Survival After Cardiopulmonary Resuscitation for an In-Hospital Cardiac Arrest

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This is a report of the results of a study of all patients who received cardiopulmonary resuscitation (CPR) for an in-hospital cardiac arrest in a community hospital from July 1983 through June 1984. Out of 121 patients, 46 survived the initial arrest, but only 13 (11 percent) survived to leave the hospital. The patient's age or sex were not predictors of survival to leave the hospital. Patients who were living independently prior to hospitalization had a higher survival rate (19 percent) than homebound (3 percent) or nursing home (3 percent) patients. Patients with acute myocardial infarctions or cardiac arrhythmias had better survival rates (26 percent and 19 percent, respectively) than with other diagnoses (5 percent), but this difference did not reach statistical significance. Patients who survived to leave the hospital did not suffer any mental loss from the arrest. General guidelines for withholding CPR based on the present study and a review of the literature are presented.

Since the introduction of closed-chest cardiac massage in 1960,[1] cardiopulmonary resuscitation (CPR) has become a common occurrence for patients who die in the hospital. Recently the ethics and legalities of the decision to withhold CPR in certain patients have received considerable attention,[2,3] and are the topic of the report of a presidential commission.[4] Factual information about the effectiveness of this procedure is desirable because of the frequency with which CPR is attempted in hospitalized patients, the current ethical concerns about withholding CPR, and the current legal climate in medicine.

This study was conducted to address the question, What are the demographic and clinical factors that predict survival for patients who have a cardiac arrest while in the hospital and receive CPR? This article reports the results of that study and reviews the literature on this subject.

METHODS

A retrospective chart review was done on all patients who suffered a cardiac arrest in the hospital and who were

given CPR between July 1, 1983, and June 30, 1984, in Grace Hospital, Detroit, Michigan. This is a community hospital of 404 beds with a comprehensive residency program affiliated with Wayne State University School of Medicine. CPR is conducted by a code blue team consisting of a senior medical resident and an anesthetist or anesthesiologist assisted by floor personnel. A CPR log is kept for each resuscitation attempt, and a copy of that log is sent to the medical records department. From the logs a monthly report is prepared. Based on these monthly reports, it was possible to retrieve the medical records for all patients who had at least one cardiac arrest followed by CPR during these 12 months.

Patients were excluded from the study if the cardiac arrest took place in the operating room, the emergency room, or the catheterization laboratories. One chart was excluded because the family interrupted the CPR attempt and demanded that the patient be allowed to die. A total of 121 charts met the criteria for the study.

Demographic information on the patient's age, sex, and functional status before admission, ie, living independently, homebound, or nursing home bound were recorded. The severity of patient's illness at the time of the arrest was assessed by recording blood pressure and urine output for the 24 hours prior to the arrest. Laboratory data that indicated the severity of the patient's illness prior to the arrest, including blood urea nitrogen (BUN), creatinine, and arterial blood gasses, were recorded. The out-

TABLE 1. DEMOGRAPHIC CHARACTERISTICS FOR 121 PATIENTS WHO UNDERWENT CARDIOPULMONARY RESUSCITATION IN THE HOSPITAL

Characteristics	No. of Subjects	Survivors No. (%)	Significance
Sex			
Female	58	6 (10)	
Male	63	7 (11)	NS
Living situation			
Independent	59	11 (19)	
Homebound	31	1 (3)	
Nursing home	31	1 (3)	P = .024

TABLE 2. FREQUENCIES OF CASES AND SURVIVORS FOR PRIMARY DIAGNOSES

Diagnosis	No. of Cases	Survivors No. (%)
Myocardial infarction	23	6 (26)
Arrhythmia	16	3 (19)
Congestive heart failure	15	0 (0)
Atherosclerotic heart disease	9	1 (11)
Hypertension	6	1 (17)
Valvular disease	3	0 (0)
Electrolyte imbalance	2	0 (0)
Sepsis	15	1 (7)
Bleeding (including gastrointestinal bleeding)	10	0 (0)
Pneumonia	6	1 (17)
Cancer	8	0 (0)
Other	8	0 (0)
Totals	121	13 (11)

come of CPR was recorded as survived the resuscitation, alive after 12 hours, alive after 24 hours, and survived to leave the hospital. The mental status of patients who survived to be discharged was recorded as being the same as or worse than at the time of admission. A primary diagnosis and up to three secondary diagnoses were recorded for each subject from the face sheet. If more than four diagnoses were listed, only the first four were recorded.

Data analysis was done using Student's t test and Pearson's chi-square statistic. The outcome of CPR was reduced to two conditions—those who survived to leave the hospital and those who died in the hospital—to decrease the degrees of freedom in the analysis.

