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Kidney Medicine

Outcomes Following In-Hospital Cardiopulmonary Resuscitation in People Receiving Maintenance Dialysis

Fahad Saeed, Haris F. Murad, Richard E. Wing, Jianbo Li, Jesse D. Schold, Kevin A. Fiscella

Rationale & Objective: Previous studies showing poor cardiopulmonary resuscitation (CPR) outcomes in the dialysis population have largely been derived from claims data and are somewhat limited by a lack of detailed characterization of CPR events. We aimed to analyze CPR-related outcomes in individuals receiving maintenance dialysis.

Study Design: Retrospective chart review.

Setting & Participants: Using electronic medical records from a single academic health care system, we identified all hospitalized adult patients receiving maintenance dialysis who had undergone in-hospital CPR between 2006 and 2014.

Exposure: Initial in-hospital CPR.

Outcomes: Overall survival, predictors of unsuccessful CPR, predictors of death during the same hospitalization among initial survivors, predictors of discharge-to-home status.

Analytical Approach: We provide descriptive statistics for the study variables and used *t* tests, χ^2 tests, or Fisher exact tests to compare differences between the groups. We built multivariable logistic regression models to examine the CPR-related outcomes.

Results: A total of 184 patients received in-hospital CPR: 51 (28%) did not survive the initial CPR event, and 77 CPR survivors died (additional 42%) later during the same hospitalization (overall mortality 70%). Only 18 (10%) were discharged home, with the remaining 32 (17%) discharged to a rehabilitation facility or a nursing home. In the multivariable model, the only predictor of unsuccessful CPR was CPR duration (OR, 1.41; 95% CI, 1.24-1.61; $P < 0.001$). Predictors of death during the same hospitalization after surviving the initial CPR event were CPR duration (OR, 1.15; 95% CI 1.04-1.27; $P = 0.007$) and older age (OR, 1.64; 95% CI, 1.23-2.2; $P < 0.001$). Older people also had lower odds of discharge-to-home status (OR, 0.25; 95% CI, 0.11-0.54; $P < 0.001$).

Limitations: Retrospective study design, single-center study, no information on functional status.

Conclusions: Patients receiving maintenance dialysis experience high mortality following in-hospital CPR and only 10% are discharged home. These data may help clinicians provide useful prognostic information while engaging in goals of care conversations.

Visual Abstract included

Complete author and article information provided before references.

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There is an urgent need to improve end-of-life care for persons receiving maintenance dialysis.[1] A majority of these people receive potentially burdensome treatments near the end of life[2] despite their frequent wish to focus on a more comfortable end-of-life course.[3]

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However, advance care planning (ACP) is not commonly performed with these patients.[3] In one US-based study of 423 individuals receiving maintenance dialysis, only 36% had completed an ACP document, and 65% expressed a wish to have a "full code" status.[3] Even in the settings of a critical illness, end-stage kidney disease status is not associated with having do not resuscitate orders.[4]

One critical barrier toward meaningful ACP discussions is the relative paucity of prognostic data on CPR-related outcomes. Some studies have shown that 74% of people receiving maintenance dialysis die within the same hospitalization after receiving CPR, and only 11% of the survivors are discharged home.[5] The median life expectancy of the survivors is less than 5 months.[6] The probability of mortality or disability after receiving CPR is high in the dialysis population, which raises questions about the wisdom of providing CPR to those with a limited chance of survival after CPR.[5] Significant limitations of prior studies include derivation of data from billing codes, which are prone to misclassifications,[5,6] and a lack of ascertainment of CPR characteristics such as initial rhythm and CPR duration, which are significant prognostic determinants of CPR-related outcomes.[7] Notably, one study of people receiving dialysis captured CPR characteristics but categorized initial rhythm as shockable versus nonshockable.[8] While this broad categorization of initial rhythm is useful in providing clinical guidance for performing CPR, prior studies have underscored the importance of each initial rhythm in determining the CPR outcomes.[7]

To add to the previous studies on CPR outcomes in persons receiving maintenance dialysis and guide goals of care and ACP discussions, we conducted a retrospective review of medical records to examine: (1) the overall survival after receiving in-hospital CPR, (2) predictors of unsuccessful CPR, (3) predictors of death during the same hospitalization among initial survivors, and (4) predictors of discharge-to-home status.

