EDITORIAL

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Successful Resuscitation From In-Hospital Cardiac Arrest—What Happens Next?

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Few moments in medicine are more vividly and regularly captured in the lay media than the resuscitation response (ie, code blue) to an in-hospital cardiac arrest. However, there is concern that outcomes from resuscitation efforts are far better on television than in real life.[1] Consequently, the public's view of the implications of in-hospital cardiac arrest may be distorted, thereby complicating ensuing care planning, especially with regard to prognosis and whether to limit care or institute do-not-resuscitate (DNR) orders.

Related article page 1264

In this issue of *JAMA*, Fendler and colleagues[2] provide a comprehensive and contemporary description of what actually happens to patients who experience in-hospital cardiac arrest, focusing on those for whom resuscitation results in successful restoration of spontaneous circulation (ROSC) and whether subsequent institution of DNR orders in these patients is aligned with their prognosis. The authors analyzed the Get With the Guidelines Resuscitation registry, a large database of in-hospital cardiac arrests at several hundred US hospitals. The analysis was limited to patients for whom there were no prearrest DNR orders and whose cardiac arrest occurred while the patient was admitted to a hospital ward or intensive care unit. For patients who achieved successful ROSC, the authors used the cardiac arrest survival post-arrest resuscitation in-hospital (CASPRI) prognostic tool to estimate the likelihood of being discharged alive without severe neurological dysfunction and then determined if and when DNR orders were instituted across deciles of risk.

Among 59 589 patients with cardiac arrest, 25 618 (43%) died during attempted resuscitation. Of the 33 971 patients who had successful ROSC, 26 327 (77.5%) were available for analysis. For this group, the overall likelihood of discharge alive without severe neurological disability was only 24%. Do-not-resuscitate orders were placed within 12 hours for 22.6% of patients, and an additional 14.5% of patients had DNR orders placed up to day 5 after cardiac arrest. In the best prognostic decile (n = 2396), DNR orders were placed in the first 12 hours for 169 (7.1%) patients, and 1550 (64.7%) were discharged with favorable neurologic outcome. In contrast, of the 2667 patients in the worst prognostic decile, 108 (4%) had a favorable outcome, yet only 959 patients (36%) had DNR orders placed. This pattern was similar for DNR orders placed up to 5 days. Not surprisingly, patients in the best prognostic decile were younger, had less preexisting comorbidity, and had less acute severity of illness, such as a lower chance of requiring mechanical ventilation, than patients in the worst-risk decile. Within the best decile, patients who had DNR orders placed were older and had more severe illness than those who did not. Within the worst prognostic decile, however, the clinical characteristics were quite similar between patients who did and did not have DNR orders placed.

It is likely that this study reflects current US practice, even though the hospitals represent only 10% of all US hospitals and participate voluntarily. In addition, a moderate number of cases were excluded from analysis because of missing data, although the authors demonstrated that the baseline characteristics of these patients were similar to those included in the analysis. Using the CASPRI score was a sound approach to assess the extent to which decisions to institute DNR orders varied based on patient characteristics, although it is important to note that this score is not used currently by clinicians. Do-not-resuscitate orders are not analogous to withdrawal or withholding of life support. It is possible that, absent DNR orders, care was nonetheless limited in other ways for patients with poor prognosis. However, hospital costs, length of stay, and resource use among patients with poor prognosis yet without DNR orders were high, suggesting any withholding of life support occurred late in the course of care.

These results could be framed as a glass half-full or half-empty. On the one hand, it is reassuring that DNR orders, if placed, are generally done quickly and appear to be instituted infrequently for patients likely to fare well and commonly for those likely to fare poorly. However, two-thirds of patients with an extremely poor chance of good recovery were managed without institution of DNR orders and incurred high costs of care. Given that cardiac arrest occurs in a broad range of patients, and that there are only a few cases per hospital per year, most clinical teams will only occasionally care for a survivor of in-hospital cardiac arrest. It is therefore quite possible that the primary team may be neither good at nor comfortable with estimating prognosis. In many instances, cardiac arrest substantially changes prognosis, with potentially important implications for aggressiveness of care. Both the clinical team and family members need to absorb the information. It is perhaps surprising that most DNR orders were instituted so soon after cardiac arrest.

As can occur when relying on registry data, the study by Fendler et al has some important missing information, especially on the large portion of patients with very poor prognosis for whom DNR orders were not instituted. What were the opinions of the clinical team and family members in these instances? What were the patient's preferences? What efforts were undertaken to establish a prognosis and ensure conversations took place around appropriate goals of care? That there were few differences between patients in the worst decile who had and did not have DNR orders instituted suggests that other important factors may affect decision making by physicians and patients' families.

