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ORIGINAL RESEARCH

Association Between Hospital Resuscitation Champion and Survival for In-Hospital Cardiac Arrest

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BACKGROUND: Although many hospitals have resuscitation champions, it is unknown if hospitals with very active physician or nonphysician champions have higher survival rates for in-hospital cardiac arrest (IHCA).

METHODS AND RESULTS: We surveyed adult hospitals in Get With The Guidelines-Resuscitation about resuscitation practices, including about their resuscitation champion. Hospitals were categorized as having a very active physician champion, a very active nonphysician champion, or other (no champion or not very active champion). For each hospital, we calculated risk-standardized survival rates for IHCA during the period of 2016 to 2018 and categorized them into quintiles of risk-standardized survival rates. The association between a hospital's resuscitation champion type and their quintile of survival was evaluated using multivariable hierarchical proportional odds logistic regression. Overall, 192 hospitals (total of 44 477 IHCAs) comprised the study cohort. Risk-standardized survival rates for IHCA varied widely between hospitals (median: 24.7%; range: 9.2%–37.5%). Very active physician champions were present in 29 (15.1%) hospitals, 64 (33.3%) had very active nonphysician champions, and 99 (51.6%) did not have a very active champion. Compared with sites without a very active resuscitation champion, hospitals with a very active physician champion were 4 times more likely to be in a higher survival quintile, even after adjusting for resuscitation practices across hospital groups (adjusted odds ratio [OR], 3.90; 95% CI, 1.39–10.95). In contrast, there was no difference in survival between sites without very active champions and those with very active non-physician champions (adjusted OR, 1.28; 95% CI, 0.62–2.65).

CONCLUSIONS: The background and engagement level of a resuscitation champion is a critical factor in a hospital's survival outcomes for IHCA.

Key Words: cardiac arrest ■ survival ■ outcomes

See Editorial by O'Halloran et al.

In-hospital cardiac arrest is a common event in hospitals, affecting ≈300 000 patients annually in the United States.[1] Survival rates to discharge are low at 20% to 25% but vary widely between hospitals by as much as 3-fold.[2] Identifying practices at hospitals with the highest survival rates for in-hospital cardiac arrest is important so that best practices can be disseminated to improve survival rates for hospitals nationwide.[3] One proposed strategy to increase survival rates for in-hospital cardiac arrest is to have a dynamic and active resuscitation champion to oversee, manage, and improve hospital resuscitation practices.

In theory, a resuscitation champion is a dynamic and charismatic individual who is an active leader in

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For Sources of Funding and Disclosures, see page 10.

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CLINICAL PERSPECTIVE

What Is New?

- Hospitals vary widely in survival rates for in-hospital cardiac arrest. Although many hospitals have resuscitation champions, it is unknown whether the type of resuscitation champion is associated with better survival outcomes for in -hospital cardiac arrest.
- In a large national registry, we found that hospitals with a very active physician resuscitation champion had higher survival rates for in-hospital cardiac arrest and were nearly 4 times as likely to be in the top hospital quintile for cardiac arrest survival.
- In contrast, hospitals with a very active nonphysician champions did not have higher survival rates for in-hospital cardiac arrest.

What Are the Clinical Implications?

- Hospitals with a very active physician champion for resuscitation care may have better survival outcomes.
- Identifying strong physician champions and providing adequate time and resources for these champions may be a priority in resuscitation quality improvement across hospitals.

Nonstandard Abbreviations and Acronyms

GWTG Get With The Guidelines

implementing programs to improve resuscitation response and quality at their hospital. This may include introducing or improving performance of mock codes, debriefing after a cardiac arrest among resuscitation team members, and fostering better communication and team dynamics among those who respond to a cardiac arrest. An active resuscitation champion would also ensure frequent review of cardiac arrest survival outcomes and process-of-care measures (eg, time to defibrillation and time to epinephrine) to identify gaps in resuscitation care for further improvement. Although most hospitals may have a resuscitation champion, their background and engagement level are likely to differ widely. To date, no study has examined if having a very active physician or nonphysician champion is associated with higher survival rates for in-hospital cardiac arrest.

Accordingly, we conducted a survey of hospitals participating in a national registry of in-hospital cardiac arrest about their resuscitation practices. Based on responses, we categorized hospitals as having a very active physician champion, a very active nonphysician champion, or other (not very active champion or no champion) and evaluated whether having a very active champion is associated with higher hospital survival rates for in-hospital cardiac arrest. If hospitals with very active champions have higher survival rates, we examined whether this was because they were more likely to achieve timely defibrillation and epinephrine administration, perform recommended resuscitation practices (eg, mock codes, immediate debriefing after an acute resuscitation), or have mechanisms in place to clearly identify team leaders, monitor chest compression quality, or use mechanical devices during an acute resuscitation.

METHODS

The data that support the findings of this study are available from the corresponding author upon request.

