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Resuscitation Science

Chest Compression Fraction Determines Survival in Patients With Out-of-Hospital Ventricular Fibrillation

Jim Christenson, MD; Douglas Andrusiek, MSc; Siobhan Everson-Stewart, MS; Peter Kudenchuk, MD;
David Hostler, PhD; Judy Powell, BSN; Clifton W. Callaway, MD, PhD;
Dan Bishop; Christian Vaillancourt, MD, MSc; Dan Davis, MD; Tom P. Aufderheide, MD;
Ahamed Idris, MD; John A. Stouffer; Ian Stiell, MD, MSc; Robert Berg, MD;
and the Resuscitation Outcomes Consortium Investigators

Background—Quality cardiopulmonary resuscitation contributes to cardiac arrest survival. The proportion of time in which chest compressions are performed in each minute of cardiopulmonary resuscitation is an important modifiable aspect of quality cardiopulmonary resuscitation. We sought to estimate the effect of an increasing proportion of time spent performing chest compressions during cardiac arrest on survival to hospital discharge in patients with out-of-hospital ventricular fibrillation or pulseless ventricular tachycardia.

Methods and Results—This is a prospective observational cohort study of adult patients from the Resuscitation Outcomes Consortium Cardiac Arrest Epistry with confirmed ventricular fibrillation or ventricular tachycardia, no defibrillation before emergency medical services arrival, electronically recorded cardiopulmonary resuscitation before the first shock, and a confirmed outcome. Patients were followed up to discharge from the hospital or death. Of the 506 cases, the mean age was 64 years, 80% were male, 71% were witnessed by a bystander, 51% received bystander cardiopulmonary resuscitation, 34% occurred in a public location, and 23% survived. After adjustment for age, gender, location, bystander cardiopulmonary resuscitation, bystander witness status, and response time, the odds ratios of surviving to hospital discharge in the 2 highest categories of chest compression fraction compared with the reference category were 3.01 (95% confidence interval 1.37 to 6.58) and 2.33 (95% confidence interval 0.96 to 5.63). The estimated adjusted linear effect on odds ratio of survival for a 10% change in chest compression fraction was 1.11 (95% confidence interval 1.01 to 1.21).

Conclusions—An increased chest compression fraction is independently predictive of better survival in patients who experience a prehospital ventricular fibrillation/tachycardia cardiac arrest. (***Circulation***. 2009;120:1241-1247.)

Key Words: heart arrest ■ cardiopulmonary resuscitation ■ fibrillation ■ survival

O ut-of-hospital cardiac arrest is a leading cause of premature death throughout the world.[1] Survival from out-of-hospital cardiac arrest is variable and often less than 5%.[2,3] Survival depends on effective cardiopulmonary resuscitation (CPR) and early defibrillation.[4] To improve survival, it is important to understand and then optimize modifiable predictors of outcome.

Clinical Perspective on p 1247

The quality of CPR is likely an important contributor to successful outcome. One of the most important aspects of quality CPR is thought to be the proportion of time spent performing chest compressions. Interruptions in chest compressions are common during treatment of cardiac arrest.[5–7] Animal studies demonstrate that interruptions in chest compressions decrease coronary and cerebral blood flow, which results in worse survival outcomes.[8,9] Emergency medical service providers typically perform chest compressions only 50% of the time during their resuscitative efforts.[7] The clinical consequences of interruptions in chest compressions on cardiac arrest survival have yet to be determined. On the basis of these clinical and laboratory observations and the rationale that minimization of blood flow disruptions during CPR should improve survival, the 2005 American Heart Association and the European Resuscitation Council guidelines for CPR recommended increasing the proportion of time

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spent delivering chest compressions.[10,11] The objective of the present multicenter cohort study was to estimate the independent effect of chest compression fraction (proportion of time spent delivering chest compressions during CPR) on survival to hospital discharge in a cohort of patients with out-of-hospital ventricular fibrillation or pulseless ventricular tachycardia.

