Published in final edited form as:

Crit Care Med. 2014 January ; 42(1): . doi:10.1097/CCM.0b013e31829eb937.

Multiple In-Hospital Resuscitation Efforts in the Elderly

Prema R. Menon, M.D.¹, William J. Ehlenbach, M.D., MSc.², Dee W. Ford, M.D., MSCR.³, and Renee D. Stapleton, M.D., PhD.¹

¹University of Vermont, Burlington, Vermont

²University of Wisconsin School of Medicine and Public Health, Madison, WI

³Medical University of South Carolina, Charleston, South Carolina

Abstract

Objective—The objective of this study was to determine the characteristics and survival rates of patients receiving CPR more than once during a single hospitalization.

Design—We analyzed inpatient Medicare data from 1992–2005 identifying beneficiaries 65 years of age and older who underwent CPR more than once during the same hospitalization.

Measurements—We examined patient and hospital characteristics, survival to hospital discharge, factors associated with survival to discharge, median survival, and discharge disposition.

Results—We analyzed data from 421,394 patients who underwent CPR during the study period. 413,403 patients received CPR once during a hospitalization and survival was 17.7% with median survival after discharge being 20.6 months. There were 7,991 patients who received CPR more than once during the same hospitalization; 8.8% survived the efforts, and median survival after leaving the hospital was 10.5 months. Patients who received more than one episode of CPR during a hospitalization were significantly less likely to go home after discharge. Greater age, black race, higher burden of chronic illness, and receiving CPR in a larger or metropolitan hospital were associated with lower survival among patients receiving CPR more than once.

Conclusions—Undergoing multiple CPR events during a hospitalization is associated with substantially reduced short and long-term survival compared with patients who undergo CPR once. This information may be useful to clinicians when discussing end-of-life care with patients and families of patients who have experienced return of spontaneous circulation following in-hospital CPR but remain at risk for recurrent cardiac arrest.

Keywords

Look in MESH or PubMed to find keywords that are appropriate to your subject.

Cardiopulmonary resuscitation; CPR; CPR outcomes; critical care; elderly; multiple CPR efforts

Background

Cardiopulmonary resuscitation (CPR) was initially developed in the 1960's primarily for patients who suffered cardiac arrest in the immediate post-operative setting¹. Since then,

Corresponding Author Address: Prema R. Menon, M.D., 89 Beaumont Ave, Given D 208, Burlington, VT 05405, prema.menon@vtmednet.org.

No potential conflict of interest relevant to this article was reported.

Drs. Ehlenbach and Menon had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

multiple attempts at improving CPR delivery have occurred,^{2,3} but survival remains low. In our previous study we found an incidence of 2.73 per 1000 hospital admissions and an 18.3% survival rate to hospital discharge in patients who receive inhospital CPR⁴, which is consistent with findings over the past 50 years⁵⁻⁹.

Current guidelines state that physicians should discuss patient preferences with regard to resuscitation efforts if the patient is at increased risk for cardiac or pulmonary failure¹⁰. While many studies have investigated outcomes after in-hospital CPR, including our recent complete epidemiologic analysis⁴, there are few data available on outcomes in patients who receive multiple resuscitation efforts in the same hospitalization. A study of 197 patients found that multiple CPR efforts during a hospitalization were a predictor of death, however this was a small single center study and 27% of CPR attempts were repeat arrests occurring in patients who had already arrested at least once¹¹. Our study seeks to further understand the outcomes and the patient and hospital characteristics associated with survival in patients who receive more than one CPR event during a hospitalization. This is a commonly encountered dilemma in critical care, and this information is important to critical care clinicians so surrogate decision-makers of patients who survive the initial episode of CPR can receive appropriate counseling on the value of subsequent CPR efforts.

Methods

We conducted an epidemiological study using Medicare Provider Analysis and Review (MedPAR) hospital claims from 1992–2005 identifying beneficiaries in the Old Age and Survivors Insurance (OASI) program 65 years of age or older for whom a claim for payment had been made for in-hospital CPR. We then further identified those participants who had more than one CPR claim during the same hospitalization. We defined CPR by the presence of either 99.60 (cardiopulmonary resuscitation, not otherwise specified) or 99.63 (closed chest cardiac massage) based on the International Classification of Diseases, Ninth Revision (ICD-9). We excluded patients who were co-enrolled in a health maintenance organization (HMO), because such patients may have had incomplete CPR claims data. The institutional review board of the University of Vermont reviewed this study and found it exempt from the need for approval. In our prior study of the epidemiology of CPR in all older adults, these same data abstraction methods were used; hence, the datasets are very similar. For this current study, a separate new dataset was created from original MedPAR data.