Study Population

Get With The Guidelines (GWTG) - Resuscitation is a large, prospective, national quality-improvement registry of in-hospital cardiac arrest and is sponsored by the American Heart Association. Its design has been described in detail previously.[4] In brief, trained quality-improvement hospital personnel identify all patients without do-not-resuscitate orders with a cardiac arrest (defined as absence of a palpable central pulse, apnea, and unresponsiveness) who undergo cardiopulmonary resuscitation (CPR). Cases are identified by multiple methods, including centralized collection of cardiac arrest flow sheets, reviews of hospital paging system logs, and routine checks of code carts, pharmacy tracer drug records, and hospital billing charges for resuscitation medications.[4] The registry uses standardized Utstein-style definitions for all patient variables and outcomes to facilitate uniform reporting across hospitals.[5,6] In addition, data accuracy is ensured by rigorous certification of hospital staff and use of standardized software with data checks for completeness and accuracy.

Because in-hospital cardiac arrest survival has improved over the past decade,[7] we restricted our study population to the 234 hospitals within GWTG-Resuscitation that entered cases throughout the period from January 1, 2016 to December 31, 2018 (Figure 1). This study was based on hospital responses to a survey on resuscitation practices; therefore, we restricted our cohort to the 208 hospitals (88.9%) that completed this resuscitation survey (see section below entitled Measures and Data Collection). Our focus was on adult in-hospital cardiac arrest; consequently we excluded 12 pediatric hospitals, as well as pediatric cases in hospitals with both pediatric and adult patients. Finally, we excluded 4 sites with fewer than 20 cases of in-hospital cardiac arrest events during the

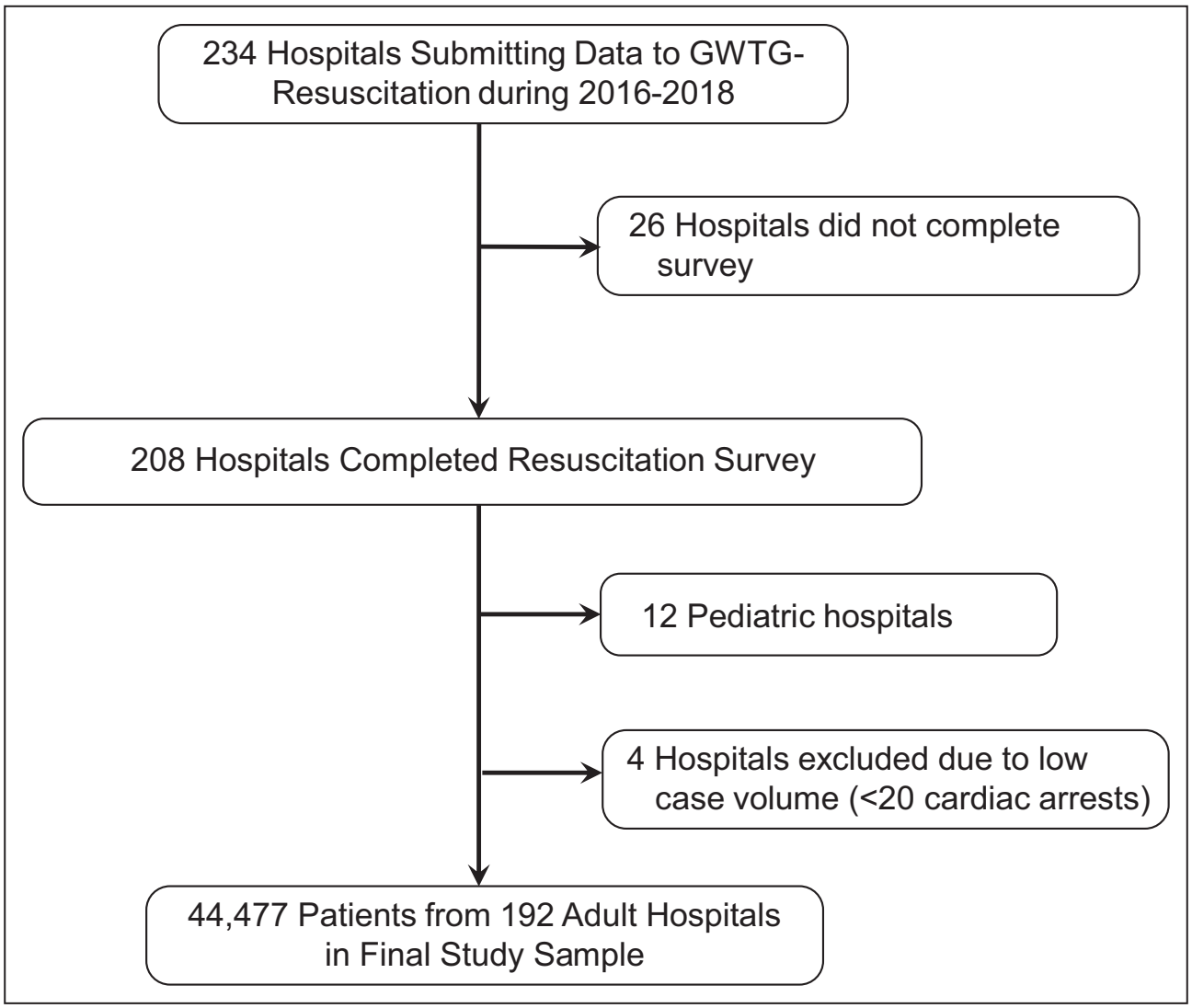

Figure 1. Definition of the study cohort.
GWTG indicates Get With The Guidelines.

study period because our analyses are on the hospital level. Our final study cohort comprised 44 477 adult patients at 192 hospitals.

