Long-term Outcomes After In-Hospital CPR in Older Adults With Chronic Illness

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BACKGROUND: Outcomes after in-hospital CPR in older adults with chronic illness are unclear.

METHODS: We examined inpatient Medicare data from 1994 through 2005 to identify CPR recipients. We grouped beneficiaries aged ≥ 67 years by severity of six chronic diseases—COPD, congestive heart failure (CHF), chronic kidney disease (CKD), malignancy, diabetes, and cirrhosis—and investigated survival to discharge, discharge destination, rehospitalizations, and long-term survival.

RESULTS: We identified 358,682 CPR recipients. Most patients with chronic disease were less likely to survive to discharge (eg, 14.8% in the advanced COPD group [$P < .001$] and 11.3% in the advanced malignancy group [$P < .001$]) than patients without chronic illness (17.3%). Among discharge survivors, the median long-term survival was shorter in patients with chronic illness (eg, 5.0, 3.5, and 2.8 months in the advanced COPD, malignancy, and cirrhosis groups, respectively; $P < .001$ for all) than without (26.7 months). Although 7.2% of CPR recipients without chronic disease were discharged home and survived at least 6 months without readmission, $\leq 2.0\%$ of recipients with advanced COPD, CHF, malignancy, and cirrhosis ($P < .001$ for all) met these criteria. Adjusted analyses confirmed that most subgroups with chronic illness had lower hospital discharge survival, and among discharge survivors, most were discharged home less often, experienced more hospital readmissions, and had worse long-term survival.

CONCLUSIONS: Older CPR recipients with any of the six underlying chronic diseases investigated generally have much worse outcomes than CPR recipients without chronic disease. These findings may substantially affect decisions about CPR in patients with chronic illness.

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ABBREVIATIONS: CHF = congestive heart failure; CKD = chronic kidney disease; GWTG = Get With The Guidelines; ICD-9 = *International Classification of Diseases, Ninth Revision*; IQR = interquartile range; MedPAR = Medicare Medical Provider Analysis and Review; SNF = skilled nursing facility

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Although first developed in the 1950s to resuscitate postoperative patients, CPR has evolved into a default procedure provided to every patient except those who opt out.^{1,2} Currently, almost one-half of US deaths occur in the hospital, and most are among older adults with chronic illness.³ Older patients who understand CPR outcomes are more likely to choose to forgo CPR.⁴⁻⁶ Therefore, discussions about life-sustaining treatments, including CPR, in the outpatient setting before older patients become acutely ill are important, and patients and family members value shared decision-making.⁷⁻¹¹ Additionally, patients with chronic disease present a unique opportunity for end-of-life discussions because they are more likely to have contact with health-care providers in outpatient settings.

Materials and Methods

Data Sources and Study Population

We analyzed 100% of Medicare Medical Provider Analysis and Review (MedPAR) hospital claims from January 1, 1994, to December 31, 2005, to identify beneficiaries aged ≥ 67 years who received in-hospital CPR, which was defined by either of two *International Classification of Diseases, Ninth Revision* (ICD-9), procedure codes: 99.60 (CPR, not otherwise specified) or 99.63 (closed-chest cardiac massage). Medicare beneficiaries receive benefits through one of three programs: Old Age & Survivors Insurance for those aged ≥ 65 years, End Stage Renal Disease for those receiving dialysis, and Social Security Disability Income for those with disabilities. We only included beneficiaries with Old Age & Survivors Insurance and End Stage Renal Disease. To avoid introducing bias, we excluded individuals enrolled in a health maintenance organization for whom CPR claims data were more likely to be incomplete.²⁰⁻²² For those with more than one CPR event during the 12-year study period, we analyzed only the first occurrence (the index hospitalization).

For each CPR recipient, we then queried MedPAR for the 2-year period prior to CPR and up to and including the index hospitalization to identify patients with one of six chronic diseases: COPD, CHF, CKD, diabetes, cirrhosis, and malignancy. Furthermore, we categorized patients in each disease subgroup as severe and mild/moderate based on data available within MedPAR and prior coding algorithms²³ (e-Table 1). Patients meeting criteria for a particular chronic illness but not meeting criteria to be defined as severe were categorized as mild/moderate. These definitions of chronic illnesses and severity had to be created from these administrative data. For example, spirometric data are not available within MedPAR, so we could not define COPD or its severity based on degree of airflow obstruction; instead, we defined severe COPD based on oxygen use and prior hospitalizations for COPD exacerbations. Participants could be assigned to having more than one chronic illness if they met the respective criteria.

