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Association Between Hospital Resuscitation Team Leader Credentials and Survival Outcomes for In-hospital Cardiac Arrest

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Abstract

Objective: To assess whether survival rates for in-hospital cardiac arrest (IHCA) vary across hospitals depending on whether resuscitations are typically led by an attending physician, a physician trainee, or a nonphysician.

Patients and Methods: In 2018, we conducted a survey of hospitals participating in the national Get with the Guidelines — Resuscitation registry for IHCA. Using responses from the question "Who typically leads codes at your institution?" we categorized hospitals on the basis of who typically leads their resuscitations: attending physician, physician trainee, or nonphysician. We then compared risk-adjusted hospital rates of return of spontaneous circulation, survival to discharge, and favorable neurological survival from 2015 to 2017 between these 3 hospital groups by using multivariable hierarchical regression.

Results: Overall, 193 hospitals completed the study survey, representing a total of 44,477 IHCAs (mean age, 65.0±15.5 years; 40.8% were women). Most hospitals had resuscitations led by physicians, with 121 (62.7%) led by an attending physician, 58 (30.0%) by a physician trainee, and 14 (7.3%) by a nonphysician. The risk-standardized rates of survival to discharge were similar across hospitals, regardless of whether resuscitations were typically led by an attending physician, a physician trainee, or a nonphysician (25.6%±4.8%, 25.9%±4.7%, and 25.7%±3.6%, respectively; P=.88). Similarly, there were no differences between the 3 groups in risk-adjusted rates of return of spontaneous circulation (71.7%±6.3%, 73%±6.3%, and 73.4%±6.4%; P=.30) and favorable neurological survival (21.6%±7.1%, 22.7%±6.1%, and 20.9%±6.5%; P=.50).

Conclusion: In hospitals in a national IHCA registry, IHCA resuscitations were usually led by physicians. However, there was no association between a hospital's typical resuscitation team leader credentials and IHCA survival outcomes.

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Survival rates for in-hospital cardiac arrest (IHCA) are low at 20% to 25%, although considerable site-level variation (11%-35%) exists.[1,2] To improve survival and reduce variability, health systems have made investments to improve resuscitation quality.[3] One such quality improvement effort entails the refinement of resuscitation team structure with a primary focus on effective communication and leadership.[4] A competent leader is one who is able to initiate team structure in a timely manner, communicate effectively with team members, and make time-sensitive decisions, which are all traits that are associated with improved team performance and outcomes.[5] Given the well-established importance of effective leadership within resuscitation teams, hospitals seeking to improve resuscitation care might believe that designating a team leader with more professional credentials will lead to higher survival rates in resuscitation care. But the type of professional who typically leads the resuscitation team and their effect on survival

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outcomes is unknown and is an important gap in knowledge to define in order to optimize the design of high-quality resuscitation teams.

The 2010 guidelines from the American Heart Association recommends the inclusion of leadership training in the Advanced Cardiac Life Support (ACLS) training module but does not provide information on the most appropriate type of resuscitation team leader.[6] Despite this training, multiple human factors, including an individual's level of clinical practice or experience, may influence adherence to ACLS guidelines and affect survival outcomes.[7,8] Nonetheless, many training hospitals view leading resuscitations as central to the education of physician trainees. These trainees are ACLS trained but may have limited real-world experience in leading resuscitations and may feel underprepared.[9] At other hospitals, resuscitation teams may be led by experienced nurses in resuscitation care.[10] Recently, a qualitative study highlighted the importance of an effective resuscitation team leader in hospitals with high rates of survival for IHCA but had no information on the effect of the leader's credentials on survival outcomes.[4] With the extensive role that physician trainees may play as resuscitation team leaders in many US hospitals, there is an urgent need to understand the association between a hospital's typical resuscitation team leader (attending physician vs physician trainee vs nonphysician) and its survival outcomes for IHCA.

Accordingly, we conducted a nationwide survey of hospitals participating in the Get with the Guidelines — Resuscitation (GWTG-R) registry to identify the typical resuscitation team leader (ie, attending physician, physician trainee, and nonphysician) at each site and compared survival outcomes across hospital groups on the basis of type of leader.