Measures and Data Collection

From April to June of 2018, we conducted a detailed survey of hospital resuscitation practices among actively participating hospitals within GWTG-Resuscitation. At each site, the director of the hospital's resuscitation committee (eg, "Code Blue" committee) was asked to provide survey responses. This current survey was developed based on clinical expertise in our team, results from our prior resuscitation survey in 2014,[8] and outside experts. Resuscitation practices in this survey focused on the type of resuscitation champion at each hospital, the composition of a hospital's rapid response and resuscitation teams, the prevention and treatment of in-hospital cardiac arrest (eg, use of simulation training, intra-arrest monitoring devices of CPR quality, post-event debriefing), and hospital culture. The latter included question items about administrative leadership, quality improvement, safety, and perceived barriers at one's hospital.

Independent Variable and Study Outcomes

The independent variable for this study was the type of resuscitation champion a hospital had and was categorized based on our prior qualitative research study[9] as a very active physician champion, a very active nonphysician champion, and other (no champion or not very active champion). This was based on our survey question on a resuscitation champion's

engagement level as very active, somewhat active, or not active as a driving force in improving cardiac arrest care. These categories were defined a priori before conducting any analyses. If a hospital had both a physician and a nonphysician resuscitation champion (which was typically a nurse), that hospital would be categorized as having a physician champion. The primary study outcome was a hospital's proportion of patients with in-hospital cardiac arrest who survived to hospital discharge. The secondary outcome was the proportion of patients with favorable neurological survival, which was defined as survival to discharge with a cerebral performance category score of 1 (no to mild neurological disability) or 2 (moderate neurological disability).[10]

Statistical Analysis

Baseline differences in hospital characteristics and resuscitation practices were compared across the 3 hospital categories of resuscitation champion using chi-square statistics. The primary outcome for this study was hospital rates of survival to discharge for in-hospital cardiac arrest. For each facility, we first computed risk-standardized survival rates to discharge for in-hospital cardiac arrest using previously validated methodology.[2] Briefly, this validated model considered a total of 26 variables to predict survival to discharge after in-hospital cardiac arrest. Using multivariable hierarchical logistic regression, an initial model of 18 predictors was derived with a c-statistic of 0.738. Further model reduction yielded a final parsimonious model (c-statistic of 0.734) of 9 predictors (age; initial cardiac arrest rhythm; hospital location of arrest; hypotension, sepsis, metastatic or hematologic malignancy, and hepatic insufficiency within 24 hours of cardiac arrest; and treatment with mechanical ventilation or continuous intravenous vasopressors at the time of cardiac arrest). For this study, we re-constructed a hierarchical logistic regression model with our study cohort and confirmed that the final model comprised these 9 final predictors to predict survival to hospital discharge (c-statistic of 0.718). Using the hospital-specific random intercept estimates derived from this hierarchical model, a risk-standardized survival rate for each hospital was determined by multiplying the registry's unadjusted survival rate by the ratio of a hospital's predicted to expected survival rate.[2]

To facilitate clinical interpretability of study findings, hospitals were then divided into quintiles of risk-standardized survival rates and categorized into 3 groups to simplify reporting: top quintile, middle three quintiles, and bottom quintile. To evaluate the association between a hospital's resuscitation champion type and hospital quintile of risk-standardized survival for in-hospital cardiac arrest, we constructed a hierarchical proportional odds logistic regression model, which quantified the odds of a hospital being in the top hospital survival quintile as compared with hospitals in the middle quintiles and of being in the middle quintiles as compared with the bottom quintile. This model then adjusted for resuscitation practices that had a bivariate association ($P<0.10$) across hospital champion groups to determine if survival differences by resuscitation champion type could be explained by differences in these resuscitation practices. In this adjusted model, we also included hospital teaching status and the number of in-hospital cardiac arrest events at each hospital (categorized as <150, 150–250, or >250), regardless of their bivariate association.

Similarly, for the secondary outcome of favorable neurological survival, we computed hospital rates of risk-adjusted favorable neurological survival using multivariable hierarchical logistic regression. Because validated risk-standardization methodologies for this outcome have not been developed, this model considered for inclusion the following variables: age, sex, location of arrest (categorized as intensive care, monitored unit, non-monitored unit, emergency room, procedural/surgical area, and other), initial cardiac arrest rhythm (ventricular fibrillation, pulseless ventricular tachycardia, asystole, and pulseless electrical activity), comorbidities or medical conditions present before cardiac arrest (heart failure, myocardial infarction, or diabetes mellitus; renal, hepatic, or respiratory insufficiency; baseline evidence of motor, cognitive, or functional deficits; acute stroke; acute nonstroke neurologic disorder; pneumonia; hypotension; sepsis; major trauma; metabolic or electrolyte abnormality; and metastatic or hematologic malignancy), and interventions present at the time of cardiac arrest (mechanical ventilation, intravenous vasopressor support). As with survival to discharge, hospitals were categorized into quintiles and a hierarchical proportional odds logistic regression model assessed whether a hospital's resuscitation champion type was associated with rates of favorable neurological survival.