Analysis

Our primary outcome was survival to hospital discharge among patients receiving CPR more than once in a hospitalization based upon discharge destination and date of death coded in the MedPAR file. Additional outcomes of interest included long-term survival using beneficiary date of death within MedPAR (censored at 12/31/2005) as well as discharge destination of home, another hospital, skilled nursing facility, or hospice. Because the vital status of some beneficiaries was unclear within the data, we excluded those with a discharge destination indicating in-hospital death but who had a recorded date of death 2 or more days beyond the date of discharge, as well as those whose discharge destination indicated they were alive at discharge but for whom the recorded date of death either preceded the date of discharge or was on the date of discharge. Some beneficiaries had a discharge destination indicating in-hospital death but also had a recorded date of death one day later than the discharge date and we assumed that this discrepancy was an error in date recording and that these beneficiaries actually died on the date of discharge. These beneficiaries were included in the crude and multivariable analyses, but for survival analyses were considered to have survived 0 days beyond discharge. We compared survival among hospital discharge survivors who received one and more than one episode of CPR during the

index hospitalization using the logrank test to determine a difference between the Kaplan Meier curves.

We also investigated associations between patient and facility characteristics and survival to hospital discharge among patients who received CPR more than once using multivariable logistic regression with robust standard error estimates. This multivariable model included covariates for age, sex, race, burden of chronic illness, median income, admission from a skilled nursing facility (SNF), hospitalization diagnosis codes (including myocardial infarction [MI], congestive heart failure [CHF], stroke, diabetes mellitus, chronic obstructive pulmonary disease [COPD]), hospital size, metropolitan or non-metropolitan location of the hospital, and teaching status of the hospital. Additionally, we explored interaction terms for hospital characteristics (between teaching status and rurality, size and rurality, and teaching status and size) in our multivariable models. For all of our analyses, a complete case approach was used (excluding those observations with missing data for any of the variables of interest). Race was categorized as black, white or other because further classification within Medicare data may not be accurate¹². Deyo-Charlson score was used to assess the burden of chronic coexisting illness¹³. This score ranges from 0 to 33 with higher scores indicating higher burden of illness. We included it in the model as ordinal categories of 0, 1, 2, or 3 or more because there were very few subjects with a score of greater than 5. Using the 1999 U.S. Census data we identified median household income according to the patient's ZIP code. We examined hospital identity using Medicare provider numbers and used data from the Centers for Medicare and Medicaid Services (CMS) to determine hospital characteristics. The location of hospitals were dichotomized as metropolitan or nonmetropolitan using the hospital ZIP codes and the Rural-Urban Commuting Area Codes, version 2.0¹².

Additionally, we investigated the association between having undergone prior CPR during the hospitalization and survival to discharge in a cohort of all patients who received CPR using a multivariable regression model adjusting for the variables associated with survival (i.e. age, sex, race, burden of chronic illness, diagnosis and hospital characteristics). In this multivariable model, receipt of prior CPR was a dichotomous variable and distinguished patients who received CPR only once from those who received CPR more than once. We also investigated the association of CPR with survival to discharge in an additional multivariable model where CPR was categorized as ordinal as the number of events.

Results

We identified 433,973 patients who underwent CPR during the study period. For 12,579 of these individuals, there was discrepancy between vital status at index hospital discharge and recorded date of death, so these cases were excluded. The remaining 421,394 patients were included in subsequent analyses including the 3,622 patients with discharge destination indicating in-hospital death but with a recorded date of death one day later than the discharge date because we assumed this discrepancy related to deaths occurring late in the day. Survival to hospital discharge for the 413,403 patients who each received only one episode of CPR during a hospitalization was 17.7% (95% CI, 17.5 to 17.8). There were 7,991 patients who underwent CPR more than once during the index hospitalization, and the proportion of this group surviving to discharge was 8.8% (95% CI, 8.2 to 9.4). (Table 1) This difference in survival to hospital discharge between the two groups was statistically significant ($p < 0.001$). As seen in Table 1, survival appears to be greater in patients receiving more than one CPR effort with a diagnosis of congestive heart failure (CHF) and stroke and those who receive CPR at non-metropolitan and smaller hospitals. Survival tended to be lower in patients >80 years of age and non-white patients. Among those alive at hospital discharge, patients who underwent only one CPR event during the index

hospitalization had a median survival of 20.6 months, whereas those with more than one episode of CPR had significantly shorter median survival of 10.5 months. ($p<0.001$) (Figure 1).