Here, the strength of the Get With the Guidelines-Resuscitation database is also a weakness: capturing information on a huge number of patients at hundreds of hospitals, by necessity, requires that data collection be of adequately low burden. Yet to have a greater understanding of the complex set of questions raised above likely requires very detailed observation. A number of groups have examined how clinical teams make decisions regarding prognosis and how they interact with families. Typically, however, such studies involve sophisticated and in-depth study, such as audiotaping and qualitative content analysis of interviews, and embedding of social scientists in the care team.[3] Consequently, these studies are small and potentially lack generalizability. The trade-off would be to find adequately insightful data instruments that can be successfully nested into larger efforts without undue burden.

Even in the absence of more data, it seems likely that there is room for improvement in the quality of decision making and support, especially for the many patients whose care is managed aggressively despite dismal prospects for a favorable outcome. Improvement strategies generally involve 2 broad domains: better preparation before cardiac arrest and better management after. Although cardiac arrest is, by definition, sudden, it is clearly not unpredictable. First, the patients are already hospitalized. Second, some of the strongest predictors of poor outcome are prearrest variables, such as severe comorbidity or requirement for life support. Thus, continuing efforts to encourage patients with severe chronic disease and their families to engage in conversations about preferences for care and execute advance directives is crucial. In addition, early conversation with the family members of any patient already receiving life support regarding prognosis and preferences for care is also likely to be helpful.

For the patient who has been resuscitated from cardiac arrest, the clinical team most likely first considers prognosis. For this purpose, the CASPRI score or an analogous validated model may have a role in the future as a decisional aid, especially because clinicians encounter the situation rarely and might otherwise be prone to erroneous estimates. However, accurate prognosis is only one element, insufficient on its own, for optimal decision making.[4] Rather, an expanding and robust literature has helped delineate that many other barriers limit optimal decisions. The clinical team may be unable to reach agreement on goals of care, they may not meet with family members, or they may meet with the family but be ineffective in communicating information, soliciting views of family members, or providing support and facilitating decisions.[5] To this end, several groups are actively engaged in testing interventions such as strategies to ensure early structured family meetings, to educate and train clinicians to be better communicators and better facilitators of family decisions around goals of care, and to consider augmenting the clinical team with better integrated palliative care or medical ethics expertise. However, uncertainty persists regarding the delivery and effectiveness of these interventions, and most involve considerable effort and resources.[6,7]

In summary, when a cardiac arrest occurs in hospital, health care teams are good at rushing in to provide robust resuscitative efforts. However, after successful ROSC, just as after the initial response to any disaster, it is clear the work has only just begun. Hopefully in the future, standardized delivery of high-quality evidence-based resuscitation guidelines for cardiac arrest will be followed by equally high-quality standard approaches to ensure patients and families are supported optimally, regardless of prognosis.

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Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Alignment of Do-Not-Resuscitate Status With Patients' Likelihood of Favorable Neurological Survival After In-Hospital Cardiac Arrest

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IMPORTANCE After patients survive an in-hospital cardiac arrest, discussions should occur about prognosis and preferences for future resuscitative efforts.

OBJECTIVE To assess whether patients' decisions for do-not-resuscitate (DNR) orders after a successful resuscitation from in-hospital cardiac arrest are aligned with their expected prognosis.

DESIGN, SETTING, AND PARTICIPANTS Within Get With The Guidelines–Resuscitation, we identified 26 327 patients with return of spontaneous circulation (ROSC) after in-hospital cardiac arrest between April 2006 and September 2012 at 406 US hospitals. Using a previously validated prognostic tool, each patient's likelihood of favorable neurological survival (ie, without severe neurological disability) was calculated. The proportion of patients with DNR orders within each prognosis score decile and the association between DNR status and actual favorable neurological survival were examined.

EXPOSURES Do-not-resuscitate orders within 12 hours of ROSC.

MAIN OUTCOMES AND MEASURES Likelihood of favorable neurological survival.

RESULTS Overall, 5944 (22.6% [95% CI, 22.1%-23.1%]) patients had DNR orders within 12 hours of ROSC. This group was older and had higher rates of comorbidities (all $P < .05$) than patients without DNR orders. Among patients with the best prognosis (decile 1), 7.1% (95% CI, 6.1%-8.1%) had DNR orders even though their predicted rate of favorable neurological survival was 64.7% (95% CI, 62.8%-66.6%). Among patients with the worst expected prognosis (decile 10), 36.0% (95% CI, 34.2%-37.8%) had DNR orders even though their predicted rate for favorable neurological survival was 4.0% (95% CI, 3.3%-4.7%) (*P* for both trends <.001). This pattern was similar when DNR orders were redefined as within 24 hours, 72 hours, and 5 days of ROSC. The actual rate of favorable neurological survival was higher for patients without DNR orders (30.5% [95% CI, 29.9%-31.1%]) than it was for those with DNR orders (1.8% [95% CI, 1.6%-2.0%]). This pattern of lower survival among patients with DNR orders was seen in every decile of expected prognosis.