PLAIN-LANGUAGE SUMMARY

Prior studies have shown poor survival after receiving CPR among persons receiving maintenance dialysis. However, much of the prior literature is derived from large claims-based data sets that largely lack CPR details. To bridge this gap in the literature, we examined the outcomes of in-hospital CPR in a single tertiary care hospital. Overall, 70% died during the same hospitalization, and only 10% of those undergoing CPR were discharged home. These data may be useful in guiding goals of care conversations during advance care planning and end-of-life situations.

METHODS

Sample and Variables

With an electronic medical records query, we identified all adult (aged >18 years) patients who had undergone CPR (regardless of outcome) at the Cleveland Clinic Foundation hospitals between January 2006 and December 2014. We further narrowed our search to include only patients receiving maintenance dialysis by using the *International Classification of Diseases, Ninth Revision* code for end-stage renal disease (585.6) and dialysis procedure codes (54.98 for peritoneal dialysis and 39.95 for hemodialysis). We identified CPR procedures using CPR billing codes (*International Classification of Diseases, Ninth Revision* diagnostic codes 99.60 and 99.63). Initial data extractions were further validated for accuracy by independent chart reviews conducted by the second author (HM). Additional variables such as CPR duration, initial rhythm, in-hospital CPR, death at the end of CPR, death during the same hospitalization, length of stay, and discharge disposition were also determined by the review of electronic medical records. Information on comorbidities was extracted from problem lists documented in patients' electronic charts. The Cleveland Clinic institutional review board approved the project based on the use of existing deidentified data (no. 14-1282).

Statistical Analyses

For continuous variables, we provide mean values and standard deviation (SD) and/or median values with interquartile range (IQR). For categorical variables, we report frequencies with percentage. We used t tests, χ^2 tests, or Fisher exact tests to examine statistically significant ($P < 0.05$) differences between groups as appropriate. We built multivariable logistic regression models to identify independent predictors for the outcomes: unsuccessful CPR, death during the same hospitalization, and discharge-to-home status for those surviving the initial CPR. All the variables were evaluated as potential risk factors. The initial list of variables for the multivariable model was based on univariate logistic regression with a P value of <0.25. We calculated the odds ratio (OR) with 95% confidence interval (CI) for each risk factor, one state over the other for binary variables (eg, men vs women) and a higher value over a lower value for continuous variables for a preferred interval. We applied a restricted cubic spline with 3 knots to the CPR duration to account for its nonlinearity. We calculated the predicted probability of outcomes in these multivariable models. Discharge status had only 6 missing observations, and there were no further missing observations for other risk factors staying in the final models. The relationship of predicted mortality (and its 95% CI) and CPR duration is presented graphically by plotting one against the other, and the predicted mortality was calculated with confounders held constant at their means. Using a similar methodology, the relationship between mortality and age was calculated and is presented. All statistical analyses were conducted using R (v 4.1, www.r-project.org).

RESULTS

Out of 184 patients, 133 patients (72%) survived the initial CPR, whereas 51 patients (28%) did not. Table 1 contains a description of the patient demographics, CPR characteristics, and outcomes for both survivors and nonsurvivors of the initial CPR. The cohort was comprised of predominantly African Americans (59.2%) and men (56%). The top 3 comorbid conditions were congestive heart failure (72.8%), diabetes mellitus (62.5%), and stroke (54.3%). The following initial rhythms were observed: pulseless electrical activity (62.3%), ventricular arrhythmia (19.2%), and asystole (18.6%).

For those undergoing an unsuccessful CPR event, the initial presenting rhythm was asystole in 17.8% (n = 8), ventricular arrhythmia in 31.1% (n = 14), and pulseless electrical activity in 51.1% (n = 23) CPR events. The average CPR duration was 32.8 (±19.4) minutes for those who had unsuccessful CPR. In the multivariable model after adjusting for confounders (Table 2), the main predictor of unsuccessful CPR was the duration, with each minute increase in CPR duration associated with 41% greater odds of death (OR, 1.41; 95% CI, 1.24-1.61; $P < 0.001$).

For those surviving the initial CPR event (n = 133) (Table 1), the initial presenting rhythm was asystole in 18.9% (n = 23), ventricular arrhythmia in 14.8% (n = 18), and pulseless electrical activity in 66.4% (n = 81) CPR events. The average CPR duration was 13.8 (±16.8) minutes for the initial survivors. Of the survivors, 57.9 % (n = 77) died during the same hospitalization leading to an overall mortality of 70%. A total of 10% (n = 18) of patients were discharged home and 17% (n = 32) to a rehabilitation facility or a nursing home. Discharge status was missing for 5% of patients.