PATIENTS AND METHODS

Get with the Guidelines — Resuscitation is a national quality improvement registry that collects data from participating hospitals on patients without a do-not-resuscitate order and who had *IHCA*, defined as the absence of a palpable central pulse, apnea, and unresponsiveness, and undergo cardiopulmonary resuscitation. Eligible patients are identified through various methods including review of hospital-wide cardiac arrest flow sheets, paging system logs, code carts, and pharmacy tracer drug records. To maintain uniformity and ensure completeness, a standardized Utstein style definition for all patient variables and outcomes is used, and data are entered into a standardized software (IQVIA) with intermittent data checks at all participating sites. IQVIA is the data collection coordination center for the American Heart Association/American Stroke Association's Get with the Guidelines programs.

In April 2018, we conducted a nationwide survey to elicit information on resuscitation practices at hospitals participating in GWTG-R. The survey was generally completed by either the hospital's director of the Code Blue Committee or their identified resuscitation champion. The survey comprised 62 questions with multiple choice answers and was developed by a team of quantitative and qualitative researchers and leadership from GWTG-R. Questions regarding IHCA prevention, treatment, and review were asked. Most importantly, details pertaining to resuscitation team structure including each hospital's typical resuscitation team leader were elicited.

For this study, we restricted our study cohort to the 234 hospitals that were actively submitting data to GWTG-R during the time of the survey. A total of 208 hospitals completed the survey, leading to a survey response rate of 88%. Of these, we excluded 12 pediatric-only hospitals and 3 hospitals with fewer than 20 IHCA cases between 2015 and 2017. Our final cohort included 193 hospitals with 44,477 patients with IHCA.

Independent Variable and Outcome Measures

We categorized hospitals on the basis of their response to the survey question "When all code team members are present, who typically leads codes at your institution?" Hospitals were then assigned to 1 of 3 groups on the basis of their typical resuscitation team leader's credentials: attending physicians, physician trainees, or nonphysicians. *Physician trainees* were defined as any physicians in residency or subspecialty fellowship training. Nonphysicians included critical care nurses, medical-surgical floor nurses, nurse practitioners, physician assistants, and certified registered nurse

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anesthetists. Our primary outcome of interest was a hospital's risk-standardized survival rate (RSSR) for their patients with IHCA, which quantifies the proportion who survive to hospital discharge. Additionally, we evaluated as secondary outcomes a hospital's rate of return of spontaneous circulation (ROSC) for patients with IHCA as well as its rate of favorable neurological survival (survival to discharge with a cerebral performance category score of 1 or 2, denoting no more than moderate neurological disability).[11]

Statistical Analyses

Given that our grouping variable is based on each hospital's typical type of resuscitation team leader (attending physicians vs physician trainee vs nonphysicians), this study involved a hospital-level analysis. Hospital- and patient-level characteristics for the 3 groups were compared using analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables.

To determine whether rates of survival to discharge for IHCA differed by a hospital's typical resuscitation team leader, we first computed each hospital's RSSR to adjust for differences in patient illness severity and cardiac arrest characteristics across sites. Thus, the RSSR ensures that comparisons of hospital rates of IHCA survival reflect patients of similar case mix. To accomplish this, we applied previously validated models for calculating the RSSR.[12] Briefly, a multivariable hierarchical logistic regression model was constructed in which the 9 predictor variables from the validated risk-standardization approach were modeled as fixed effects and hospitals were modeled as random effects. Using the hospital-specific estimates (ie, random intercepts) from the hierarchical model, RSSRs for each hospital were calculated by multiplying the registry's unadjusted survival rate by the ratio of a hospital's predicted to expected survival rate. We then compared the RSSRs for hospitals whose resuscitations are typically led by attending physicians, physician trainees, and nonphysicians by using ANOVA.