CONCLUSIONS AND RELEVANCE Although DNR orders after in-hospital cardiac arrest were generally aligned with patients' likelihood of favorable neurological survival, only one-third of patients with the worst prognosis had DNR orders. Patients with DNR orders had lower survival than those without DNR orders, including those with the best prognosis.

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Editorial page 1238

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Do-not-resuscitate (DNR) orders are often established for patients whose prognosis is poor. One such example is in-hospital cardiac arrest, which affects nearly 200 000 patients in the United States annually, with rates of favorable neurological survival (ie, survival without severe cognitive disability) of less than 20%.[1] Accordingly, this poor prognosis frequently prompts discussions about DNR status among resuscitated patients and their families.[2] However, the likelihood of favorable neurological survival is variably influenced by many factors, including patients' age, illness severity, comorbidities, and arrest characteristics.[3-7] It therefore remains unknown if real-world decisions for DNR orders after successful resuscitation from in-hospital cardiac arrest are aligned with patients' likelihood of favorable neurological survival.

A critical challenge in making decisions about DNR status in this clinical setting has been the lack of a tool to quantify a patient's prognosis after initial resuscitation from an in-hospital cardiac arrest. Recently, such a prognosis tool was developed and internally validated.[8] Accordingly, to better understand current practice patterns for DNR decisions for in-hospital cardiac arrest, we used the multicenter Get With the Guidelines–Resuscitation registry to examine whether DNR orders after successful resuscitation from an in-hospital cardiac arrest occurred primarily in patients with a low likelihood of favorable neurological survival. Moreover, we explored whether patients with DNR orders had similar or lower hospitalization costs and lengths of stay after return of spontaneous circulation (ROSC) than did patients without DNR orders, even among those with a high likelihood of a good neurological outcome.

Methods

Study Design

The institutional review board of the Mid-America Heart Institute approved this study and waived the requirement for informed consent.

The registry is a multicenter, observational database of in-hospital cardiac arrests among US hospitals that began in 2000, details of which have been published.[9] Hospital participation in the registry is voluntary. In short, trained research personnel at each participating hospital identify and enroll all patients with in-hospital *cardiac arrest*, defined as unresponsiveness, apnea, and absence of a palpable central pulse, without prior DNR orders and who have undergone cardiopulmonary resuscitation (CPR). This is accomplished through multiple sources of case identification, including medical records, centralized cardiac arrest flow sheets, hospital paging-system logs, code cart checks, pharmacy tracer drug records, and hospital billing charges for use of resuscitation medications.[5,9] Standardized data collection methods, including Utstein consensus definitions for all variables and outcomes, and strict oversight across all participating centers ensure accuracy, uniformity, and completeness of the data.[7,10,11]

Study Population

Information on DNR status after ROSC was introduced into the data collection form in April 2006. Thus, the cohort consisted of adult patients who were 18 years or older with an in-hospital cardiac arrest between April 2006 and September 2012. To focus on patients who experienced cardiac arrest in either general inpatient or intensive care units, we excluded patients who had experienced in-hospital cardiac arrest in the emergency department, operating room, and procedural and postprocedural areas. For the purposes of this study, in which decisions about DNR status after ROSC were assessed, patients who died during the acute resuscitation, as well as patients from hospitals that did not routinely collect information on DNR status, were excluded. Additionally, patients were excluded if they had missing data on neurological status at discharge because this variable comprised one of the study outcomes. Patients for whom the time of DNR decision could not be calculated due to missing or implausible times were also excluded.

Definition of Variables

This study examined the relationship between DNR orders after initial resuscitation from in-hospital cardiac arrest and a patient's likelihood of favorable neurological survival. Because many patients who eventually die have DNR orders closer to the time of their deaths and because this study examined whether DNR decisions were associated with prognosis, we defined *DNR status*—the independent variable—as a patient for whom a DNR order was placed within 12 hours after ROSC. Successfully resuscitated patients without DNR orders at any time during their admission or those with a DNR order placed more than 12 hours after ROSC were defined as *patients without DNR status*. In sensitivity analyses, *DNR status* was defined as within 24 hours, 72 hours, and 5 days after ROSC.

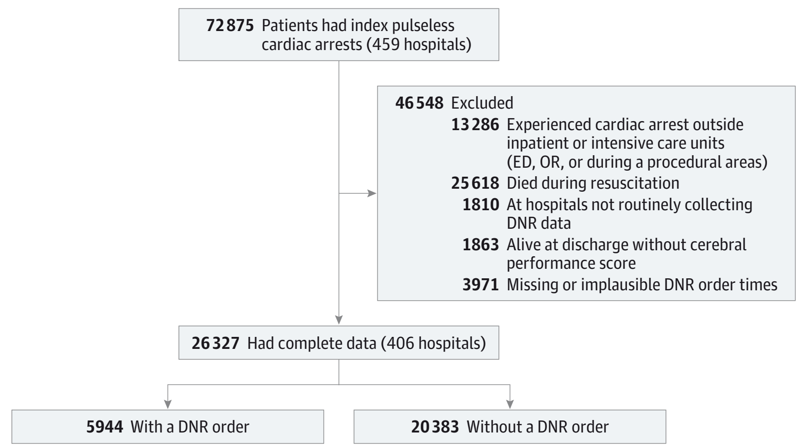
Favorable neurological survival was defined as survival to hospital discharge without severe neurological disability. Neurological disability in the database is measured by cerebral performance category scores, wherein a score of 1 denoted little to no neurological disability; 2, moderate disability; 3, severe disability; 4, coma or vegetative state; and 5, brain death. Based on prior work, favorable neurological survival was defined as survival to hospital discharge with a cerebral performance category score of 1 or 2.[8,12] The dependent variable, likelihood of favorable neurological survival, was defined by each patient's expected prognosis, described below.

