Original Investigation

Rates of Cardiopulmonary Resuscitation Training in the United States

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Invited Commentary page 201

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IMPORTANCE Prompt bystander cardiopulmonary resuscitation (CPR) improves the likelihood of surviving an out-of-hospital cardiac arrest. Large regional variations in survival after an out-of-hospital cardiac arrest have been noted.

OBJECTIVES To determine whether regional variations in county-level rates of CPR training exist across the United States and the factors associated with low rates in US counties.

DESIGN, SETTING, AND PARTICIPANTS We used a cross-sectional ecologic study design to analyze county-level rates of CPR training in all US counties from July 1, 2010, through June 30, 2011. We used CPR training data from the American Heart Association, the American Red Cross, and the Health & Safety Institute. Using multivariable logistic regression models, we examined the association of annual rates of adult CPR training of citizens by these 3 organizations (categorized as tertiles) with a county's geographic, population, and health care characteristics.

EXPOSURE Completion of CPR training.

MAIN OUTCOME AND MEASURES Rate of CPR training measured as CPR course completion cards distributed and CPR training products sold by the American Heart Association, persons trained in CPR by the American Red Cross, and product sales data from the Health & Safety Institute.

RESULTS During the study period, 13.1 million persons in 3143 US counties received CPR training. Rates of county training ranged from 0.00% to less than 1.29% (median, 0.51%) in the lower tertile, 1.29% to 4.07% (median, 2.39%) in the middle tertile, and greater than 4.07% or greater (median, 6.81%) in the upper tertile. Counties with rates of CPR training in the lower tertile were more likely to have a higher proportion of rural areas (adjusted odds ratio, 1.12 [95% CI, 1.10-1.15] per 5–percentage point [PP] change), higher proportions of black (1.09 [1.06-1.13] per 5-PP change) and Hispanic (1.06 [1.02-1.11] per 5-PP change) residents, a lower median household income (1.18 [1.04-1.34] per $10 000 decrease), and a higher median age (1.28 [1.04-1.58] per 10-year change). Counties in the South, Midwest, and West were more likely to have rates of CPR training in the lower tertile compared with the Northeast (adjusted odds ratios, 7.78 [95% CI, 3.66-16.53], 5.56 [2.63-11.75], and 5.39 [2.48-11.72], respectively).

CONCLUSIONS AND RELEVANCE Annual rates of US CPR training are low and vary widely across communities. Counties located in the South, those with higher proportions of rural areas and of black and Hispanic residents, and those with lower median household incomes have lower rates of CPR training than their counterparts. These data contribute to known geographic disparities in survival of cardiac arrest and offer opportunities for future community interventions.

JAMA Intern Med. 2014;174(2):194-201. doi:10.1001/jamainternmed.2013.11320
Published online November 18, 2013.

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More than 350 000 Americans experience out-of-hospital cardiac arrest (OHCA) each year.[1] In most US communities, overall survival has remained at 7% to 9% annually for the past 30 years.[2-5] However, the rates of OHCA incidence and survival vary significantly across geographic regions. For example, according to Resuscitation Outcomes Consortium observational data, survival of OHCA in Alabama counties is 500% lower than the rates in Seattle and Washington's suburban King County.[4] Cardiopulmonary resuscitation (CPR) performed by bystanders is a critical step in the chain of interventions for OHCA survival, with early initiation dramatically improving OHCA outcomes.[6-8] Every 1-minute delay in initiating CPR is associated with a 10% decrease in survival.[7] Nevertheless, rates of bystander CPR vary from 10% to 65% in observational studies,[2-4,9] with the lowest reported rates being in rural, minority, and low-income communities.[10-14] A recent American Heart Association (AHA) consensus statement called for an increase in bystander CPR training among communities.[15] Currently, very little is known about CPR training patterns in the United States, but this information could be invaluable for understanding how to increase bystander CPR rates.

We used data from several major US CPR training programs sponsored by the AHA, American Red Cross (ARC), and Health & Safety Institute (HSI) to examine patterns of annual CPR training in the United States. We also examined the degree to which county demographic, geographic, and health care factors were associated with low rates of CPR training.