To compare hospital rates of ROSC and favorable neurological survival, we computed risk-adjusted rates of both outcomes for each hospital by using multivariable hierarchical logistic regression. For these 2 outcomes, as validated risk-standardization methodologies have not been developed, we constructed multivariable models in which various patient variables were considered. These variables included age, sex, location of arrest (categorized as intensive care, monitored unit, nonmonitored unit, emergency department, procedural/surgical area, and other), and initial cardiac arrest rhythm (ventricular fibrillation, pulseless ventricular tachycardia, asystole, and pulseless electrical activity). In addition, the following comorbidities or medical conditions present before cardiac arrest were evaluated for the model: heart failure, myocardial infarction, or diabetes mellitus; renal, hepatic, or respiratory insufficiency; baseline evidence of motor, cognitive, or functional deficits (central nervous system depression); acute stroke; acute nonstroke neurological disorder; pneumonia; hypotension; sepsis; major trauma; metabolic or electrolyte abnormality; and malignant neoplasm. Also considered for model inclusion were several critical care interventions (mechanical ventilation, intravenous vasopressor support, pulmonary artery catheter, intra-aortic balloon pump, or dialysis) already in place at the time of cardiac arrest. We then examined whether risk-adjusted hospital rates of ROSC and favorable neurological survival differed when resuscitations are typically led by attending physicians, physician trainees, and nonphysicians by using ANOVA. Finally, we assessed for interactions between a hospital's typical resuscitation leader and hospital size (number of beds) and US census region for all 3 study outcomes by using multivariable linear regression. Based on the number of hospitals with resuscitations typically led by attending physicians vs physician-trainees, our study had 80% power to detect, at a significance level of .05, a 2.1%, 2.6%, and 2.9% difference in hospital rates of survival to discharge, ROSC, and favorable neurological discharge between these 2 hospital types.

Given that the GWTG-R registry is a quality improvement registry, informed consent from patients was not required. All data available for analysis were de-identified. The institutional review board at Saint Luke's Mid America Heart waived the requirement for informed consent and approved the study.

All analyses were performed with SAS version 9.4 (SAS Institute Inc) and were evaluated using a 2-sided significance level of .05.

RESULTS

Of 193 hospitals in the study cohort, 121 hospitals (62.7%) had resuscitations led by attending physicians whereas 58 (30.0%) had resuscitations led by physician trainees and 14 (7.3%) by nonphysicians, of which 10 (71.4%) were by critical care nurses. Hospital characteristics varied across the 3 groups (Table 1). Hospitals whose resuscitations were typically led by physician trainees tended to be large academic hospitals with more than 500 beds, whereas those with resuscitations led by attending physicians or nonphysicians were typically medium (200-499 beds) or small (<200 beds) hospitals. Hospitals also differed geographically across the resuscitation leader group.

Patient characteristics, stratified by a hospital's typical resuscitation team leader, are summarized in Table 2. The mean patient age was 65.0±15.5 years; 18161 (40.8%) were women; and 30310 (68.2%) were White. There were no differences in the rates of nonshockable vs shockable cardiac arrest rhythms across the 3 groups. There were small to moderate differences in the rates of most comorbidities across the 3 hospital groups. In general, where there were significant differences, patients with IHCA at hospitals with resuscitations led by physician trainees were sicker than those at hospitals with resuscitations led by attending physicians or nonphysicians.

Overall, the median hospital RSSR across the study cohort was 25.8% (interquartile range, 23.1%-28.2%; range, 13.3%-42.7%). After adjusting for differences in patient case mix, there was no difference in the primary outcome of RSSR when evaluated by a hospital's typical team leader: mean hospital rate: attending physicians, 25.6%±4.8%; physician trainees, 25.9%±4.7%, nonphysicians, 25.7%±3.6% (P=.88). When examining secondary outcomes, the median hospital risk-adjusted rate of ROSC across the study cohort was 71.8% (interquartile range, 68.5%-77.1%; range, 41.4%-86.0%). There also was no significant difference in the mean hospital rates of ROSC by hospital

TABLE 1. Baseline Characteristics of Hospitals Categorized by Its Type of Typical Resuscitation Team Leader

