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Rates of Bystander CPR and AED Use by Healthcare Providers for Cardiac Arrest in U.S. Nursing Homes

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Abstract

Residents of nursing homes are often excluded from research on out-of-hospital cardiac arrest (OHCA). Given the presence of trained healthcare staff on site, one would expect near-universal initiation of cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use by these providers before emergency medical services arrive. However, data on bystander response by nursing home staff and the extent of facility-level differences in these practices remain limited. Using data from the U.S. Cardiac Arrest Registry to Enhance Survival (CARES) from 2013 to 2021, we identified 71,530 adults who experienced OHCA in nursing homes and had resuscitation attempted. We examined rates of CPR initiation and AED application performed by nursing home healthcare staff. Multivariable hierarchical logistic regression was used to measure facility-level variation in these interventions, expressed as the median odds ratio (MOR). The MOR indicates how much the odds of receiving staff-initiated CPR or AED application would differ for two identical patients at two randomly chosen nursing homes. The cohort had a mean age of 74 ± 13 years, with 53.5% male. Overall, 82.2% (58,814) received CPR from healthcare staff, and 28.4% (20,302) had an AED applied by staff. Among 4,014 nursing homes with at least 5 OHCAs (totaling 42,399 cases), the median OR was 2.13 (95 percent CI: 2.05–2.22) for staff CPR and 4.54 (95 percent CI: 4.31–4.76) for staff AED application, indicating substantial between-facility variation in both practices. Rates of healthcare provider-initiated CPR and AED use in U.S. nursing homes during OHCA fall short of optimal levels and show marked variation across facilities. These findings highlight opportunities to standardize and improve early resuscitation practices in this setting.

Keywords: Nursing homes, OHCA, AED, Bystander CPR

Introduction

Residents of nursing homes are routinely excluded from research on out-of-hospital cardiac arrest (OHCA) because trained staff are present on-site and can respond immediately. When 9-1-1 is called for a nursing home resident in cardiac arrest and paramedics take over or continue resuscitation, it is reasonable to assume that facility staff would almost always start CPR right away and frequently use an automated external defibrillator (AED). Surprisingly, nationwide data on how often nursing home personnel actually perform bystander CPR or apply an AED—and how much this differs from one facility to another—have been largely unknown. We therefore carried out a large retrospective study to establish the overall rates of staff-initiated CPR and AED use in U.S. nursing homes and to measure the degree of variation between individual facilities.

Methods

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Data were drawn from the Cardiac Arrest Registry to Enhance Survival (CARES), a voluntary, population-based registry covering approximately 175 million people across the United States [1]. The registry captures all non-traumatic OHCAs in which resuscitation is attempted by EMS personnel, using standardized Utstein definitions for reporting. The project received approval from the Institutional Review Board at Saint Luke's Hospital.
Between 2013 and 2021, CARES recorded 735,990 OHCAs with attempted resuscitation by 9-1-1 responders. After excluding events that took place outside nursing homes (n = 657,878), arrests witnessed by arriving EMS crews (n = 6,492), pediatric cases (n = 76), and records missing bystander information (n = 14), the final cohort consisted of 71,530 cardiac arrests among nursing home residents.
The two outcomes of interest were the percentage of cases in which nursing home staff (considered the bystanders) initiated CPR and the percentage in which they applied an AED before EMS arrival.

Statistical analysis
Given the large cohort size, comparisons of patient characteristics according to receipt of staff CPR or AED use relied on standardized mean differences rather than p-values; differences exceeding 10% were regarded as noteworthy.
To assess facility-level differences, we included only nursing homes that had at least five recorded OHCAs. Separate multilevel logistic regression models were built for staff CPR and AED application, treating individual nursing homes as random effects to account for clustering. Models adjusted for age, sex, race/ethnicity, whether the arrest was witnessed, presumed cause, and initial rhythm. The median odds ratio from each model indicated how much the likelihood of receiving staff CPR (or AED use) varied between two otherwise similar patients cared for at two randomly chosen nursing homes.
All calculations were performed in SAS 9.4 (SAS Institute, Cary, NC).