Methods

Data Sources

Our study was submitted to the Duke University Health System Institutional Review Board and was determined to be exempt from review. For this study, we used data from the AHA, ARC, and HSI to determine rates of CPR training throughout the United States. To access this information, we obtained data use agreements according to Duke University research practices. Training data from the AHA, which were available at the county level, were based on course completion cards and community CPR products sold in the United States. Because 97% of the AHA training data were course completion cards that are distributed to a single individual (for Advanced Cardiovascular Life Support [ACLS], Pediatric Advanced Life Support [PALS], Basic Life Support [BLS], or Heartsaver [workplace training]), we assumed 1 card sold equated to 1 person trained. The AHA also has the following 2 community-based CPR products: (1) the Family & Friends CPR Course and (2) the Family & Friends CPR Anytime Personal Learning Program. For the Family & Friends CPR Course, a book is distributed to participants; therefore, we assumed that 1 book sold equated to 1 person trained. For the Family & Friends CPR Anytime Personal Learning Program, a home-training kit is provided; estimates conclude that 2.5 persons are trained per kit.[16,17] As a result, with the sale of these products, the AHA applies a multiplier of 2.5 to each kit sold to estimate regional training.

The ARC database tracks persons trained in CPR; these data are collected by 616 regional offices, are maintained by the ARC national headquarters,[18] are available at the zip code level, and are largely divided by professional (CPR/automated external defibrillator training for professional rescuers and health care providers) vs lay (first aid/CPR/automated external defibrillator training) rescuer programs. The professional program provides BLS training, whereas the lay rescuer program provides certification for the workplace and for lay responders who require certification.

Information obtained from HSI was based on product sales data distributed to regions in the United States. The HSI comprises 2 training companies: the American Health & Safety Institute and Medic FirstAid. All HSI products are based on certification cards; therefore, we assumed that 1 product sold equated to 1 person trained. Training is based on layperson BLS, PALS, and ACLS certifications. The lay training program is largely based on workplace training. These data were available at the zip code level.

For the primary analysis, we assumed that persons trained in ACLS or PALS concomitantly received BLS training in the same year. Therefore, to limit the chances of a single individual's training being counted twice, we excluded ACLS and PALS training provided by the AHA and HSI. We did not apply these exclusions to the ARC because BLS training is the most advanced level of training offered by this organization. To account for alternate possibilities, we performed a sensitivity analysis, which included the entire data set of the ACLS and PALS.

County-level demographic, geographic, and health care information were obtained from the Area Resource File,[19] 2010 Decennial Census, and Centers for Disease Control and Prevention. Similar to census data, Area Resource File data were not collected in the same year (eg, rural data were collected in the year 2000, hospital data in 2007, and physician data in 2008).

Definitions

Rates of CPR training for each county were calculated as the estimated number of residents trained by the AHA, ARC, and HSI divided by the overall county population aged 15 to 80 years. We chose this age group to exclude children and the elderly because they would not typically be targets of CPR educational programs. We considered all counties in each of the 50 US states and Washington, DC. We excluded counties in Puerto Rico and the US Virgin Islands. We also excluded AHA and ARC training data that could not be mapped to a specific county or zip code (13.1% of the data set).

Statistical Analysis

In a cross-sectional ecologic study design, we examined variability in county-level rates of CPR training and determined factors associated with low rates of CPR training. We defined tertiles by consecutively ordering counties (based on rates of CPR training) from lowest to highest. We then grouped our data into tertiles (lower, middle, and upper). Because previous data were not available to establish what could be considered low rates of training, we defined low rates as the range of data in the low-

est tertile (<1.29%). Tertiles also allowed easier display of the baseline characteristics of counties in lower vs other tertiles. A choropleth map was created using county-level concentrations of CPR training by tertiles. The Getis-Ord Gi* test was used to determine geographic areas of spatial clustering.[20]

We compared county-level characteristics across tertiles using Kruskal-Wallis tests for categorical row variables and χ^2 test rank correlation statistics with 2 *df* for ordinal and continuous row variables. To account for outliers, counties with rates of CPR training greater than 15% were truncated at 15% (3.3% of the primary analysis data set), the point at which only a few counties were represented in each training rate category. This cut point was determined after examining the histogram of training rates.

