Outcomes of Cardiopulmonary Resuscitation in Dialysis Patients$^{1,2}$

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ABSTRACT

Patients with renal failure are believed to have a poor survival rate after cardiopulmonary resuscitation, but there is little specific information about the outcomes of cardiopulmonary resuscitation in dialysis patients. To be better able to inform dialysis patients and assist them in decision making about cardiopulmonary resuscitation, the eight-year experience with cardiopulmonary resuscitation in dialysis patients at a university dialysis program was analyzed and outcomes were compared with those of a control group of nondialysis patients undergoing cardiopulmonary resuscitation during the same time period in the same hospital. Of 221 dialysis patients experiencing cardiopulmonary arrest, 74 (34%) had CPR compared with 247 (21%) of 1,201 control patients (P = 0.0002). Six of 74 (8%; 95% confidence interval, 2 to 14%) dialysis patients survived to hospital discharge compared with 30 of 247 (12%; 95% confidence interval, 8 to 16%) control patients (P = not significant). At 6 months after CPR, 2 (3%) of 74 dialysis patients were still alive compared with 23 (9%) of 247 controls (P = 0.044); this difference was not explained by age or comorbid conditions. Twenty-one (78%) of the 27 successfully resuscitated dialysis patients died a mean of 4.4 days later; 95%

were on mechanical ventilation in an intensive care unit at the time of death. It was concluded that cardiopulmonary resuscitation is a procedure that rarely results in extended survival for dialysis patients. In discussions about cardiopulmonary resuscitation with dialysis patients, nephrologists should provide this information.

Key Words: Survival, advance directives, decision making

Only 15% of all patients who undergo cardiopulmonary resuscitation (CPR) survive to hospital discharge (1). Survival after CPR for selected groups of patients such as elderly nursing home residents and those with metastatic cancer is much worse (2–4). Physicians have been encouraged to inform such patients of their likely poor outcomes after CPR and to refrain from offering it to them (2,4,5).

The information in the medical literature about outcomes of resuscitation in patients with renal failure is limited (6–12). However, the available studies suggest that 10% or fewer of renal failure patients undergoing CPR survive to hospital discharge. Data on CPR outcomes in dialysis patients are even more limited; in one small study, 2 of 10 peritoneal dialysis patients left the hospital alive after CPR (13). Nine of these patients had major complications of the CPR; five had flail chests, and four had multiple rib fractures. We know that the attitudes of hemodialysis patients toward CPR do not differ from those of other patients (14). Unfortunately, aside from the above study, there is little specific information about CPR outcomes in dialysis patients. Thus, the risks and benefits of CPR are difficult for nephrologists to enumerate in discussions with their dialysis patients.

We conducted this study to answer the following three questions about CPR in dialysis patients. (1) What percentage of dialysis patients undergo CPR, which factors distinguish those who do from those who do not, and how does this percentage compare with that of a control group of nondialysis patients? (2) What are the causes of cardiopulmonary arrest preceding CPR in dialysis patients? (3) What are the outcomes of CPR in dialysis patients and how do they compare with those of nondialysis patients?

METHODS

Study Population

Dialysis Patients. All adult chronic dialysis patients of the West Virginia Health Care Cooperative
who experienced a cardiopulmonary arrest between January 1983 and May 1991 were included. Patients were identified from the dialysis unit and West Virginia University Hospitals records of CPR procedures and patient deaths. All of these patients underwent CPR unless a "Do Not Resuscitate" order had been written, or unless they were found dead with rigor mortis. They were identified retrospectively for the years 1983 to 1986 and prospectively for 1987 to 1991.

The dialysis program of the West Virginia Health Care Cooperative provided dialysis of 100 patients on average per year during the study and was treating 130 patients at the end of the study. Patients were dialyzed in one of two free-standing units. Dialysis care at each unit was provided by registered nurses who were certified in Advanced Cardiac Life Support by the American Heart Association. All inpatient care was provided at West Virginia University Hospitals.

Control Patients. Control group patients were included in this study if they were adults and met the following criteria: (1) experienced a cardiopulmonary arrest while an inpatient at West Virginia University Hospitals, (2) underwent CPR between March 1987 and May 1989, and (3) did not have acute or chronic renal failure requiring dialysis. Control group patients were identified retrospectively from hospital records of consecutive CPR procedures between March 1987 and May 1989.

Each patient chart was reviewed for the following patient parameters: age, gender, dialysis treatment (peritoneal, hemodialysis, or none), survival after CPR, comorbid conditions including diabetes, chronic pulmonary disease, cardiac disease, malignancy, cerebrovascular disease, and sepsis; and cause of cardiopulmonary arrest. Charts were also reviewed for CPR parameters: performance of CPR, duration of procedure, location, and complications.