Outcomes were survival to discharge for the index hospitalization, discharge disposition after the index hospitalization, repeat hospital-

Survival to hospital discharge after in-hospital CPR has not changed over the past several decades and remains between 13% and 18%.^{1,12,13} However, data regarding outcomes after in-hospital CPR in patients with chronic illness, such as congestive heart failure (CHF), COPD, chronic kidney disease (CKD), cirrhosis, diabetes, and malignancy, are not clear. Most studies either were small or did not capture sufficient data on chronic illness.¹⁴⁻¹⁶ Furthermore, long-term survival beyond hospital discharge after CPR remains largely unclear, with studies reporting conflicting results.^{6,16-19} We, therefore, investigated outcomes after in-hospital CPR in older adults with chronic illness by using 14 years of Medicare hospital data.

izations until conclusion of the study period, and long-term survival. Predictors chosen a priori were age; sex; race; chronic comorbid illness; zip code median income; admission from a skilled nursing facility (SNF); and hospital size, rurality, and teaching status. The 22 discharge destination codes within MedPAR were reduced to four categories: home, another hospital, SNF, and hospice. Long-term survival was ascertained by linking MedPAR data with Social Security Administration data. We categorized race as white, black, or other.²⁴ We used the Charlson-Deyo Index of Comorbidity score (0, 1, 2, or ≥ 3) to measure burden of chronic illness prior to the hospitalization involving CPR. Importantly, this score is not a measure of severity of acute illness.²³ Median household income from 1999 US Census data using patient zip code was a marker of socioeconomic status. We determined hospital identity from Medicare provider numbers, and we used Centers for Medicare & Medicaid Services data to determine such hospital characteristics as number of beds and presence of physician trainees. We ascertained hospital location using hospital zip code and the Rural-Urban Commuting Area Codes approximation version 2.0, dichotomized as metropolitan and nonmetropolitan.²⁵ The University of Washington Human Subjects Committee approved this study (approval number 29344).

Statistical Analysis

We evaluated crude differences in patient and hospital characteristics and outcomes by using bivariate regression, Wilcoxon rank sum, and χ^2 tests for linear, nonparametric, and categorical data, respectively. Analyses with a $P < .05$ were considered statistically significant. We conducted multivariable analyses of the association between patient or hospital characteristics and both survival to hospital discharge among all CPR recipients and discharge to home among CPR survivors by using logistic regression with robust SE estimates. We used zero-inflated negative binomial regression to analyze the association between characteristics and the number of repeat hospitalizations through the end of the study period in hospital discharge survivors and Cox proportional hazards modeling to analyze the associations between characteristics and long-term survival, with censoring on December 31, 2005, for patients who had not died by the end of the study period. Because hospital readmission and death are competing risks, we also investigated a composite end point of time to hospital readmission or death. All multivariable models included all a priori predictors and only included patients without missing data. Of the 46,437 patients (12.9%) who received CPR and were missing one or more variables, 91% were missing only income data. Therefore, we performed sensitivity analyses by excluding income from the multivariable models. Given the nature of administrative data, there were discrepancies in vital status. To avoid biasing the survival analyses, we excluded CPR recipients whose coded discharge destination

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was death but whose date of death was ≥ 2 days after the hospital discharge date ($n = 4,850$ [1.3%]). Similarly, we excluded CPR recipients who were discharged alive but whose date of death was ≥ 1 days earlier than the date of hospital discharge ($n = 57$ [0.02%]). Some patients had (1) a discharge destination indicating death but a death date 1 day later than the discharge date ($n = 2,999$ [0.84%]) or (2) a discharge destina-

tion indicating alive but a death date recorded as the date of discharge ($n = 4,705$ [1.3%]). We assumed that discrepancies in the first group were errors in date recording, and 87% of the second group were patients who were transferred to another hospital and died quickly thereafter. We included these patients in the analyses, assigned the death date as the date of discharge, and assigned 0 days survival beyond hospital discharge.

Results

We identified 363,589 recipients of in-hospital CPR from January 1, 1994, to December 31, 2005, and 4,907 of these were excluded due to discrepancies in vital status, resulting in a total of 358,682 studied. Of these, 87,231 (24.3%) had none of the six chronic diseases of interest, 69,876 (19.5%) had COPD, 187,882 (52.4%) had CHF, 62,416 (17.4%) had CKD, 38,358 (10.7%) had malignancy, 117,216 (32.7%) had diabetes, and 5,882 (1.6%) had cirrhosis. Patient baseline characteristics are shown in Table 1 by subgroups of severe and mild/moderate disease, as are hospital characteristics where CPR was received. Compared with patients with none of the chronic diseases of interest, patients with any of these diseases were generally younger, more often black, and had a higher Charlson-Deyo Index of Comorbidity score. With the exception of severe malignancy and mild/moderate cirrhosis, patients with any chronic disease were also more likely to be admitted from an SNF. Additionally, except for diabetes and severe COPD and CHF, patients with a chronic disease were less often women.

