Out-Of-Hospital Management and Outcomes of Sudden Cardiac Death

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[redacted]

Pathophysiology of Cardiac Arrest

Electrical Phase

Less than four minutes following arrest, the cardiac muscle uses its sugar/oxygen stores.

Circulatory Phase

From four to ten minutes following arrest, the cardiac muscle switches to anaerobic metabolism.

Metabolic Phase

Greater than ten minutes following arrest, cardiac cells swell, rupture, and die.

CPR TIME LIMIT

- 0-4 mins. brain damage unlikely
- 4-6 mins. brain damage possible
- 6-10 mins. brain damage probable
- over 10 mins. probable brain death

Sudden Cardiac Death (SCD) Definition

'Natural death due to cardiac causes, within one hour of the onset of acute symptoms in a person with known or unknown cardiac disease, but the time and mode of death are unexpected'.

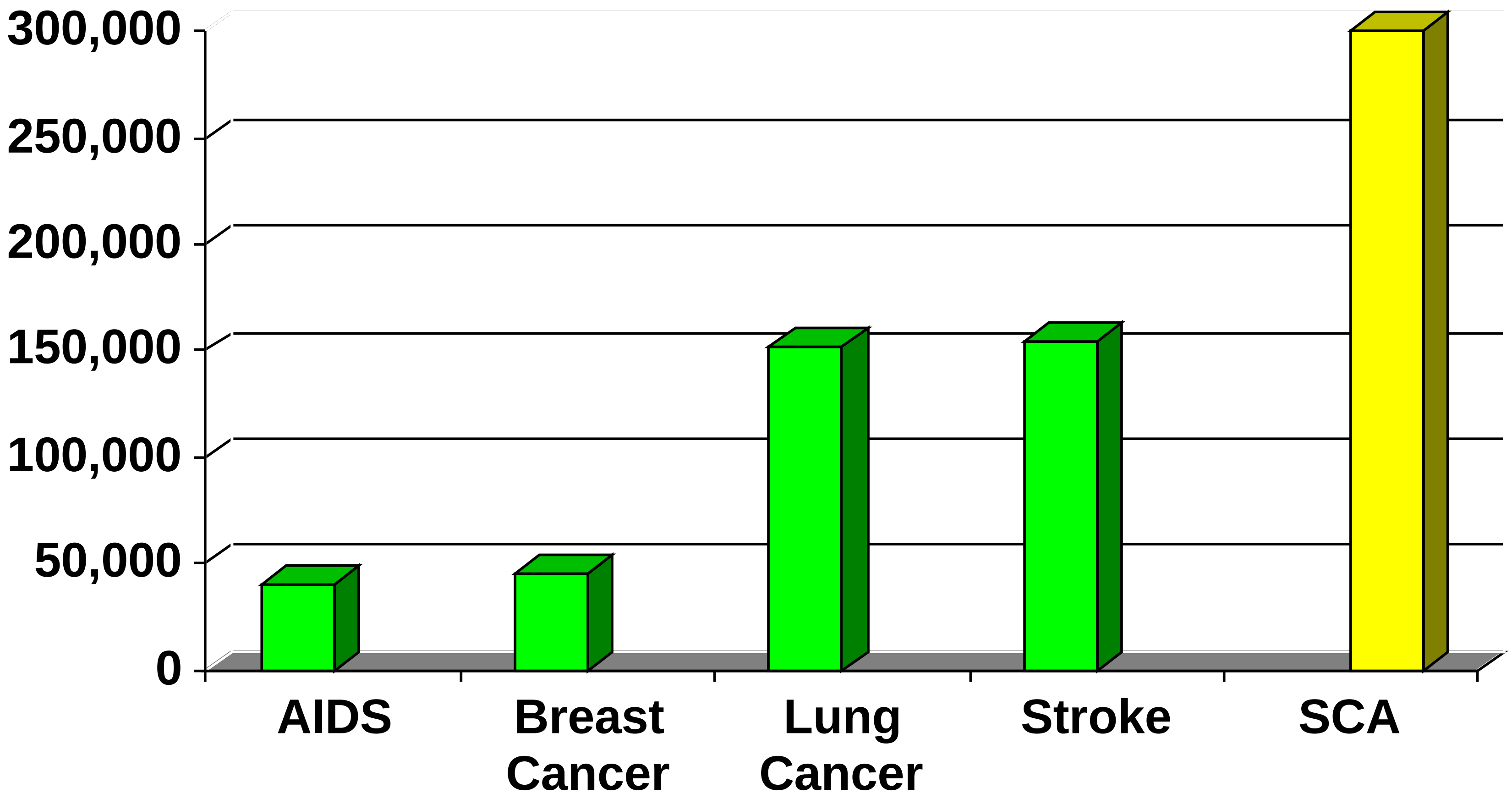
Sudden Cardiac Death
A Major Public Health Problem

