The wisdom of applying CPR routinely is questionable.

Cost/Benefit Analysis of Cardiopulmonary Resuscitation: A History of CPR — Part I

by MARY C. VRTIS

Cardiopulmonary resuscitation (CPR) is initiated in most U.S. hospitals on all who suffer cardiopulmonary arrest, regardless of underlying disease process, unless there is a *Do Not Resuscitate* order. For over 25 years, CPR has been considered a life-saving maneuver that should be available to all hospital clients. As a result, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires that all hospital nursing staff, respiratory therapists, anesthetists, anesthesiologists and emergency medical personnel be trained annually in basic life support (BLS).[1] Over the past 30 years, resuscitation programs have grown dramatically, yet routine cost versus benefit analyses have not been done.

Attempts at cardiopulmonary resuscitation date back to the late 19th century when several attempts at open chest cardiac message were attempted. A few successful open chest cardiopulmonary resuscitations were reported in the early 1900s and soon the method was used frequently in hospitals. Since the closed chest resuscitation method was introduced in 1960, the open chest method has been used infrequently.[2]

According to the Kouwenhoven report, 13 patients received artificial respiration along with cardiac massage while seven patients received only cardiac massage. It was reported that all 20 of these resuscitations (even those where artificial respiration was not used) were successful — and that 14 of the 20 resuscitated individuals were alive and neurologically intact 10 months later. It is interesting to note that five of the six arrests discussed were anesthesia-induced, so may have been preventable. In addition, cardiac massage was initiated in one individual while a pulse was still present.[3] Based upon the high success rates reported, closed chest cardiopulmonary resuscitation techniques gained favor in U.S. hospitals.

In an earlier article which advocated open chest cardiac massage, data were collected from 1,200 cardiac arrests over a period of 10 years from physicians around the world.[4] The authors claimed a 28 percent "permanent" survival rate and, though this was not defined clearly, these survivors appeared to have lived at least seven days postresuscitation. It is interesting to note that 86 percent of these cases were anesthesia-related, and thus possibly preventable.

The high success rates reported by Kouwenhoven have never been repeated. In 1987, McGrath published a review of journal articles covering 12,961 cases.[5] This showed a mean 24-hour survival rate of 38.5 percent (Range:13-59%) and a mean survival to hospital discharge rate of 14.6 percent (Range: 3-27%). Between 1983 and 1989, immediate postresuscitation survival rates ranged from 37.5 to 55.0 percent and survival to discharge rates from 6.4 to 24.3 percent.[6-15] Complete information was provided in eight of the above publications and it was therefore possible to calculate means for a total of 1,459 cases where CPR was initiated. The mean initial, postresuscitation survival rate was 43.1 percent with a survival to discharge rate of 12.4 percent (secondary analysis).

The success rates for out-of-hospital cardiopulmonary arrests are even lower as only 16 to 19 percent of those resuscitated live long enough to be admitted to the hospital, and only three to eight percent survive to hospital discharge.[16-19] One of the above cited studies excluded all arrests that were not of cardiac etiology and another excluded all traumas, suicides, terminal cancers and other significant non-cardiac events. Combined data for the other three indicated a mean survival to hospital admission rate of 18.3 percent and a mean survival to discharge rate of 6.8 percent for a total of 3,623 pre-hospital resuscitation events (secondary analysis).

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Cardiopulmonary arrests due to ventricular fibrillation and pulseless ven-

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tricular tachycardia have higher success rates. For those with ventricular fibrillation or pulseless ventricular tachycardia as the initial rhythm, 8.5 to 11 percent of those undergoing prehospital resuscitation and 27 to 48 percent of those undergoing in-hospital resuscitation survived until hospital discharge.[6,10,12,15,16,18-20] When data for the 1983-1989 articles are combined for in-hospital arrests, where the initial rhythm was ventricular fibrillation or pulseless ventricular tachycardia, the mean survival to discharge rate was 36.2 percent for 406 CPR events (secondary analysis). Combined data for the two articles reviewing the same variables for out-of-hospital arrests generated a mean survival to discharge rate of 9.2 percent for 1,677 CPR events (secondary analysis).[16,18]

Acute respiratory failure need not lead to cardiopulmonary arrest.