Crude analyses of clinical outcomes following CPR are shown in Table 2. Among those receiving CPR, patients without chronic disease survived to hospital discharge 17.3% of the time. With the exception of mild/moderate CHF and severe CKD and diabetes, patients with chronic disease were less likely to survive to hospital discharge than those without chronic disease.

Of the 15,123 CPR recipients without chronic disease who survived to hospital discharge, 20.4% were discharged to an SNF, and 44.6% were discharged home. In contrast, patients with chronic disease were more likely to be discharged to an SNF and less likely to be discharged home (except for those with severe CKD and severe and mild/moderate malignancy who were at least or more likely to be discharged home than patients without chronic disease). Repeat hospitalizations were also more common among patients with chronic diseases, except among those with malignancy who experienced fewer rehospitalizations and those with cirrhosis whose rehospitalizations were not significantly different from patients without chronic disease.

Among hospital discharge survivors, 26.2% had not died by the end of the study period on December 31, 2005, and were censored. Patients without chronic disease who survived to hospital discharge had a median survival of 26.7 months (interquartile range [IQR], 4.2-63.8 months). This long-term survival was shorter among hospital discharge survivors with chronic disease (eg, 5.0 [IQR, 0.9-17.0] months in severe COPD, 4.1 [IQR, 0.8-14.5] months in severe CHF, 3.5 [IQR, 0.7-12.5] months in severe malignancy, 2.8 [IQR, 0.3-12.3] months in severe cirrhosis). These results of poorer long-term survival in patients with chronic disease are demonstrated by Kaplan-Meier survival plots in Figure 1. Survival curves stratified by Charlson-Deyo Index of Comorbidity score (e-Fig 1) and number of chronic diseases (e-Fig 2) demonstrate that long-term survival after CPR is worse with greater burden of comorbidity and chronic disease, respectively.

As an additional clinically meaningful outcome, we identified the proportion of patients with each chronic disease who were discharged home and survived at least 6 months without rehospitalization (Table 2). We found that 7.2% of CPR recipients without any of the study chronic diseases met this outcome. However, this proportion was much lower among those with chronic disease, with only 1.9% with severe COPD and 2.0% with severe CHF or severe malignancy achieving this outcome.

Multivariable analyses (Table 3) generally confirmed the findings from crude analyses. In these models, patients without a particular chronic disease were the reference group for each disease. Chronic disease was associated with reduced survival to hospital discharge after CPR among those with COPD, malignancy, cirrhosis, severe CHF, and mild/moderate CKD and diabetes. Interestingly, patients with mild/moderate CHF had an increased odds of hospital survival compared with patients without CHF. The presence of COPD, CHF, diabetes, and mild/moderate CKD were also associated with a decreased likelihood of discharge home, whereas mild/moderate malignancy was associated with a greater likelihood of discharge

TABLE 1] Demographics of Patients Receiving CPR and Hospital Characteristics by Severity of Chronic Illness, 1994-2005