Among the group of patients undergoing more than one episode of CPR in the hospitalization, we used multivariable logistic regression to evaluate for associations between patient and hospital factors and survival to discharge (Table 2). Age greater than 90 years was associated with lower survival (OR 0.53 [95% CI 0.34–0.82]), as was race other than white (OR 0.51 [0.39–0.66] for black race and OR 0.57 [95% CI 0.35–0.90] for other). Additional covariates associated with reduced hospital discharge survival were Deyo-Charlson Score of 2 (OR 0.68 [95% CI 0.49–0.96]) and 3 (OR 0.51 [95% CI 0.34–0.76]), and hospital size of >450 beds (OR 0.74 [95% CI 0.58–0.95]). None of the interaction terms or tests of collinearity between hospital teaching status, rurality and size were statistically significant (data not shown). Hospitalization diagnoses of congestive heart failure (OR 1.85 [95% CI 1.52–2.27]) and stroke (OR 1.78 [95% CI 1.34–2.36]) were associated with improved survival. Receiving CPR at a non-metropolitan hospital was also associated with a trend toward improved survival (OR 1.25 [95% CI 0.99–1.55], $p=0.052$).

In a multivariable logistic regression model of the entire cohort of patients who received CPR during the study period (378,309 who received CPR one or more times and who had no missing data points) adjusted for patient and hospital factors known to be associated with lower survival as well as a variable indicating that a patient had more than one episode of CPR during the index hospitalization, we found that having had prior CPR was associated with almost 60% lower adjusted odds of survival (OR 0.42 [95% CI 0.38–0.45]). Of the patients who survived more than one CPR event during the index hospitalization 34% were discharged home, compared to 43.7% of patients who survived one episode of CPR. (Table 3).

Of the 7991 patients who received CPR more than once, 7379 had 2 episodes, 528 had 3, 66 had 4, and 16 had 5 episodes. In the additional multivariable model with CPR categorized ordinally as the number of events, we found that each additional episode of CPR was associated with a 55% decrease in the odds of survival to discharge. (Table 4)

Discussion

We found that 17.5% of patients who received CPR in-hospital survived to hospital discharge, which is similar to prior reports⁴. In patients who underwent more than one episode of CPR during the same hospitalization, survival to discharge was less than half of this, at 8.8%. Additionally, patients who received CPR more than once during hospitalization and survived to discharge had a median survival of only 10.5 months. These results are perhaps not surprising since patients receiving CPR more than once during a hospitalization are likely to have a higher severity of illness as well as a different distribution of the underlying proximal causes of cardiac arrest than patients who undergo one CPR event. However, in this study we were only able to assess burden of chronic illness with Deyo-Charlson score, which is a valid measure of chronic disease burden but does not accurately estimate acute severity of illness¹³. In addition to probable increased severity of illness, there are other explanations for decreased survival after a second episode of CPR than after a first episode. Cardiac arrest can lead to multi-organ failure, even when CPR successfully restores spontaneous circulation. Patients with underlying organic heart disease are more likely to have an arrest rhythm of ventricular tachycardia or ventricular fibrillation compared to people with severe underlying non-cardiac illnesses where arrest rhythms such as asystole or pulseless electrical activity are more common¹⁴. Outcomes of CPR with initial arrest rhythms of asystole and PEA are significantly worse than other dysrhythmias and

often recur in patients with high severity of illness and a primary non-cardiac illness that is the underlying risk factor for cardiac arrest^{8,15,16}.

Among all patients receiving CPR twice or more in a hospitalization, we found that black patients had a lower survival rate than whites and patients of other races, and this finding was confirmed in adjusted analyses. These results are similar to prior reports of CPR that did not specifically investigate multiple episodes of CPR. Prior work with CMS data has found that a greater proportion of black patients than white patients receive CPR before death⁴. These findings might be explained by the higher incidence of cardiovascular disease and increased severity of illness among black patients¹⁷. However, multiple studies have also found that black patients tend to choose to receive life sustaining treatments more often than white patients, despite having worse severity of illness¹⁸. It is interesting in our study that black patients comprise 13.6% of all patients receiving CPR once, but 16.2% of patients receiving CPR two or more times. Therefore, it is also possible that a higher proportion of black patients than white patients are choosing to remain “full code” even after having survived one episode of CPR. Alternatively, physicians tend to have fewer end-of-life discussions with black patients¹⁹, which may also lead to a higher proportion of black patients receiving CPR twice. It is also interesting that unlike the results of most studies of survival after CPR, this study of individuals receiving in-hospital CPR more than once during a hospitalization did not find a linear association with greater age and lower odds of survival. Only in patients > 90 years of age was the association between lower odds of survival and age statistically significant. Explanations for this lack of association are unclear. Among patients receiving CPR more than once during a hospitalization, adjusted analyses also found that undergoing CPR at a non-metropolitan hospital was associated with improved survival to hospital discharge. The most likely explanation for this finding is the variation in illness severity among patients hospitalized in metropolitan versus non-metropolitan hospitals with metropolitan hospitals having more seriously ill inpatient populations²⁰. However, we cannot examine this explanation within MedPAR data because they do not contain a true measure of severity of illness. This finding could also be explained by transfer of sick survivors from one or more episode of CPR from non-metropolitan to metropolitan hospitals. Indeed, a significant proportion of patients undergoing CPR one or more times were discharged from one hospital to another hospital implying transfer for higher levels of care (Table 4).