We used logistic regression to determine factors associated with counties in the lower tertile of CPR training rates. County-level variables included in the analysis were the percentage of male residents; median age; percentage of black, Hispanic, and Asian residents; median household income; percentage of residents who had completed a college-level education; percentage of rural population; rate of mortality due to heart disease; number of physicians; and geographic region. Geographic regions were divided into the Northeast, South, Midwest, and West. The percentage of residents living in poverty was not included in the final model because of the high correlation with median household income. Percentage data and income variables in the regression analysis were modeled continuously and are reported by percentage point change in variable, which was defined as the arithmetic (absolute) difference between 2 percentages. We used the Wald χ^2 test to determine the strength of each variable's association with the outcome. Missing rates for each variable included in the model were minimal (<0.3%) and were imputed to the tertile-specific median. The primary analysis was performed without accounting for ACLS and PALS training, as discussed previously; the secondary sensitivity analysis included all CPR training. A third sensitivity analysis compared the lower tertile with the middle and upper tertiles to determine if the strength of associations increased in parallel with disparity in training rates. For this analysis, the proportional odds assumption was violated, so 2 separate models were constructed comparing (1) the middle and lower tertiles and (2) the upper and lower tertiles. Finally, we assessed factors associated with continuous training rates using Poisson regression accounting for overdispersion.

All statistical tests were 2 sided, with a *P* value of <.05 indicating statistical significance. Analyses were performed using commercially available software (SAS, version 9.3 [SAS Institute Inc] and ArcGIS Desktop 10 [Esri].

Results

From July 1, 2010, through June 30, 2011, 15 109 467 persons received CPR training across 3143 counties in the United States (ie, 100% of all US counties), and 86.9% of the training data could be linked with county-level demographic, geographic, and health care data via county zip codes or county names. After excluding unmatched training data, 13 123 113 persons were included in the analysis. The AHA provided training to 8 293 401 persons (63.2% of all trained), of whom 55.6% received BLS training, 40.0% received Heartsaver training, and 4.4% received Friends & Family training. The ARC provided training to 3 638 169 persons (27.7% of all trained), of whom 80.4% were lay rescuers and 19.6% were professionals. The HSI provided training to 1 191 543 persons (9.1% of all trained), of whom 17.9% received BLS training and 82.1% received lay or workplace training.

The median annual CPR training rate in our cohort for all US counties was 2.39% (25th-75th percentiles, 0.88%-5.31%) and ranged from 0.00% to less than 1.29% (median, 0.51%) in the lower tertile, 1.29% to 4.07% (median, 2.39%) in the middle tertile, and greater than 4.07% (median, 6.81%) in the upper tertile counties. Of those counties in the lower tertile of CPR training, 57.0% were located in the South (**Table 1**). As illustrated by **Figure 1**, we observed substantial and important geographic variability in CPR training across the country. Clustering of lower rates of CPR training were observed in the South and Midwest; clustering of higher rates of CPR training were found in the Northeast and eastern Midwest and along the Pacific coast (**Figure 2**).

Using univariate analyses, we determined that counties in the lowest tertile for rates of CPR training had lower population densities (median, 24.0 vs 44.1 and 92.7 persons per square mile [$P < .001$]) and more rural populations (median, 82.8% vs 60.7% and 38.6% [$P < .001$]) compared with counties in the middle and upper tertiles of CPR training, respectively. Counties in the lower tertile for CPR training had significantly lower median percentages of residents with at least a college degree (12.1% vs 14.4% and 17.7% [$P < .001$]), lower median household incomes ($38 087 vs $43 358 and $45 267 [$P < .001$]), and higher median percentages of residents living in poverty (16.3 vs 13.5% and 13.5% [$P < .001$]) compared with county residents in the middle and upper tertiles of CPR training, respectively. Compared with counties from the upper 2 tertiles, lower-tertile counties also had significantly fewer physicians and hospitals and higher rates of mortality due to heart disease (208.0 vs 195.8 and 191.2 per 100 000 persons [$P < .001$], respectively) (Table 1).

After multivariable adjustment, several factors remained independently associated with counties in the lower tertile (**Table 2**), with the strongest factor being the proportion of rural residents in a given county. For every 5-percentage point increase in the rural population composition, the odds of being in a lower-tertile county increased (adjusted odds ratio [AOR], 1.12 [95% CI, 1.10-1.15]; $\chi^2 = 106.85$). Geographic region was the second strongest factor ($\chi^2 = 32.43$). For instance, compared with the Northeast, counties in the South had a greater than 7-fold odds of being in the lower tertile of CPR training (Table 2). Counties in the West and Midwest were also more likely to have counties in the lower tertile of CPR training compared with the Northwest. Counties with a lower number of physicians (per 100 physician decrease) were also significantly associated with the lower tertile of CPR training (AOR, 1.59 [95% CI, 1.32-1.92]; $\chi^2 = 23.61$). Finally, counties with lower median household incomes were significantly more likely to be in the lower tertile