Statistical Analysis

Because of the large study sample size, baseline differences between patients with and without DNR orders were compared using standardized differences, which account for the large sample size of the compared groups. Based on prior work, a standardized difference of greater than 10% was considered a significant and meaningful difference.[13]

To evaluate whether a patient's decision to have DNR orders was aligned with their prognosis, the discriminative accuracy of 4 prognosis risk scores for in-hospital cardiac arrest was first evaluated: (1) the prearrest morbidity (PAM) score,[14] (2) the prognosis after resuscitation (PAR) score,[15] (3) the cardiac arrest survival postresuscitation in-hospital (CASPRI) score,[8] and (4) the good outcome following attempted resuscitation (GO-FAR) score.[16] To accomplish this, 4 separate mul-

Figure 1. Patients With In-hospital Cardiac Arrest With or Without DNR Orders Exclusion Flowchart



Abbreviations: DNR, do not resuscitate; ED, emergency department; OR, operating room.

tivariable hierarchical logistic regression models were constructed to predict favorable neurological survival using the variables for each prognostic score. Two-level hierarchical models were used to account for clustering of patients within hospitals, with individual hospitals modeled as random effects and patient characteristics as fixed effects within each hospital.[17,18] The *C* statistics from each model were then compared to determine which model had the highest discriminative accuracy. Because the CASPRI risk score had significantly higher discrimination than the 3 other prognosis scores (eTable 1 in the Supplement), subsequent analyses evaluating DNR decision making and prognosis primarily used the CASPRI risk score.

We then calculated each patient's likelihood of favorable neurological survival using the CASPRI score.[8] Briefly, this score was derived and validated using data from 42 957 patients in the Get With the Guidelines–Resuscitation database. A final parsimonious model with excellent discrimination (*C* statistic, 0.802) and calibration identified the following 11 significant predictors of favorable neurological survival among patients successfully resuscitated from an in-hospital cardiac arrest: age, initial cardiac arrest rhythm, prearrest neurological disability, hospital location of arrest, duration of cardiopulmonary resuscitation, requirement for mechanical ventilation at the time of cardiac arrest, and the presence of renal insufficiency, hepatic insufficiency, sepsis, malignant disease, and hypotension at the time of cardiac arrest. The CASPRI score was calculated for each patient by applying the model coefficients to each patient's case-mix profile. CASPRI scores range from 0 to 50, with higher scores indicating a lower likelihood of favorable neurological survival. To assess the alignment of early decision making for DNR status with patients' prognoses, the cohort was stratified into deciles of CASPRI score and rates of DNR orders as well as actual favorable neurological survival were examined within each CASPRI decile. As sensitivity analyses, the main analyses were repeated after redefining DNR orders as those made within 24 hours, 72 hours, and 5 days of ROSC. In addition, to examine whether DNR orders within the first 12 hours were surrogates for comfort care, the likelihood of an order for withdrawal of life-sustaining treatments at any time after ROSC was examined for patients with and without DNR orders. For exploratory analyses, we examined the length of hospital stay from the time of ROSC for patients with and without DNR orders, stratified by CASPRI decile. For the 9733 patients who were 65 years or older and linked to Medicare inpatient claims files using a probabilistic matching algorithm from our prior work,[19,20] index hospitalization costs for patients with and without DNR orders were also compared. Hospitalization costs were obtained from the inpatient Medicare files and represented actual reimbursement of the index hospitalization paid to hospitals for each patient linked to Medicare claims data.

For all analyses, the null hypothesis was evaluated at a 2-sided significance level of .05 with 95% confidence intervals. All analyses were conducted using SAS statistical software version 9.1 (SAS Institute Inc) and R version 2.6.2.[21]

Results

An initial 72 875 in-hospital cardiac arrest events from 459 hospitals were identified (**Figure 1**). Excluded were 13 286 patients with an in-hospital cardiac arrest in procedural or operative settings or the emergency department, 25 618 patients who died during the acute resuscitation, 1810 patients whose hospitals did not routinely collect information on DNR status, 1863 patients with missing data on neurological status at discharge, and 3971 patients for whom the timing of DNR decisions could not be calculated. For the 8013 patients with missing data on DNR status or discharge neurological status (last 3 exclusions), there were no significant differences in baseline characteristics when compared with those of the study cohort (eTable 2 in Supplement). The final cohort included 26 327 patients from 406 hospitals who were successfully resuscitated after in-hospital cardiac arrest.