All study analyses were performed with SAS 9.2 (SAS Institute, Cary, NC) and R version 2.10.0.[11] The hierarchical models were fitted with the use of the GLIMMIX macro in SAS and evaluated at a 2-sided significance level of 0.05. The authors ensured the manuscript adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting in observational studies.[12] Dr. Paul Chan had full access to the data and takes responsibility for their integrity. All authors have read and agree to the article as written. The Mid America Heart Institute Institutional Review Board approved the study protocol.

RESULTS

Of 192 hospitals in the study cohort comprising 44 477 IHCAs, 29 (15.1%) had a very active physician champion, 64 (33.3%) had a very active nonphysician champion (of which 38 were critical care nurses; 20 were medical-surgical nurses; and 6 were nurse practitioners, physician assistants, or nurse anesthetists), and 99 (51.6%) did not have an active champion or had no champion. Hospitals with a very active physician champion were more likely to be major teaching hospitals, whereas hospitals with a very active nonphysician champion or without a very active champion were more likely to be nonteaching hospitals (Table 1). Compared with the other two hospital champion groups, hospitals with a very active physician champion were more likely to use a lanyard or hat to denote their code leader, report always communicating well, monitor diastolic pressures, and have designated staff members assigned to perform chest compressions during an acute resuscitation. Hospitals with a very active physician champion were also more likely to conduct code debriefings immediately following a resuscitation event and to not cite direct feedback as a barrier to resuscitation care. Notably there were no differences in the three hospital champion groups in the number of in-hospital cardiac arrest events, credentials of who typically led their acute resuscitations, use of devices to measure chest compression quality, use of mechanical devices for delivering CPR, use of an individual to monitor CPR quality during an acute resuscitation, allowing nurses to deploy a manual defibrillator without a physician, and frequency of resuscitation simulations.

Hospital processes of care during acute resuscitations did not differ between the 3 resuscitation champion hospital groups. Rate of prompt defibrillation within the first 2 minutes of a shockable cardiac arrest rhythm of ventricular fibrillation or pulseless ventricular tachycardia were similar, with a hospital mean rate of 74% to 75% in each group. Similarly, rates of prompt epinephrine administration within the first 5 minutes of a nonshockable cardiac arrest rhythm of asystole or pulseless electrical activity were not different between the 3 hospital champion groups (Table 2).

Overall, risk-standardized survival rates to discharge for in-hospital cardiac arrest varied widely across study hospitals (median: 24.7%; range: 9.2%–37.5%) (Figure 2). Hospitals with a very active physician champion had a mean risk-standardized survival rate to discharge of 29.5±4.3%, whereas rates were lower at 26.7±5.3% in hospitals with a very active nonphysician champion and 26.3±5.2% in hospitals without very active champions (P=0.01). Hospitals with a very active physician champion also had higher rates of favorable neurological survival than the other 2 hospital champion groups (Table 3).

Compared with hospitals without a very active resuscitation champion, hospitals with a very active physician champion were more than 4 times as likely to be in the top quintile of risk-standardized survival (odds ratio [OR], 4.39; 95% CI, 1.89–10.23; P<0.001). Hospitals with a very active nonphysician champion, however, were not more likely to be in a higher quintile of survival than hospitals without a very active champion (Table 4). After adjusting for differences in resuscitation practices across the 3 hospital champion groups, hospitals with a very active physician champion were still almost 4 times as likely to be in the top survival quintile as compared with hospitals without a very active champion (adjusted OR, 3.90; 95% CI, 1.39– 10.95; P=0.01). Similarly, hospitals with a very active physician champion were almost 4 times as likely to be in the top quintile of favorable neurological survival as compared with hospitals without a very active champion (OR, 3.91; 95% CI, 1.69–9.04; P=0.001). These differences in rates of favorable neurological survival were only modestly attenuated after adjusting for differences in resuscitation practices between the hospital groups (adjusted OR, 3.11; 95% CI, 1.08–8.90; P=0.036) (see Table 4).

DISCUSSION

Using data from acute care hospitals in the United States that were participating in a national registry, we found that approximately half of hospitals did not have a very active resuscitation champion, whereas 15% of hospitals had a very active physician resuscitation champion, and 33% had a very active nonphysician champion. Compared with hospitals without a very active resuscitation champion, hospitals with a very active physician champion had higher rates of risk-standardized survival for in-hospital cardiac arrest and were 4 times as likely to be in the top hospital quintile of cardiac arrest survival. In contrast, there were no differences in survival between hospitals with a very active nonphysician champion and those without a very active resuscitation champion. A similar pattern was seen across the 3 hospital groups for the outcome of survival with favorable neurological status. Collectively, our study provides important insights into which type of resuscitation champion at a hospital is associated with higher survival rates for in-hospital cardiac arrest.