Table 1. Characteristics of US Counties by Tertiles of Rates of CPR Training

Baseline Characteristic[a]	Overall (N = 3143)	Tertile of CPR Training[b]			*P* Value[c]
		Lower Tertile (n = 1047)	Middle Tertile (n = 1048)	Upper Tertile (n = 1048)	
Population density, No. of persons per square mile	42.8 (16.5-107.6)	24.0 (7.7-46.7)	44.1 (20.0-96.6)	92.7 (32.8-282.1)	<.001
Race					
White	89.1 (75.2-95.5)	89.1 (72.6-96.3)	90.4 (78.2-96.0)	87.8 (74.9-94.1)	.001
Black	2.0 (0.5-10.2)	1.3 (0.3-15.0)	1.7 (0.5-7.1)	2.8 (0.8-9.8)	<.001
Hispanic	3.3 (1.6-8.2)	2.5 (1.4-6.2)	3.2 (1.6-8.5)	4.1 (2.0-9.5)	<.001
Asian	0.5 (0.3-1.0)	0.3 (0.2-0.5)	0.5 (0.3-1.0)	0.9 (0.5-2.1)	<.001
Male sex	49.5 (48.9-50.4)	49.7 (49.0-50.7)	49.6 (49.0-50.3)	49.4 (48.7-50.1)	<.001
Median age, y	40.3 (37.4-43.4)	41.4 (38.9-44.8)	40.4 (37.6-43.4)	39.3 (36.1-41.9)	<.001
Rural residents	60.4 (35.8-90.2)	82.8 (60.3-100.0)	60.7 (38.8-82.3)	38.6 (18.0-60.0)	<.001
College degree educational level	14.5 (11.2-19.3)	12.1 (10.0-15.4)	14.4 (11.3-18.8)	17.7 (13.7-24.8)	<.001
Median annual household income, $	42 390 (36 518-49 241)	38 087 (33 551-43 693)	43 358 (37 630-50 332)	45 267 (40 135-52 386)	<.001
Living in poverty	14.3 (10.9-18.3)	16.3 (12.3-21.0)	13.5 (10.6-17.8)	13.5 (10.4-16.7)	<.001
No. of physicians per county	20.0 (5.0-93.0)	6.0 (2.0-15.0)	22.0 (7.0-76.0)	94.0 (24.5-405.5)	<.001
Heart disease mortality rate, persons per 100 000	197.4 (170.6-228.9)	208.0 (176.2-246.4)	195.8 (170.6-226.1)	191.2 (164.4-215.4)	<.001
Region					
West	14.3	11.1	14.4	17.3	<.001
South	45.3	57.0	43.9	34.9	
Midwest	33.6	31.1	34.6	34.9	
Northeast	6.9	0.8	7.1	12.9	

Abbreviation: CPR, cardiopulmonary resuscitation.

[a] Data for race and ethnicity were collected independently via US Census and represent the percentage of persons within the county. Unless otherwise indicated, data are expressed as median percentage (25th to 75th percentiles). For each race and ethnicity collected independently from the US Census data, county-level percentages were obtained. Median percentages were then calculated overall and for each tertile and do not represent person-level percentages. As a result, values in the table do not sum to 100% because they are summaries of county-level data.

[b] Tertiles are described in the Statistical Analysis subsection of the Methods section and in the Results section.

[c] Kruskal-Wallis tests were used to calculate categorical variables; χ^2 rank correlation statistics for ordinal/continuous rows.

for CPR training. For every $10 000 decrease in median household income, the AOR of being in the lower tertile was 1.18 (95% CI, 1.04-1.34; χ^2 = 6.68). Other factors associated with the lower tertile for CPR training were median age, race, and ethnicity (Table 2). The strength of these associations increased when modeling the lower tertile to the upper tertile compared with modeling the lower tertile to the middle tertile (Supplement [eTable 2]). After modeling the data continuously, similar variables remained associated with any CPR training, including rural populations, race/ethnicity, median household income, and college educational level. The strongest factor associated with rates of CPR training in this model was proportion of rural residents (rate ratio, 0.953 [95% CI, 0.947-0.959]; χ^2 = 214.5).

After including training in ACLS and PALS, the total number of residents who received CPR training increased by 1 217 848 to a total of 14 340 961 persons trained, of which ACLS represented 9.5% of AHA training and 0.9% of HSI training and PALS represented 3.2% of AHA training and 0.4% of HSI training. The median training rate for counties in the United States increased to only 2.45%, with lower, middle, and upper tertile median rates of CPR training of 0.52%, 2.45%, and 7.18%, respectively. Multivariable factors associated with the lower tertile of CPR training remained unchanged from the primary analysis (Supplement [eTable 1]).