Characteristic	All CPR Recipients	Without Chronic Disease	COPD (n = 69,876)		CHF (n = 187,882)		CKD (n = 62,416)		Malignancy (n = 38,358)		DM (n = 117,216)		Cirrhosis (n = 5,882)	
			Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod
Patient														
No. patients	358,682	87,231	10,322	59,554	40,323	147,559	20,286	42,130	13,290	25,068	31,400	85,816	1,592	4,290
Age, ^a y	78.9 ± 7.2	77.2 ± 7.4	76.6 ± 6.4	77.9 ± 6.8	78.6 ± 7.1	79.3 ± 7.2	75.5 ± 6.0	79.0 ± 7.0	76.3 ± 6.3	78.0 ± 6.7	75.7 ± 6.0	78.1 ± 6.8	73.8 ± 5.5	75.3 ± 6.1
P value	...	...	<.001	<.001	<.001	.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Female sex ^b	49.7	51.3	52.5	46.5	51.3	49.4	49.3	43.2	47.8	43.7	51.8	51.5	42.0	38.9
P value	...	...	.02	<.001	.90	<.001	<.001	<.001	<.001	<.001	.10	.33	<.001	<.001
Race/ethnicity ^b														
White	80.4	84.0	78.4	82.0	77.8	81.7	59.8	73.5	77.7	81.1	69.0	76.1	71.9	76.5
Black	14.6	11.8	16.0	12.9	17.2	13.5	31.0	20.9	17.8	14.7	22.4	17.5	14.9	15.3
Other/missing	5.0	4.2	5.5	5.1	5.0	4.8	9.2	5.6	4.5	4.2	8.6	6.3	13.2	8.2
P value	...	...	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Admitted from SNF ^b	2.5	2.0	3.9	2.5	3.8	2.5	2.4	3.3	2.1	2.3	3.2	2.9	3.3	2.4
P value	...	...	<.001	<.001	<.001	<.001	.001	<.001	.52	.03	<.001	<.001	.001	.13
Charlson-Devo Index of Comorbidity score ^a	1.8 ± 1.8	0.6 ± 1.1	2.2 ± 1.4	2.2 ± 1.7	2.2 ± 1.4	2.1 ± 1.6	2.1 ± 1.6	2.2 ± 1.7	6.7 ± 3.1	2.6 ± 1.4	2.4 ± 1.6	2.2 ± 1.7	3.9 ± 2.1	2.4 ± 1.8
P value	...	...	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Zip code median income, ^a \$1,000	39.6 ± 16.0	39.9 ± 16.1	39.2 ± 15.5	39.4 ± 15.9	40.0 ± 16.4	39.8 ± 16.0	39.4 ± 16.4	39.4 ± 15.8	40.8 ± 16.8	40.4 ± 16.6	39.3 ± 16.0	38.9 ± 16.0	39.0 ± 16.4	38.9 ± 16.0
P value	...	...	.02	.01	<.001	.007	.08	.21	<.001	<.001	.02	<.001	.16	.01
Hospital														
CPR received at metropolitan hospital ^b	83.2	81.8	82.5	82.8	84.2	83.4	90.4	85.4	86.7	85.3	86.3	82.4	89.3	86.3
P value	...	...	.08	.01	<.001	<.001	<.001	<.001	<.001	<.001	<.001	.27	<.001	.02

(Continued)

TABLE 1] (continued)

Characteristic	All CPR Recipients	Without Chronic Disease	COPD (n = 69,876)		CHF (n = 187,882)		CKD (n = 62,416)		Malignancy (n = 38,358)		DM (n = 117,216)		Cirrhosis (n = 5,882)	
			Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod	Severe	Mild/Mod
Hospital size where CPR received, ^a beds	326 (183-489)	325 (180-450)	300 (166-458)	310 (176-466)	329 (182-494)	327 (184-485)	368 (234-541)	335 (192-492)	350 (208-522)	341 (199-512)	339 (201-502)	315 (178-481)	331 (200-494)	329 (185-479)
P value	...	...	<.001	<.001	.009	.43	<.001	.001	<.0001	<.001	<.001	.001	.006	.65
CPR received at teaching hospital ^b	33.4	33.0	30.2	31.3	34.0	33.6	38.1	34.2	37.2	35.7	34.9	32.8	36.2	34.5
P value	...	...	<.001	<.001	.001	.002	<.001	<.001	<.001	<.001	<.001	.43	.007	.04

Data are presented as mean $\pm$ SD, %, or median (interquartile range) unless otherwise indicated. Comparisons are between patients in each chronic disease category and those with chronic disease.

CHF = congestive heart failure; CKD = chronic kidney disease; DM = diabetes mellitus; Mod = moderate; SNF = skilled nursing facility.

^aBivariate regression.

^b χ^2 test.

home. Except for those with malignancy, cirrhosis, and mild/moderate CKD, patients with chronic disease had more hospital readmissions during the study period. All subgroups of CPR recipients with chronic disease who survived to hospital discharge had an increased hazard of death compared with those without that chronic disease (eg, hazard ratio, 1.39 [95% CI, 1.32-1.48] in advanced COPD). Similarly, analysis of a combined end point of death or rehospitalization found that all subgroups of chronic disease had an increased risk of this end point.

Because income was a commonly missing variable, we performed sensitivity analyses by excluding income from the multivariable models. Generally, removal of income from the multivariable model did not substantially affect the results (e-Table 2). Additionally, because discharge to home vs to an SNF may be a very important predictor of long-term survival after CPR,¹⁹ we performed separate multivariable analyses for these two discharge dispositions. Adjusted outcomes in each were generally similar to the entire study population (e-Tables 3, 4).

Discussion

We found that survival to hospital discharge after in-hospital CPR was lower in patients with concomitant COPD, malignancy, cirrhosis, severe CHF, and mild/moderate CKD and diabetes than in patients without any of these chronic diseases. This reduction was particularly notable among those with malignancy, cirrhosis, and advanced COPD. Among patients who survived the index hospitalization, the majority was discharged to another hospital or SNF rather than to home, and median survival of patients with a severe chronic disease was ≤ 6.0 months. Finally, an extremely small proportion of patients ($\leq 4.7\%$ in all subgroups) with chronic disease who received CPR were discharged home and survived for at least 6 months without rehospitalization.