Our finding that diagnoses of CHF and stroke during the hospitalization were associated with improved survival is somewhat surprising. An earlier meta-analysis found that patients with severe CHF (Class III/IV) and recent stroke had higher mortality after CPR²¹ and a separate study consisting largely of patients with primary cardiac disease as the risk for cardiac arrest found that the likelihood of survival decreased with increasing CHF severity²². Reasons for differences between the results of our study and prior studies are unclear, especially with regard to stroke. Within our data, it is not possible to discern the severity of CHF, so it is possible that our CHF population predominately consists of patients with very mild disease who are more likely to have more survivable arrhythmias such as ventricular fibrillation and tachycardia or are more likely to be hospitalized in monitored beds where impending cardiopulmonary arrest might be noticed earlier. Another explanation may be that patients who undergo CPR are being misclassified as having CHF as a result of the CPR itself.

Crude analyses found that survival to hospital discharge in patients who experience more than one CPR event (8.8%) was less than half of that in patients having one CPR event (17.7%). Multivariable analyses confirmed this finding and demonstrated that patients who had CPR previously during a hospitalization had a 60% lower odds of survival to discharge.

These results are important when discussing prognosis and advanced directives with patients and their loved ones.

Median survival in patients receiving more than one CPR effort was 10.5 months compared to those receiving only one CPR event at 20.6 months. Additionally, those having more than one CPR event were significantly less likely to be discharged home, with two-thirds of these patients being discharged to skilled nursing facilities, other hospitals or hospice. This information is also important to convey to patients and families when discussing treatment preferences, as prior work has suggested that patients will often choose to forgo CPR if they understand that the sequelae of surviving CPR may likely involve institutionalization and reduced quality of life^{23–25}.

This study has several limitations. Our definition of CPR within CMS data is based on ICD-9 codes. Although this definition of CPR does not reflect a single method of resuscitation or its effectiveness, it has been used in prior work utilizing CMS data⁴. This definition has not been validated, and short of a large, lengthy, and expensive prospective cohort study cannot be validated. However, the fact that overall incidence of and survival after CPR in this cohort is similar to numerous studies is reassuring that case ascertainment within CMS data is accurate^{26,27,9}. Another limitation is the absence of information known to be associated with survival within our dataset. For example, we did not have data on severity of illness or initial rhythm at the time of cardiac arrest. This information would be beneficial in understanding the poor long-term survival for patients receiving CPR more than once. Though it is not the most recently validated comorbidity index, we chose to use the Deyo-Charlson score to assess the burden of chronic coexisting illness so that the results of this study could be compared to prior studies using the Deyo-Charlson index.

Additionally, these data were obtained from Medicare patients only. Previous studies have shown that in non-Medicare patient variables such as age, diabetes and cardiac disease have significant associations with outcomes even when these are not seen in Medicare populations.²⁸ Further, these findings may not be generalizable to a younger population as our results pertain to adults older than 64 years. However, our results are generalizable to most older patients because 97% of Americans older than 64 years of age have Medicare.²⁹ These limitations need to be considered when clinicians use these data to discuss treatment options with patients. These findings should be used along with other prognostic information such as severity of illness and patient's goals of care while making shared decisions about treatment.

Conclusion

In summary, survival to discharge in patients who receive more than one episode of CPR during a hospitalization is only 8.8%, much lower than a 17.7% survival rate in patients receiving CPR once. Long-term survival in the cohort of patients who survived a second CPR event is also significantly reduced with a median survival of 10.5 months. Predictors of survival to discharge include non-metropolitan hospital location and white race. Finally, the number of patients receiving CPR more than once is substantially smaller than the number receiving a single episode of CPR. This observation is likely an indirect reflection of a complex set of factors including clinician prognostication, patient and surrogate values and preferences, and communication between these parties. Subsequent investigation should explore these important dimensions in CPR decision-making.

This study provides important prognostic information for patients who have had one episode of CPR and survived. Clinicians are often asked to discuss end-of-life care with patients in the in-patient setting. Patients who have survived an episode of in-hospital CPR compose a

unique population that should receive counseling on end-of-life care and preferences. Our findings will allow clinicians to have this information available when carrying out these discussions.