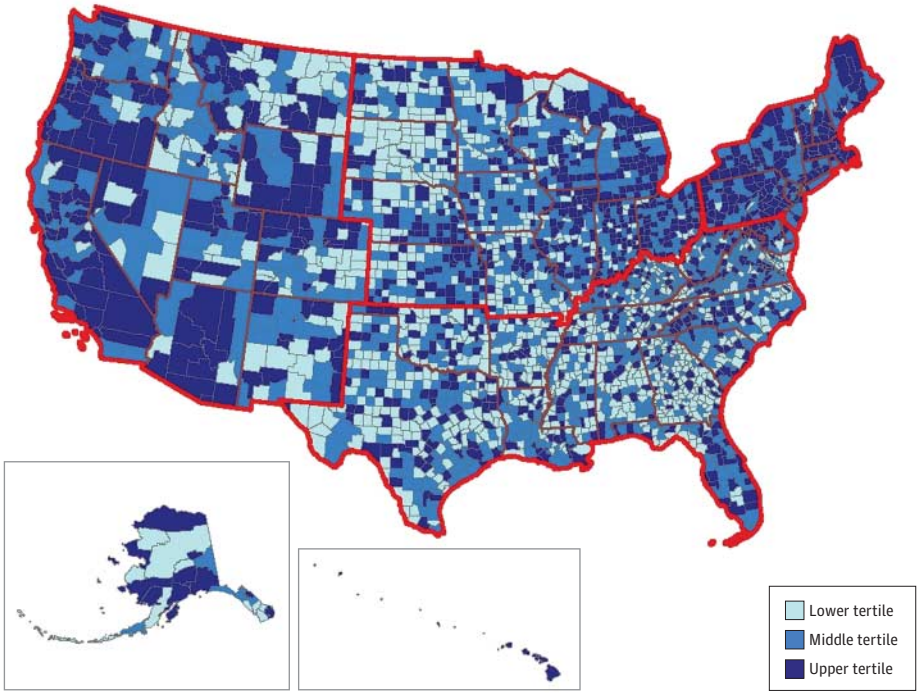
Discussion

To our knowledge, this study represents the first national study of rates of CPR training in the United States. Overall, training rates were low (median, 2.39% per year) and highly variable among US counties. Factors associated with lower rates of CPR training included increasing proportions of residents living in rural areas, high proportions of black or Hispanic residents, lower median household income levels, fewer physicians, and geographic region. Our findings may help explain known variability in the use of bystander CPR and survival of OHCA.

Previously published data on regional CPR training in the United States have primarily been limited to small household- and population-based survey data.[21-24] Nevertheless, these data only examine prevalent training rates, and most respondents had their last CPR training 5 to 10 years before administration of the survey. In contrast, our study examined current incident patterns of annual training, thereby making our data more likely to assist in the identification of geographical gaps in CPR training and to inform public policy about future training efforts.

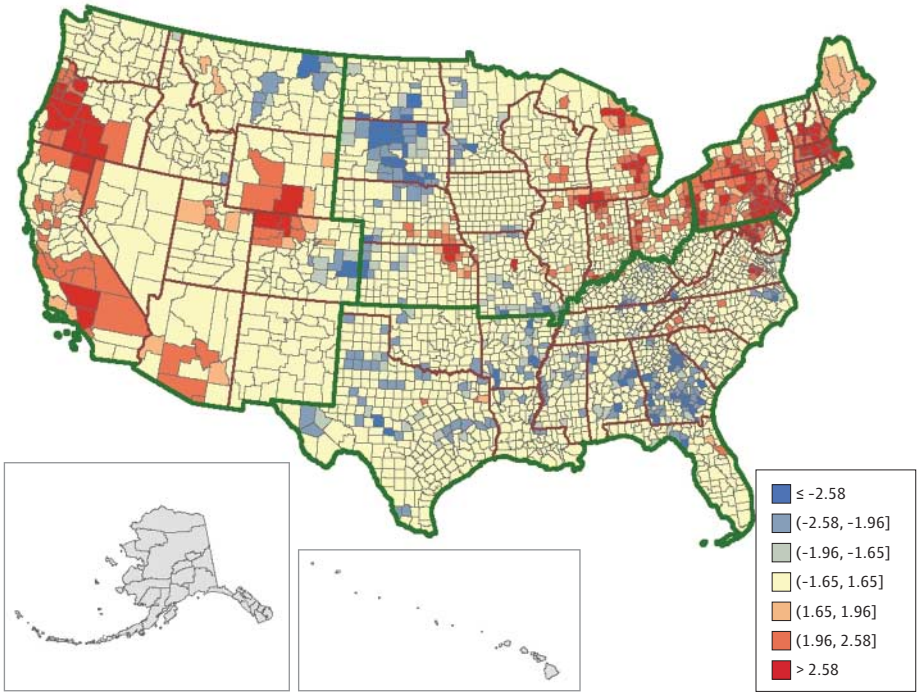
Our study found that several county-level demographic and geographic factors are associated with the odds of being