Overall, 5944 (22.6% [95% CI, 22.1%-23.1%]) had DNR orders within the first 12 hours after ROSC, while 20 383 (77.4% [95% CI, 76.9%-77.9%]) did not. **Table 1** compares

Table 1. Baseline Characteristics of Study Participants

	DNR Order Status		
	Yes (n = 5944)	No (n = 20 383)	Standardized Differences, %
Age, mean (SD), y	68.6 (15.2)	64.2 (15.7)	28.5
Women, No. (%)	2775 (46.7)	8663 (42.5)	8.5
Race, No. (%)			
White	4310 (73.6)	13 697 (68.3)	11.8
Black	1165 (19.9)	4726 (23.6)	8.9
Other	381 (6.5)	1644 (8.2)	6.5
Conditions present prior to admission, No. (%)			
Heart failure	1225 (20.6)	4279 (21.0)	1.0
Myocardial infarction or ischemia	851 (14.3)	2974 (14.6)	0.8
Conditions present at time of cardiac arrest, No. (%)			
Heart failure	996 (16.8)	3783 (18.6)	4.7
Myocardial infarction or ischemia	809 (13.6)	2814 (13.8)	0.6
Arrhythmia	1867 (31.4)	6447 (31.6)	0.5
Hypotension	2065 (34.7)	5003 (24.5)	22.5
Respiratory insufficiency	2963 (49.8)	8864 (43.5)	12.8
Renal insufficiency	2499 (42.0)	7501 (36.8)	10.7
Hepatic insufficiency	661 (11.1)	1622 (8.0)	10.8
Metabolic or electrolyte abnormality	1264 (21.3)	3096 (15.2)	15.8
Diabetes mellitus	1807 (30.4)	7040 (34.5)	8.9
Baseline depression in central nervous system function[a]	820 (13.8)	2159 (10.6)	9.8
Acute stroke	275 (4.6)	767 (3.8)	4.3
Acute central nervous system, nonstroke event	455 (7.7)	1354 (6.6)	3.5
Pneumonia	983 (16.5)	3112 (15.3)	3.3
Septicemia	1447 (24.3)	3779 (18.5)	3.8
Major trauma	200 (3.4)	832 (4.1)	3.7
Metastatic or hematologic malignancy	1014 (17.1)	2250 (11.0)	4.7
Interventions in place at time of cardiac arrest, No. (%)			
Mechanical ventilation	2428 (40.8)	6365 (31.2)	20.1
Pacemaker	334 (5.6)	1321 (6.5)	18.6
Dialysis	254 (4.4)	789 (4.0)	6.4
Event characteristics, No. (%)			
Night	2197 (37.1)	6543 (32.4)	10.0
Weekend	1776 (29.9)	5824 (28.6)	2.9
Location, No. (%)			
Intensive care unit	3896 (65.5)	11 985 (58.8)	13.9
Monitored unit	1273 (21.4)	5706 (28.0)	15.3
Nonmonitored unit	775 (13.0)	2692 (13.2)	0.5
Initial cardiac rhythm, No. (%)			
Asystole	2028 (34.1)	6888 (33.8)	0.7
Pulseless electrical activity	3457 (58.2)	10 781 (52.9)	10.6
Ventricular fibrillation	423 (7.1)	2539 (12.5)	18.0
Ventricular tachycardia	36 (0.6)	175 (0.9)	3.0
Time to ROSC, mean (SD), min	16.4 (15.2)	14.5 (16.1)	12.5
Median (IQR), min	12 (6-21)	10 (5-19)	12.5
CPC when admitted to hospital, No. (%)[b]			
1	2436 (50.7)	9802 (58.8)	16.4
2	1244 (25.9)	4006 (24.0)	4.3
3	691 (14.4)	1895 (11.4)	9.0
4	435 (9.0)	956 (5.7)	12.7
5	1 (<1.0)	5 (<1.0)	0.6

Abbreviations: CPC, cerebral performance category; DNR, do not resuscitate; IQR, interquartile range; ROSC, return of spontaneous circulation.

[a] Defined as a motor, cognitive, or functional deficit on admission.

[b] The CPC score is a validated measure of neurological disability ranging from 1 to 5 with the following definitions: 1, no or mild neurological disability; 2, moderate disability; 3, severe disability; 4, persistent coma or vegetative state; and 5, brain death.