Acknowledgments

Supported by an Association of Specialty Professors–CHEST Foundation of the American College of Chest Physicians Geriatric Development Research Award funded by Atlantic Philanthropies, the CHEST Foundation, the John A. Hartford Foundation, and the Association of Specialty Professors; a National Center for Research Resources Roadmap K12 award (8K12RR023265, to Dr. Stapleton); a Centers of Biomedical Research Excellence (COBRE) award (5P20RR015557, to Dr. Stapleton); a Beeson Career Development Award in Aging funded by The National Institute on Aging, The Atlantic Philanthropies, The John A. Hartford Foundation, the Starr Foundation, the National Institute on Neurological Disorders and Strokes, and an anonymous donor (1K23AG038352-01A1, PI: Ehlenbach) and a training grant (T32 HL076122, to Dr. Menon).

Dr. Ehlenbach received grant support from the National Institutes of Health (National Institute on Aging). Dr. Stapleton receives royalties from UpToDate and has received travel reimbursements from the American Thoracic Society.

References

1. Linko E, Koskinen PJ, Siitonen L, Ruosteenoja R. Resuscitation in cardiac arrest. An analysis of 100 successive medical cases. *Acta Med Scand.* Nov; 1967 182(5):611–620. [PubMed: 6057573]
2. Cobb LA, Fahrenbruch CE, Walsh TR, et al. Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation. *JAMA.* Apr 7; 1999 281(13): 1182–1188. [PubMed: 10199427]
3. Eisenberg MS, Bergner L, Hallstrom A. Out-of-hospital cardiac arrest: improved survival with paramedic services. *Lancet.* Apr 12; 1980 1(8172):812–815. [PubMed: 6102690]
4. Ehlenbach WJ, Barnato AE, Curtis JR, et al. Epidemiologic study of in-hospital cardiopulmonary resuscitation in the elderly. *N Engl J Med.* Jul 2; 2009 361(1):22–31. [PubMed: 19571280]
5. Ebell MH, Becker LA, Barry HC, Hagen M. Survival after in-hospital cardiopulmonary resuscitation. A meta-analysis. *J Gen Intern Med.* Dec; 1998 13(12):805–816. [PubMed: 9844078]
6. Tresch D, Heudebert G, Kutty K, Ohlert J, VanBeek K, Masi A. Cardiopulmonary resuscitation in elderly patients hospitalized in the 1990s: a favorable outcome. *J Am Geriatr Soc.* Feb; 1994 42(2): 137–141. [PubMed: 8126324]
7. Warner SC, Sharma TK. Outcome of cardiopulmonary resuscitation and predictors of resuscitation status in an urban community teaching hospital. *Resuscitation.* Jan; 1994 27(1):13–21. [PubMed: 8191022]
8. Peberdy MA, Kaye W, Ornato JP, et al. Cardiopulmonary resuscitation of adults in the hospital: a report of 14720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. *Resuscitation.* Sep; 2003 58(3):297–308. [PubMed: 12969608]
9. Tian J, Kaufman DA, Zarich S, et al. Outcomes of critically ill patients who received cardiopulmonary resuscitation. *Am J Respir Crit Care Med.* Aug 15; 2010 182(4):501–506. [PubMed: 20413625]
10. Levy CR, Fish R, Kramer A. Do-not-resuscitate and do-not-hospitalize directives of persons admitted to skilled nursing facilities under the Medicare benefit. *J Am Geriatr Soc.* Dec; 2005 53(12):2060–2068. [PubMed: 16398888]
11. Dodek PM, Wiggs BR. Logistic regression model to predict outcome after in-hospital cardiac arrest: validation, accuracy, sensitivity and specificity. *Resuscitation.* Mar; 1998 36(3):201–208. [PubMed: 9627072]
12. Arday SL, Arday DR, Monroe S, Zhang J. HCFA's racial and ethnic data: current accuracy and recent improvements. *Health Care Financ Rev.* Summer; 2000 21(4):107–116. [PubMed: 11481739]
13. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol.* Jun; 1992 45(6):613–619. [PubMed: 1607900]