Characteristic	Total (N=193)	Attending physician (n=121)	Physician trainee (n=58)	Nonphysician (n=14)	*P* value
Beds					
<200	38 (19.7)	30 (24.8)	5 (8.6)	3 (21.4)	<.001
200-499	77 (39.9)	54 (44.6)	15 (25.9)	8 (57.1)	
≥500	46 (23.8)	16 (13.2)	29 (50.0)	1 (7.1)	
Missing	32 (16.6)	21 (17.4)	9 (15.5)	2 (14.3)	
Geographic location					
North Mid-Atlantic	25 (12.9)	8 (6.6)	17 (29.3)	0 (0)	
South Atlantic	42 (21.8)	30 (24.8)	7 (12.1)	5 (35.7)	<.001
North Central	38 (19.7)	24 (19.8)	11 (18.9)	3 (21.4)	
South Central	28 (14.5)	14 (11.6)	11 (18.9)	3 (21.4)	
Mountain Pacific	29 (15.0)	25 (20.7)	3 (5.2)	1 (7.1)	
Missing	31 (16.1)	20 (16.5)	9 (15.5)	2 (14.3)	
Academic status					
Major teaching	51 (26.4)	13 (10.7)	37 (63.8)	1 (7.4)	
Minor teaching	46 (23.9)	35 (28.9)	12 (20.7)	5 (35.7)	<.001
Nonteaching	64 (33.2)	52 (42.9)	0 (0)	6 (42.9)	
Missing	32 (16.6)	21 (17.4)	9 (15.5)	2 (14.3)	

Data are presented as No. (percentage).

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TABLE 2. Baseline Characteristics of Patients by Hospital's Typical Resuscitation Team Leader[a,b]

Characteristic	Total (N=44,477)	Attending physician (n=23,114)	Physician trainee (n=18,781)	Nonphysician (n=2582)	*P* value
Demographic characteristics					
Age (y)	65.0±15.5	65.9±15.1	63.7±16.0	67.0±14.2	<.001
Female sex	18,161 (40.8)	9551 (41.3)	7503 (40.05)	1107 (42.9)	.001
White race	30,310 (68.2)	15,562 (67.4)	12,715 (67.8)	2033 (78.8)	<.001
Rhythm type					
Shockable	7760 (17.4)	4052 (17.5)	3258 (17.3)	450 (17.4)	.88
Nonshockable	36,717 (82.6)	19,062 (82.5)	15,523 (82.7)	2132 (82.6)	.88
Comorbidities					
Heart failure current admission	6440 (14.5)	3027 (13.1)	3075 (16.4)	338 (13.1)	<.001
MI/ischemia current admission	6404 (14.4)	3365 (14.6)	2636 (14.0)	403 (15.6)	.06
Respiratory insufficiency	20,908 (47.0)	10,066 (43.5)	9660 (51.4)	1182 (45.8)	<.001
Renal insufficiency	16,085 (36.2)	8137 (35.2)	7086 (37.7)	862 (33.4)	<.001
Hepatic insufficiency	3772 (8.5)	1644 (7.1)	1930 (10.3)	198 (7.7)	<.001
Metabolic/electrolyte abnormality	11,117 (25.0)	5139 (22.2)	5537 (29.5)	441 (17.1)	<.001
Diabetes mellitus	15,411 (34.6)	8018 (34.7)	6420 (34.2)	973 (37.7)	.002
Acute stroke	1854 (4.2)	882 (3.8)	896 (4.8)	76 (2.9)	<.001
Pneumonia	6240 (14.0)	3207 (13.9)	2583 (13.8)	450 (17.4)	<.001
Major trauma	2358 (5.3)	941 (4.1)	1220 (6.5)	197 (7.6)	<.001
Previous MI	6370 (14.3)	3278 (14.2)	2698 (14.4)	394 (15.3)	.32
Previous hypotension/ hypoperfusion	12,166 (27.4)	5868 (25.4)	5712 (30.4)	586 (22.7)	<.001
Previous sepsis	8123 (18.3)	3876 (16.8)	3739 (19.9)	508 (19.7)	<.001
Previous malignant neoplasm	4694 (10.6)	2313 (10.0)	2151 (11.5)	230 (8.9)	<.001
Previous hepatic insufficiency	3772 (8.5)	1644 (7.1)	1930 (10.3)	198 (7.7)	<.001
Mechanical ventilation	18,804 (42.3)	9398 (40.7)	8342 (44.4)	1064 (41.2)	<.001
Vasoactive agent	11,598 (26.1)	5932 (25.7)	5006 (26.7)	660 (5.6)	.05
Location of IHCA					
ICU	21,661 (48.7)	11,219 (48.6)	9289 (49.5)	1153 (44.7)	<.001
Monitored	6322 (14.2)	3513 (15.2)	2483 (13.2)	326 (12.6)	
Nonmonitored	6714 (15.1)	3227 (14.0)	2996 (16.0)	491 (19.0)	
ED	5300 (11.9)	2878 (12.5)	2094 (11.2)	328 (12.7)	
Procedural	3613 (8.1)	1763 (7.6)	1614 (8.6)	236 (9.1)	
Other	847 (1.9)	507 (2.2)	292 (1.6)	48 (1.9)	