The percentage of dialysis patients undergoing CPR was calculated by dividing the number of patients on whom CPR was performed by the number of dialysis patients experiencing cardiopulmonary arrest during the study period. The percentage of control group patients undergoing CPR was calculated by dividing the number of patients on whom CPR was performed by the number of hospital patients experiencing cardiopulmonary arrest during the study period. Patients who were dead on arrival in the emergency department, stillborn births, and patients dying in the operating room were not included because CPR was not attempted in the first two groups and CPR procedure records were not submitted for the last group.

Follow-Up

Survival to 6 months after CPR in dialysis and control group patients was determined by reviewing dialysis and hospital records and, when these records were incomplete, by contacting the primary physician.

For the purpose of this study, CPR was defined according to the Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care of the American Heart Association (15).

Statistical Analysis

Comparisons of population proportions were performed by the χ² test with Yates’ correction and the Fisher’s exact test where appropriate. Parametric data were analyzed by the t test for independent samples. P values of less than 0.05 were considered significant. Data are presented as the mean ± standard deviation.

This study protocol was approved by the West Virginia University Institutional Review Board for the Protection of Human Subjects.

RESULTS

Patients and Rates of CPR

Between 1983 and 1991, 221 dialysis patients experienced cardiopulmonary arrest, and 74 (34%) underwent CPR. The patients who underwent CPR were younger, and there was a trend for the patients to more often be men. A smaller percentage also had cancer (Table 1). The diabetics who underwent CPR were significantly younger than those who did not (56 ± 13 versus 62 ± 12 yr; P = 0.007). The mean age of the men and women undergoing CPR was the same for both diabetics and nondiabetics. There was no difference in the percentage of patients undergoing CPR on the basis of their dialysis modality: 49 (34%) of 143 hemodialysis patients and 14 (31%) of 45 peritoneal dialysis patients. Eleven (31%) of 35 patients who had been on both in the recent past underwent CPR. Sixty-three (85%) patients experienced cardiopulmonary arrest in the hospital, six experienced it in their homes, and five experienced it in the outpatient dialysis units.

From 1987 to 1989, 1,201 control group patients experienced cardiopulmonary arrest, and 247 (21%) experienced acute or chronic renal failure requiring dialysis.

<table>
<thead>
<tr>
<th>TABLE 1. Demographics of dialysis patients experiencing cardiopulmonary arrest</th>
<th>CPR (N = 74)</th>
<th>No CPR (N = 147)</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>Mean Age (yr)</td>
<td>55 ± 15</td>
<td>65 ± 12</td>
<td>0.001</td>
</tr>
<tr>
<td>No. of Men (%)</td>
<td>41 (55)</td>
<td>63 (43)</td>
<td>0.08</td>
</tr>
<tr>
<td>No. of Diabetics (%)</td>
<td>39 (53)</td>
<td>81 (55)</td>
<td>NS</td>
</tr>
<tr>
<td>No. of Diagnosis of Cancer (%)</td>
<td>8 (11)</td>
<td>43 (29)</td>
<td>0.007</td>
</tr>
<tr>
<td>Mean Time on Dialysis (months)</td>
<td>24 ± 26</td>
<td>20 ± 26</td>
<td>NS</td>
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underwent CPR. The percentage of control group patients who received CPR was less than that of dialysis patients (21 versus 33%; \( P = 0.0002 \)). These patients were older, and fewer were diabetics compared with the dialysis patients undergoing CPR (Table 2). The diabetics in the control group were significantly older than the diabetic dialysis patients who underwent CPR (68 ± 11 versus 56 ± 13 yr; \( P < 0.001 \)). There was no difference in the mean age of the control group compared with that of the entire dialysis patient population (63 ± 16 versus 62 ± 14 yr; \( P = \text{not significant} \ [\text{NS}] \)). The mean age of the men in the control group was significantly less than that of the women (61 ± 17 versus 67 ± 15 yr; \( P = 0.004 \)). The percentage of patients with comorbid conditions—chronic pulmonary disease, cardiac disease, malignancy, cerebrovascular disease, neurologic disease, and sepsis—did not differ between dialysis patients undergoing CPR and control group patients.