- 1/2 of all cardiac deaths
- 1/7 of all deaths

SCD: Epidemiology

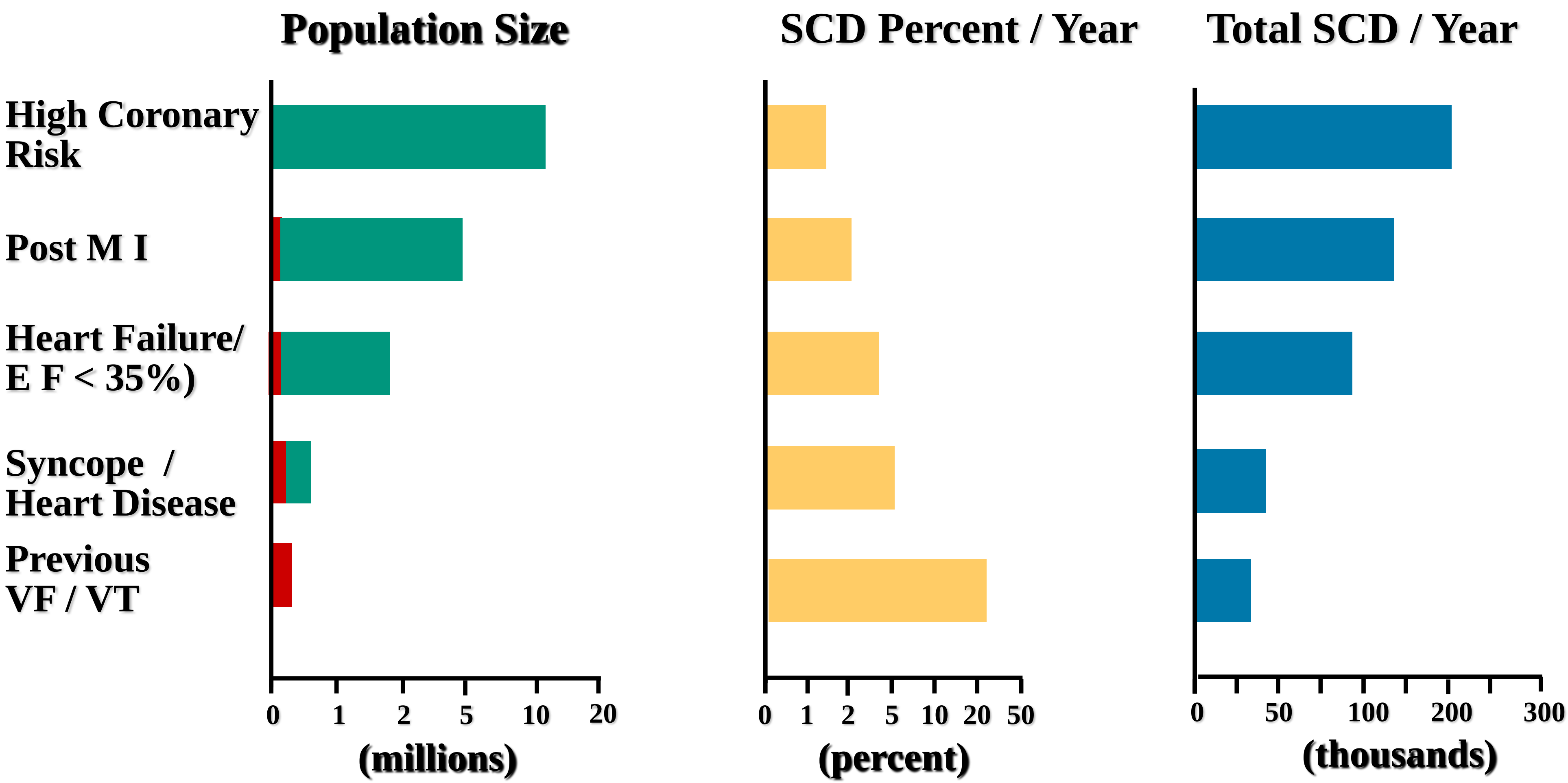
- 250,000 to 460,000 persons die each year of SCD in the US.
- 0.1 – 0.2 % / year in the adult population
- First presentation for 25 – 50 % of Cardiac Disease.
- More common in men.
- Peak age: 40 – 70 y

Sudden Cardiac Arrest is one of the Leading Causes of Death in the U.S.



Source: Statistical Abstract of the U.S. 1998, Hoover's Business Press, 118th Edition