A few studies have addressed outcomes after CPR in patients with COPD. In a study of 226 hospitalized CPR recipients, 14% survived to discharge, 10% were alive 6 months later, and COPD was not significantly associated with CPR outcomes.¹⁶ Explanations for why the present finding of a strong association between severe COPD and death differs from this earlier study include our much larger sample size and that we defined severe disease by oxygen dependence or frequent hospitalizations.

TABLE 2] Unadjusted Outcomes of Patients Receiving CPR by Severity of Chronic Illness, 1994-2005

Patient Characteristic	All CPR Recipients	Without Chronic Disease	COPD (n = 69,876)			CHF (n = 187,882)			CKD (n = 62,416)			Malignancy (n = 38,358)			DM (n = 117,216)			Cirrhosis (n = 5,882)		
			Severe	Mild/Mod	Severe	Severe	Mild/Mod	Severe	Severe	Mild/Mod	Severe	Severe	Mild/Mod	Severe	Severe	Mild/Mod	Severe	Severe	Mild/Mod	Severe
No. patients	358,682	87,231	10,322	59,554	40,323	147,559	20,286	42,130	13,290	25,068	31,400	85,816	1,592	10.1	13.5					
Survival to hospital discharge ^a	17.1	17.3	14.8	16.7	16.7	18.4	18.3	14.7	11.3	13.6	17.8	16.5	10.1	13.5						
<i>P</i> value	...	...	<.001	.009	.008	<.001	.001	<.001	<.001	<.001	.048	<.001	<.001	<.001	<.001					
Discharge disposition (% of survivors) ^a																				
SNF	24.8	20.4	29.7	25.5	29.5	26.6	26.2	28.5	25.3	23.6	27.4	25.0	26.9	28.1						
Home	41.3	44.6	38.4	40.3	36.8	39.5	44.1	35.9	48.9	44.7	39.0	39.6	41.3	40.3						
Another hospital	31.8	33.6	29.5	31.6	30.5	31.6	27.6	37.4	20.5	28.3	31.1	33.3	28.2	29.2						
Hospice	2.1	1.7	2.5	2.6	3.2	2.3	2.1	4.2	5.3	3.4	2.5	2.1	...	2.4						
<i>P</i> value	...	...	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001					
Rehospitalizations among discharge survivors through December 31, 2005 ^c	2 (1-5)	2 (1-5)	3 (1-6)	2 (1-5)	2 (1-5)	2 (1-5)	3 (1-6)	2 (1-4)	1 (0-3)	2 (1-4)	3 (1-6)	2 (1-5)	1 (1-4)	2 (1-5)						
<i>P</i> value	...	...	<.0001	<.0001	.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	.06	.17						
Survival after discharge, ^c mo	11.1 (1.5-38.6)	26.7 (4.2-63.8)	5.0 (0.9-17.0)	7.7 (1.1-27.0)	4.1 (0.8-14.5)	8.9 (1.2-31.8)	5.9 (1.2-17.6)	3.5 (0.6-15.8)	3.5 (0.7-12.5)	6.3 (1.0-24.0)	6.0 (1.0-20.6)	8.9 (1.2-31.9)	2.8 (0.3-12.3)	5.6 (0.9-20.8)						
<i>P</i> value	...	...	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001					
CPR recipients discharged home who survived ≥ 6 mo without hospital readmission ^a	4.9	7.2	1.9	3.9	2.0	4.7	2.4	2.4	2.0	3.2	2.9	4.2	1.3	2.6						
<i>P</i> value	...	...	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001					

Data are presented as % and median (interquartile range) unless otherwise indicated. Comparisons are between patients in each chronic disease category and those with no chronic disease. See Table 1 legend for expansion of abbreviations.

^aχ² test.

^bUnable to show contents of cell due to data presentation rules of the Center for Medicare & Medicaid Services.

^cWilcoxon rank sum test.

Figure 1 – Long-term survival among CPR recipients who survived to hospital discharge, grouped by chronic illness. A-F, Survival in patients with COPD (A), CHF (B), CKD (C), malignancy (D), diabetes (E), and cirrhosis (F). In these cases, survival is significantly reduced for patients with each chronic disease compared with those without that chronic disease ($P < .001$). CHF = congestive heart failure; CKD = chronic kidney disease.