### Causes of Cardiopulmonary Arrest

The causes of cardiopulmonary arrest in the dialysis patients are listed in Table 3. Fewer than 10% of the arrests (7 of 74) occurred while patients were receiving a hemodialysis treatment, yielding a cardiopulmonary arrest rate on dialysis of roughly 1 per 82 patient yr. All of these arrests were likely precipitated in some way by the dialysis process; in six cases, it is likely that the cardiovascular stress of hemodialysis contributed to the arrests. Five of these patients had known severe cardiac disease (four had ischemic disease, and one who had a cardiomyopathy also had an allergic reaction to a dialyzer), and the sixth had amyloidosis and developed refractory hypotension. In the seventh patient, a dialysis-related air embolus caused the arrest. Two (3%) of the arrests were the result of hyperkalemia. One patient with atherosclerotic cardiovascular disease suffered a cardiac arrest from electromechanical dissociation after receiving phenytoin at a rate greater than 25 mg/min.

### Resuscitation Outcomes and Survival

The survival after CPR in the dialysis and control group patients is listed in Table 4. There was no difference in initial successful resuscitation of dialysis and control group patients (27 [37%] of 74 versus 98 [40%] of 247; \( P = \text{NS} \)). The mean duration of CPR was significantly less in dialysis and control group patients who were successfully resuscitated than in those who were not (dialysis patients, 22 ± 17 versus 37 ± 18 min; \( P = 0.008 \); control group, 18 ± 19 versus 36 ± 21 min; \( P < 0.001 \)). There was no significant difference in the mean duration of resuscitation for successfully resuscitated dialysis and control group patients.

After CPR, 6 (8%) of 74 (95% confidence interval, 2 to 14%) dialysis patients, three men and three women, survived to hospital discharge compared with 30 (12%) of 247 (95% confidence interval, 8 to 16%) control group patients (\( P = \text{NS} \)). None of the
dialysis patients who were resuscitated at home or in the dialysis unit survived to discharge. At 6 months after CPR, 2 (3%) of 74 dialysis patients were still alive compared with 23 (9%) of 247 controls ($P = 0.044$).

The presence of diabetes did not affect survival to hospital discharge after CPR in dialysis or control group patients. Three of 39 diabetic dialysis patients lived to discharge compared with 3 of 35 non diabetic dialysis patients (8 versus 9%; $P = NS$). Six of 51 diabetic control group patients lived to discharge compared with 24 of 176 nondiabetic control group patients (12 versus 14%; $P = NS$).

Four of the six dialysis patients who survived to hospital discharge after CPR died within 4 months of the resuscitation. One patient with end-stage heart disease who also had diabetes and a prior stroke discontinued dialysis and died within 3 months of her CPR. The second patient was a 30-year-old type I diabetic who had had a previous myocardial infarction and who was found dead in bed 3 months and 1 day after resuscitation. The third patient, who also had end-stage heart disease, experienced a second cardiac arrest 3 months and 8 days after his first cardiac arrest and died 3 days later. The fourth patient, who had arrested after a phenytoin infusion and who was hospitalized several months later for weight loss, was found dead in bed 4 months and 1 day after resuscitation.

Two dialysis patients lived for more than 6 months after CPR. The first, who had experienced a respiratory arrest after aspiration, was debilitated and remained in the hospital for 2½ months after CPR. He died 14 months after CPR from complications of a stroke. His baseline weight was 55 kg, and he weighed 36 kg shortly before his death. The second, who had a respiratory arrest as a complication of sepsis, remained on mechanical ventilation for 23 days and was discharged to a nursing home 3½ months later. She has survived 19 months, has required oxygen by nasal cannula 24 h/day for her severe chronic obstructive pulmonary disease, and has been confined to a wheelchair. She continues to live in a nursing home, and although she is happy to be alive, she has requested not to be resuscitated again.

Twenty-one (78%) of the 27 dialysis patients who were successfully resuscitated did not live to discharge; 20 (95%) of 21 required intubation and mechanical ventilation for a mean of 4.4 days before death. Only three of the successfully resuscitated patients who did not live to discharge had autopsies, so data on other complications of CPR in these patients are unavailable.

**DISCUSSION**

This study had several noteworthy findings. First, the percentage of dialysis patients undergoing CPR was more than that of the control group. It is possible that the previously described inclination of nephrologists to use CPR more than other internists, both in dialysis patients and in other patients with impaired functional status, may account for this finding (16).

Second, the dialysis patients who underwent CPR were significantly younger than those who did not. Because, in our study, the patients who did not have CPR had requested not to be resuscitated, this finding is consistent with reported preferences of older dialysis patients to decline CPR more often than younger ones (13,17).