Methods

Setting and Design

The Resuscitation Outcomes Consortium consists of 11 geographically distinct regional clinical centers across North America created to study promising out-of-hospital therapies for cardiac arrest and significant traumatic injury.[12] The 11 regional centers are in Ottawa, Toronto, and British Columbia in Canada and Iowa City, Iowa; Pittsburgh, Pa; Dallas, Tex; Milwaukee, Wis; Birmingham, Ala; Seattle/King County, Washington; Portland, Ore; and San Diego, Calif, in the United States, and they include more than 260 separate emergency medical service agencies. Since December 2005, the Resuscitation Outcomes Consortium Cardiac Arrest Epistry[13] has prospectively gathered data on out-of-hospital cardiac arrest cases attended by a participating emergency medical services agency. Prespecified data related to out-of-hospital treatments and outcomes were collected by use of standardized operational definitions, including initial cardiac rhythms, response times, descriptions of professional responders, timing of CPR and defibrillation, response to interventions, return of spontaneous circulation, and survival to hospital discharge. The Resuscitation Outcomes Consortium encouraged the collection of digital, electronic recordings of rhythm and chest compressions. All data were managed by a central data coordinating center. Seven sites and 78 agencies contributed cases for the present report.

Patient Population

Between December 2005 and March 2007, all patients who experienced a cardiac arrest before emergency medical services arrival with a first recorded rhythm of ventricular fibrillation/tachycardia and who were not enrolled in a concurrent clinical trial were eligible for the present study. The initial rhythm was determined to be ventricular fibrillation/tachycardia if the initial automated external defibrillator analysis recommended a shock or if the emergency medical service provider interpreted the initial rhythm as ventricular fibrillation/tachycardia. Rhythm diagnosis was confirmed as ventricular fibrillation/tachycardia by research staff. We excluded patients who received public access defibrillation before emergency medical services arrival, patients without at least 1 minute of digitally recorded CPR before or during the minute of the first shock, and patients in whom the outcome was unknown.

Measurement

The presence and frequency of chest compressions were measured indirectly either by changes in thoracic impedance recorded from external defibrillation electrodes as described by Valenzuela et al[6] or via an accelerometer interface between the rescuer and the patient's chest with commercially available defibrillators. The chest compression fraction was defined as the proportion of resuscitation time without spontaneous circulation during which chest compressions were administered. This was calculated by automated external defibrillator analytic software that permitted identification of all interruptions greater than 2 seconds (Philips [Andover, Mass] and ZOLL [Chelmsford, Mass] devices) or 3 seconds (Medtronic [Minneapolis, Minn] devices). These pauses were defined as time without chest compressions. Tracings were acquired and downloaded from Medtronic defibrillators (n=482), Zoll defibrillators (n=18), and Phillips defibrillators (n=6). Each case included the minute interval during which the first analysis was performed (including some time before and after the first shock) and all recorded minute intervals before the first analysis. The chest compression fraction values for all minute intervals were averaged for each patient. Trained research staff reviewed the automated calculation of chest compression fraction at each site before entering chest compression fraction values. The prospectively selected primary outcome measure was survival to hospital discharge.

Statistical Analysis

All statistical analyses were performed with a commercially available statistical package (SAS, version 9.1.3, Cary, NC; R, version 2.5.1, Vienna, Austria). Summary results are presented as mean (±SD) or median (interquartile range). We categorized chest compression fraction (from 0% to 100%) into 5 groups based on the average chest compression fraction delivered to the patient over all minutes with available data: 0% to 20%, 21% to 40%, 41% to 60%, 61% to 80%, and 81% to 100%. These groups corresponded to receipt of CPR, on average, for 0 to 12, 13 to 24, 25 to 36, 37 to 48, and 49 to 60 seconds per minute, respectively, over all analyzed minutes of data. Potential confounding variables identified a priori included age, gender, location of cardiac arrest (public place or private residence), bystander CPR, bystander-witnessed cardiac arrest, and the time interval from receipt of the emergency call to arrival of emergency medical services at the scene. We calculated descriptive and bivariate statistics and used logistic regression to estimate the unadjusted and adjusted odds ratio of survival for each category of chest compression fraction relative to the lowest category (0% to 20%). The adjusted model was repeated with the inclusion of the Resuscitation Outcomes Consortium site as a covariate to determine whether other unknown local influences affected the relationship. A secondary multivariable linear-regression analysis estimated the effect of a 10% change in chest compression fraction. As an exploratory analysis, we fit a penalized cubic smoothing spline curve to further characterize the nature of the relationship between chest compression fraction and survival.[14]