Figure 1. Geographic Distribution of Counties by Tertiles of Cardiopulmonary Resuscitation (CPR) Training in the US Community CPR Training Cohort



This map shows the tertiles of CPR training levels for each county in the United States. Lower-tertile counties had rates of CPR training ranging from 0.00% to less than 1.29% (median, 0.51%); middle-tertile counties, from 1.29% to 4.07% (median, 2.39%); and upper-tertile counties, greater than 4.07% (median, 6.81%).

Figure 2. Spatial Clustering of Rates of Cardiopulmonary Resuscitation (CPR) Training in the United States



This map shows the clustering pattern of tertiles of CPR training categories. Spatial clustering is demonstrated with high values ("hot spots") and low values ("cold spots") on the map. The *z* scores, calculated with the Getis-Ord Gi* test,[20] show the degree of clustering. Negative *z* scores indicate spatial clustering of low values (lowest tertile); positive *z* scores, spatial clustering of high values (upper tertile); and *z* scores ranging from −1.65 to 1.65, no statistically significant clustering in that area. The number of counties in Alaska and Hawaii is too small to calculate valid *z* scores. In the Figure key, the opening parenthesis indicates that the value is not included in the category and the closing bracket, that the number is included.

in a county with a lower tertile of CPR training. The strongest factor associated with low rates of CPR training was a high proportion of rural residents. Rural population was defined in the census data by a process of exclusion: all population, housing, and territory not included within an urban area and typically inhabited by fewer than 2500 persons.[25] Studies of OHCA in rural areas have consistently shown uniformly poor survival after cardiac arrest—a finding usually attributed to the lack

Table 2. Factors Associated With a County Being in the Lower Tertile of CPR Training[a]

Variable	AOR (95% CI)	χ^2 Test Value[b]	*P* Value
Rural residents, per 5-PP increase	1.12 (1.10-1.15)	106.85	<.001
Region		32.43	<.001
South vs Northeast	7.78 (3.66-16.53)	28.43	<.001
Midwest vs Northeast	5.56 (2.63-11.75)	20.14	<.001
West vs Northeast	5.39 (2.48-11.72)	18.01	<.001
Black residents, per 5-PP increase	1.09 (1.06-1.13)	23.79	<.001
No. of physicians, per 100-physcian decrease	1.59 (1.32-1.92)	23.61	<.001
Hispanic residents, per 5-PP increase	1.06 (1.02-1.11)	9.23	.002
Median annual household income, per $10 000 decrease	1.18 (1.04-1.34)	6.68	.01
Median age, per 10-y decrease	1.28 (1.04-1.58)	5.35	.02
No college education, per 5-PP decrease	1.09 (0.97-1.21)	2.24	.14
Male population, per 5-PP increase	1.07 (0.88-1.30)	0.42	.52
Asian residents, per 5-PP increase	1.06 (0.73-1.53)	0.10	.76
Heart disease mortality, per 100 000 population	1.000 (0.997-1.002)	0.09	.77

Abbreviations: AOR, adjusted odds ratio; CPR, cardiopulmonary resuscitation; PP, percentage.

[a] Logistic regression was used in the multivariable model comparing lower-tertile counties to upper- (middle- and upper-) tertile counties (described in the Statistical Analysis subsection of the Methods section and in the Results section).

[b] For χ^2 test, *df* = 1.

of consistently available paramedic and central dispatcher services. In addition, longer response and transport times for emergency medical services contribute to poorer survival.[14,26] In this context, singly focusing on efforts to improve CPR and community education programs for use of automated external defibrillators[6] may not improve survival without also addressing longer ambulance arrival times. Rather, policy efforts by national associations and federal organizations are needed to address the entire "chain of survival" for prehospital care, including transfer to a tertiary care hospital for rural community residents who experience OHCA. Future trials are needed to determine cost-effective and efficacious interventions for rural communities.