Several investigations have reported low hospital discharge survival after CPR in patients with malignancy.²⁶⁻²⁸ A 2006 meta-analysis of 1,707 patients with cancer found that 6.2% of all CPR recipients with malignancy and 5.6% of those with metastases survived to hospital discharge,²⁶ whereas we found that 12.3% of all patients with malignancy and 11.7% of patients with severe malignancy survived to hospital discharge. A possible explanation for these conflicting results is differing study populations. We included all patients with a MedPAR diagnosis of malignancy during any hospital admission from 2 years prior to the CPR event up to and including the index hospitalization, rather than only including patients who had cancer noted as a diagnosis in the admission during which CPR occurred. Thus, the present population could have had an overall lower severity of illness.

Beyond survival to discharge, we also found that long-term outcomes among CPR recipients with underlying chronic illness were generally worse than in patients without chronic disease. Those with COPD, CHF, diabetes, and mild/moderate CKD who survived to discharge were less often discharged home than patients without chronic illness.

Approximately 30% of participants who survived to hospital discharge were discharged to another hospital. Of these, 81.4% were discharged to another acute care hospital for inpatient care (data not shown), and although we cannot be sure because the needed information is not contained within MedPAR, we believe that these patients most likely experienced cardiopulmonary arrest at one hospital and were transferred soon after to another hospital for a higher level of care. Only 5.2% of those

TABLE 3] Multivariable Analysis of CPR Recipients for Patient and Hospital Factors Associated With Survival to Discharge and Discharge Disposition, Rehospitalizations, Long-term Survival, and Death or Rehospitalization Among Survivors

Patient Characteristics	Survival to Hospital Discharge ^a		Discharge Home Among Survivors ^a		Rehospitalizations Through December 31, 2005, Among Discharge Survivors ^b		Long-term Survival Among Hospital Discharge Survivors ^c		Combined End Point of Time to Rehospitalization or Death Among Hospital Discharge Survivors ^c	
	OR (95% CI)	P Value	OR (95% CI)	P Value	IRR (95% CI)	P Value	HR of Death (95% CI)	P Value	HR of Death or Rehospitalization (95% CI)	P Value
COPD										
None	Ref	...	Ref	...	Ref	...	Ref	...	Ref	...
Mild/Moderate	0.96 (0.94-0.99)	.004	0.95 (0.90-0.99)	.03	1.05 (1.03-1.08)	<.001	1.26 (1.23-1.29)	<.001	1.17 (1.14-1.20)	<.001
Severe	0.81 (0.76-0.86)	<.001	0.88 (0.79-0.95)	<.001	1.27 (1.19-1.35)	<.001	1.39 (1.32-1.48)	<.001	1.37 (1.30-1.45)	<.001
CHF										
None	Ref	...	Ref	...	Ref	...	Ref	...	Ref	...
Mild/Moderate	1.24 (1.22-1.27)	<.001	0.86 (0.83-0.89)	<.001	1.05 (1.03-1.08)	<.001	1.40 (1.37-1.43)	<.001	1.24 (1.22-1.27)	<.001
Severe	0.94 (0.89-0.98)	.004	0.81 (0.75-0.86)	<.001	1.10 (1.06-1.14)	<.001	1.81 (1.75-1.87)	<.001	1.54 (1.49-1.59)	<.001
CKD										
None	Ref	...	Ref	...	Ref	...	Ref	...	Ref	...
Mild/Moderate	0.84 (0.81-0.87)	<.001	0.86 (0.81-0.92)	<.001	0.85 (0.82-0.88)	<.001	1.40 (1.35-1.45)	<.001	1.25 (1.21-1.29)	<.001
Severe	0.996 (0.95-1.04)	.86	1.07 (0.98-1.16)	.11	1.10 (1.06-1.15)	<.001	1.58 (1.52-1.64)	<.001	1.42 (1.37-1.47)	<.001
Malignancy										
None	Ref	...	Ref	...	Ref	...	Ref	...	Ref	...
Mild/Moderate	0.76 (0.73-0.79)	<.001	1.11 (1.02-1.19)	.01	0.83 (0.79-0.86)	<.001	1.33 (1.28-1.39)	<.001	1.13 (1.09-1.17)	<.001
Severe	0.70 (0.66-0.75)	<.001	1.11 (0.97-1.27)	.11	0.67 (0.62-0.72)	<.001	1.70 (1.58-1.84)	<.001	1.27 (1.19-1.37)	<.001
Diabetes										
None	Ref	...	Ref	...	Ref	...	Ref	...	Ref	...
Mild/Moderate	0.95 (0.93-0.97)	.004	0.89 (0.85-0.93)	<.001	1.10 (1.07-1.12)	<.001	1.15 (1.13-1.18)	<.001	1.13 (1.11-1.16)	<.001
Severe	0.99 (0.96-1.02)	.68	0.84 (0.79-0.91)	<.001	1.14 (1.10-1.18)	<.001	1.29 (1.25-1.34)	<.001	1.23 (1.19-1.27)	<.001
Cirrhosis										
None	Ref	...	Ref	...	Ref	...	Ref	...	Ref	...
Mild/Moderate	0.73 (0.66-0.80)	<.001	0.96 (0.80-1.15)	.66	0.90 (0.80-1.01)	.08	1.26 (1.14-1.39)	<.001	1.15 (1.05-1.26)	.004
Severe	0.58 (0.49-0.69)	<.001	0.93 (0.67-1.28)	.65	0.92 (0.73-1.16)	.48	1.69 (1.40-2.05)	<.001	1.57 (1.33-1.84)	<.001
Age	0.968 (0.966-0.969)	<.001	0.972 (0.970-0.975)	<.001	0.982 (0.981-0.984)	<.001	1.039 (1.037-1.041)	<.001	1.015 (1.014-1.016)	<.001