Results

A total of 14 090 cardiac arrest cases occurred before emergency medical services arrival and were treated by emergency medical service responders. Of these, 3170 patients had an initial rhythm of ventricular fibrillation/tachycardia, and 506 were eligible for analysis. The remaining 2664 patients were excluded primarily because a shock was delivered before initiation of CPR (n=1114) or chest compression fraction data were not obtained (n=1550; Figure 1). Two sites with preexisting capacity to download these electronic data contributed 79% of the eligible cases. The number of cases contributed by site is shown in Table 1.

Clinical characteristics and outcome of the excluded patients with an initial rhythm of ventricular fibrillation/tachycardia but less than 1 minute of recorded compression data before the first shock are compared in Table 1. Analyzed patients had a higher proportion of males, more arrests in public places, more frequent bystander CPR, and a higher proportion of patients with return of spontaneous circulation. Overall, 117 subjects (23%) in the cohort survived to hospital discharge. The mean age of patients was 64±15 years, 80% were male, 34% arrested in a public location, 71% of arrests were witnessed by bystanders, and 51% received bystander CPR.

The demographics by chest compression fraction category are shown in Table 2. The percentage of patients with return of spontaneous circulation was 58%, 73%, 76%, 73%, and 79%, respectively, in the 5 categories of increasing chest compression fraction. Survival to hospital discharge in these
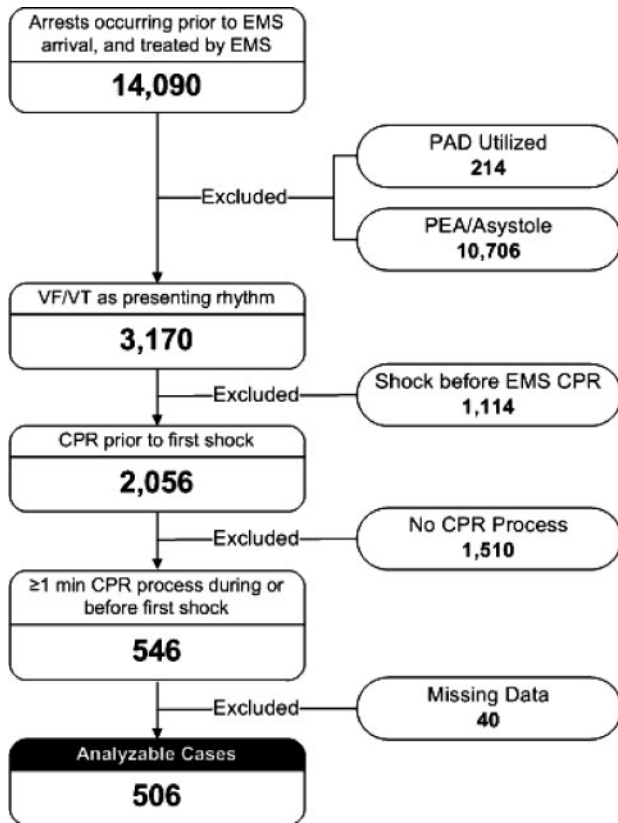
Figure 1. Study cohort and exclusions. EMS indicates emergency medical services; PAD, public access defibrillation; PEA, pulseless electrical activity; and VF/VT,ventricular fibrillation/tachycardia.