14. Nadkarni VM, Larkin GL, Peberdy MA, et al. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. *JAMA*. Jan 4; 2006 295(1):50–57. [PubMed: 16391216]
15. Salcido DD, Stephenson AM, Condle JP, Callaway CW, Menegazzi JJ. Incidence of rearrest after return of spontaneous circulation in out-of-hospital cardiac arrest. *Prehosp Emerg Care*. Oct-Dec; 2010 14(4):413–418. [PubMed: 20809686]
16. Reynolds JC, Salcido DD, Menegazzi JJ. Coronary perfusion pressure and return of spontaneous circulation after prolonged cardiac arrest. *Prehosp Emerg Care*. Jan-Mar; 2010 14(1):78–84. [PubMed: 19947871]
17. Watkins LO. Epidemiology and burden of cardiovascular disease. *Clin Cardiol*. Jun; 2004 27(6 Suppl 3):III2–6. [PubMed: 15239484]
18. Shepardson LB, Gordon HS, Ibrahim SA, Harper DL, Rosenthal GE. Racial variation in the use of do-not-resuscitate orders. *J Gen Intern Med*. Jan; 1999 14(1):15–20. [PubMed: 9893086]
19. Rich SE, Gruber-Baldini AL, Quinn CC, Zimmerman SI. Discussion as a factor in racial disparity in advance directive completion at nursing home admission. *J Am Geriatr Soc*. Jan; 2009 57(1):146–152. [PubMed: 19170791]
20. Wallen E, Venkataraman ST, Grosso MJ, Kiene K, Orr RA. Intrahospital transport of critically ill pediatric patients. *Crit Care Med*. Sep; 1995 23(9):1588–1595. [PubMed: 7664562]
21. Cohn EB, Lefevre F, Yarnold PR, Arron MJ, Martin GJ. Predicting survival from in-hospital CPR: meta-analysis and validation of a prediction model. *J Gen Intern Med*. Jul; 1993 8(7):347–353. [PubMed: 8410394]
22. Mifune J, Takeda Y. Sudden cardiac arrest: clinical characteristics and predictors of survival. *Jpn Circ J*. Dec; 1989 53(12):1536–1540. [PubMed: 2632823]
23. Phillips RS, Wenger NS, Teno J, et al. Choices of seriously ill patients about cardiopulmonary resuscitation: correlates and outcomes. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments. *Am J Med*. Feb; 1996 100(2):128–137. [PubMed: 8629646]
24. Torian LV, Davidson EJ, Fillit HM, Fulop G, Sell LL. Decisions for and against resuscitation in an acute geriatric medicine unit serving the frail elderly. *Arch Intern Med*. Mar; 1992 152(3):561–565. [PubMed: 1510746]
25. Choudhry NK, Choudhry S, Singer PA. CPR for patients labeled DNR: the role of the limited aggressive therapy order. *Ann Intern Med*. Jan 7; 2003 138(1):65–68. [PubMed: 12513047]
26. Zhan C, Miller MR. Administrative data based patient safety research: a critical review. *Qual Saf Health Care*. Dec; 2003 12(Suppl 2):ii58–63. [PubMed: 14645897]
27. Quan H, Parsons GA, Ghali WA. Assessing accuracy of diagnosis-type indicators for flagging complications in administrative data. *J Clin Epidemiol*. Apr; 2004 57(4):366–372. [PubMed: 15135837]
28. Hannan EL, Racz MJ, Jollis JG, Peterson ED. Using Medicare claims data to assess provider quality for CABG surgery: does it work well enough? *Health Serv Res*. Feb; 1997 31(6):659–678. [PubMed: 9018210]
29. Moon M. What Medicare has meant to older Americans. *Health Care Financ Rev*. Winter; 1996 18(2):49–59. [PubMed: 10167859]

Figure 1.

Survival after in-hospital CPR, by number of CPR events during hospitalization. Logrank test of differences between curves $p < 0.001$. Median survival was 20 months and 5 days for those with one CPR events during the hospitalization versus 10 months and 15 days for those with 2 or more CPR events during the hospitalization

Table 1

Survival to discharge by patient and hospital characteristics and number of CPR events during a single hospitalization