In the multivariable model, after adjusting for confounders (Table 2), predictors of death during the same hospitalization after surviving the initial CPR included each

Table 1. Demographic, Clinical, CPR Characteristics, and Outcomes in Patients Receiving Maintenance Dialysis Undergoing In-Hospital CPR

	All (n = 184)	Those Not Surviving the Initial CPR Event (n = 51)	Those Surviving the Initial CPR Event (n = 133)	*P* value[a]
Age, n, mean (SD)/median (IQR)	184, 64.3 (13.8)/66 (54-74)	51, 65.7 (13.4)/65 (55-78)	133, 63.7 (14)/66 (54-74)	0.4
Race, n (%)				>0.99
African American	109 (59.2)	30 (58.8)	79 (59.4)	
White	67 (36.4)	19 (37.3)	48 (36.1)	
Other	8 (4.35)	2 (3.92)	6 (4.5)	
Sex, n (%)				0.3
Women	81 (44.0)	26 (51.0)	55 (41.4)	
Men	103 (56.0	25 (49.0)	78 (58.6)	
Duration of dialysis (months), n, mean (SD)/ median (IQR)	178, 49.9 (49.8)/36 (17-70)	49, 55.2 (56.9)/38 (18-72)	129, 47.9 (47)/36 (17-64)	0.4
Cardiomyopathy, n (%)				0.8
No	126 (68.5)	36 (70.6)	90 (67.7)	
Yes	58 (31.5)	15 (29.4)	43 (32.3)	
Diabetes mellitus, n (%)				0.2
No	69 (37.5)	15 (29.4)	54 (40.6)	
Yes	115 (62.5)	36 (70.6)	79 (59.4)	
Cancer, n (%)				0.4
No	132 (71.7)	34 (66.7)	98 (73.7)	
Yes	52 (28.3)	17 (33.3)	35 (26.3)	
Dementia, n (%)				0.5
No	174 (94.6)	47 (92.2)	127 (95.5)	
Yes	10 (5.43)	4 (7.8)	6 (4.51)	
Peripheral vascular disease, n (%)				0.4
No	98 (53.3)	30 (58.8)	68 (51.1)	
Yes	86 (46.7)	21 (41.2)	65 (48.9)	
Stroke, n (%)				>0.99
No	84 (45.7)	23 (45.1)	61 (45.9)	
Yes	100 (54.3)	28 (54.9)	72 (54.1)	
Congestive heart failure, n (%)				0.8
No	50 (27.2)	15 (29.4)	35 (26.3)	
Yes	134 (72.8)	36 (70.6)	98 (73.7)	
Malnutrition, n (%)				0.5
No	106 (57.6)	27 (52.9)	79 (59.4)	
Yes	78 (42.4)	24 (47.1)	54 (40.6)	
Presenting rhythm, n (%)				0.06
Pulseless electrical activity	104 (62.3)	23 (51.1)	81 (66.4)	
Ventricular arrhythmia	32 (19.2)	14 (31.1)	18 (14.8)	
Asystole	31 (18.6)	8 (17.8)	23 (18.9)	
Presence of ≥2 extrarenal comorbid conditions, n (%)				0.5
1 or 2	22 (12.0)	8 (15.7)	14 (10.5)	
≥2	162 (88.0)	43 (84.3%)	119 (89.5)	
Death in hospital, n (%)				
Alive	56 (30.4)		56 (42.1)	
Dead	128 (69.6)	51 (100%)	77 (57.9)	
Discharge disposition (alive), n (%)				
Home	18 (36.0)		18 (36.0)	
Nursing home or rehab	32 (64.0)		32 (64.0)	

(Continued)

Table 1 (Cont'd). Demographic, Clinical, CPR Characteristics, and Outcomes in Patients Receiving Maintenance Dialysis Undergoing In-Hospital CPR

	All (n = 184)	Those Not Surviving the Initial CPR Event (n = 51)	Those Surviving the Initial CPR Event (n = 133)	*P* value[a]
Average CPR duration, n, mean (SD)/median (IQR)	184, 19.0 (19.5)/13.5 (5-28)	51, 32.8 (19.4)/30 (18.5-39)	133, 13.8 (16.8)/9 (4-16)	<0.001
Average CPR duration for initial survivors who died during the same hospitalization, n, mean (SD)/median (IQR)	77, 16.4 (19.3) /10 (6-20)		77, 16.4 (19.3)/10 (6-20)	

Abbreviations: CPR, cardiopulmonary resuscitation; IQR, interquartile range; SD, standard deviation.
[a]Comparison between patients who survived the initial CPR or not.

minute increase in CPR duration (OR, 1.15; 95% CI, 1.04-1.27]; $P = 0.007$) and each 10-year increase in age (OR, 1.64; 95% CI, 1.23-2.2; $P < 0.001$). Each 10-year increase in age was also associated with 25% lower odds of discharge-to-home status (OR, 0.25; 95% CI, 0.11-0.54; $P < 0.001$).