Table 1.   Comparison of Cohort With Excluded Patients Who Had an Initial Rhythm of VF/VT and Some CPR Before the First Shock but No Available CPR Process Measures

	Analyzed Cohort (n=506)	Excluded Patients (n=1467)	P (χ^2 or t Test)
Age, y, mean (SD)	63.9 (15.2)	64.7 (15.7)	0.329
Male, % (n)	80 (407)	76 (1121)	0.059
Site code, % (n)			
Site 216	0 (0)	0 (1)	
Site 307	54 (272)	12 (178)	
Site 315	0 (0)	6 (83)	
Site 389	4 (18)	26 (388)	
Site 434	6 (30)	13 (186)	
Site 477	2 (12)	4 (65)	<0.001
Site 663	1 (6)	3 (44)	
Site 671	25 (129)	8 (120)	
Site 791	7 (37)	25 (367)	
Site 864	0 (0)	1 (18)	
Site 925	0 (2)	1 (17)	
Public location, % (n)	34 (174)	30 (436)	0.065
Bystander witnessed, % (n)	71 (359)	68 (992)	0.163
Bystander CPR, % (n)	51 (256)	45 (666)	0.044
Minutes from call to scene, mean (SD)	5.8 (2.7)	5.5 (2.3)	0.020
Minutes from call to first shock, mean (SD)	10.7 (4.5)	10.4 (4.7)	0.238
Minutes of CPR before first shock, mean (SD)	3.2 (3.1)	2.9 (3.3)	0.089
Epinephrine use noted, % (n)	74 (373)	79 (1162)	0.010
ROSC, % (n)	72 (362)	45 (666)	<0.001

VF/VT indicates ventricular fibrillation/tachycardia; ROSC, return of spontaneous circulation.

5 categories of increasing chest compression fraction was 12.0%, 22.9%, 24.8%, 28.7%, and 25.0%, respectively.

We did not identify any imbalances in demographic or arrest characteristics in patients among the categories. The association between chest compression fraction categories and the probability of survival is shown in Figure 2.

Unadjusted and adjusted odds ratios of survival for the preselected factors potentially associated with survival are shown in Table 3. The effect of an increasing chest compression fraction on survival remained significant after adjustment for possible and known determinants of survival, including age, gender, bystander CPR, bystander witnessed arrest, emergency medical services response time, and location. The estimated adjusted linear effect on odds ratio of survival for a 10% change in chest compression fraction was 1.11 (95% confidence interval 1.01 to 1.21).

When the model was extended to include site, the recalculated odds ratios for survival to hospital discharge were 2.71 (95% confidence interval 1.18 to 6.26) for the 61% to 80% category and 2.02 (95% confidence interval 0.78 to 5.20) for the 81% to 100% category. The odds ratio for survival for an average 10% increase in chest compression fraction was 1.08 (95% confidence interval 0.98 to 1.20).

Because 2 sites contributed such a large percentage of cases, we ran a post hoc analysis using only cases from those 2 sites. The odds ratio (95% confidence interval) of survival to discharge in the 5 ascending categories of chest compression fraction were very similar to that for the entire cohort,

and the conclusions are unchanged. A spline smoother was fit to visually explore the relationship between chest compression fraction and survival changes over the range of chest compression fractions (Figure 3).

Discussion

The results of the present large, observational, multicenter study demonstrate an association between the proportion of resuscitation time that chest compressions are performed before the first defibrillation and survival to hospital discharge after out-of-hospital cardiac arrest due to ventricular fibrillation/tachycardia. The relationship of chest compression fraction and survival was independent of other known predictors. This observation is important and provides a rationale for relatively simple changes to resuscitation training and practice that are likely to improve survival if implemented.

These clinical findings strongly support animal study observations that the minimization of coronary and cerebral blood flow disruptions during resuscitation improves survival from cardiac arrest.[8,15–20] The present findings build on previous but smaller clinical studies. Edelson et al[21] observed