	One CPR Event*		More than One CPR Event*	
	n (%)	% Surviving [95% CI]	n (%)	% Surviving [95% CI]
Total	413,403	17.7 [17.5, 17.8]	7,991	8.8 [8.2, 9.4]
Sex				
Men	208,740 (50.5)	16.8 [16.6, 16.9]	4,057 (50.7)	9.1 [8.2, 10.0]
Women	204,663 (49.5)	18.6 [18.4, 18.8]	3,934 (49.2)	8.4 [7.5, 9.2]
Age				
65-69	60,056 (14.5)	21.8 [21.4, 22.1]	1,368 (17.1)	8.9 [7.4, 10.5]
70-74	80,241 (19.4)	20.3 [20.0, 20.6]	1,667 (20.8)	9.3 [7.9, 10.7]
75-79	93,582 (22.6)	18.4 [18.2, 18.7]	1,852 (23.2)	9.0 [7.7, 10.3]
80-84	87,365 (21.1)	16.3 [16.0, 16.5]	1,664 (20.8)	7.1 [7.9, 10.7]
85-89	59,700 (14.4)	14.3 [14.0, 14.6]	969 (12.1)	7.8 [6.1, 9.5]
90	32,459 (7.9)	11.3 [11.0, 11.7]	471 (5.9)	5.3 [3.2, 7.3]
Race				
White	337,020 (81.2)	18.5 [18.4, 18.6]	6,263 (78.4)	9.7 [9.0, 10.5]
Black	56,077 (13.6)	13.6 [13.3, 13.9]	1,293 (16.2)	5.0 [2.8, 6.2]
All Other Races	20,306 (4.9)	15.6 [15.1, 16.1]	435 (5.4)	5.5 [3.3, 7.6]
Deyo-Charlson score				
0	73,659 (17.8)	18.0 [17.7, 18.2]	1,263 (15.8)	7.8 [6.3, 9.3]
1	138,600 (33.5)	18.5 [18.2, 18.7]	2,679 (33.5)	8.8 [7.7, 9.9]
2	111,047 (26.9)	18.4 [18.1, 18.6]	2,237 (27.9)	9.9 [8.6, 11.1]
3	90,097 (21.8)	15.3 [15.1, 15.6]	1,812 (22.7)	7.9 [6.7, 9.2]
SNF Residence				
Yes	10,411 (2.5)	11.0 [10.4, 11.6]	183 (2.3)	4.9 [1.7, 8.0]
No	402,992 (97.5)	17.9 [17.7, 18.0]	7,808 (97.7)	8.8 [8.2, 9.5]
Zip code Median Income				
< \$15,000	8,644 (2.0)	7.1 [6.5, 7.6]	69 (0.9)	5.8 [1.4, 11.4]

	One CPR Event*		More than One CPR Event*	
	n (%)	% Surviving [95% CI]	n (%)	% Surviving [95% CI]
\$15,000–29,999	80,955 (19.6)	16.2 [15.9, 16.4]	1,649 (20.6)	7.2 [5.9, 8.4]
\$30,000–44,999	185,745 (44.9)	18.5 [18.3, 18.7]	3,635 (45.5)	9.9 [8.9, 10.9]
\$45,000–59,999	78,507 (18.9)	18.4 [18.1, 18.6]	1,511 (18.9)	9.0 [7.5, 10.4]
\$60,000–74,999	31,433 (7.6)	18.2 [17.7, 18.6]	594 (7.4)	7.4 [5.3, 9.5]
\$75,000+	15,894 (3.8)	18.3 [17.7, 18.9]	277 (3.4)	6.8 [3.8, 9.8]
No income data	12,225 (2.9)	16.6 [16.0, 17.3]	260 (3.25)	6.9 [3.8, 10.0]
<i>Diagnoses</i>				
Myocardial Infarction				
Yes	88,441 (21.4)	19.9 [19.6, 20.2]	2,124 (26.6)	9.2 [7.9, 10.4]
No	324,962 (78.6)	17.1 [16.9, 17.2]	5,867 (73.4)	8.6 [7.9, 9.3]
Congestive Heart Failure				
Yes	160,522 (38.8)	19.9 [19.7, 20.1]	3,616 (45.2)	10.7 [9.7, 11.7]
No	252,881 (61.2)	16.3 [16.1, 16.4]	4,375 (54.8)	7.1 [6.4, 7.9]
Stroke				
Yes	36,275 (8.8)	17.4 [16.9, 17.7]	593 (7.4)	11.4 [8.9, 14.0]
No	377,128 (91.2)	17.7 [17.6, 17.8]	7,398 (92.6)	8.5 [7.9, 9.2]
Diabetes Mellitus				
Yes	75,034 (18.1)	16.6 [16.3, 16.9]	1,484 (18.5)	7.4 [6.1, 8.7]
No	338,369 (81.8)	17.9 [17.8, 18.1]	6,507 (81.4)	9.1 [8.4, 9.8]
COPD				
Yes	111,776 (27.0)	18.3 [18.1, 18.5]	2,190 (27.4)	8.8 [7.6, 10.0]
No	301,627 (72.9)	17.5 [17.3, 17.6]	5,801 (72.6)	8.7 [8.0, 9.5]
<i>Hospital Characteristics</i>				
Rurality				
Metropolitan	329,683 (79.7)	17.4 [17.3, 17.5]	6,647 (83.2)	8.4 [7.7, 9.0]
Non-Metro	69,770 (16.9)	20.5 [20.2, 20.7]	1,201 (15.0)	11.2 [9.4, 13.0]
Unknown	13,950 (3.3)	10.2 [9.7, 10.7]	143 (1.8)	5.6 [1.8, 9.4]
Teaching Status				