Figure 1A shows the relationship between patient survival (y-axis) and duration of CPR (x-axis) with confounders held constant at their means. The thin lines represent death at the end of CPR, and the thick lines represent death in the hospital. Dotted lines represent 95% CI that widens as the length of CPR increases. The chance of death at the end of CPR was 7.4% if CPR lasted 10 minutes, 22.9% at 15 minutes, and 42.8% at 20 minutes. For survivors of initial CPR, chances of death during the same hospitalization were 62% at 10 minutes of CPR, 70.5% at 15 minutes, and 74.8% at 20 minutes. Figure 1B shows the relationship between patient survival (y-axis) and age (x-axis). The chances of death at the end of CPR were 15.2% at age 40, 22.7% at age 60, and 32.4% at age 80. For survivors of initial CPR, chances of death during the same hospitalization were 31.8% at age 40, 54.8% at 60, and 75.9% at 80.

DISCUSSION

In the current study, of the 184 people receiving maintenance dialysis, we found that 28% did not survive the initial CPR event and an additional 42% died during the same hospitalization leading to an overall in-hospital mortality of 70%. Longer CPR duration was associated with both unsuccessful CPR and death during the same hospitalization. Only 10% of patients undergoing CPR were discharged home. Older age was associated with higher odds of death during the same hospitalization and lower odds of discharge-to-home status. These findings provide useful prognostic information to guide ACP or goals of care discussions.

The CPR-related mortality seen in our study is somewhat lower than that reported in previous studies in the dialysis population. In a Get With The Guidelines-Resuscitation registry-based study of 8,498 people on maintenance dialysis undergoing CPR from 2000-2012, 31% died after the initial CPR, and 77% died during the same hospitalization.[9] Similarly, reported in-hospital mortality in previous studies[5,6] from the Nationwide Inpatient Sample (2005-2011) and Medicare Claims data set (2000-2010) was 73.9% and 78.1%, respectively. Plausible reasons for this discrepancy could include variation in CPR practices and outcomes across different centers[10] and improvement in CPR outcomes in the relatively recent years as seen in our study.[11,12] Additionally, the presence of a dedicated certified resuscitation team and postcardiac arrest care at a specialized tertiary care center like the Cleveland Clinic may have led to improved outcomes.[13] However, future studies are needed to address this question.

Table 2. Multivariable Model Predicting Unsuccessful CPR, Death in the Same Hospitalization, and Discharge-to-Home Status

Factor	Odds Ratio	95% Confidence Interval	*P* value
Unsuccessful CPR			
CPR duration (each 1 min increase)	1.41	1.24-1.61	<0.001
Women (reference, men)	2.29	0.98-5.35	0.06
Death of initial CPR survivors during the same hospitalization			
CPR duration (each 1 min increase)	1.15	1.04-1.27	0.007
Age (each 10 y increase in age)	1.64	1.23-2.2	<0.001
Discharge-to-home			
CPR duration (each 1 min increase)	0.93	0.78-1.11	0.4
Age (each 10 y increase in age)	0.25	0.11-0.54	<0.001

Note: Variables included in the initial models but dropped out in the final models: diabetes mellitus, presenting rhythm, presence of comorbidity, stroke, cardiomyopathy, and malnutrition.
Abbreviations: CPR, cardiopulmonary resuscitation.