To date, few studies have evaluated resuscitation practices across hospitals, as such studies require site- and patient-level data from many hospitals in a large registry. In a recent survey of GWTG-Resuscitation hospitals, we conducted one of the first

Table 1. Characteristics of Study Hospitals, Stratified by Resuscitation Champion Type at Hospitals

	Very Active MD Champion (n=29)	Very Active Non-MD Champion (n=64)	No Champion or Not Active Champion (n=99)	*P* Value
Hospital academic status				
Major teaching	14 (56.0%)	16 (28.1%)	21 (26.9%)	
Minor teaching	7 (28.0%)	18 (31.6%)	20 (25.6%)	
Nonteaching	4 (16.0%)	23 (40.4%)	37 (47.4%)	
Missing	4	7	21	0.03
US census region				
Northeast and Mid-Atlantic	3 (12.0%)	6 (10.5%)	16 (20.3%)	
South Atlantic	3 (12.0%)	18 (31.6%)	21 (26.6%)	
North Central	6 (24.0%)	13 (22.8%)	19 (24.1%)	
South Central	5 (20.0%)	10 (17.5%)	12 (15.2%)	
Mountain/Pacific	8 (32.0%)	10 (17.5%)	11 (13.9%)	
Missing	4	7	20	0.38
No. IHCA events				
<150	9 (31.0%)	22 (34.4%)	36 (36.4%)	0.54
150–250	5 (17.2%)	10 (15.6%)	24 (24.2%)	
>250	15 (51.7%)	32 (50.0%)	39 (39.4%)	
Code leader uses lanyards or hat				
Yes	10 (34.5%)	12 (18.8%)	8 (8.1%)	
No	19 (65.5%)	52 (81.3%)	91 (91.9%)	0.002
Who typically leads codes				
Attending-level physicians	15 (51.7%)	42 (65.6%)	63 (63.6%)	
Critical care nurses	0 (0.0%)	4 (6.3%)	7 (7.1%)	
Nurse-practitioner or nurse	0 (0.0%)	0 (0.0%)	1 (1.0%)	
Physician trainees—residents	10 (34.5%)	13 (20.3%)	22 (22.2%)	
Physician trainees—fellows	4 (13.8%)	3 (4.7%)	6 (6.1%)	
Other	0 (0.0%)	2 (3.1%)	0 (0.0%)	0.39
Code team members communicate well during resuscitations				
Always (80%–100%)	13 (44.8%)	18 (28.1%)	21 (21.2%)	
Most of the time (60%–80%)	8 (27.6%)	41 (64.1%)	58 (58.6%)	
About half the time (40%–60%)	6 (20.7%)	5 (7.8%)	16 (16.2%)	
Sometimes (20%–40%)	2 (6.9%)	0 (0.0%)	4 (4.0%)	0.005
Code team members comfortable making their voices during resuscitations				
Always (80%–100%)	8 (27.6%)	19 (29.7%)	30 (30.3%)	
Most of the time (60%–80%)	13 (44.8%)	37 (57.8%)	51 (51.5%)	
About half the time (40%–60%)	8 (27.6%)	6 (9.4%)	10 (10.1%)	
Sometimes (20%–40%)	0 (0.0%)	1 (1.6%)	7 (7.1%)	
Never or rarely (0%–20%)	0 (0.0%)	1 (1.6%)	1 (1.0%)	0.22
Devices used to assist in resuscitation				
CPR process measure device	11 (37.9%)	18 (28.1%)	24 (24.2%)	0.35
Capnography	18 (62.1%)	45 (70.3%)	54 (54.5%)	0.13
Mechanical CPR device	4 (13.8%)	3 (4.7%)	8 (8.1%)	0.34
Monitoring of diastolic pressures	7 (24.1%)	8 (12.5%)	7 (7.1%)	0.046
Number of devices routinely used				
1	15 (51.7%)	31 (48.4%)	63 (63.6%)	
2	9 (31.0%)	28 (43.8%)	29 (29.3%)	
3	5 (17.2%)	5 (7.8%)	7 (7.1%)	0.15

(*Continued*)