High Risk Groups for SCD



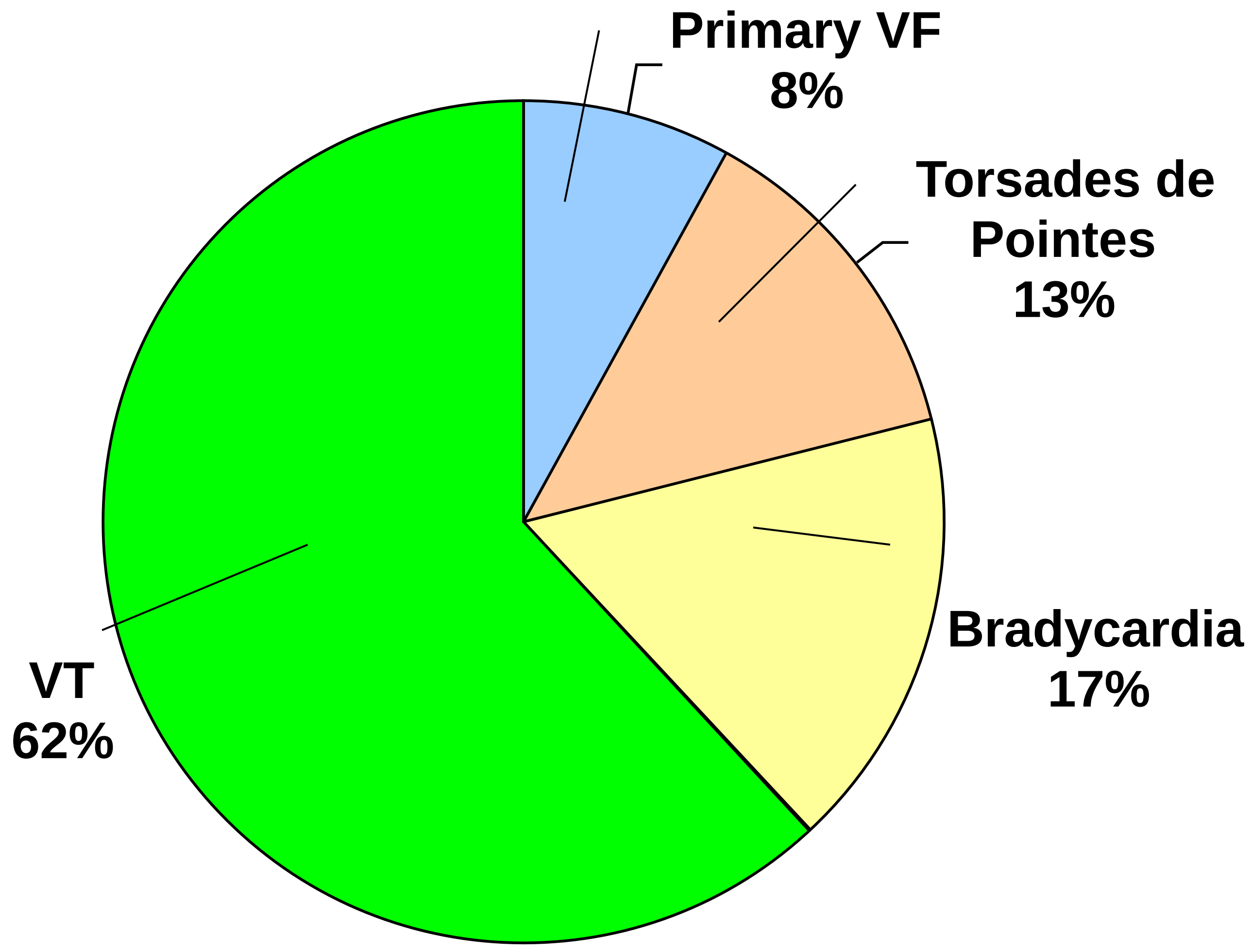
Adapted from Myerburg

Table 1 **The different groups that contribute to the total number of sudden cardiac deaths and our current ability to identify possible candidates before the event**

	% of all SCD	Predictability
Not diagnosed with heart disease	45	Poor
History of heart disease: LVEF >40%	40	Limited
History of heart disease: LVEF <40%	13	Possible
Genetically based arrhythmic disease	2	Limited

SCD, sudden cardiac death; LVEF, left ventricular ejection fraction.

Underlying Arrhythmia of Sudden Cardiac Arrest



What do we know about SCD in Athletes?

- 12-15 million young (<30 years) competitive athletes in the US
- Estimated incidence of sudden cardiac death at 2.1 per 100 000 athletes per year
- Estimated 200 athletes in the US die per year of sudden cardiac death
- Sudden death of the young athletes is mostly unexpected, dramatic, tragic and carries huge emotional impact on the society

WHAT IS KNOWN

- Two resuscitation rules for emergency medical services (EMS) personnel have recently been shown to accurately predict which out-of-hospital cardiac arrest (OHCA) patients warrant rapid transport to the hospital for further care. These rules use 5 clinical criteria to predict survival from OHCA-arrest witnessed by a bystander, arrest witnessed by EMS, provision of bystander cardiopulmonary resuscitation (CPR), shockable cardiac rhythm, and return of spontaneous circulation (ROSC) in the field. Recently, 3 independent teams of researchers validated these decision rules with a misclassification rate of 0.1%.

Circulation
Cardiovascular Quality and Outcomes

Predictors of Survival From Out-of-Hospital Cardiac Arrest: A Systematic Review and Meta-Analysis

Comilla Sasson, Mary A.M. Rogers, Jason Dahl and Arthur L. Kellermann

Circ Cardiovasc Qual Outcomes. 2010;3:63-81; originally published online November 10, 2009;