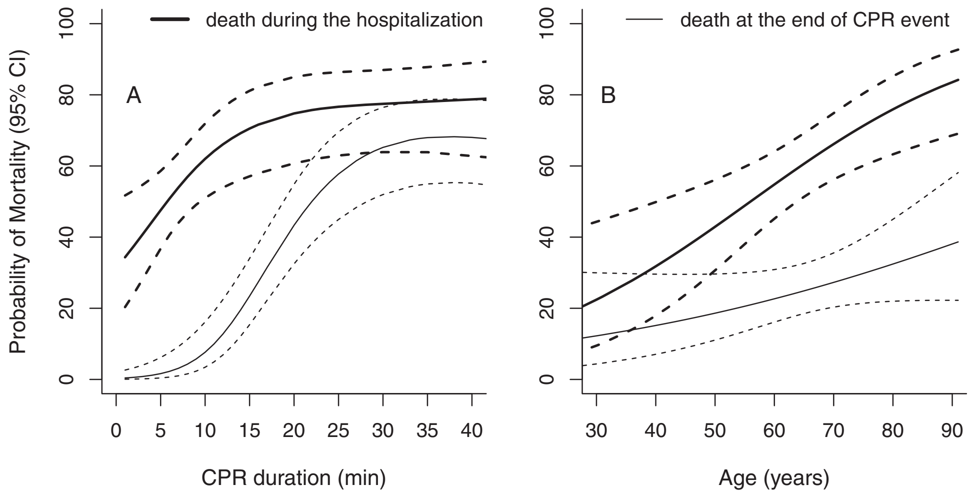

Figure 1. Relationship of patient survival to cardiopulmonary resuscitation (CPR) duration (A) and age (B). Solid lines are mortality rate (y-axis) for death in hospital (thick line) or at the end of CPR event (thin line), and the corresponding dotted lines represent the 95% confidence interval (CI).

Patients receiving longer durations of CPR were more likely to die both at the end of the CPR event and during the same hospitalization. Such findings are consistent with those reported in the general population. In a study of 313 patients, Ballew et al[14] observed that 45% of patients survived to discharge when the CPR duration was <5 minutes, and <5% of patients survived when the resuscitation duration was >20 minutes. Another study reported 2% survival if the resuscitation duration was >10 minutes.[15] A study from Taiwan found that the rate of achieving return of spontaneous circulation was >90% when the CPR duration was <10 minutes but reduced to 50% when it was ≥30 minutes.[16] In a study of people receiving maintenance dialysis, Moss et al[17] showed that successfully resuscitated dialysis patients had a lower mean duration of CPR when compared with those who were not (22 ± 1 7 minutes vs 37 ± 1 8 minutes; $P = 0.008$). However, they studied only 74 patients and did not capture the discharge destination.

Older age was associated with lower survival and worse discharge outcomes (Table 2). Such findings are consistent with the previous literature showing that increased age is a significant risk factor for in-hospital mortality and discharge-to-nursing home status.[5,18,19] Data from the general population also support these findings.[18,20,21] Age remained a significant predictor of poor CPR-related outcomes, even after adjusting for the duration of CPR, a finding that, to the best of our knowledge, has not been previously reported in a dialysis population.

Our study has several strengths and limitations. We were able to capture detailed descriptions of the presenting rhythms, which are important prognostic markers for CPR outcomes.[7] Further, all the data from the initial electronic query were further verified by an independent reviewer. We also acknowledge that the current study has several limitations. First, we extracted data from a single health care system with no direct assessment of functional or neurological status and long-term outcomes. However, we were able to capture information on discharge destination, which has been shown to correlate with the patient's functional status at the time of discharge.[22] Second, we did not capture data on a second resuscitation event, and data on discharge destination was missing for 5% of patients. Third, it is also possible that patients died due to hospital complications not captured in the data set. Last, we acknowledge that we could not capture all comorbid conditions.

Our study has several clinical and research implications. It provides useful data to clinicians for ACP and goals of care discussions. Furthermore, it offers prognostic data on CPR outcomes for older persons receiving maintenance dialysis. Such data may also be helpful in relieving the moral distress of clinicians after an unsuccessful CPR for futile cases.[23] We wish to emphasize that our study provides general guidance for ACP and goals of care discussions, and individual patient factors will need to be considered for decisions to continue or terminate CPR efforts. Finally, our study calls for the development of future research calculators to estimate the chances of survival and quality of life after CPR.[24]

In summary, persons receiving maintenance dialysis, especially older adults, have high mortality after receiving CPR. Both CPR duration and older age were significant factors in determining CPR outcomes. Further, older adults also had lower odds of discharge-to-home status. These data need to be discussed with patients during ACP and with families during goals of care discussions.