Though few studies do follow-up beyond discharge, three studies reported that 15 percent died within three months, 20 percent within six months, and 52 percent within 36 months.[6,9,10] For those who do survive CPR to hospital discharge, many never return to pre-hospitalization levels of function. Of 168 patients successfully resuscitated in-hospital, 19 percent were discharged to a nursing home.[15] Of 58 patients successfully resuscitated pre-hospital, only 55 percent lived to discharge with good cerebral function, whereas five percent had severe neurological deficits.[21] In a study of 114 patients referred to the neurological service for new-onset coma following resuscitation, eight percent had severe neurological deficits and/or a chronic vegetative state. This sample did not include those with prior neurological problems, trauma, drug overdose or severe metabolic disorders.[22]

Pre vs. post arrest outcomes

Cardiopulmonary arrest rarely occurs without warning and warning signs may be apparent to trained observers for hours or minutes preceding the full arrest. Catastrophic events that can cause sudden cardiopulmonary arrest occurred prior to terminal cardiopulmonary arrest in only 12 percent of intensive care patients, while deepening coma accounted for 40.3 percent of all deaths.[23] Deepening coma is rarely reversible and arrest prevention is not likely to be possible in most situations. On the other hand, frequent neurological assessments that would allow for rapid intervention in the event of a potentially reversible neurological catastrophe may be far more effective than providing an excellent resuscitation after cardiopulmonary arrest has occurred. Whereas the former may not only save life, but also quality of life, the latter results only in temporary death postponement.

Acute circulatory failure, the terminal event in 35 percent of 258 intensive care patients, was the most common potentially reversible problem observed that ultimately caused death. Circulatory failure was caused by cardiogenic shock, sepsis, hemorrhage, or obstruction.[23] Cardiac arrest often can be avoided if supportive and/or preventive measures are taken early in the course of the disease process, at least in the cases of pump failure, hemorrhage and sepsis. Whereas sepsis alone has a 66 percent survival to discharge rate, sepsis-precipitated cardiac arrest has a zero survival rate.[6,12,24] Hemorrhage-precipitated cardiopulmonary arrest has a zero survival rate.[15] Hemorrhage alone, even when requiring five to nine units of blood, has an 86 percent survival to discharge rate and hemorrhage requiring ten or more units of blood has a 70 percent survival to discharge rate.[25]

When a cardiopulmonary resuscitation attempt is successful and the client is discharged home, it is usually because an acute, reversible event has occurred. Many of these events, such as the anesthesia-related cardiopulmonary arrests cited by Kouwenhoven and Stephenson, probably could have been prevented.[3,4] Acute respiratory failure, which typically leads to a full cardiopulmonary arrest when ventilator support is not initiated quickly enough or when end-stage lung pathology prevents adequate tissue oxygenation, has a fairly high survival rate post-cardiopulmonary arrest. In 1989, it was reported that 38.2 percent of 34 patients who suffered cardiopulmonary arrest related to acute respiratory failure survived to hospital discharge.[10] Many cases of acute respiratory failure need not lead to cardiopulmonary arrest if appropriate supportive action to prevent respiratory arrest is initiated early. Respiratory failure has a 55 to 63 percent survival to discharge rate when cardiopulmonary arrest does not result prior to treatment.[26] Whereas pneumonia-precipitated cardiopulmonary arrest resulted in a zero survival rate, pneumonia severe enough to require intensive care nursing has a 70 percent survival to discharge rate.[6,12,24]

High success rates also exist with ventricular fibrillation and pulseless ventricular tachycardia, both of which are potentially reversible, temporary processes. It is doubtful that most ventricular dysrhythmias can be prevented, although the incidence may be reduced by careful titration of drugs that decrease myocardial irritability and improve myocardial function and oxygenation. Rapid defibrillation, rather than cardiac compressions, is the definitive treatment for ventricular fibrillation or pulseless ventricular tachycardia.[27]

Cardiac life support training programs

In addition to BLS certification (BLS-C), specialty nurses and other healthcare workers are strongly encouraged by healthcare facilities, the American Heart Association (AHA) and professional organizations to obtain advanced cardiac life support (ACLS), neonatal advanced life support (NALS) and pedi-