Results

The 71,530 nursing home residents who experienced cardiac arrest had an average age of 74 years (SD 13) and 53.5% were male. Nursing home staff provided CPR before EMS arrival in 58,814 cases (82.2%) and applied an AED in 20,302 cases (28.4%). Patient demographics, arrest characteristics, and etiology were virtually identical between cases that did and did not receive staff-initiated CPR or AED use **(Table 1)**.

Table 1. Characteristics of patients with and without bystander CPR and AED application. Patient and cardiac arrest characteristics are reported for the 71,530 patients with OHCA

	No Bystander CPR	Bystander CPR	Std Diff	No Bystander AED	Bystander AED	Std Diff
Characteristic	**n = 12,716**	**n = 58,814**	**%***	**n = 51,228**	**n = 20,302**	**%***
Age, mean ± standard deviation	74.8 ± 13.4	73.8 ± 12.9	8.0	74.1 ± 13.1	73.7 ± 12.7	3.1
Male sex, no (%)	6,633 (52.2)	31,629 (53.8)	3.2	27,223 (53.1)	11,039 (54.4)	2.5
Race/Ethnicity, no. (%)			3.1			2.8
White	6,404 (50.4)	29,176 (49.6)		25,244 (49.3)	10,336 (50.9)	
Black	3,156 (24.8)	16,086 (27.4)		13,369 (26.1)	5,873 (28.9)	
Hispanic	653 (5.1)	2,892 (4.9)		2,698 (5.3)	847 (4.2)	
Asian	253 (2.0)	934 (1.6)		932 (1.8)	255 (1.3)	
American Indian or Alaska Native	36 (0.3)	182 (0.3)		165 (0.3)	53 (0.3)	
Native Hawaiian or Pacific Islander	33 (0.3)	177 (0.3)		157 (0.3)	53 (0.3)	
Unknown	2,181 (17.2)	9,367 (16.0)		8,663 (16.9)	2,885 (14.2)	
Witnessed arrest, no. (%)	3,640 (28.6)	17,010 (28.9)	0.7	14,796 (28.9)	5,854 (28.8)	0.1
Etiology of arrest, no. (%)			6.1			1.5
Presumed Cardiac	11,362 (89.4)	53,401 (90.8)		46,372 (90.5)	18,391 (90.6)	
Respiratory	1,109 (8.7)	4,371 (7.4)		3,914 (7.6)	1,566 (7.7)	
Other causes	245 (1.9)	1042 (1.8)		942 (1.8)	345 (1.7)	
First Monitored rhythm, no. (%)			15.9			46.6
Asystole	7,845 (61.7)	36,925 (62.8)		33,396 (65.2)	11,374 (56.0)	
Idioventricular/PEA	2,796 (22.0)	10,215 (17.4)		9,935 (19.4)	3,076 (15.2)	
Unknown Unshockable	1,225 (9.6)	7,441 (12.7)		4,409 (8.6)	4,257 (21.0)	
Ventricular fibrillation	559 (4.4)	2,459 (4.2)		2,562 (5.0)	456 (2.3)	
Ventricular tachycardia	105 (0.8)	337 (0.6)		370 (0.7)	72 (0.4)	
Unknown Shockable	186 (1.5)	1,435 (2.4)		554 (1.1)	1,067 (5.3)	
Bystander AED, no. (%)	418 (3.3)	19,884 (33.8)	85.4	38,930 (76.0)	19,884 (97.7)	69.0

Abbreviations: AED= automated external defibrillator; CPR= cardiopulmonary resuscitation; Std Diff= standardized difference.
*A standardized difference of >10% denotes a significant difference.