[a]ED, emergency department; ICU, intensive care unit; IHCA, in-hospital cardiac arrest; MI, myocardial infarction.
[b]Data are presented as mean ± SD or as No. (percentage).

category: attending physicians, 71.7%±6.3%; physician trainees, 73.0%±6.3%; nonphysicians, 73.4%±6.4% (*P*=.30). In addition, the median hospital risk-adjusted rate of favorable neurological survival across the study cohort was 22.4% (interquartile range, 17.4%–25.5%; range, 4.0%-44.9%), and there was no significant difference across all 3 categories of hospitals: attending physicians, 21.6%±7.1%; physician trainees, 22.7%±6.1%; nonphysicians, 20.9%±6.5% (*P*=.50) (Figure). Finally, there was no significant interaction between type of typical resuscitation team leader and hospital size (*P*>.05) or geographic location (*P*>.05) for either the primary or secondary outcomes (Table 3).

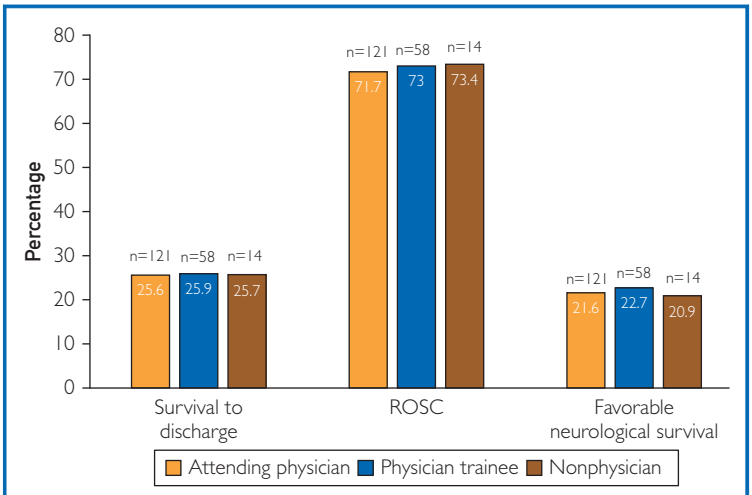

FIGURE. Hospital level risk-adjusted in-hospital cardiac arrest survival outcomes categorized by hospital's typical type of resuscitation team leader. ROSC = return of spontaneous circulation.

DISCUSSION

Although substantial variability exists in survival outcomes after IHCA across hospitals, it is not clear whether resuscitations at hospitals typically led by attending physicians have better survival outcomes than those typically led by physician trainees or nonphysicians. Leveraging the infrastructure of GWTG-R and survey responses from participating hospitals, we found no difference in the rates of survival to discharge, ROSC, or favorable neurological survival when a hospital's resuscitations for IHCA are typically led by an attending physician, a physician trainee, or a nonphysician. These results were similar when evaluating survival outcomes in small, medium, and large hospitals and by geographical region. Our results provide important insights into whether attending physicians are required to lead resuscitations at hospitals.

Prompt defibrillation and epinephrine, as well as other resuscitation process measures, have been found to improve a patient's likelihood of survival.[13,14] Poor leadership skills are associated with delays in providing these timely interventions and cardiopulmonary resuscitation along with poor adherence to ACLS guidelines.[15] Moreover, simulation-based trials with medical students and physician trainees as resuscitation team leaders have found that although they have adequate knowledge of ACLS principles, they often exhibit inadequate leadership skills, raising the question of whether physician trainees would make effective resuscitation team leaders.[7,16] Others have found that brief leadership instructions and training improves delivery of cardiopulmonary resuscitation and adherence to ACLS guidelines within simulation-based settings.[17]

However, there are limited data on the ability of physician trainees to be effective resuscitation team leaders in a real-world emergency setting such as an IHCA. One single-center study comparing IHCA survival outcomes between resuscitation teams led by emergency department house officers and attending hospitalists found similar outcomes between resuscitations led by both groups, but those results may not have been generalizable as they were conducted within 1 hospital and may reflect the skill level of the entire resuscitation team.[18] Our study extends this previous study's findings in 2 ways. We evaluated *risk-adjusted* survival outcomes across a broad range of hospitals. In addition, we evaluated IHCA survival outcomes at hospitals in which resuscitations are typically led by nonphysicians, which has not been examined.