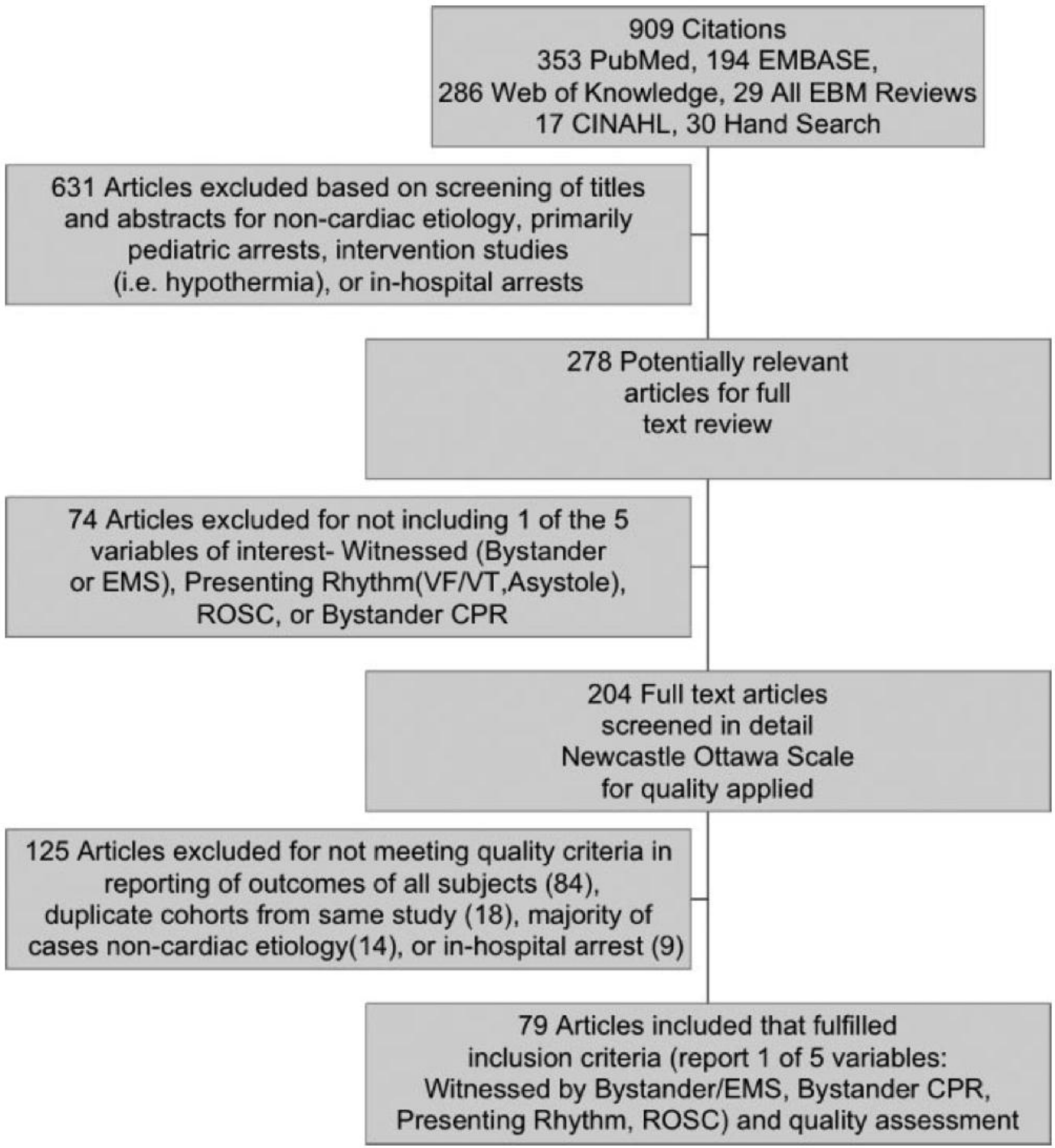


Figure 1. Flowchart of meta-analysis.

WHAT THE STUDY ADDS

- This meta-analysis brings together 30 years of research, involving more than 142 000 patients. Our findings conclusively affirm the value of bystander CPR, the critical importance of "shockable" rhythms, and the predictive value of ROSC in the prehospital setting.
- Forty percent of patients with OHCA are found with ventricular fibrillation/ventricular tachycardia, yet only 22% achieve ROSC. This group may be a priority population for future efforts to improve ROSC and survival to hospital discharge.
- The magnitude of effect sizes for the 5 clinical factors, such as provision of bystander CPR and an initial rhythm of ventricular fibrillation/ventricular tachycardia, are higher in communities that have low baseline survival rates. This suggests that efforts such as targeted CPR training to increase bystander CPR rates will have their greatest effect in communities with low baseline rates of survival.
- Survival from OHCA has not significantly improved in almost 3 decades, despite enormous efforts in research spending and the development of novel drugs and devices. The aggregate survival rate, recorded across various populations, is between 6.7% and 8.4%.

Resuscitation 89 (2015) 50–57

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical Paper

Comparison of out-of-hospital cardiac arrest occurring before and after paramedic arrival: Epidemiology, survival to hospital discharge and 12-month functional recovery☆

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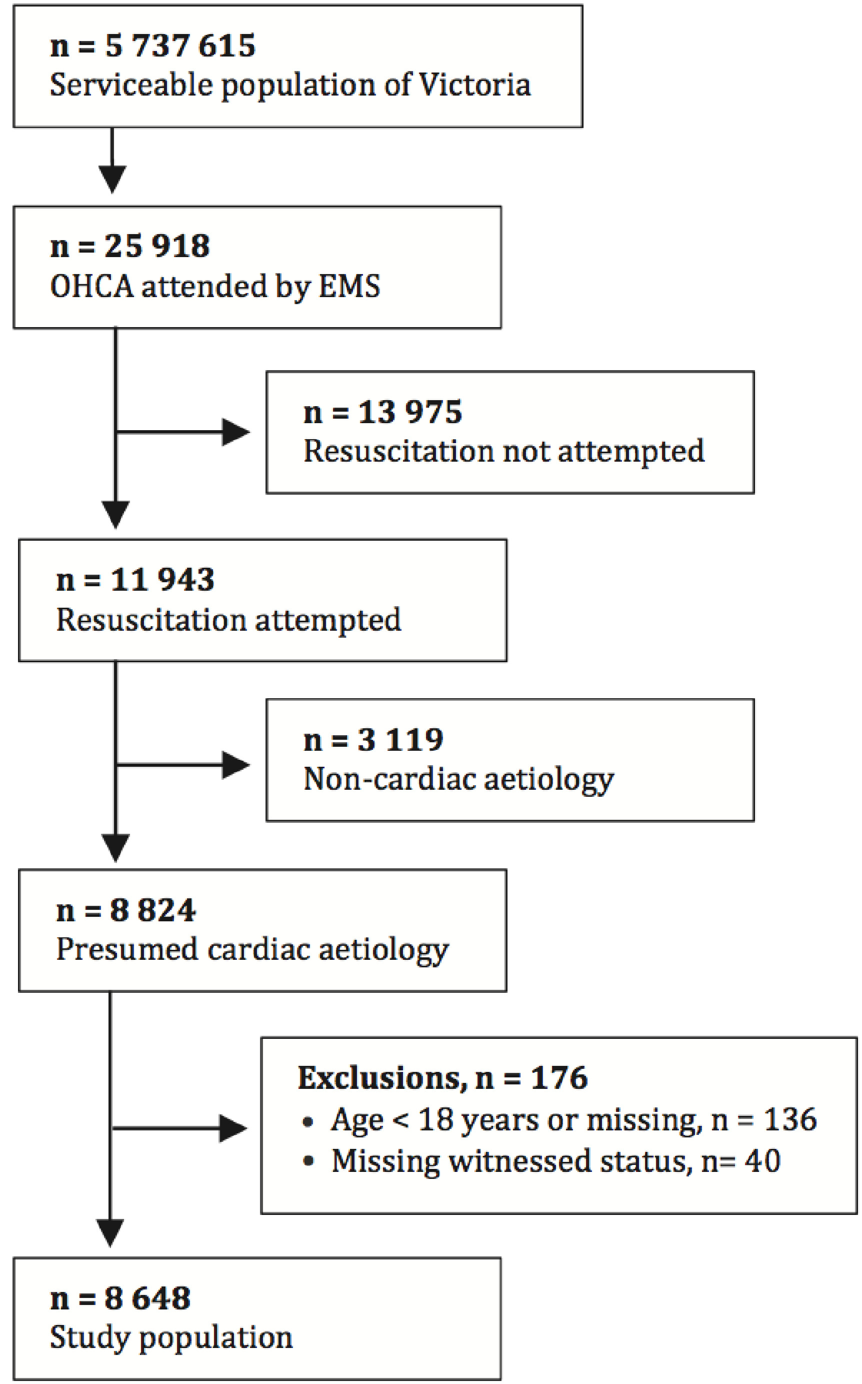
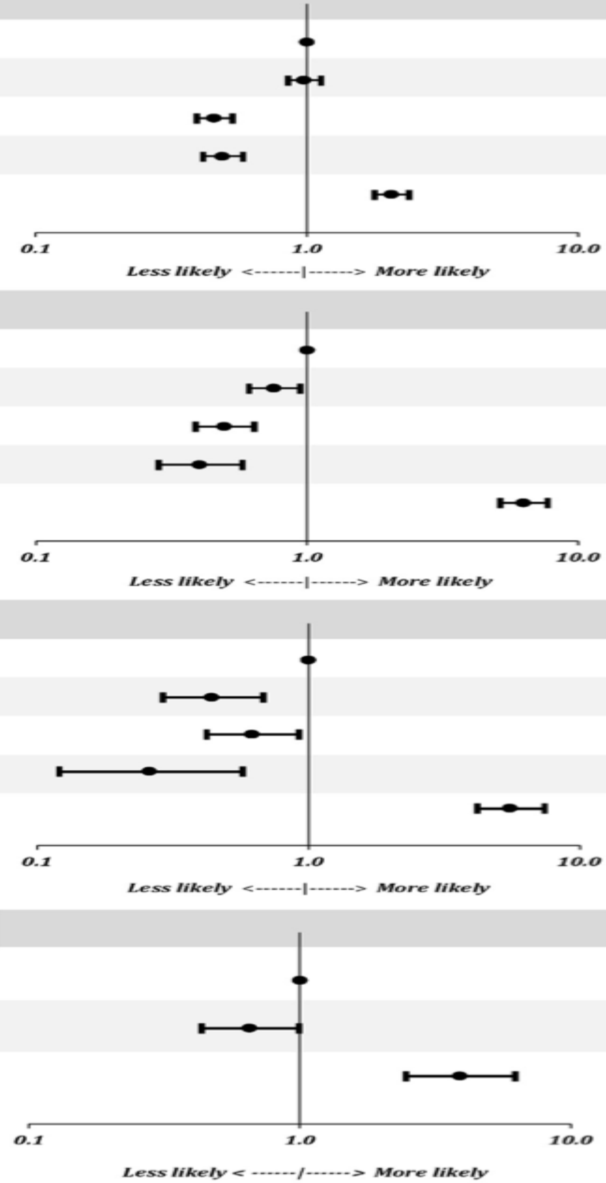