Across 4,014 nursing homes that each experienced at least five out-of-hospital cardiac arrests (42,399 events in total), the proportion of cases in which staff provided bystander CPR varied widely **(Figure 1A)**. At the typical facility, staff initiated CPR in 88.9% of cases (interquartile range 80.0–100%), though rates at individual homes spanned the full range from 0 percent to 100 percent. The median odds ratio of 2.13 (95 percent CI 2.05–2.22) means a patient's chance of receiving CPR from a healthcare provider could be more than twice as high in one nursing home compared with another, even after accounting for patient characteristics. Patients of Hispanic ethnicity were less often given CPR by staff, whereas arrests that were witnessed or judged to be of cardiac origin were significantly more likely to receive immediate staff CPR.

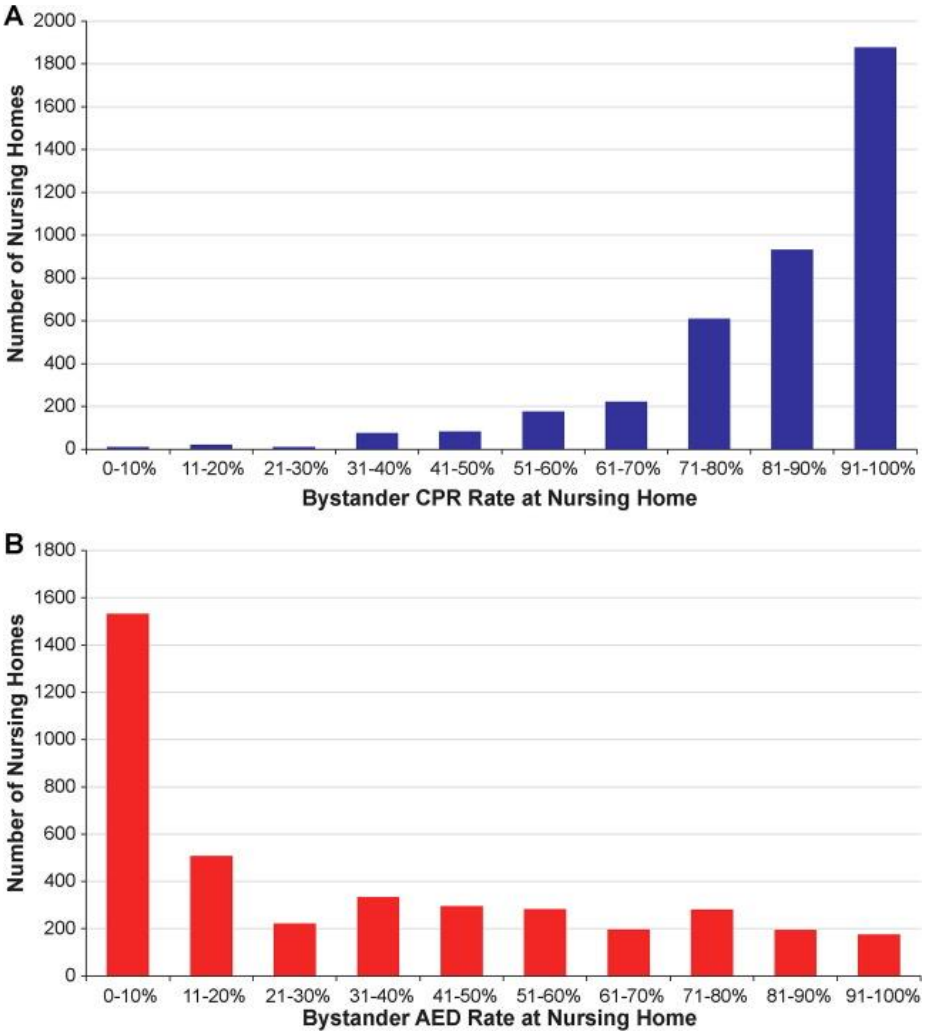

Figure 1. Bystander CPR and AED application rates in nursing homes

The figure summarizes outcomes from 22,410 nursing homes that reported at least one OHCA event to CARES. A particularly striking pattern emerged in the distribution of healthcare provider–initiated AED use across facilities **(Figure1B)**. The median proportion of residents receiving an AED application was 20.0% (IQR: 0%–57.1%), with rates spanning the full spectrum from 0% to 100%. The median odds ratio (OR = 4.54; 95% CI: 4.31–4.76) indicates that the likelihood of an AED being applied by nursing home staff varied more than fourfold between any two randomly selected facilities. Certain demographic and clinical factors were associated with differing probabilities of AED use: Hispanic residents were less often treated with an AED, while cases with a presumed cardiac origin or a shockable rhythm showed higher odds of AED application.

Discussion

Drawing on a large, national OHCA registry, this study shows that nursing home residents frequently do not receive optimal healthcare provider–initiated CPR or AED support, and that substantial variation exists among

facilities. Despite activation of 9-1-1 and continuation of resuscitative efforts by emergency responders, approximately 22% of residents had no CPR started by on-site clinical staff. Even more notable, most residents did not have an AED applied prior to EMS arrival. Furthermore, when comparing nursing homes, the probability of healthcare provider–initiated CPR differed twofold, and the probability of AED use differed fourfold, underscoring major inconsistencies in emergency response readiness.

Although previous investigations have evaluated OHCA outcomes in nursing home populations [2–6], these studies primarily focused on differences in survival rather than on-site provider response. For example, one analysis from Singapore identified poorer survival among nursing home residents relative to those experiencing arrest in private homes [2], a pattern likely influenced by older age and higher comorbidity burden. The present study advances this literature by quantifying how extensively CPR initiation and AED application rates diverge across facilities that have staff immediately available.