Table 2.   Patient Characteristics by Chest Compression Fraction Category

Demographics	CCF Categories					
	0–20% (n=100)	21–40% (n=74)	41–60% (n=117)	61–80% (n=143)	81–100% (n=72)	Total (n=506)
Age, mean (SD)	63.5 (16.6)	63.7 (13.9)	64.9 (15.6)	64.6 (14.3)	61.7 (15.7)	63.9 (15.2)
Male, % (n)	85 (85)	88 (65)	74 (86)	81 (116)	76 (55)	80 (407)
Public location, % (n)	33 (33)	35 (26)	38 (45)	32 (46)	33 (24)	34 (174)
No. of professional rescuers, mean (SD)*	6.7 (1.7)	6.4 (2.1)	6.8 (2.1)	7.4 (2.3)	8.0 (2.3)	7.0 (2.2)
No. of EMS units at scene, mean (SD)*	2.8 (0.4)	2.6 (0.6)	2.8 (0.6)	2.8 (0.6)	2.9 (0.6)	2.8 (0.6)
No. of contributing agencies, mean (SD)*	1.9 (0.3)	1.9 (0.4)	1.8 (0.5)	1.7 (0.6)	1.4 (0.5)	1.7 (0.5)
Minutes from 9-1-1 call to scene, median (Q1, Q3)	5.6 (4.6, 7.0)	5.8 (4.5, 7.8)	5.1 (3.9, 6.3)	5.0 (3.9, 7.3)	4.6 (3.8, 6.4)	5.2 (4.1, 7.0)
Minutes from 9-1-1 call to AED on scene, median (Q1, Q3)	9.7 (7.4, 12.5)	8.3 (6.4, 10.8)	8.3 (6.7, 10.1)	7.4 (5.8, 9.9)	7.6 (6.0, 9.3)	8.1 (6.3, 10.6)
Minutes from 9-1-1 call to first analysis, median (Q1, Q3)	10.0 (7.8, 13.0)	9.0 (7.3, 11.7)	9.3 (7.5, 10.9)	8.9 (7.5, 11.6)	9.2 (7.9, 10.9)	9.1 (7.6, 11.5)
Minutes from 9-1-1 call to first shock, median (Q1, Q3)	10.3 (8.1, 13.4)	9.5 (7.7, 12.7)	9.9 (7.8, 11.7)	9.2 (7.6, 12.0)	9.9 (8.2, 12.3)	9.6 (7.9, 12.4)
Bystander-witnessed arrest, % (n)	73 (73)	73 (54)	68 (80)	73 (105)	65 (47)	71 (359)
Bystander CPR, % (n)	45 (45)	49 (36)	52 (61)	55 (78)	50 (36)	51 (256)
ALS first on scene, % (n)	8 (8)	15 (11)	16 (19)	15 (22)	25 (18)	15 (78)
CCF, %, median (Q1, Q3)	8 (0, 14)	30 (26, 36)	51 (45, 55)	70 (65, 75)	86 (82, 91)	54 (28, 73)
Chest compression rate, median (Q1,Q3)†	99 (0, 120)	115 (103, 127)	113 (98, 124)	111 (100, 123)	111 (97, 121)	111 (97, 123)
Minutes of CPR before first shock, mean (SD)	3.2 (2.4)	2.6 (3.7)	3.1 (3.2)	3.1 (2.5)	4.2 (4.2)	3.2 (3.1)
Minutes of CPR included in CCF calculation, mean (SD)	1.0 (0.4)	1.3 (0.9)	1.6 (1.1)	1.9 (1.2)	2.5 (1.3)	1.6 (1.1)
Epinephrine use noted, % (n)	68 (68)	68 (50)	74 (87)	74 (106)	86 (62)	74 (373)

CCF indicates chest compression fraction; EMS, emergency medical services; 9-1-1 call, telephone contact with EMS; Q1, Q3, quartiles 1 and 3; ALS, advanced life support; and AED, automated external defibrillator.

*Information was only available about the first 4 EMS units at the scene.

†Chest compression rate is the number of chest compressions per minute.

that an increased pause in compressions just before the first shock was associated with a lower rate of successful conversion of ventricular fibrillation among 60 hospital and prehospital patients. Ko et al[22] reviewed electronic ECG tracings in 52 cases of out-of-hospital witnessed ventricular fibrillation and demonstrated a positive correlation between the quality of CPR and survival. In that study, the number of chest compressions delivered was one component of quality CPR.[22] Eftestol et al[23] observed that increasing hands-off time (the reciprocal of chest compression fraction) just before out-of-hospital defibrillation in 156 cases correlated with a lower rate of return of spontaneous circulation. The present results also support the large before-and-after study by Bobrow et al[24] in which they demonstrated an increase in survival in an emergency medical services system after training responders to adhere to a protocol of 200 uninterrupted compressions before and after the first analysis.