ꞔ. **1.** Patient selection between 1st July 2008 and 30th June 2013 in Victoria, stralia. EMS, emergency medical services.

Outcome	*Adjusted OR (95% CI)*	*p-Value*
Survival to hospital †		
Bystander witnessed, bystander CPR	1.00 (Reference)	-
Bystander witnessed, no bystander CPR	0.98 (0.85 – 1.12)	0.725
Unwitnessed, bystander CPR	0.46 (0.39 – 0.53)	<0.001
Unwitnessed, no bystander CPR	0.49 (0.41 – 0.58)	<0.001
EMS Witnessed	2.02 (1.75 – 2.35)	<0.001
Survival to hospital discharge ‡		
Bystander witnessed, bystander CPR	1.00 (Reference)	-
Bystander witnessed, no bystander CPR	0.76 (0.61 – 0.94)	0.011
Unwitnessed, bystander CPR	0.50 (0.39 – 0.64)	<0.001
Unwitnessed, no bystander CPR	0.41 (0.28 – 0.58)	<0.001
EMS Witnessed	6.16 (5.04 – 7.52)	<0.001
Survival to 12 months post arrest with good functional recovery (GOSE ≥ 7) ∫		
Bystander witnessed, bystander CPR	1.00 (Reference)	-
Bystander witnessed, no bystander CPR	0.44 (0.29 – 0.68)	<0.001
Unwitnessed, bystander CPR	0.62 (0.42 – 0.93)	0.016
Unwitnessed, no bystander CPR	0.26 (0.12 – 0.57)	0.001
EMS Witnessed	5.56 (4.18 – 7.40)	<0.001
Survival to hospital discharge in cases with an initial shockable rhythm ∬		
Bystander witnessed, bystander CPR, PAD used	1.00 (Reference)	-
Bystander witnessed, bystander CPR, no PAD used	0.65 (0.43 – 0.99)	0.043
EMS Witnessed	3.90 (2.45 – 6.20)	<0.001



* Models adjusted for: age, gender, public location, metropolitan region, and shockable rhythm on arrest.

† Model includes all cases over the study period (n=8529), and excludes 119 (1.4%) cases with missing data.

‡ Model includes all cases over the study period (n=8460), and excludes 188 (2.2%) cases with missing data.

∫ Model includes cases between January 2010 and June 2013 (n=5734), and excludes 273 (4.5%) cases with missing data.

∬ Model includes bystander witnessed and EMS witnessed cases with an initial shockable rhythm (n=2252), and excludes 67 (3.0 missing data. Model adjusted for: age, gender, public location, and metropolitan region.