RESULTS

Hospitalized patients have been identified as having an illness severe enough to require a level of treatment higher than is available in the community. This population is, therefore, different from patients who present to the emergency department and have a cardiac arrest and from patients who have a cardiac arrest outside the hospital. Patients who have a cardiac arrest in the operating room or in the catheterization laboratory will be undergoing an unusual and time-limited stress that is due to anesthesia and surgical procedures; thus they form a special category. This study concerns the patient who is hospitalized and who is not undergoing any special procedures.

The effectiveness of CPR is determined by the number of patients who survive who would not have survived had CPR not been available. Thus, survival, not mortality, is the meaningful dependent variable. Since the overall survival rates for patients with in-hospital cardiac arrests are quite low, the number of survivors in any study is much lower than the number of patients who die. A much larger sample is therefore required to arrive at statistically significant survival rates than statistically significant mortality rates in these studies. This article will concentrate

on the prediction of survival rather than mortality after CPR.

During the study period 121 patients had at least one cardiopulmonary arrest and were given CPR. Seventy-five of these patients did not survive the initial arrest. Of the 46 survivors, 31 survived at least 24 hours and 13 (11 percent) survived to be discharged from the hospital.

Demographic Characteristics

There were 58 women and 63 men in the study group of whom 6 women and 7 men survived. There was no sex difference in survival (chi-square = .018, P = .89). The mean age of the patients who died was 70.0 years (SD = 13.9 years) and the mean age of the survivors was 67.2 years (SD = 15.1 years), which are not significantly different ($t = 0.69$, P = .49, two-tailed test). Of the 121 subjects, 59 patients including 11 of the survivors were living independently prior to hospitalization, 31 patients including 1 survivor were homebound, and 31 patients including 1 survivor were nursing home patients prior to admission. The difference in survivorship between patients living independently and those who were homebound or in nursing homes is significant (chi-square = 7.49, P = .024). These data are summarized in Table 1.

Clinical Characteristics

Seventeen different primary diagnoses were found among the 121 cases. Eight of these diagnoses were represented by only one patient each and were combined into the group "other." The diagnoses are listed in Table 2 along with the number of cases, the number of survivors, and the percentage of survivors for each diagnosis. For only

two diagnoses were there more than one survivor, myocardial infarction and arrhythmia. Among the 23 cases with a primary diagnosis of myocardial infarction, 6 cases had a secondary diagnosis of arrhythmia, and 3 of these patients survived. Five of the myocardial infarction victims had a secondary diagnosis of congestive heart failure, and none survived.

The main effect of diagnosis on survival is not significant because of the large number of diagnoses and the small number of survivors in this study. Furthermore, the small number of survivors in any diagnostic category made a meaningful analysis of the clinical and laboratory data impossible.

Characteristics of the Code

Seventy-six of the patients were in a monitored bed at the time of their arrest and 10 survived, while 55 patients were in a general ward and 3 survived. This difference is not significant (chi-square = 2.12, $df = 1$, $P > .10$). Shorter resuscitations had a higher success rate than longer efforts. Twenty-two resuscitation attempts lasted less than 15 minutes with seven survivors, while 86 resuscitation attempts lasted more than 15 minutes with six survivors (chi-square = 7.14, $P = .008$). Multiple cardiac arrests did not significantly change the chances for survival. Eighty-five patients had one resuscitation and 10 survived, while 23 patients had more than one resuscitation and 3 survived (chi-square = .022, $P = .88$).

Condition at Discharge

The 13 patients who survived to leave the hospital were all reported to have suffered no change in mental status as a result of the cardiac arrest. No further follow-up data were available.

DISCUSSION

Overall survival after CPR in hospitalized patients in studies that exclude emergency room and special procedure rooms, including the present study, ranges from a high of 14 percent[5,6] to a low of 4.8 percent.[7] Survival rates as high as 24 to 27 percent[8-10] were realized in studies that included the emergency departments and special procedure rooms. Emergency department survival rates were 44 percent and special procedure survival rates were 80 percent in a report by Jeresaty et al.[8] Their survival rate for patients in the hospital was 16 percent, which is consistent with the other reports.

Neither age nor sex appears to be a consistent predictor of survival after CPR. Age was not a predictor of survival in the present study and in several previous reports.[5-8,10-11] Three reports found that younger patients did better than older patients.[9,12,13] On the other hand, Gulati et al[14] reported that 9 of 52 patients aged over 64 years survived one month after CPR, and 7 of that 52 survived to leave the hospital. Sex was not a predictor of survival in the present study and in two other reports.[5,15] Bedell et al[6] and Saphir[13] reported that women had a better survival than men, while Fuesgen and Summa[12] reported that young men had a substantially higher survival rate than women and older men.