The present study is the largest clinical investigation to evaluate the independent association between chest compression fraction in the minutes before the first attempted defibrillation and survival to hospital discharge. There are several unique aspects of this Resuscitation Outcomes Consortium investigation. It includes a large cohort of cardiac arrest patients with outcome data and CPR process information that were collected prospectively by use of standardized operational definitions. The primary analysis was determined a priori without the bias of preliminary data exploration. These data represent a diverse group of emergency medical services providers within North America, including large cities, rural areas, and a multitude of systems and populations, all of which used a common database. Because sites had varying levels of ECG upload and monitoring sophistication, the majority of cases were contributed by 2 sites with preexisting ability to analyze ECG recordings. For part of the collection period, the cardiac arrest protocol at these 2 sites recommended that emergency medical services providers deliver continuous chest compressions with superimposed ventilations at 8 to 10 per minute before and after endotracheal intubation. The post hoc analysis of the adjusted odds ratios of survival did not differ substantively whether all sites were included or only the 2 most prominent sites.

These data suggest that increasing the chest compression fraction is an effective approach to improving outcomes from sudden cardiac arrest. This is an important finding that is
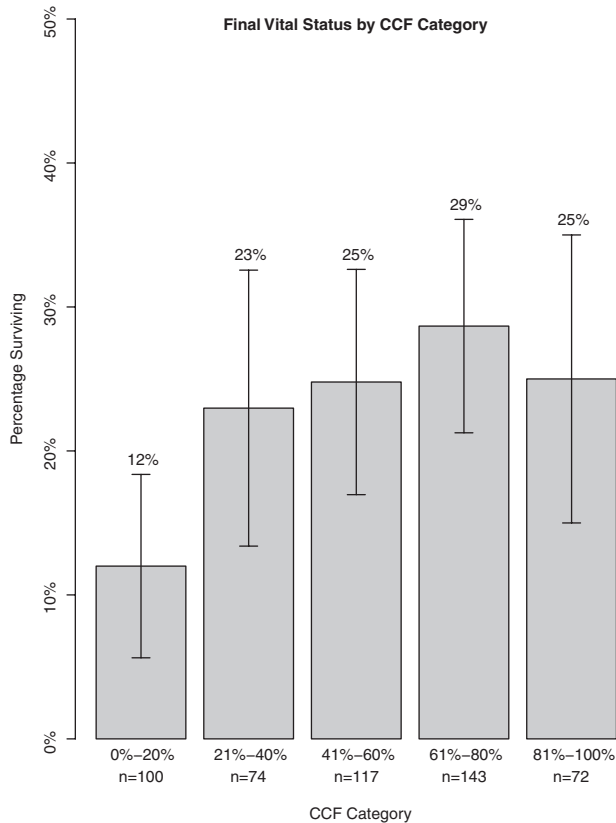
Figure 2. Survival to discharge for each category of chest compression fraction.

Table 3. Survival and Factors Potentially Associated With Survival to Hospital Discharge

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)*
OR (95% CI) of survival for chest compression fraction categories		
0–20%	Reference	Reference
21–40%	2.19 (0.97–4.92)	2.27 (0.92–5.57)
41–60%	2.42 (1.16–5.04)	2.39 (1.06–5.40)
61–80%	2.95 (1.46–5.96)	3.01 (1.37–6.58)
81–100%	2.44 (1.09–5.47)	2.33 (0.96–5.63)
OR (95% CI) of factors associated with survival		
CC fraction (linear, 10% change)	1.12 (1.04–1.22)	1.11 (1.01–1.21)
Bystander CPR	1.24 (0.82–1.88)	1.14 (0.73–1.78)
Bystander-witnessed arrest	2.35 (1.39–3.98)	2.28 (1.31–3.95)
Age (10-year increase)	0.71 (0.62–0.82)	0.72 (0.63–0.84)
Male sex	0.81 (0.49–1.34)	0.69 (0.40–1.20)
Minutes from 9-1-1 call to presence at scene	0.92 (0.84–1.00)	0.94 (0.86–1.03)
Chest compression rate (10-compressions/min increase)	1.07 (1.00–1.15)	1.02 (0.94–1.11)
Public location	1.83 (1.20–2.80)	1.66 (1.04–2.64)

OR indicates odds ratio; CI, confidence interval.