Fig. 3. Adjusted odds ratios (95% CIs) for survival across witness groups.*

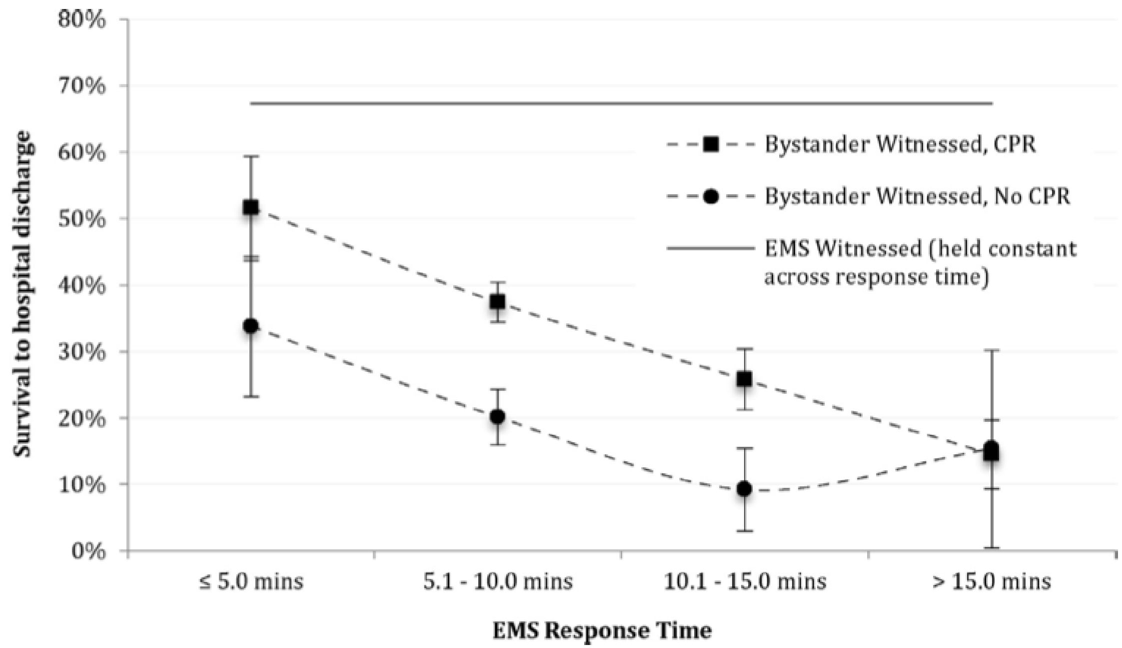


Fig. 4. Proportion of bystander witnessed and EMS witnessed cases with an initial shockable arrest rhythm who survive to hospital discharge. Error bars represent 95% confidence intervals.

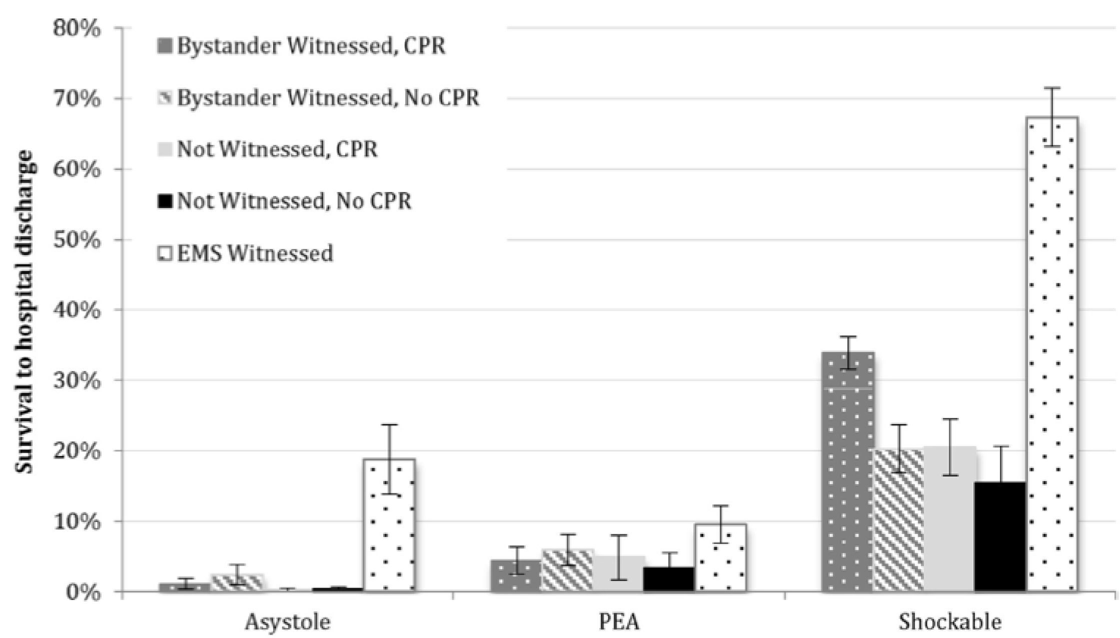


Fig. 5. Crude survival to hospital discharge proportions across witness groups stratified by rhythm of arrest. Error bars represent 95% confidence intervals.

Circulation
Cardiovascular Interventions

American Heart Association®

Immediate Percutaneous Coronary Intervention Is Associated With Better Survival After Out-of-Hospital Cardiac Arrest: Insights From the PROCAT (Parisian Region Out of Hospital Cardiac Arrest) Registry

Florence Dumas, Alain Cariou, Stéphane Manzo-Silberman, David Grimaldi, Benoît Vivien, Julien Rosencher, Jean-Philippe Empana, Pierre Carli, Jean-Paul Mira, Xavier Jouven and Christian Spaulding

Circ Cardiovasc Interv. 2010;3:200-207; originally published online May 18, 2010;
doi: 10.1161/CIRCINTERVENTIONS.109.913665