Despite appearing relatively high overall, healthcare provider–initiated CPR rates were still substandard, with one in four nursing homes reporting a rate below 80%. This raises concerns about the practical implementation of basic cardiac life support (BLS) requirements for nursing home staff [7]. Hesitancy may stem from beliefs that resuscitation for frail, medically complex residents is unlikely to succeed [8], yet all included cases had resuscitation undertaken by EMS, indicating that such assumptions should not have deterred on-site efforts. Moreover, it is improbable that variation in patient characteristics alone could explain the twofold differences observed between facilities. Divergent approaches to advanced directives may also contribute; inconsistent documentation or irregular review of residents' goals of care could lead to uneven CPR initiation practices. Standardized approaches to establishing and updating advanced directives may therefore help align staff actions with resident and family preferences.

In contrast, healthcare provider–initiated AED use in nursing homes was markedly low. Only about 22% of OHCA cases received AED application from on-site staff—a figure only slightly higher than the 10% bystander AED rate reported for public OHCAs [9]. Potential contributors include inadequate AED-specific training or simply the absence of AEDs within facilities. Nevertheless, nearly 190 nursing homes demonstrated that high performance is achievable, reporting AED use in 90%–100% of OHCAs. This is particularly notable given that some recent assessments suggest that AED availability in U.S. nursing homes may be as limited as 16%, and that current regulatory requirements regarding AED possession are minimal [10]. Considering that nursing home residents constitute a high-risk population for cardiac arrest, future policy initiatives should strongly consider mandating AED placement in these settings.

Several limitations should be acknowledged. CARES does not capture potentially important facility-level variables—such as staffing levels or the number and accessibility of on-site AEDs—that could help explain heterogeneity in provider response. Additionally, although CARES is the largest OHCA registry in the U.S., participating nursing homes may not fully reflect all facilities nationwide.

Conclusions

Across U.S. nursing homes, healthcare provider–initiated CPR and AED use for OHCA were suboptimal and exhibited considerable inter-facility variability. These findings indicate a need for strengthened BLS training and improved AED access within nursing homes to enhance emergency response for this vulnerable population.

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Ethics statement: None.

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