Nursing home placement and homebound status prior to hospitalization carry a poor prognosis for survival after cardiac arrest. Bedell et al[6] reported that six of 137 (4 percent) homebound and nursing home patients survived to leave the hospital. This figure is consistent with the present study, which found two survivors out of 62 patients. None of the other reports discussed the patients' status prior to admission. Significantly, some of these patients survive, so homebound or nursing home status cannot be taken as an automatic indication for withholding CPR.

The diagnosis of myocardial infarction carries a relatively good prognosis in all reports with a survival rate of 18 to 30 percent.[8-10,13,16] Myocardial infarction accounts for most of the survivors in all studies. In the present study myocardial infarction and cardiac arrhythmias, presumably due to ischemic heart disease, accounted for all but four of the survivors. These were the only diagnostic categories that had more than one survivor.

Noncardiac illness has a poor prognosis in most studies. Bedell et al[6] reported no survivors with pneumonia or sepsis. Aderka et al[15] disagree and state that they had a very high rate of success (5 out of 7) with patients with prior myocardial infarctions who had a cardiac arrest during a hospitalization for pneumonia or sepsis. The present study found survivors in both groups. Cancer[6,8,13] and kidney failure[6,13] carry a poor prognosis, but survivors have been reported for both. Stroke with coma carries a poor prognosis[6] as does gastrointestinal bleeding.[17] Considerable research is needed to elucidate the relationships among the clinical diagnosis, the severity of illness, and survival after cardiac arrest.

Bedell et al[6] examined several clinical factors that measured the severity of the patient's illness prior to the cardiac arrest. They found that hypotension (systolic blood pressure less than 100 mmHg), uremia (blood urea nitrogen greater than 17.9 mmol/L; 50 mg/dL), and low urine output (less than 300 mL/24 hr) were poor prognostic indicators. They examined mortality rather than survival, however, and it is not clear whether these parameters would have reached statistical significance had survival been the dependent variable. These potentially useful predictors of survival are objective and easily measured. Further study of these predictors should be very fruitful.

The location of the code has been reported to be significantly correlated with survival,[8,11,13] with intensive care unit and coronary care unit patients doing better than ward patients. This relationship did not reach statistical significance in the present study or that of Bedell et al.[6] Obviously location of arrest can be confounded with diagnosis, as the patients suffering from a myocardial infarction who have about a 30 percent survival rate would be found preferentially in the special care units at the time of their cardiac arrest.

Patients who are resuscitated in less than 15 minutes do better than those who have longer resuscitation attempts[5,6,9]; however, six survivors in the present study required more than 15 minutes of resuscitation. Scaff et al[5] report one patient who was resuscitated for more than 1 hour and survived, and Dupont et al[9] reported a case of one patient who survived after a $3\frac{1}{2}$-hour resuscitation. The length of resuscitation is not a clinically significant predictor of long-term survival.

Multiple codes do not carry a poor prognosis. In the present study and others,[10-12] patients who had more than one resuscitation had survival rates similar to those who had one code.

The long-term outcome for patients who survive to leave the hospital is good.[5-20] Lemire and Johnson[18] report 75 percent one-year survival and 30 percent ten-year survival in a group of 230 survivors of CPR. Johnson et al[17] report that 21 of 37 patients with coronary artery disease were alive up to 35 months after discharge. Minuck and Perkins[20] studied 22 patients who were alive from one to four years after a cardiac arrest. Two had their physical activity limited by angina. Four others had minor limitations in activity. Two had persistent but minor memory deficits. Four patients had been readmitted for heart disease including the two with angina. Eleven patients were working at their previous occupations. Five had previously retired, and two were forced to retire because of their heart disease. These results are similar to what one expects from patients who suffer a heart attack or other serious illness without a cardiac arrest.

Patients who suffer severe brain damage during a resuscitation effort apparently die in the hospital. Bedell et al[6] report that coma after CPR is a strong predictor of mortality in the hospital. Hollingsworth[11] reported that the survival of a comatose patient for 24 hours is rare. Saphir[13] reported that of 50 brain-damaged patients, 31 died within one hour and none survived 5 days. Johnson et al,[17] however, report a patient who survived 42 days in a vegetative state. Thus, while most brain-damaged patients die shortly after a CPR attempt, some survive for a considerable period.

The results presented here provide some useful guidelines in making the decision to withhold CPR. A patient's age and sex are not significant predictors of survival even in geriatric populations and thus should not influence the decision not to resuscitate. Patients who cannot live independently, however, have significantly and substantially poorer survival rates than patients who are independent. These findings should be helpful in making decisions on withholding CPR from seriously ill patients in the hospital as well as serving as pilot data for the design of further studies.

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