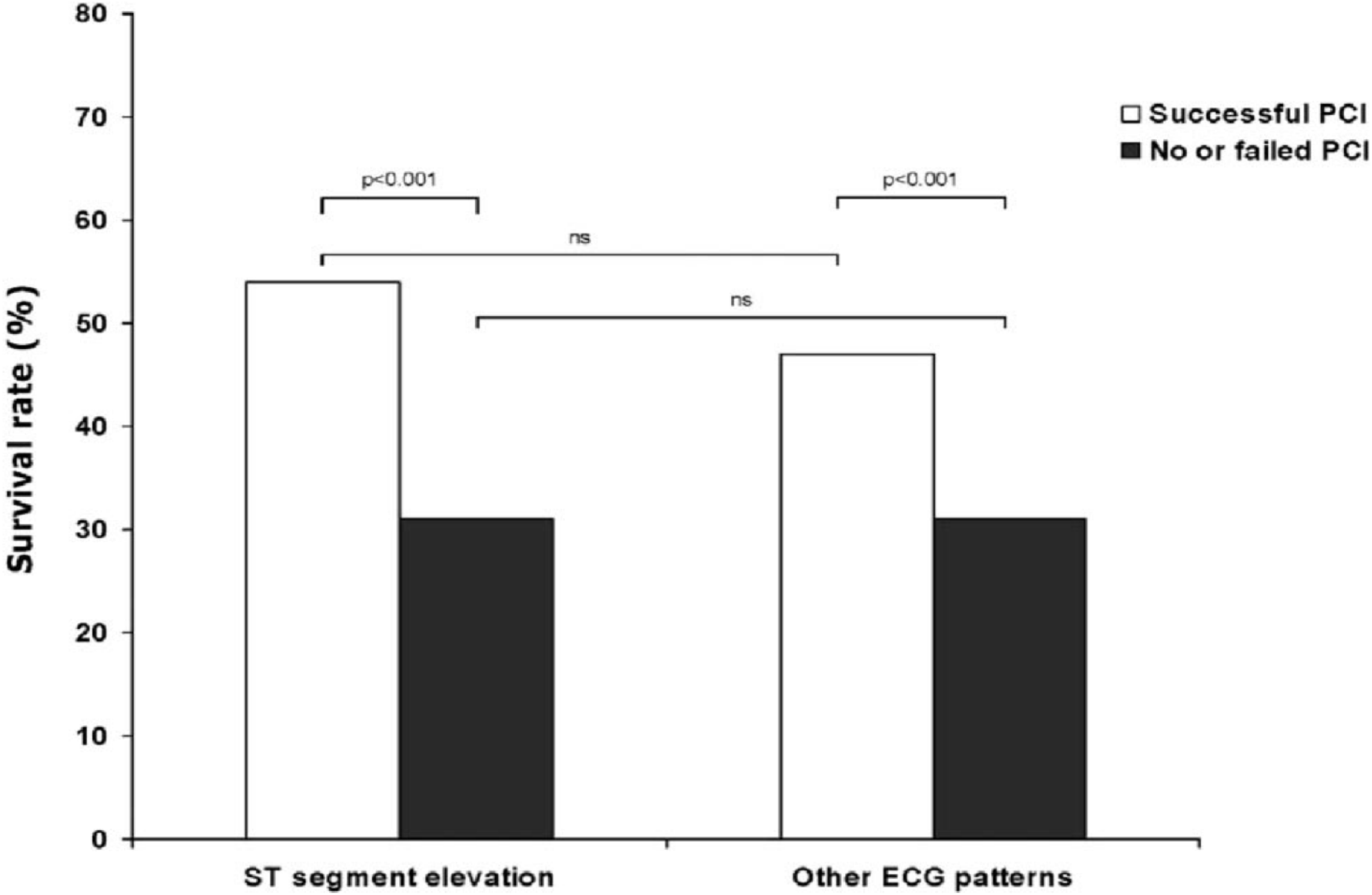
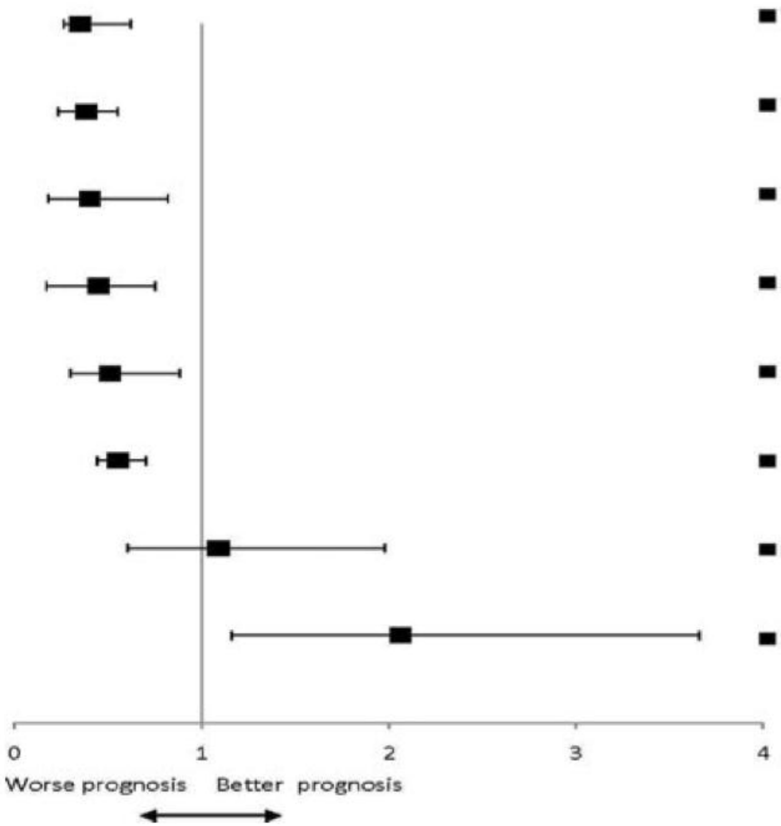


Figure 2. Survival rates according to the performance and outcome of PCI. ns indicates not significant.



