved was published in the May 1965 issue of *Circulation* (*27*). The statement carried the endorsement of the Public Health Service, American Heart Association, American National Red Cross, and the Industrial Medical Association. The American Nursing Association has been distributing reprints of the editorial to help State nurses' associations formulate their own policy statements (*28*).

### Application in Hospitals

Personnel of hospital emergency wards, cardiac catheterization laboratories, intensive care units, operating rooms, pediatric units, and X-ray services must be ready to act in a cardiac emergency, for cardiac arrest may occur in any part of the hospital. Because potential cardiac emergencies may require hospital services distributed over a wide area of the hospital, not only physicians and nurses but also technicians, and perhaps even hospital porters, should be ready to initiate the emergency phase of resuscitation (*29*). Serious delays in institution of therapy have occured after extensive

training programs and have contributed to failure of the resuscitation efforts. Much attention has therefore been devoted to improving organization and drill of hospital personnel. The concept of the cardiac arrest team using special emergency carts has been gradually accepted, and improvements in method have led to perfected techniques and improved results (*30–34*). Parallel advances in the use of drug therapy, defibrillators, and pacemakers have made this team type of organization even more effective (*35, 36*).

As a corollary to general improvement in hospital organization, the concept of special-care areas was introduced. Coronary care units for patients with acute myocardial infarction is an example of this new hospital practice. This general concept of having hospital facilities concentrated in a separate area where specially skilled persons are well versed in use of special resuscitation and electronic equipment has been developed in detail (*37, 38*). Although experience with the coronary care unit is just beginning, the trend definitely suggests a greater hope for patients who suffer potentially lethal arrhythmias (*39–41*).

The success in organizing the hospital for emergency care has emphasized the importance of studying and improving methods of post-resuscitation observation and care. Much interest has been aroused, for example, in the use of hypothermia, assisted respiration, and the control of acidosis (*42–44*).

### Communitywide Application

Although the technique of expired-air ventilation was rapidly accepted and is now practiced throughout the population, closed-chest cardiac compression was originally used outside the hospital only by a few rescue groups on a pilot or study basis, in line with the early policy statements. Several authors, however, have reported that the trained rescue worker not only could perform the techniques correctly and effectively but also that his knowledge of resuscitation practice was often more thorough than that of many local physicians (*45–47*). Wilder (*48*) experienced a significant measure of success working with the Baltimore, Md., Fire Department. He reported 15 survivors from 153 emergency episodes of cardiac arrest and stated that performance of the closed-chest technique by the firemen presented no significant complications.

Some training effort in closed-chest resuscitation has been directed toward members of the general population (*49*). There is evidence, however, from Safar, in the University of Pittsburgh project, that training unskilled lay persons is unsatisfactory even when they are well controlled and supervised. When motivation, organization, and performance of such groups were objectively assessed, results were generally discouraging (data on file in Heat Disease Control Branch, Division of Chronic Diseases Public Health Service). Moreover, the opportunities for nonprofessionals to apply their resuscitation training, particularly in the closed-chest technique, and the possibilities for retesting and retraining appear insufficient to warrant larger scale teaching programs. In 1964, the Second National Conference on Cardiscouraging (data on file in Heart Disease training in expired-air respiration be extended at this time to the public at large (*26*).

The experience with rescue squads again illustrates that thorough unified organization of the various groups involved in emergency care is crucial to the success of any resuscitation program. Proper continuity and definition of roles, beginning with the rescue worker in the field and progressing along the rescue chain to the physician or team of hospital "resuscitologists," has to be planned in advance. Attention now centers on needed improvement in ambulance design and service (*17*) and on redesign of ambulances to permit adequate performance of resuscitation within these vehicles (*50*).

Chest compression and expired-air ventilation can be performed manually for periods of at least 45 minutes (*3, 30, 51, 52*). Nevertheless, methods for reducing physical fatigue of the resuscitator and improving his efficiency through mechanical chest compressors have been developed and tried (*53, 54*). Preliminary reported experience, though limited to hospitals, indicates the general usefulness of these instruments in skilled and practiced hands. The effectiveness of such devices in emergencies occurring outside hospitals requires further study and evaluation.

The use of special cardiac units is being broadened to include industrial organizations (*55*), and cardiac-arrest registries are being established to serve entire communities. These new activities provide further incentives for the growth of training and organization for emergency resuscitation as well as the opportunity to evaluate and improve current practice.

## Conclusion

Closed-chest cardiac resuscitation is an effective method for treating cardiopulmonary arrest. Before long its use will become widespread. The method will be accepted by the staff of many institutions and will involve numerous persons with varying levels of competence and training. Responsibility for emergency preparedness in this procedure will extend beyond hospital walls, beyond the physician's moral obligation to his patients, and into the community. The public will demand that in emergencies policemen, firemen, ambulance drivers, and similar groups be trained, ready, and able to resuscitate persons ordinarily considered dead (*56*).

Physicians and hospitals must be ready to meet the demands for organization and training for resuscitation (*15*, *57*). Yet physicians have sometimes been among those least interested in the relatively simple, uncomplicated techniques required. Hopefully, physician apathy will not hinder proper application of closed-chest resuscitation (*58*). The policy, method, and equipment for resuscitation have been developed. Physicians now need to offer effective leadership and participate in efforts to apply resuscitation techniques throughout their communities in every appropriate emergency.

Although coronary artery surgery, heart transplantation, and assisted circulation are still in the research stage, the day may soon come when they will become standard clinical practice. The future challenge of resuscitation will be to delay biological death in those patients who do not respond to emergency measures. The time gained may then be used for application of more elaborate and effective techniques to correct the basic pathological abnormality.

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