Table 2. Rates of Favorable Neurological Survival and DNR Order Within 12 Hours After Return of Spontaneous Circulation

CASPRI Score Decile[a]	CASPRI score per Decile, Median (Range)	Total No. of Patients	No. (%) of Patients: Overall Favorable Neurological Survival Rate[b]	No. (%) of Patients: Patients With DNR Order	Survival Rate[b]: Patients With DNR Order	Survival Rate[b]: Patient Without DNR Order
Overall	22 (0-44)	26 327	6318 (24.0)	5944 (22.6)	105 (1.8)	6213 (30.5)
1	8 (0-10)	2396	1550 (64.7)	169 (7.1)	12 (7.1)	1538 (69.1)
2	12 (11-12)	1726	834 (48.3)	181 (10.5)	11 (6.1)	823 (53.3)
3	14 (13-14)	2535	892 (35.2)	372 (14.7)	18 (4.9)	874 (40.4)
4	16 (15-16)	3359	937 (27.9)	601 (17.9)	11 (1.8)	926 (33.6)
5	17 (17-17)	1857	389 (20.1)	398 (21.4)	9 (2.3)	380 (26.1)
6	18 (18-19)	3696	679 (18.4)	890 (24.1)	23 (2.6)	656 (23.4)
7	20 (20-20)	1680	262 (15.6)	465 (27.7)	4 (0.9)	258 (21.2)
8	21 (21-22)	2840	347 (12.2)	749 (26.4)	4 (0.5)	343 (16.4)
9	24 (23-26)	3571	320 (9.0)	1160 (32.5)	13 (1.1)	307 (12.7)
10	29 (27-44)	2667	108 (4.0)	959 (36.0)	0 (0.0)	108 (6.3)

Abbreviations: CASPRI, cardiac arrest survival postresuscitation in-hospital; DNR, do not resuscitate; ROSC, return of spontaneous circulation.

[a] CASPRI is a validated score for prognosis after ROSC. Scores range from 0 to 50. Higher scores represent a worse prognosis.

[b] Refers to survival with a cerebral performance category score of 1 or 2.

characteristics of patients with and without DNR orders. Patients with DNR orders were older, more frequently of white race, and were more likely to have baseline neurological disability (cerebral performance category, >1). In addition, they had higher rates of preexisting conditions including hypotension, respiratory insufficiency, renal insufficiency, hepatic insufficiency, metabolic or electrolyte abnormalities, and pneumonia. Patients with DNR orders after ROSC were more likely to have cardiac arrest rhythms associated with lower overall survival (eg, pulseless electrical activity) and longer resuscitation times.

Relationship Between DNR Status and Expected Prognosis

The rate of favorable neurological survival was 24.0% (95% CI, 23.5%-24.5%) among patients with ROSC. When patients were stratified by prognosis deciles, this rate was 64.7% (95% CI, 62.8%-66.6%) in decile 1 and decreased to 4.0% (95% CI, 3.3%-4.7%) in decile 10 (*P* for trend <.001; **Table 2**). The proportion of patients with DNR orders increased as prognosis worsened, from 7.1% (95% CI, 6.1%-8.1%) in decile 1 to 36.0% (95% CI, 34.2%-37.8%) in decile 10 (*P* for trend <.001). Of all patients in decile 10, 64.0% (95% CI, 62.2%-65.8%) did not have DNR orders after ROSC despite the decile's 4% (95% CI, 3.3%-4.7%) rate for favorable neurological survival. Compared with patients in decile 1, patients in decile 10 were much older, had higher rates of comorbidities, and had markedly longer mean resuscitation times (20.3 vs 5.7 minutes) (eTable 3 in the Supplement). Moreover, the majority of patients in decile 10 (78.1% [95% CI, 76.5%-79.7%]) had severe neurological disability or worse prior to their cardiac arrest (25.7% [95% CI, 24.0%-27.4%] in a comatose state) compared with those in decile 1 (0.3% [95% CI, 0.01%-0.21%]).

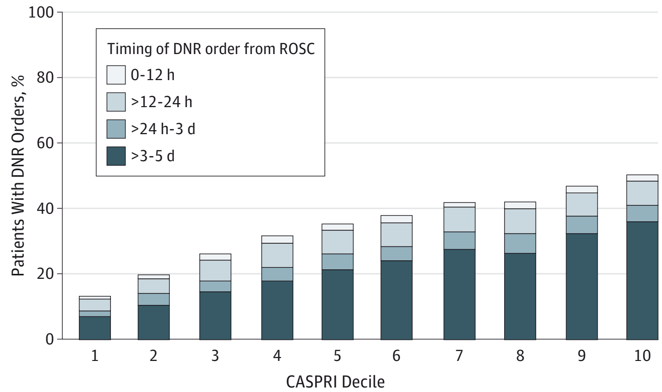
In sensitivity analyses, there were an additional 1165 (4.4% [95% CI, 4.2%-4.6%]) patients with DNR orders between 12 and 24 hours, an additional 1779 (6.8% [95% CI, 6.5%-7.1%]) between 24 hours 3 days, and an additional 877 (3.3% [95% CI, 3.1%-3.5%]) between 3 and 5 days after ROSC, with no significant change in patterns of DNR decisions by patients' prognosis (**Figure 2**). A similar pattern of low DNR rates in the highest-risk deciles emerged when the analyses were repeated using the PAM, PAR, and GO-FAR scores (eFigure 1 in the Supplement).