Table 1. Continued

	Very Active MD Champion (n=29)	Very Active Non-MD Champion (n=64)	No Champion or Not Active Champion (n=99)	*P* Value
Staff member usually assigned performing chest compressions				
No staff member usually assigned	13 (44.8%)	37 (57.8%)	55 (55.6%)	
Critical care nurses	1 (3.4%)	3 (4.7%)	7 (7.1%)	
Medical-surgical floor nurses	1 (3.4%)	9 (14.1%)	12 (12.1%)	
Physician trainees	3 (10.3%)	4 (6.3%)	4 (4.0%)	
Nursing student or paramedic	1 (3.4%)	0 (0.0%)	1 (1.0%)	
Respiratory therapist	6 (20.7%)	7 (10.9%)	6 (6.1%)	
Clinical technician	2 (6.9%)	3 (4.7%)	14 (14.1%)	
Other	2 (6.9%)	1 (1.6%)	0 (0.0%)	0.04
An individual outside of leader monitors CPR quality				
Yes	7 (24.1%)	18 (28.1%)	15 (15.2%)	
No	22 (75.9%)	46 (71.9%)	84 (84.8%)	0.12
Code debriefing performed immediately				
Always or almost always (80%–100%)	5 (17.2%)	6 (9.4%)	16 (16.2%)	
Frequently (60%–80%)	7 (24.1%)	15 (23.4%)	9 (9.1%)	
Occasionally (20%–60%)	6 (20.7%)	21 (32.8%)	24 (24.2%)	
Rarely (1%–20%)	11 (37.9%)	17 (26.6%)	34 (34.3%)	
Never (0%)	0 (0.0%)	5 (7.8%)	16 (16.2%)	0.03
Nursing staff can use manual defibrillator	5 (17.2%)	14 (21.9%)	29 (29.3%)	0.33
Mock codes				
Yes	25 (86.2%)	56 (87.5%)	85 (85.9%)	
No	4 (13.8%)	8 (12.5%)	14 (14.1%)	0.96
Frequency of mock codes				
Not done	4 (13.8%)	8 (12.5%)	14 (14.1%)	0.34
Less than once quarterly	13 (44.8%)	38 (59.4%)	63 (63.6%)	
At least quarterly	12 (41.4%)	18 (28.1%)	22 (22.2%)	
Barriers to resuscitation care				
Lack of direct feedback				
Yes	12 (41.4%)	24 (37.5%)	63 (63.6%)	
No	17 (58.6%)	40 (62.5%)	36 (36.4%)	0.002
Inadequate training				
Yes	5 (17.2%)	12 (18.8%)	28 (28.3%)	
No	24 (82.8%)	52 (81.3%)	71 (71.7%)	0.26
Lack of support from administration				
Yes	3 (10.3%)	5 (7.9%)	17 (17.3%)	
No	26 (89.7%)	58 (92.1%)	81 (82.7%)	
Missing	0	1	1	0.23
Lack of financial resources				
Yes	10 (34.5%)	13 (20.6%)	25 (25.3%)	
No	19 (65.5%)	50 (79.4%)	74 (74.7%)	
Missing	0	1	0	0.36
Are cardiac arrest data routinely reviewed				
Yes	29 (100.0%)	61 (95.3%)	88 (88.9%)	
No	0 (0.0%)	3 (4.7%)	11 (11.1%)	0.09
Rank the purpose of routine cardiac arrest data review				
Review IHCA metrics				
Strongly agree	25 (86.2%)	49 (76.6%)	63 (63.6%)	
Somewhat agree	4 (13.8%)	10 (15.6%)	20 (20.2%)	

(Continued)

Table 1. Continued

	Very Active MD Champion (n=29)	Very Active Non-MD Champion (n=64)	No Champion or Not Active Champion (n=99)	*P* Value
Neither agree nor disagree	0 (0.0%)	2 (3.1%)	3 (3.0%)	
Strongly disagree	0 (0.0%)	0 (0.0%)	3 (3.0%)	
No routine data review	0 (0.0%)	3 (4.7%)	10 (10.1%)	0.34
Identify areas for improvement				
Strongly agree	23 (79.3%)	48 (75.0%)	55 (55.6%)	
Somewhat agree	5 (17.2%)	11 (17.2%)	22 (22.2%)	
Neither agree nor disagree	1 (3.4%)	2 (3.1%)	6 (6.1%)	
Somewhat disagree	0 (0.0%)	0 (0.0%)	3 (3.0%)	
Strongly disagree	0 (0.0%)	0 (0.0%)	3 (3.0%)	
No routine data review	0 (0.0%)	3 (4.7%)	10 (10.1%)	0.25
Identify errors in resuscitation Care				
Strongly agree	20 (69.0%)	43 (67.2%)	42 (42.4%)	
Somewhat agree	7 (24.1%)	14 (21.9%)	26 (26.3%)	
Neither agree nor disagree	1 (3.4%)	2 (3.1%)	11 (11.1%)	
Somewhat disagree	1 (3.4%)	1 (1.6%)	6 (6.1%)	
Strongly disagree	0 (0.0%)	1 (1.6%)	4 (4.0%)	
No routine data review	0 (0.0%)	3 (4.7%)	10 (10.1%)	0.059
Track success of QI initiative				
Strongly agree	20 (69.0%)	41 (64.1%)	46 (46.9%)	
Somewhat agree	5 (17.2%)	15 (23.4%)	20 (20.4%)	
Neither agree nor disagree	3 (10.3%)	5 (7.8%)	16 (16.3%)	
Somewhat disagree	1 (3.4%)	0 (0.0%)	3 (3.1%)	
Strongly disagree	0 (0.0%)	0 (0.0%)	3 (3.1%)	
No routine data review	0 (0.0%)	3 (4.7%)	10 (10.2%)	
Missing	0	0	1	0.14

IHCA indicates in-hospital cardiac arrest; MD, physician; and QI, quality improvement.

such studies and identified several key hospital practices associated with higher survival for in-hospital cardiac arrest. These included frequent review of cardiac arrest data to identify gaps in care and implement quality improvement programs, adequate resuscitation education for hospital staff, and monitoring for interruptions in chest compressions during CPR.[8] In our subsequent qualitative study in which we interviewed multiple stakeholders in resuscitation care at hospitals that were either top or bottom performers for in-hospital cardiac arrest survival, we found that a dynamic and active resuscitation champion was a critical attribute for top-performing sites to achieve high rates of cardiac arrest survival.[9] A recurrent theme from these site interviews was that a very active resuscitation champion helped hospital staff prioritize cardiac arrest outcomes as a measure of hospital quality and a cornerstone of patient safety. Moreover, the presence of a very active resuscitation champion was often a sign of support