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atric advanced life support (PALS) certifications when appropriate to their practice. To provide BLS-C training, a hospital either must purchase or rent an appropriate number of adult, child and infant manikins. Also, there are numerous costs involved in maintenance, repair, cleaning and decontamination of equipment. For advanced life support training, additional equipment and spe-

cial manikins are required, as well as instructors. Providing BLS, ACLS, NALS and PALS courses is a costly endeavor for any hospital, as many hospitals fund the courses, provide fees and tuition, and/or pay salaries while nurses attend.

Undoubtedly, basic and advanced cardiac life support training classes have improved the technique of CPR practitioners in clinical settings, but to date, there are no empirical data to suggest that these courses have improved patient outcomes. In fact, one study that examined patient outcomes pre- and post-BLS training of physicians and nurses found essentially similar death rates whether or not the participants had received BLS training.[28] Another study that looked at patient outcome pre- and post-ACLS training mandatory for physicians found no statistically significant difference between patient survival rates. Post-ACLS, however, 38 percent of survivors required transfer to a chronic care facility on discharge, whereas this was not necessary for any of the survivors in the pre-ACLS training group.[29]

Most participants in BLS training programs, medical and lay people alike, do not retain the skills and knowledge obtained for more than six months despite intensive training sessions.[30-32] These findings have led many to suggest that even more frequent recertification in cardiac life support is needed in spite of the fact that there is no evidence to suggest that such certification is of benefit in terms of client survival. Improvement in technique is of no practical value unless the client lives as a result.

Costs of a CPR program

Every acute care hospital in the nation holds costly resuscitation equipment, drugs, and other supplies on standby for when a cardiopulmonary arrest occurs. Most hospitals maintain at least one "crash cart" per nursing unit. The equipment should be checked at least annually by biomedical engineering, and supplies at least once every day by a nurse. Equipment checking rituals consume both nursing and biomedical technician time, thus increasing costs.

A great deal of time and money is spent for person power response to cardiopulmonary arrest calls within the hospital. A typical resuscitation requires at least two or three nurses, a respiratory therapist, a physician and an x-ray technician. A nursing supervisor also usually responds. Cardiopulmonary resuscitation efforts usually exceed 15 minutes, and the majority exceed 30 minutes.[6,12] Even a short cardiopulmonary resuscitation attempt consumes a minimum of 45 to 60 minutes per participant when response time, transport time and observation time are included. Thus, a typical resuscitation would involve at least 3.25 to 5.25 person hours.

Although many people want *everything* done for their loved one, few people know what *everything* means. Of 134 elderly clients, 47 percent had never heard of it and after having it explained, 47 percent said they did not wish to be resuscitated themselves. Over 80 percent indicated that elderly clients should be encouraged to express their views on resuscitation either prior to or on admission to the hospital.[33] When CPR is factually and objectively

explained, many people refuse it.[34] It is interesting to note that only 55 percent of CPR survivors interviewed at the time of hospital discharge would choose to be resuscitated again.[6] Demystification of the cardiopulmonary resuscitation event, reality-based explanations of the probability of survival, and asking individuals about their wishes when they are admitted to the hospital probably will decrease client and significant other desire for *routine* CPR.

The total costs of a full cardiopulmonary resuscitation program are not available in the literature. A *Med-Line* search done in August, 1990 yielded 323 abstracts on CPR, but no references that examined costs related to cardiopulmonary resuscitation programs. An examination of these costs is important not only because they are disproportionate to the population served, but also because only a small percentage of those who receive CPR survive long enough to be discharged from the hospital. The value of this procedure in the vast majority of situations where it is applied routinely is at best questionable. Funds currently consumed by end-stage pathology-oriented care could be utilized better elsewhere in disease prevention, cardiopulmonary arrest prevention and to meet basic human needs for food and shelter. Clearly, in-depth cost/benefit analyses of cardiopulmonary resuscitation programs throughout the U.S. are needed. Results of a comprehensive cost/benefit analysis of the CPR program in a 576-bed community teaching hospital will be reported in the next issue.

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