	One CPR Event*		More than One CPR Event*	
	n (%)	% Surviving [95% CI]	n (%)	% Surviving [95% CI]
Teaching Hosp.	138,051 (33.4)	16.9 [16.7, 17.1]	2,351 (29.4)	8.6 [7.5, 9.7]
Non-Teaching	274,606 (66.4)	18.1 [17.9, 18.2]	5,637 (70.5)	8.8 [8.1, 9.6]
Hospital Size				
<250 beds	157,088 (38.0)	18.7 [18.5, 18.9]	2,925 (36.76)	10.1 [8.9, 11.1]
250-449 beds	135,860 (32.8)	17.3 [17.1, 17.5]	2,951 (36.9)	8.4 [7.4, 9.4]
450 + beds	119,709 (28.9)	16.8 [16.6, 17.0]	2,112 (26.4)	7.6 [6.5, 8.7]

* χ^2 p<0.001 for all between-category differences both groups (one CPR event and more than one CPR event)

Table 2

Multivariable analyses of factors associated with survival to discharge in patients with more than one CPR event during a single hospitalization

Predictor	Adjusted Odds Ratio of Survival [95%CI]	P value
Age (years)		
65–69	(reference)	--
70–74	1.01 [0.79, 1.3]	0.93
75–79	0.94 [0.74, 1.2]	0.62
80–84	0.96 [0.76, 1.22]	0.77
85–89	0.76 [0.56, 1.03]	0.084
90	0.53 [0.34, 0.82]	0.005
Male sex	1.04 [0.89, 1.22]	0.61
Race		
White	(reference)	--
Black	0.51 [0.39, 0.66]	<0.001
Other	0.57 [0.35, 0.90]	0.017
Deyo-Charlson Score		
0	(reference)	--
1	0.77 [0.58, 1.01]	0.063
2	0.68 [0.49, 0.96]	0.03
3	0.51 [0.34, 0.76]	0.001
Admission from SNF Residence	0.61 [0.31, 1.22]	0.16
Discharge Diagnosis		
Myocardial Infarction	1.14 [0.93, 1.40]	0.20
Congestive Heart Failure	1.85 [1.52, 2.27]	<0.001
Stroke	1.78 [1.34, 2.36]	<0.001
Diabetes Mellitus	0.93 [0.73, 1.20]	0.59
COPD	1.10 [0.91, 1.35]	0.32
Hospital Characteristics		
Non-metropolitan	1.25 [0.99, 1.55]	0.052
Teaching	1.15 [0.94, 1.55]	0.17
Hospital size		
<250 beds	(reference)	--
250–449 beds	0.84 [0.69, 1.03]	0.09
450 + beds	0.74 [0.58, 0.95]	0.02

Table 3

Discharge destination for survivors of CPR events during the index hospitalization

Discharge Destination	One CPR event (n=73,218)	More than one CPR event (n=702)
Skilled nursing facility	22.8%	21.8%
Other hospital	31.6%	42.6%
Hospice	1.8%	1.6%
Home	43.7%	34%

χ^2 p<0.001 for all comparisons between one CPR event and More than one CPR event.

Table 4

Multivariable analyses of number of CPR events and other factors associated with survival to discharge

Predictor	Adjusted Odds Ratio of Survival [95%CI]	P value
Number of CPR events	0.45 [0.42, 0.49]	<0.001
Age (years)		
65–69	(reference)	--
70–74	0.90 [0.87, 0.92]	<0.001
75–79	0.77 [0.75, 0.79]	<0.001
80–84	0.65 [0.63, 0.66]	<0.001
85–89	0.54 [0.52, 0.56]	<0.001
90	0.41 [0.39, 0.43]	<0.001
Male sex	0.84 [0.83, 0.85]	<0.001
Race		
White	(reference)	--
Black	0.71 [0.69, 0.74]	<0.001
Other	0.93 [0.89, 0.97]	0.001
Deyo-Charlson Score		
0	(reference)	--
1	0.75 [0.73, 0.77]	<0.001
2	0.58 [0.56, 0.60]	<0.001
3	0.43 [0.41, 0.45]	<0.001
Admission from SNF Residence	0.63 [0.57, 0.69]	<0.001
Discharge Diagnosis (referent group patients without any of these diseases)		
Myocardial Infarction	1.39 [1.35, 1.42]	<0.001
Congestive Heart Failure	1.63 [1.59, 1.66]	<0.001
Stroke	1.30 [1.26, 1.35]	<0.001
Diabetes Mellitus	1.10 [1.07, 1.12]	<0.001
COPD	1.24 [1.21, 1.27]	<0.001
Hospital Characteristics		
Non-metropolitan	1.13 [1.08, 1.18]	<0.001
Teaching	1.01 [0.96, 1.06]	0.768
Hospital size		
<250 beds	(reference)	--
250–449 beds	0.92 [0.88, 0.96]	<0.001
450 + beds	0.89 [0.84, 0.94]	<0.001