Table 2. Mean Hospital Rates for Prompt Defibrillation and Epinephrine Administration by Hospital Resuscitation Champion Type

Process of Care Measure	Very Active MD Champion	Very Active Non-MD Champion	No Champion or Not Active Champion	*P* Value
Prompt defibrillation ≤2 minutes				0.98
Mean±SD	74.5±6.9%	74.4±6.4%	74.3±5.9%	
Median (IQR)	74.4% (70.4%, 79.1%)	75.2% (70.4%, 79.1%)	74.6% (70.6%, 78.4%)	
Prompt epinephrine ≤5 minutes				0.62
Mean±SD	92.4±1.9%	92.4±2.0%	92.1±2.5%	
Median (IQR)	92.7% (91.7%, 93.3%)	92.6% (91.2%, 93.7%)	92.2% (90.7%, 93.8%)	

IQR indicates interquartile range; MD, physician; and SD, standard deviation.

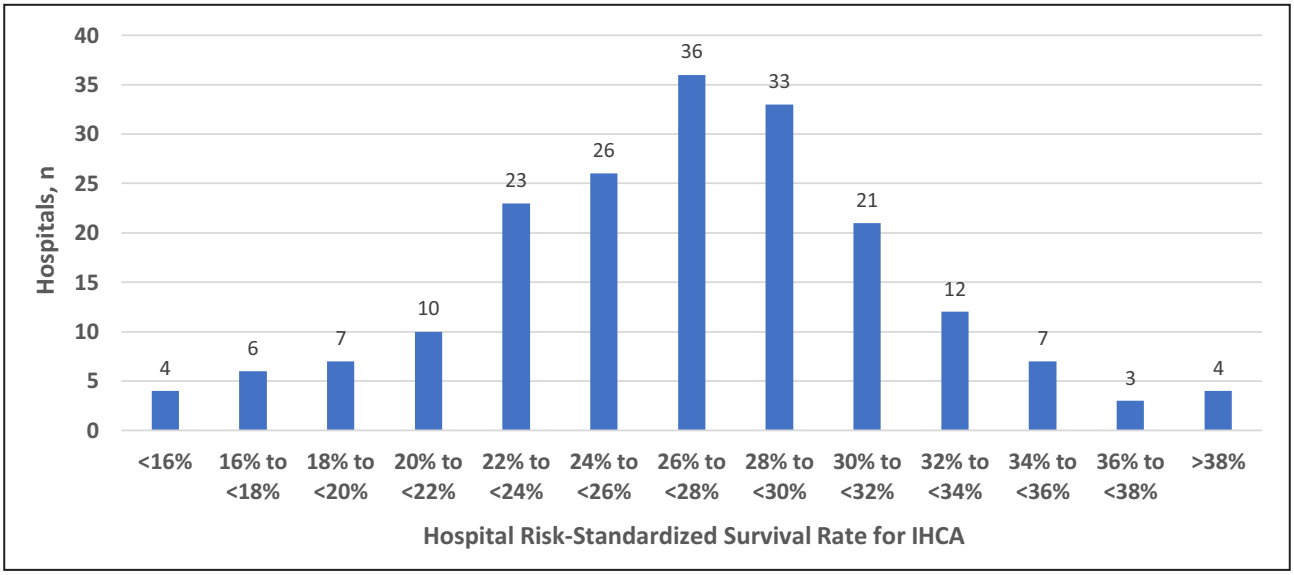

Figure 2. Distribution of risk-standardized survival rates for in-hospital cardiac arrest among study hospitals.
IHCA indicates in-hospital cardiac arrest.

from a hospital's administration to commit resources for their time and quality improvement initiatives. However, the results from our qualitative study required validation because they were based on site visits at only 9 hospitals.

This study extends the findings from our recent qualitative work and found that hospitals were indeed more likely to excel in in-hospital cardiac arrest survival only if they had a very active physician resuscitation champion. Higher survival rates for in-hospital cardiac arrest at hospitals with a very active physician champion were not explained by better compliance with processes-of-care measures such as prompt defibrillation and epinephrine, and were only modestly explained by resuscitation practices such as lanyards or hats to denote code team leaders during an acute resuscitation, frequency of resuscitation simulations, use of devices to monitor or deliver high-quality CPR, and immediate debriefing after resuscitation events. This suggests that the higher survival rates at sites with a very active physician champion are likely mediated by other quality measures (eg, improved post-resuscitation care in the intensive care unit and delivery of more consistent and effective chest compressions during an acute resuscitation) and leadership activities (eg, building a culture of teamwork and communication during acute resuscitations) not captured in our study survey. Identification of what these other programs or activities are warrants further study in order to disseminate best practices in resuscitation care.