Relationship Between DNR Status and Actual Outcomes

Among patients with DNR orders after ROSC, 105 (1.8% [95% CI, 1.6%-2.0%]) had favorable neurological survival. Rates for this outcome remained relatively low regardless of CASPRI score decile, including those with a high predicted likelihood of favorable neurological survival (eg, 7.1% [95% CI, 6.1%-8.1%] for patients with DNR orders in decile 1; Table 2). In contrast, 6213 (30.5% [95% CI, 29.9%-31.1%]) of the 20 383 patients without DNR orders had favorable neurological survival, with substantially higher rates in the lower CASPRI deciles (eg, 69.1% [95% CI, 67.3%-70.9%] in decile 1 vs 6.3% [95% CI, 5.4%-7.2%] in decile 10).

Do-not-resuscitate orders were not surrogates for withdrawal of life-sustaining treatments. Only 47.5% (95% CI, 46.9%-48.1%) of patients with DNR orders placed within 12 hours of ROSC withdrew life-sustaining treatments at any time after ROSC (eTable 4 in the Supplement). Nevertheless, patients with DNR orders had shorter lengths of stay after ROSC and lower hospitalization costs than patients without DNR orders, regardless of prognosis risk (**Table 3**). There were no major differences in baseline neurological status, resuscitation duration, location of arrest, and most comorbidities between patients with and without DNR orders in deciles 1 and 10 to account for these large differences in resource use (eTable 5 in Supplement). Notably, hospitalization costs for patients with DNR orders in decile 1 were similar to those of decile 10 although only 0.4% (95% CI, 0.1%-0.6%) of patients with DNR orders in decile 1 had severe neurological disability or worse, as compared with 79.2% (95% CI, 77.7%-80.7%) in decile 10 (see Table 3).

Figure 2. Rates of DNR Order Up to 5 Days After Cardiac Arrest, Stratified by CASPRI Score Decile



	1	2	3	4	5	6	7	8	9	10
No. of patients	2396	1726	2535	3359	1857	3696	1680	2840	3571	2667
Median score	8	12	14	16	17	18	20	21	24	29
Range	0-10	11-12	13-14	15-16	17	18-19	20	21-22	23-26	27-44

Abbreviations: DNR, do not resuscitate; CASPRI, cardiac arrest survival postresuscitation in-hospital; ROSC, return of spontaneous circulation.

Table 3. Resource Use by Patients With and Without DNR Order

	Patients Without DNR Order		Patients With DNR Order		
CASPRI Decile[a]	No.	Length of Stay, Median (IQR), d	No.	Length of Stay, Median (IQR), d	*P* Value
1	2227	10 (4-19)	169	0 (0-1)	<.001
2	1545	9 (2-21)	181	0 (0-1)	<.001
3	2163	8 (1-21)	372	0 (0-1)	<.001
4	2758	6 (1-18)	601	0 (0-1)	<.001
5	1459	5 (1-16)	398	0 (0-1)	<.001
6	2806	5 (1-6)	890	0 (0-1)	<.001
7	1215	4 (1-15)	465	0 (0-0)	<.001
8	2091	3 (1-15)	749	0 (0-0)	<.001
9	2411	3 (1-13)	1160	0 (0-0)	<.001
10	1708	2 (0-10)	959	0 (0-0)	<.001
Total Hospitalization Costs[b]					
		Costs, US $, Mean (SD)		Costs, US $, Mean (SD)	
1	629	42 618 (1579)	63	21 522 (4990)	<.001
2	474	47 218 (1819)	75	18 823 (4574)	<.001
3	695	40 376 (1502)	144	18 557 (3301)	<.001
4	937	40 553 (1294)	233	19 052 (2601)	<.001
5	551	36 993 (1687)	166	17 970 (3074)	<.001
6	1009	37 602 (1247)	414	18 287 (1947)	<.001
7	453	36 960 (1863)	219	23 908 (2677)	<.001
8	781	34 155 (1417)	329	20 810 (2184)	<.001
9	947	35 297 (1288)	525	19 104 (1732)	<.001
10	654	32 323 (1550)	435	19 901 (1904)	<.001
		P for trend <.001		*P* for trend = .56	

Abbreviations: CASPRI, cardiac arrest survival postresuscitation in-hospital; DNR, do not resuscitate; ROSC, return of spontaneous circulation.

[a] CASPRI is a score for prognosis after ROSC. Scores range from 0 to 50. Higher scores represent a worse prognosis.

[b] Applies to the 9733 patients who were linked to Medicare inpatient files.