(Continued)

TABLE 3] (continued)

Patient Characteristics	Survival to Hospital Discharge ^a		Discharge Home Among Survivors ^a		Rehospitalizations Through December 31, 2005, Among Discharge Survivors ^b		Long-term Survival Among Hospital Discharge Survivors ^c		Combined End Point of Time to Rehospitalization or Death Among Hospital Discharge Survivors ^c	
	OR (95% CI)	P Value	OR (95% CI)	P Value	IRR (95% CI)	P Value	HR of Death (95% CI)	P Value	HR of Death or Rehospitalization (95% CI)	P Value
Female sex	1.21 (1.18-1.23)	<.001	0.93 (0.89-0.96)	<.001	1.14 (1.12-1.16)	<.001	0.85 (0.83-0.87)	<.001	0.96 (0.94-0.97)	<.001
Race/ethnicity										
White	Ref	...	Ref	...	Ref	...	Ref	...	Ref	...
Black	0.70 (0.68-0.72)	<.001	0.90 (0.85-0.95)	<.001	0.98 (0.95-1.01)	.24	1.21 (1.17-1.25)	<.001	1.15 (1.11-1.18)	<.001
Other	0.87 (0.83-0.91)	<.001	1.09 (0.99-1.19)	.056	0.96 (0.91-1.01)	.13	1.00 (0.95-1.06)	.92	1.03 (0.99-1.08)	.15
Admitted from SNF	0.62 (0.58-0.67)	<.001	0.11 (0.09-0.15)	<.001	0.85 (0.79-0.93)	<.001	1.44 (1.33-1.55)	<.001	1.15 (1.07-1.23)	<.001
Charlson-Deyo Index of Comorbidity (each increase in score)	0.96 (0.95-0.97)	<.001	1.02 (1.01-1.04)	.002	0.97 (0.96-0.98)	<.001	1.06 (1.05-1.07)	<.001	1.03 (1.02-1.04)	<.001
Zip code median income (\$1,000 increase)	0.999 (0.999-1.000)	.51	1.00 (0.999-1.001)	.95	1.000 (0.999-1.001)	.27	0.999 (0.998-0.999)	<.001	0.999 (0.998-0.999)	.001
Hospital characteristics										
CPR received at rural hospital	1.14 (1.11-1.17)	<.001	0.82 (0.78-0.86)	<.001	1.06 (1.03-1.09)	<.001	0.94 (0.91-0.96)	<.001	0.99 (0.96-1.01)	.29
No. beds (each increase in 100)	0.98 (0.97-0.99)	<.001	1.08 (1.07-1.09)	<.001	0.998 (0.994-1.001)	.50	0.97 (0.96-0.98)	<.001	0.98 (0.97-0.99)	<.001
CPR received at teaching hospital	1.02 (0.99-1.04)	.13	1.12 (1.07-1.17)	<.001	1.06 (1.03-1.08)	<.001	0.97 (0.94-0.99)	.008	0.97 (0.95-0.99)	.02

HR = hazard ratio; IRR = incident rate ratio; Ref = reference group. See Table 1 legend for expansion of other abbreviations.

^aLogistic regression.^bZero-inflated negative binomial regression.^cCox proportional hazards modeling.

discharged to another hospital were discharged to a long-term acute care facility.

Patients with COPD, CHF, diabetes, and severe CKD also had more repeat hospitalizations throughout the study period than patients without chronic illness. The finding that patients with malignancy had fewer hospital readmissions may reflect that these patients chose to forgo readmission. Alternatively, the results may be confounded by death (ie, their shorter median survival after discharge allowed less time to be readmitted). However, patients with severe COPD and CHF also had a short median survival after hospital discharge, yet their hospital readmission rate was greater than that for patients without chronic disease.