Contrary to our expectations, hospitals with a very active nonphysician champion did not have higher survival rates for in-hospital cardiac arrest than hospitals without a very active champion. The reasons for this were not explicitly captured in our survey. We do know from our prior qualitative study that hospitals with a very active physician champion frequently also had a very active nonphysician (typically nursing) champion, suggesting that they were successful because these hospitals had leaders in both their medical and nursing staff. Moreover, our prior qualitative interviews

Table 3. Mean Hospital Rates for Survival Outcomes by Hospital Resuscitation Champion Type

Survival Outcomes	Very Active MD Champion	Very Active Non-MD Champion	No Champion or Not Active Champion	*P* Value
Risk standardized rate of survival to discharge				0.01
Mean±SD	29.5±4.3%	26.7±5.3%	26.3±5.2%	
Median (IQR)	29.7% (26.6%, 32.5%)	27.4% (23.6%, 29.7%)	26.5% (23.0%, 29.6%)	
Risk-adjusted rate of favorable neurological survival				
Mean±SD	26.7±5.7%	22.5±7.0%	22.3±7.2%	0.009
Median (IQR)	24.4% (21.8%, 31.7%)	23.2% (18.5%, 26.6%)	22.5% (17.7%, 26.5%)	

IQR indicates interquartile range; MD, physician; and SD, standard deviation.

Table 4. Unadjusted and Adjusted Associations Between Hospital Resuscitation Champion Type and Survival Outcomes for In-Hospital Cardiac Arrest

	Hospital Resuscitation Champion Type				
	Not Active Champion	Very Active MD Champion		Very Active Non-MD Champion	
		OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Risk-standardized survival to discharge*					
Unadjusted for hospital practices	Reference	4.39 (1.89, 10.23)	<0.001	1.30 (0.69, 2.45)	0.45
Adjusted for hospital practices	Reference	3.90 (1.39, 10.95)	0.01	1.28 (0.62, 2.65)	0.51
Risk-adjusted favorable neurological survival*					
Unadjusted for hospital practices	Reference	3.91 (1.69, 9.04)	0.001	0.96 (0.51, 1.80)	0.90
Adjusted for hospital practices	Reference	3.11 (1.08, 8.90)	0.036	0.83 (0.39, 1.74)	0.62

Hospitals without a very active resuscitation champion were the reference group for these comparisons. MD indicates physician; and OR indicates odds ratio.
*Both outcomes are adjusted for differences in patient case-mix severity across hospitals (see Methods for variables used for risk-standardized survival rate to discharge and risk-adjusted favorable neurological discharge). Adjusted models included as covariates hospital teaching status, in-hospital cardiac arrest volume (<100, 100–250, >250), and resuscitation practices that had a bivariate association (*P*<0.10) across hospital champion groups.

suggested that a physician champion typically wielded more clout in enacting quality improvement initiatives and obtaining support from hospital administration. These explanations may help explain why hospitals with and without a very active physician champion had different survival outcomes. Alternatively, unmeasured confounding may help explain why hospitals with a very active nonphysician champion did not have better survival outcomes. Hospitals with a very active nonphysician champion may not have had as much administrative support or dedicated resources (time, staff, and money) for quality improvement efforts as compared with those with a very active physician champion, which could explain the former's lack of effect on hospital survival rates for in-hospital cardiac arrest. These factors were not measured in our survey and deserve further study.

Our study should be interpreted in the context of the following limitations. First, the survey data were reported by a single respondent in collaboration with other staff at the hospital, and the reported policies and practices were not independently confirmed. However, survey respondents were typically the director of each hospital's Code Blue committee and were therefore among the most knowledgeable individuals to evaluate their institution's resuscitations practices. Moreover, inaccurate responses would be expected to be nondifferential and bias findings toward the null, thereby reinforcing the validity of our positive associations. Second, our study population was limited to hospitals participating in GWTG-Resuscitation and our findings may not apply to nonparticipating hospitals. Specifically, the prevalence of some resuscitation strategies may be lower in nonparticipating hospitals and the prevalence of perceived resuscitation barriers may be higher, although GWTG-Resuscitation does represent a diverse set of US hospitals. Finally, although we found that hospitals with a very active physician champion generally achieved higher rates of in-hospital cardiac arrest survival, we could only explain part of this survival difference. Therefore, the specific programs and initiatives that underlie the higher survival rates for in-hospital cardiac arrest at hospitals with a very active physician champion remain poorly defined and deserve further study.

In conclusion, although many hospitals have a resuscitation champion, the background and engagement level of a resuscitation champion is a critical factor in a hospital's survival outcomes for in-hospital cardiac arrest. Using survey information from acute care hospitals participating in a national quality improvement registry, we found that fewer than half of hospitals reported having a very active physician or nonphysician resuscitation champion. Hospitals with a very active physician resuscitation champion were 4 times more likely to be in the top quintile of in-hospital cardiac arrest survival, whereas there was no difference between hospitals with a very active nonphysician champion and those without a very active champion.

ARTICLE INFORMATION

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Disclosures

None.

Supplementary Material

Appendix S1

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SUPPLEMENTAL MATERIAL

APPENDIX

American Heart Association's Get With the Guidelines®-Resuscitation Investigators from the Adult Research Task Force members

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