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Trends in Survival After In-Hospital Cardiac Arrest During Nights and Weekends

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ABSTRACT

BACKGROUND Survival after in-hospital cardiac arrest (IHCA) is lower during nights and weekends (off-hours) compared with daytime during weekdays (on-hours). As overall IHCA survival has improved over time, it remains unknown whether survival differences between on-hours and off-hours have changed.

OBJECTIVES This study sought to examine temporal trends in survival differences between on-hours and off-hours IHCA.

METHODS We identified 151,071 adults at 470 U.S. hospitals in the Get with the Guidelines-Resuscitation registry during 2000 to 2014. Using multivariable logistic regression with generalized estimating equations, we examined whether survival trends in IHCA differed during on-hours (Monday to Friday 7:00 AM to 10:59 PM) versus off-hours (Monday to Friday 11:00 PM to 6:59 AM, and Saturday to Sunday, all day).

RESULTS Among 151,071 participants, 79,091 (52.4%) had an IHCA during off-hours. Risk-adjusted survival improved over time in both groups (on-hours: 16.0% in 2000, 25.2% in 2014; off-hours: 11.9% in 2000, 21.9% in 2014; p for trend $<$0.001 for both). However, there was no significant change in the survival difference over time between on-hours and off-hours, either on an absolute ($p = 0.75$) or a relative scale ($p = 0.059$). Acute resuscitation survival improved significantly in both groups (on-hours: 56.1% in 2000, 71% in 2014; off-hours: 46.9% in 2000, 68.2% in 2014; p for trend $<$0.001 for both) and the difference between on-hours and off-hours narrowed over time ($p = 0.02$ absolute scale, $p < 0.001$ relative scale). In contrast, although post-resuscitation survival also improved over time in both groups (p for trend $<$ 0.001 for both), the absolute and relative difference persisted.

CONCLUSIONS Despite an overall improvement in survival, lower survival in IHCA during off-hours compared with on-hours persists. (J Am Coll Cardiol 2018;71:402-11) © 2018 by the American College of Cardiology Foundation.

In-hospital cardiac arrest (IHCA) affects approximately 200,000 hospitalized patients annually in the United States and this rate may be increasing (1). Survival after IHCA is integrally dependent on early recognition, prompt initiation of high-quality resuscitation response, and high-quality post-resuscitation care. A previous study of 86,478 patients with IHCA found that rates of survival and neurological outcomes were 15% to 20% lower among patients who experienced a cardiac arrest during nights or weekends (defined as between 11:00 PM and 6:59 AM on weekdays or all day on Saturday and Sunday) (2).

Although poor survival during nights and weekends (off-hours) has been documented, much less is known regarding how survival differences are changing over time in patients who arrest during this period. Yet, this information is important to identify

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opportunities for focusing future quality improvement efforts. Given that nearly 50% of IHCAs occur during nights or weekends, improving survival during this vulnerable period could impact a substantial number of patients.

To address this gap in knowledge, we examined whether survival differences between IHCA occurring during on-hours versus off-hours have changed over time. Understanding how outcomes are changing over time in this population has important implications for improving resuscitation care at hospitals across the United States.

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METHODS

DATA SOURCE. The Get With the Guidelines-Resuscitation (GWTG-R) is a prospective, multisite registry of IHCA events in the United States. Its design has been previously described (3). Briefly, hospitalized patients with a confirmed cardiac arrest, defined as absence of pulse, apnea, and unresponsiveness in a patient without a previous do-not-resuscitate order, are identified and enrolled by trained personnel. Multiple case-finding approaches, such as centralized collection of cardiac arrest flow sheets, review of hospital page system logs, and routine checks of code carts, pharmacy tracer drug records ensure that all cases within a hospital are captured (4,5). Data collection in the registry is based on the Utstein template of uniform reporting guidelines and standardized across participating sites (4,6). A rigorous training and certification process of the medical staff at participating hospitals along with the use of standardized software, internal data checks, and a periodic reabstractions process ensures data completeness and accuracy. The institutional review board at Geisinger Medical Center deemed this study exempt because of its use of deidentified data.

STUDY POPULATION. Within the GWTG-R, we identified 204,176 patients at least 18 years of age with an index pulseless IHCA between January 1, 2000, and December 31, 2014. We excluded 43,742 (21.4%) arrests that occurred outside of an intensive care unit or hospital ward (e.g., emergency room, operating room, other procedural areas), and arrests in patients with an implantable cardioverter-defibrillator because of the unique circumstances associated with resuscitation response in such situations. To ensure that the survival estimates obtained from our multivariable models were statistically reliable, we also excluded 7,109 (3.5%) arrests at 232 hospitals with <3 years of data submission or hospitals with a mean annual case volume of <5. Additionally, we also excluded 2,254 patients because of missing information related to survival and cardiac arrest timing. The final study sample comprised of 151,071 arrests at 470 participating hospitals (Figure 1).

ABBREVIATIONS AND ACRONYMS

GWTG-R = Get With The Guidelines-Resuscitation

IHCA = in-hospital cardiac arrest

STUDY VARIABLES AND OUTCOMES. Our primary exposure variable was time of cardiac arrest, which was recorded to the nearest minute. Because a previous GWTG-R study found that survival in patients who arrested during daytime and nighttime on weekends (Saturday, Sunday) was similar to patients who arrested during nighttime on weekdays (2), we categorized our exposure variable as follows: on-hours (7:00 AM to 10:59 PM Monday to Friday) or off-hours (11:00 PM to 6:59 AM Monday to Friday or anytime on weekends). The primary outcome was survival to hospital discharge. To further explore temporal trends in the primary outcome, we also examined as secondary outcomes acute resuscitation survival (defined as return of spontaneous circulation for at least 20 contiguous min at any time after the initial pulseless arrest) and post-resuscitation survival (defined as survival to hospital discharge among patients who achieved return of spontaneous circulation).

Patient-level data included demographics (age, sex, race), comorbidities and pre-existing medical conditions (current or prior myocardial infarction, current or prior heart failure, diabetes mellitus, hypotension, metabolic and electrolyte abnormalities, respiratory failure, renal insufficiency, hepatic insufficiency, metastatic or hematologic malignancy, septicemia, pneumonia, major trauma, acute stroke, baseline depression in neurological function, and cerebral performance category at time of admission), cardiac arrest characteristics (initial arrest rhythm [asystole, pulseless electrical activity, ventricular fibrillation, pulseless ventricular tachycardia], hospital location of cardiac arrest [intensive care unit, monitored ward, nonmonitored ward], whether the event was witnessed, use of hospital-wide cardiac arrest alert), and interventions in place before time of cardiac arrest (assisted or mechanical ventilation, vasoactive agent, antiarrhythmic, pulmonary artery catheter, and renal dialysis). Hospital-level variables were obtained from the American Hospital Association data and included geographic location, hospital setting (urban vs. rural), hospital ownership, bed size, and teaching status. Hospital characteristics are summarized in Online Table 1.

STATISTICAL ANALYSIS. Patient and hospital characteristics were summarized using mean ± SD or median (interquartile range) for continuous variables, and frequency counts with percentages for categorical variables. Next, we compared patient