*Model includes bystander CPR attempted, bystander witnessed, age, sex, time from 9-1-1 call to arrival on scene, chest compression fraction category, chest compression rate, and public location. The model for the linear effect of CCF does not include CCF category.

relatively easily implemented and widely generalizable. The optimal level of chest compression fraction that defines a practical goal for emergency medical services training and quality improvement, however, cannot be established by the present study.

A curious finding in the present analysis was the modest reduction in the point estimate of survival in the highest category of chest compression fraction (81% to 100%) compared with the next-highest category (61% to 80%). The most likely reason is due to the small sample size and wide confidence limits. Other possible reasons include a true plateau effect of chest compression fraction above 80%, association of better performance in patients who are perceived as unlikely to survive, or the chance inclusion of patients in this group with variables associated with poor survival that were not included in the present model. Some of the characteristics in this group were unusual compared with other groups, including a slightly prolonged time to first shock; a higher proportion of cases with advanced life support personnel on the scene first; a longer period of electronic tracing before defibrillation, which may suggest inordinately long CPR before defibrillation; and a higher probability of epinephrine use. It is unknown but possible that 1 or more of these variables are associated with a reduction in survival.

The spline graph (Figure 3) depicts how a survival curve related to chest compression fraction (CCF) may appear over a more complete range of values. Moving from low levels of chest compression fraction to intermediate levels provides

clinically significant benefit. Above the middle range, an incremental benefit continues but is less dramatic. More research is required to better define the optimum target for chest compression fraction. Nevertheless, this spline curve based on clinical data supports the evidence that increasing preshock coronary and cerebral blood flow can improve outcome.

These findings are especially important in clinical practice. Chest compression fraction is often poor and therefore provides significant opportunity for improvement. Improving the chest compression fraction is a matter of education and subsequent behavior change. With the use of new technology, such as that used in the present study, the behavior change can be measured and appropriate feedback given to emergency medical services personnel. It is also possible to provide direct, real-time feedback to emergency medical services personnel during actual CPR. The impact of real-time feedback on quality CPR and training programs is under evaluation. We believe that the survival benefit of increasing chest compression fraction is real and that improving care by increasing chest compression fraction is a relatively easy and inexpensive intervention.

Study Limitations
The present study has several limitations. First, because this is an observational cohort study, it can only establish an association between chest compression fraction and survival rather than a causal relationship. It is possible that chest
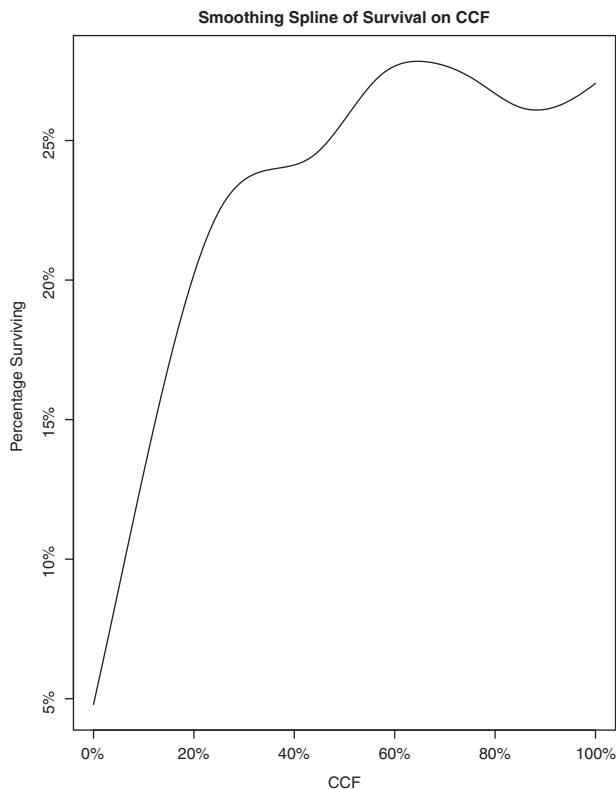
Figure 3. Smoothing spline representing the incremental probability of survival corresponding to a linear increase in chest compression fraction.