Discussion

In this national registry of in-hospital cardiac arrest, we found that DNR orders after successful resuscitation were generally aligned with patients' likelihood for favorable neurological survival, with increasing rates of DNR orders as a patient's likelihood to survive without neurological disability decreased. Nevertheless, almost two-thirds of patients with the worst prognosis did not have DNR orders, even though only 4.0% of patients within this decile had favorable neurological survival. Moreover, patients who had DNR orders despite a good prognosis had significantly lower survival and less resource use than patients without DNR orders who had a similar prognosis after ROSC. Our findings suggest that, while DNR orders after resuscitation from in-hospital cardiac arrest are correlated with expected prognosis, there may be opportunities to better align DNR decisions with patients' prognosis.

Several studies have reported varied rates of DNR orders in patients with other disease conditions, such as 9% for acute myocardial infarction,[22] 13% to 22% for acute stroke,[23,24] 22% for community-acquired pneumonia,[25] and 38% to 47% for initial survivors of out-of-hospital cardiac arrest.[26,27] Although these prior studies reported overall rates of DNR orders, they did not assess whether code-status decision making was aligned with a patient's prognosis. To our knowledge, this is the first study to analyze the association between DNR decision making and patients' expected prognosis to better understand contemporary practice patterns.

Among patients with a low likelihood of favorable neurological survival after in-hospital cardiac arrest, our findings highlight the potential to improve DNR decision making. Because 78% of patients with the worst prognosis (decile 10) had severe neurological disability or were comatose prior to their cardiac arrest and given long resuscitation times, it was notable that only 36% of patients in this decile had DNR orders after ROSC. This rate remained below 50% even when DNR status was redefined as any time within 5 days after ROSC. Patients' decisions to have DNR orders may be motivated by many factors, including inaccurate clinician prognostication, inadequate communication, poor understanding of the prognosis, family influence, or patients' personal beliefs and goals. The database did not distinguish between these possibilities. Furthermore a DNR order is not the appropriate choice for all patients with a very poor prognosis. Some patients opt for aggressive treatment regardless of prognosis. However, our findings suggest that decisions about DNR orders can be better aligned among patients with a low likelihood of favorable neurological survival. Future use of prognosis tools can facilitate shared, informed decision making for DNR orders in this patient group.

Some patients with the best prognosis had DNR orders soon after ROSC. The survival rate of 7.1% among patients with DNR orders in decile 1, however, differed markedly from patients without DNR orders (69.1%) who had a similar prognosis score profile. This pattern was repeated across all prognosis score deciles (Table 2). Whether the survival difference by DNR status among patients with a high likelihood of favorable neurological survival reflects less aggressive care among patients with DNR orders or factors not measured in a prognosis tool remains unknown and is an area for future research. Nevertheless, patients who had DNR orders in the setting of a favorable prognosis (eg, decile 1) did not differ substantially from patients without DNR orders. Of concern, total hospitalization costs for patients with DNR orders in decile 1 were similar to those patients with DNR orders in decile 10 who had the worst prognosis (Table 3), despite large differences in resuscitation duration and baseline neurological disability between these 2 populations (eTable 5 in the Supplement). Although we are unable to distinguish whether DNR orders were a marker or mediator for worse outcomes, these initial insights raise questions about whether DNR decisions may have led to lower intensity and aggressiveness of care for patients with DNR orders, especially for those with a good prognosis. In this setting, use of decision support tools may reduce the possibility of decreased treatment intensity among those with a high likelihood of favorable neurological survival.

Our study should be interpreted in the context of certain limitations. First, the CASPRI score has been internally validated but still requires external validation. Therefore, the clinical applicability of this tool for hospitals not participating in the Get With the Guidelines–Resuscitation database may be limited. Second, the occurrence, frequency and content of patient-clinician discussions about early DNR status were not measured. Therefore, the reasons some patients in the deciles with the best prognosis chose to have DNR orders placed while others with the worst prognosis did not could not be determined. Studies are needed to assess the extent to which this is due to patients' beliefs and preferences or discordance between physicians' perceptions of patients' prognoses and those of available prognosis tools. Third, although a prognosis tool with excellent discrimination was used, it is likely that some decisions regarding DNR status may reflect unmeasured patient characteristics that were not included in the prediction tool. This is an especially germane limitation in regard to those patients with good neurological prognosis who nevertheless had DNR orders after ROSC. Fourth, despite a wealth of evidence that DNR status is associated with mortality in a number of clinical settings, it is not established whether patients' DNR status is a marker or mediator of survival. Delineation of the exact nature of this relationship merits further study.

Conclusions

Although DNR orders after in-hospital cardiac arrest were generally aligned with patients' likelihood of favorable neurological survival, only one-third of patients with the worst prognosis had DNR orders. Patients with DNR orders had lower survival than those without DNR orders, including among those with the best prognosis.

ARTICLE INFORMATION

Author Contributions: Drs Fendler and Chan had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Fendler, Spertus, Chan.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Fendler, Chan.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Fendler, Kennedy.
Obtained funding: Spertus.
Study supervision: Fendler, Spertus, Chan.

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