Individual and neighborhood socioeconomic status are associated with bystander CPR use. In a prior study, Vaillancourt et al[11] found that patients who experienced cardiac arrest inside their homes and were of lower socioeconomic status (measured by individual property value) were significantly less likely to receive bystander CPR compared with those of higher socioeconomic status. Recent data found an additive effect between race and neighborhood median household income: black communities consisting of lower-income households are more likely to have lower rates of bystander CPR than white communities consisting of higher-income households.[12] In our study, counties with lower median household incomes were also significantly associated with lower CPR training. This finding may be driven by the fact that lower median household incomes often parallel jobs that do not require CPR training and the lack of CPR awareness campaigns in these communities.

Communities with higher proportions of black and Hispanic residents have been shown to deliver bystander CPR less frequently despite the higher incidence of OHCA in this population.[13,27,28] Our study found an association between counties with high rates of black and Hispanic residents and lower rates of CPR training. Although we cannot know from our analysis who is being trained in a county, the finding of low training rates overall in these areas may account for the lower use of bystander CPR in minority populations. Simple target interventions could improve the recognition of OHCA and the availability of citizens to perform this life-saving intervention. Finally, in our study, counties with fewer physicians had lower rates of CPR training. Limited physician availability may reflect areas without major health care institutions and CPR programs.

There is significant regional variation in the incidence and outcomes of OHCA.[4,5,29-31] The variability in OHCA outcomes is far greater than the variability in stroke or ST-segment elevation myocardial infarction outcomes across the United States.[1] In our study, we demonstrated significant variability in incident rates of CPR training. Some of the factors associated with this variability overlap with factors previously found to be associated with variation in bystander CPR use (ie, black race, Hispanic ethnicity, and median household income). As a result, lower county-level rates of CPR training may, in part, contribute to the lower use of bystander CPR and consequently lower rates of OHCA survival.

At present, no county-level data on OHCA or OHCA survival rates in the United States are available; however, we found that counties with low rates of CPR training had disproportionately higher rates of mortality due to heart disease. Although these data cannot directly link low levels of CPR training with low rates of OHCA survival, they suggest that CPR training may not occur more intensively in populations with a high density of heart disease (ie, populations at highest risk for OHCA). Given population data suggesting that bystander CPR could double the chances of an individual's survival,[3] programs providing simple and inexpensive CPR training that target vulnerable populations could markedly reduce inequalities in outcomes after OHCA.[15]

Our study had several limitations. First, zip code data for AHA and HSI represent the place where CPR products are shipped (eg, training centers), not the home addresses of participants. We assumed that people lived in the county in which they were trained; as a result, rates of CPR training can be overestimated or underestimated. Second, we were unable to link 13.1% of data owing to a lack of or to invalid mapping (eg, zip

code or county name) of data; this issue may have slightly underestimated training rates. Third, although we believe that our estimates are accurate measures of persons trained for AHA BLS and Heartsaver, the AHA Family & Friends program might have trained more people per session than we estimated (eg, if Family & Friends kits are used in mass community training events). Fourth, data on emergency medical technicians were available in only 15% of US counties. Nursing data could have complemented the number of physicians as a more accurate estimator of number of health care professionals certified or recertified each year. Unfortunately, recent and aggregated nursing data were not available at the county level. Addition of these variables could have affected the strength of association of other independent variables in our models. Fifth, our data do not account for CPR training provided by other organizations or for those trained via social media or the Internet. Finally, we did not have the ability to discriminate between participants who received first-time training vs those who were recertified.

Conclusions

Current rates of CPR training in the United States are low, with significant variability among counties. Reasons for overall observed low annual rates of CPR training may be secondary to a lack of knowledge of CPR training opportunities, unavailability of CPR training organizations in the geographic areas, inability to afford the training courses, or longer travel times. Efforts are needed to improve rates of CPR training in all counties but particularly those in the Southern and Western regions and in those with high rates of rural population and lower median household incomes. Future research should be directed toward understanding whether targeted and intensive CPR training will narrow existing disparities in rates of bystander CPR and OHCA survival in these vulnerable communities. With regard to rural areas, more studies are needed on interventions that target the entire chain of survival.

ARTICLE INFORMATION

Accepted for Publication: August 11, 2013.

Published Online: November 18, 2013. doi:10.1001/jamainternmed.2013.11320.