ARTICLE INFORMATION

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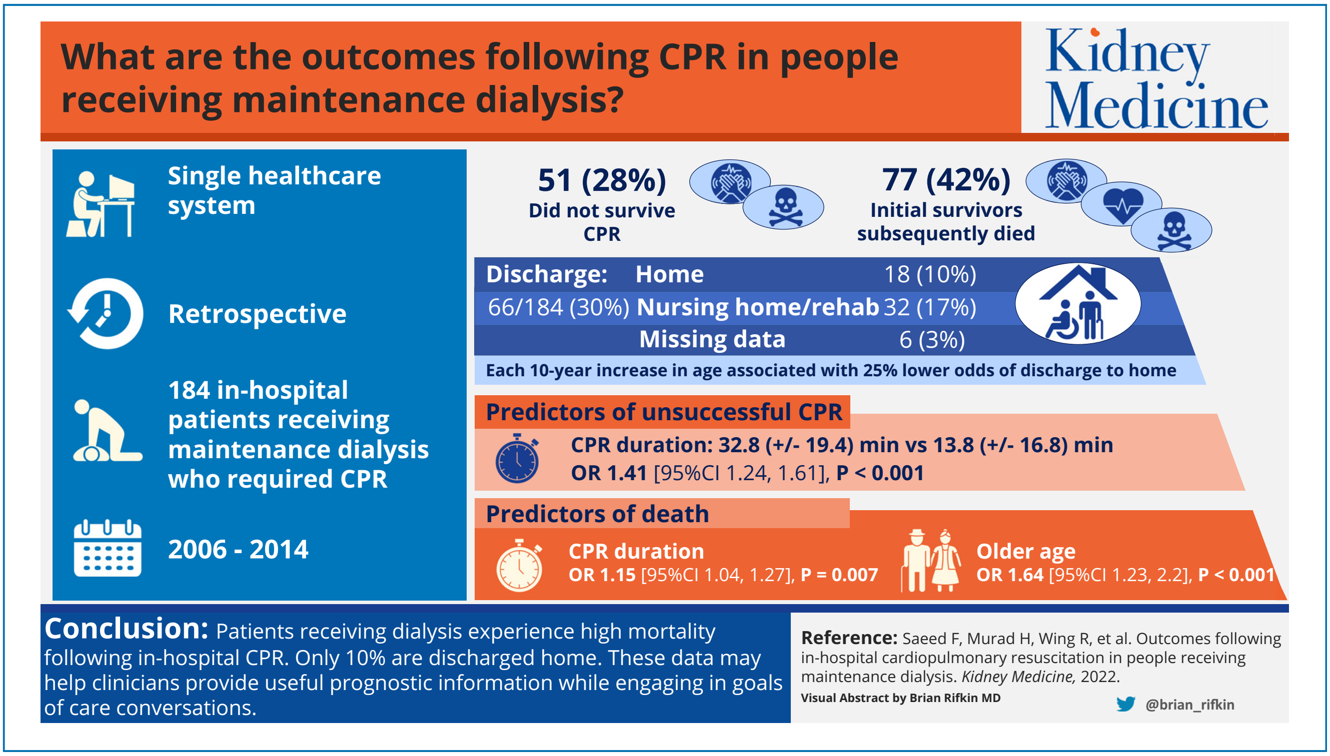
What are the outcomes following CPR in people receiving maintenance dialysis?
Kidney Medicine
Single healthcare system
Retrospective
184 in-hospital patients receiving maintenance dialysis who required CPR
2006 - 2014
51 (28%)
Did not survive CPR
77 (42%)
Initial survivors subsequently died
Discharge: Home 18 (10%)
66/184 (30%) Nursing home/rehab 32 (17%)
Missing data 6 (3%)
Each 10-year increase in age associated with 25% lower odds of discharge to home
Predictors of unsuccessful CPR
CPR duration: 32.8 (+/- 19.4) min vs 13.8 (+/- 16.8) min
OR 1.41 [95%CI 1.24, 1.61], P < 0.001
Predictors of death
CPR duration
OR 1.15 [95%CI 1.04, 1.27], P = 0.007
Older age
OR 1.64 [95%CI 1.23, 2.2], P < 0.001
Conclusion: Patients receiving dialysis experience high mortality following in-hospital CPR. Only 10% are discharged home. These data may help clinicians provide useful prognostic information while engaging in goals of care conversations.
Reference: Saeed F, Murad H, Wing R, et al. Outcomes following in-hospital cardiopulmonary resuscitation in people receiving maintenance dialysis. Kidney Medicine, 2022.
Visual Abstract by Brian Rifkin MD
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