compression fraction is correlated with an unmeasured determinant of survival (eg, rescuer commitment to the resuscitation or expectation of patient survival). Nevertheless, we believe a causal relationship is likely. The present findings are biologically plausible; an increase in the intervention incrementally improved the clinical outcome; preclinical experimental trials in animals support a direct causal relationship[19,20,25]; and no differential effect from chest compression fraction was observed across sites. A second limitation is the possibility of selection bias introduced by the exclusion of patients who were less likely to survive. It is possible that these excluded patients represent those who received poorer quality of CPR, including reduced chest compression fraction, although this is impossible to verify. Should this have been the case, and such patients included in the analysis, it is likely that the number of patients in the two lower categories would increase, which would result in greater precision of our effect estimate. A third limitation is that the majority of cases contributed to the present study came from 2 sites with preexisting ability to analyze electronic resuscitation recordings; however, the inclusion of study site in the multivariate analysis did not substantially alter the relationship observed between chest compression fraction and survival. Likewise, limiting the analysis to the 2 sites that provided the largest number of cases yielded similar results.

Conclusions

Chest compression fraction appears to be an important determinant of survival from cardiac arrest, but many questions remain unanswered. These include whether uninter-

rupted chest compressions are more important during specific periods before and after the shock than at others times,[20,21,26] the optimal duration of preshock CPR for prolonged ventricular fibrillation,[27,28] and the relative importance of chest compression fraction immediately after the shock, which may be a critical time for stabilizing an organized electrical activity and reestablishing adequate myocardial contractility.

Increasing chest compression fraction during out-of-hospital resuscitation of patients with ventricular fibrillation/tachycardia is an independent determinant of survival to hospital discharge. These data strongly support the contention that more time spent performing chest compressions in the early phase of resuscitation substantially affects survival to hospital discharge. Implementation of strategies to alter resuscitation practices to maximize chest compression fraction are likely to result in a real and sustainable increase in survival from cardiac arrest.

Disclosures

None.

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CLINICAL PERSPECTIVE

Sudden cardiac death is an epidemic with an extremely high mortality rate. Recent attention to this problem provides hope that better clinical management even after heart arrest can have a very important influence on survival. The quality of cardiopulmonary resuscitation is important. The proportion of time in which chest compressions are performed in each minute of cardiopulmonary resuscitation is one key modifiable aspect of quality cardiopulmonary resuscitation. This observational cohort study of patients from the Resuscitation Outcomes Consortium Cardiac Arrest Epistry estimated the effect of an increasing proportion of time spent performing chest compressions during cardiac arrest on survival to hospital discharge in patients with out-of hospital ventricular fibrillation. Overall, 23% of patients survived. After adjustment for age, gender, location, bystander cardiopulmonary resuscitation, bystander witness status, and response time, the odds ratios of surviving to hospital discharge in the 2 highest categories of chest compression fraction compared with the reference category were 3.01 (95% confidence interval 1.37 to 6.58) and 2.33 (95% confidence interval 0.96 to 5.63). The estimated adjusted linear effect on odds ratio of survival for a 10% change in chest compression fraction was 1.11 (95% confidence interval 1.01 to 1.21). This study confirms that an increase in the chest compression fraction (hands-on time) during out-of-hospital resuscitation of patients with ventricular fibrillation/tachycardia is an independent determinant of survival to hospital discharge. Cardiopulmonary resuscitation protocols devised to take advantage of this simple fact can save thousands of lives each year and would be extremely inexpensive to implement.