Our findings, on face value, contradict the common belief that hospitals that have attending physicians as their typical resuscitation team leader has higher IHCA survival.

TABLE 3. Interaction Between a Hospital's Typical Resuscitation Leader and Hospital Characteristics

Characteristic	Survival to discharge (*P* value for interaction)	Return of spontaneous circulation (*P* value for interaction)	Favorable neurological survival (*P* value for interaction)
Typical team leader × Hospital bed size	.97	.18	.76
Typical team leader × US geographic location	.66	.31	.08

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These results, though, may be explained by certain considerations. Although attending physicians may have greater clinical experience, they may not lead resuscitations any more frequently than physician trainees or well-trained critical care nurses and may not routinely participate in simulation training for in-hospital resuscitation. In contrast, physician trainees, by virtue of their limited experience in leading resuscitation teams, routinely participate in resuscitation simulations and may use ACLS decision aids (eg, pocket cards) to achieve higher adherence to ACLS guidelines. Furthermore, hospitals in which physician trainees are the typical resuscitation team leaders are frequently large academic sites with greater staffing resources and more experienced resuscitation team members. Regardless, as leading resuscitation teams is an integral part of training house officers and subspecialty fellows, these findings are reassuring because physician trainees at many teaching hospitals care for patients with high illness severity.

Although only 7% of hospitals in our study had resuscitations typically led by nonphysicians (with most being critical care nurses), we also found that survival outcomes for IHCA at these hospitals were similar to those in which resuscitations are typically led by attending physicians or physician trainees. It is possible that at these hospitals, a core group of nurses lead all resuscitations for IHCA, which leads to greater experience and higher competence. This was our finding in our 9-hospital qualitative study.[4] If true, this is a particular advantage when compared to hospitals in which resuscitations are led by attending physicians or physician trainees, as resuscitations at these sites are often led by many more individuals, thus decreasing the overall case volume and experience. Future studies examining the training of nonphysician resuscitation team leaders are needed to better understand whether this structure can be replicated more universally.

Our findings are to be interpreted in the context of the following limitations. First, as with any survey research, we were unable to validate responses at each hospital. Any misclassification of a hospital's typical resuscitation leader may have biased our results to the null. However, the survey was filled out by each hospital's Code Blue director or identified resuscitation champion, so we expect misclassification bias to be rare. Second, we did not have detailed information on the experience level of all team leaders within a hospital, including typical IHCA case volume per team leader and the number of years out from training for attending physicians. We also did not have information on whether attending physicians were present and assisted trainees to lead resuscitations at hospitals in which the typical resuscitation leader was a physician trainee, which could have limited our ability to distinguish between these 2 hospital groups. However, this would not be expected to affect our finding of similar IHCA survival outcomes at hospitals whose resuscitations were typically led by a nonphysician. Third, our analyses were conducted at the hospital level and we did not have information on who actually led resuscitations at the patient level. Therefore, we were unable to conduct a patient-level analysis within each hospital. Fourth, our study was conducted in hospitals that participated in the GWTG-R registry and may not be generalizable to nonparticipating hospitals. Nonetheless, GWTG-R represents a broad range of hospitals throughout the United States, and we have no reason to believe that the relationship between who typically leads a resuscitation at one's hospital and survival outcomes would be different at nonparticipating sites.

CONCLUSION

In hospitals in a national IHCA registry, IHCA resuscitations were usually led by physicians. However, there was no association between whether a hospital's typical resuscitation team leader was an attending physician, a physician trainee, or a nonphysician and IHCA survival outcomes.

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Abbreviations and Acronyms: **ACLS** = Advanced Cardiac Life Support; **ANOVA** = analysis of variance; **GWTG-R** = Get with the Guidelines — Resuscitation; **IHCA** = in-hospital cardiac arrest; **ROSC** = return of spontaneous circulation; **RSSR** = risk-standardized survival rate

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