Author Contributions: Dr Anderson and Ms Cox had full access to all 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: Anderson, Cox, Al-Khatib, Thomas, Fosbol, Peterson.
Acquisition of data: Anderson, Cox, Nichol, Eigel, Clendenen, Peterson.
Analysis and interpretation of data: Anderson, Cox, Al-Khatib, Nichol, Thomas, Chan, Saha-Chaudhuri, Fosbol, Clendenen, Peterson.
Drafting of the manuscript: Anderson.
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Statistical analysis: Anderson, Cox, Saha-Chaudhuri, Fosbol, Peterson.
Obtained funding: Peterson.
Administrative, technical, and material support: Anderson, Eigel, Clendenen, Peterson.
Study supervision: Anderson, Nichol, Thomas, Saha-Chaudhuri, Peterson.

Conflict of Interest Disclosures: Dr Nichol reports being a board member for Medic One Foundation; being co-principal investigator for Resuscitation Outcomes Consortium and principal investigator for the Dynamic Automated External Defibrillator Registry (2010-2015); having received grants from the National Institutes of Health, the US Food and Drug Administration, Phillips Healthcare Inc, Physio-Control Inc, and Zoll Inc; and having received travel reimbursement from the American Heart Association (AHA). Dr Chan reports being a consultant for the AHA, Optum Rx, and Johnson & Johnson and having received a grant from the National Heart, Lung, and Blood Institute. Dr Eigel reports being an employee of the American Heart Association (AHA); as part of the AHA's mission to improve cardiovascular health and reduce cardiovascular deaths, the AHA develops and sells CPR training books, videos, and online courses that generate revenue to further support the AHA mission. Mr Clendenen reports being the chief executive officer of and owning minority shares in the Health and Safety Institute. Dr Peterson reports serving as the principal investigator for the AHA Get With the Guidelines data analysis center. No other disclosures were reported.

Funding/Support: This study was supported by an award from the AHA-Pharmaceutical Roundtable (PRT) and by David and Stevie Spina.

Role of the Sponsor: The AHA-PRT and David and Stevie Spina had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

Additional Contributions: Barbara Lytle, MS, Linda Davidson-Ray, MA, Vladimir Demyanenko, MS, and Erin LoFrese, MS, of the Duke Clinical Research Institute, John Thompson, BS, of the ARC, Steve Barnett, MBA, and Jeff Myers, BA, of the HSI, and Tim Williams, BA, of the AHA provided expertise and data support. They did not receive compensation for their contributions apart from employment at the institution where this study was conducted.

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Invited Commentary

Incidence of Cardiopulmonary Resuscitation Training in the United States

Assessment of a Key Link in the "Chain of Survival"

Audrey L. Blewer, MPH; Benjamin S. Abella, MD, MPhil

Immediate provision of cardiopulmonary resuscitation (CPR) by a layperson or a health care provider may double an individual's likelihood of surviving cardiac arrest. Despite extensive CPR training programs throughout the United States, studies from a range of communities have demonstrated that fewer than one-third of individuals who experience out-of-hospital cardiac arrest receive bystander-initiated CPR before the arrival of emergency medical services personnel and that CPR delivery varies considerably between different locales.[1,2] Whether such variability is the result of differences in a willingness to provide care or differences in the prevalence of CPR training remains unknown. This knowledge gap underscores a related and perhaps more fundamental question that remains unanswered some 50 years after the development of CPR: What is the rate of CPR training in the US population?

Related article page 194

To highlight the challenge of low rates of bystander CPR, a recent scientific statement from the American Heart Association called for an increased emphasis on CPR training for the lay public.[3] Large-scale CPR training projects have been initiated by nonprofit organizations and academic institutions to address this deficiency, such as the HeartRescue Project, in which 6 states intend to increase survival of cardiac arrest by 50% within 5 years, with an emphasis on early, effective bystander CPR.[4] Efforts have also been made to target at-risk populations by providing CPR training to family members of hospitalized patients with cardiac disease.[5] In addition, school-based CPR educational projects have been undertaken to increase training prevalence.

Measuring the Scope of CPR Training

Although efforts have been made to increase bystander CPR education and encourage delivery, the annual rate of CPR training incidence and the prevalence of CPR-trained individuals in the US population are unknown. Anderson et al[6] compiled CPR training data from 3 large organizations that conduct CPR certification (the American Heart Association, the American Red Cross, and the Health and Safety Institute) to estimate CPR training rates and to examine the association of such incidence with county-level variables. These 3 organizations provide the majority of CPR training in the United States. This important work represents the first attempt to study the incidence of CPR train-