Third, despite the fact that the dialysis patients were significantly younger than the control group patients, there was a lower long-term survival in the dialysis patients. Overall, fewer than 10% of the dialysis patients survived to hospital discharge and only 3% were still alive 6 months after CPR. Although many more of the dialysis patients were diabetics, diabetes did not account for the worse survival rate in dialysis patients. Other comorbid conditions also did not account for this difference. It would appear that the underlying ESRD is responsible for the poor survival after CPR in dialysis patients.

Even those six dialysis patients who did survive to hospital discharge had limited long-term benefit from the CPR. Two thirds were dead within 4 months, and two of these had a progressively downhill course, one dying after the discontinuation of dialysis. Both patients who survived longer than 6 months sustained a marked decrease in their functional status compared with prearrest status. These findings are similar to those for nondialysis patients who were monitored for 6 months after resuscitation (18).

Fourth, the dialysis patients who were successfully resuscitated experienced significant short-term morbidity and mortality. Over three quarters of them died on average within a week. Of these, 95% were intubated and on mechanical ventilation in an intensive care unit at the time of death.

Six limitations of this study need to be acknowledged. The outcomes in fewer than 100 dialysis patients undergoing CPR are reported. It is possible that with large numbers a significant decrease in survival

<table>
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<th>TABLE 4. Survival After CPR in Dialysis and Control Patients</th>
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<tr>
<td>Dialysis Group <em>(N = 74)</em></td>
</tr>
<tr>
<td>No. of Resuscitations (%)</td>
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<tr>
<td>No. of Discharges (%)</td>
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<tr>
<td>No. Surviving at Six Months (%)</td>
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to hospital discharge might be seen in dialysis patients compared with others. However, this study reports 8 yr of observation of CPR outcomes and, in the last 4 yr, there has been no trend toward a statistically significant difference. The lack of difference in either duration of resuscitation or percentage of patients successfully resuscitated supports the observation that the short-term results of CPR in dialysis and control patients do not vary. Yet, despite the small numbers, this study shows clearly that dialysis patients undergoing CPR have a significantly worse 6-month survival compared with that of non-dialysis patients.

A second limitation is that the outcomes of 247 patients in the control group who all had CPR in the hospital are compared with those of 74 dialysis patients, 11 of whom had CPR in their homes or the dialysis unit. Despite this dissimilarity in location, the percentage of patients successfully resuscitated and surviving to discharge did not differ between the two groups.

Third, it could be argued that the low survival rates for dialysis and control group patients are the result of poor CPR technique at West Virginia University Hospitals. However, the survival to discharge and 6-month survival of our control group patients are comparable to those previously reported (18).

Fourth, in this study, the outcomes of CPR in dialysis patients over an 8-yr period, from 1983 to 1991, are compared with those for control patients over a more recent part of this period, from 1987 to 1989. It would be desirable if the dialysis patients and control patients undergoing CPR were compared over the same period of time, but West Virginia University Hospitals' system for tracking all resuscitations was implemented in 1987 and a retrospective analysis of CPR for the years before 1987 would not be accurate. To examine this limitation, the age, gender, and percentage of dialysis patients undergoing CPR after 1986 were compared with those of dialysis patients undergoing CPR in the earlier years of the study. There were no differences in age, gender, or rate of CPR, and the percentage of patients surviving to discharge were similar: 9% for the years 1983 to 1986 and 7% for the years 1987 to 1991. The 6-month survival for both groups was very low; none of the 33 patients in the earlier years survived, and 2 (5%) of 41 patients in the later years survived.

Fifth, although it was possible to verify the dialysis unit records of deaths and CPR with hospital records, it is likely that some control patients undergoing CPR during the study period were missed because hospital CPR documentation forms were not submitted.

Sixth, multiple statistical comparisons were made in this study and some of the results may have arisen by chance alone.

Despite the paucity of information about CPR outcomes in dialysis patients and the inference from the experience of CPR in renal failure patients that the expected outcomes would be poor, most dialysis patients indicate that they want CPR in the event of cardiopulmonary arrest (13,14,17,19).

Our data show that CPR is a procedure that rarely results in extended survival for dialysis patients. Kjellstrand has written that nephrologists need to be more open with their patients and more realistic about what they can and cannot do (20). Such discussions need to contain useful information for patients that allows them to make informed decisions, and nephrologists have been encouraged to obtain advance directives from patients as part of these discussions (21,22). The poor outcomes of CPR in dialysis patients and the automatic presumption that CPR will be performed unless a "Do Not Resuscitate" order has been written should be included in the information that nephrologists provide during conversations about CPR with their dialysis patients. In this way, nephrologists can assist patients in making informed decisions about their future treatment.

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