Survival after hospital discharge was much shorter in patients with chronic disease. A few studies have examined long-term survival after hospital discharge among CPR recipients and found that 5% to 15% were alive at 6 months.^{19,29-31} A recent study linking data from the American Heart Association Get With the Guidelines (GWTG)-Resuscitation project with inpatient Medicare data reported that 58.5% of survivors who received CPR were alive at 1 year,¹⁹ whereas median survival in all CPR recipients in the present study was lower at 11.1 months. Discrepancies in these results might be explained by differences in study populations because the present study included all Medicare beneficiaries and the prior report included patients who received CPR at participating GWTG-Resuscitation hospitals. Additionally, the quality of CPR at hospitals participating in GWTG may be higher than at non-participating hospitals, thus, resulting in improved outcomes.

Prior research has found that 30% to 50% of in-hospital CPR recipients who survive the episode refuse further CPR and wish that CPR had not been performed.^{28,32,33} The finding that patients with chronic illness, especially those with severe COPD, CHF, malignancy, and cirrhosis, are not only less likely to survive the CPR attempt but are more likely to have a significantly foreshortened lifespan after discharge is important for patients and their families when making decisions about preferences for life-sustaining therapies. The additional findings of lower likelihood of discharge home as well as the increased incidence of repeat hospitalizations after CPR among many subgroups add to the burden of CPR for some survivors and may substantially affect the choices of some patients and their families regarding CPR.

The major strengths of this study are the extremely large sample size and the generalizability of the results to a wide population of older adults. There are also several important limitations. First, we did not investigate all individual chronic diseases, choosing instead to study those that commonly occur in older adults. Many individuals with diseases we did not investigate were presumably grouped into the no chronic disease category and would, thus, only have attenuated differences in the results. Second, our definition of CPR depended on ICD-9 codes in MedPAR. This definition has not been validated, and short of a long and expensive prospective study, the validity of ICD-9 codes as a definition of CPR will likely remain unknown. Our estimates of hospital survival and other outcomes are similar to past studies, which is reassuring and suggests that our definition is reasonably accurate. Third, our definitions of chronic disease and severity also relied on ICD-9 codes submitted on inpatient claims and, thus, are biased toward more severe illness because patients had to be hospitalized in the 2 years prior to meet these definitions. Medicare beneficiaries who receive CPR have a high prevalence of certain diseases, such as CHF (52.8% of CPR recipients in the present data). This finding could be explained by the prevalence of CHF increasing among CPR recipients; alternatively, it could represent misclassification (ie, many CPR recipients receiving a CHF diagnosis as a result of postarrest myocardial dysfunction when actually not a chronic condition). Furthermore, our definitions of severity of chronic diseases were designed to be specific (rather than sensitive) in identifying severe disease, which would also have attenuated the differences found among the severe, mild/moderate, and no disease groups. Fourth, MedPAR does not contain important pieces of information that would have been helpful in this study. For example, we did not have information about the severity of acute illness, cardiac rhythm during arrest, or location of CPR within the hospital. MedPAR also does not contain information about neurologic or functional outcome, so we used discharge disposition as a surrogate. Finally, because of the data use agreement with the Centers for Medicare & Medicaid Services, the most current MedPAR data we have are from 2005. A prior study from our group demonstrated that outcomes after CPR within MedPAR did not change substantially between 1992 and 2005, and we have no reason to believe that outcomes have improved since.¹³ However, it is possible that with advances in hypothermia protocols and other processes of care, outcomes after CPR have improved since 2005.

Conclusions

We found that patients with advanced CHF as well as any degree of COPD, malignancy, or cirrhosis who receive in-hospital CPR have significantly lower hospital survival than patients without chronic disease. CPR survivors with COPD, CHF, and diabetes are much less likely to be discharged home and are more likely to experience repeat hospitalizations after CPR. Patients with any of the chronic diseases of interest in this study who survive CPR to hospital discharge have significantly shorter long-term survival. These findings

provide useful information for older adults and their families and clinicians when making decisions about CPR preferences. Because prior studies found that older patients who understand the estimates of outcomes after CPR more often choose to forgo CPR, the present results may substantially affect the choices of some patients and family members.^{4,5} The results may also inform the discussion about whether life-sustaining vs palliative care should be prioritized in hospitalized older adults who survive CPR but have a high burden of comorbid illness.

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Author contributions: R. D. S. had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. R. D. S. contributed to the study concept and design; literature searches; data collection, analysis, and interpretation; and writing and final approval of the manuscript and W. J. E., R. A. D., and J. R. C. contributed to the literature searches; study design; data collection, analysis, and interpretation; and editing and final approval of the manuscript.

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