	OR	[95% Conf.Interval]	p-value
Time From BLS to ROSC ≥ 15 minutes	0.28	(0.19-0.55)	< 0.001
Time From Collapse to BLS > 5 minutes	0.32	(0.17-0.49)	<0.001
Diabete mellitus	0.42	(0.20-0.84)	0.015
Age> 59yrs	0.45	(0.27-0.75)	0.002
Initial Arrest Rhythm: Asystole/PEA	0.51	(0.30-0.88)	0.035
Blood lactate (for each quartile increase)	0.55	(0.44-0.70)	< 0.001
ST segment elevation	1.09	(0.60-1.98)	0.778
Successfull PCI	2.06	(1.16-3.66)	0.013

Figure 3. Multivariable logistic regression analysis of early predictors of survival in patients with OHCA without obvious extracardiac causes. PEA indicates pulseless electrical activity.

In conclusion, in this selected cohort of 435 patients with OHCA of presumed cardiac origin, a high rate of coronary artery lesions was found. The predictive value of postresuscitation ECG data was poor. Successful PCI was associated with an increased hospital survival by multivariate analysis, with similar rates of survival in patients with or without ST-segment elevation. Immediate PCI seems to offer survival benefit in patients with OHCA with no obvious noncardiac cause, regardless of the ECG pattern.

REACT

Recognize

Evaluate

Activate EMS

Cardiac Care

Transport

Target goal of <3 minutes from time of collapse to first shock is strongly recommended

REACT: Cardiac Care

- CPR should be implemented while waiting for an AED
- AED should be applied as soon as possible and turned on for rhythm analysis in any collapsed and unresponsive victim

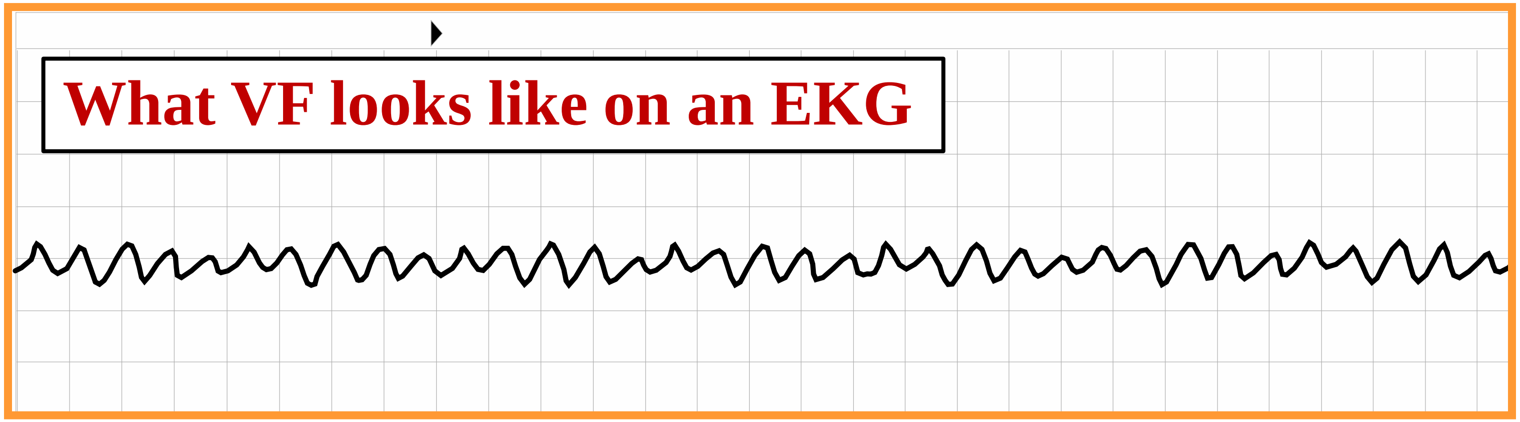
REACT: Cardiac Care
2010 CPR Guidelines

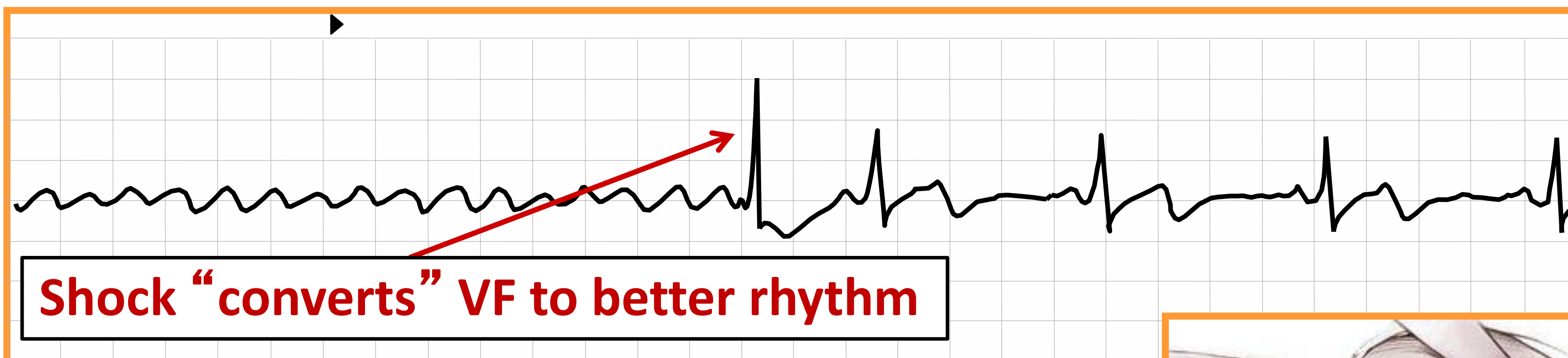
- "Push hard and fast"
  - depth of compression at least 2"
  - rate of at least 100 to 120 compressions per minute
- Allow full chest recoil
- 30:2 compression to breath ratio
- Start with CPR if downtime is unknown or greater than 4-5 minutes
- If downtime < than 4-5 minutes, use AED

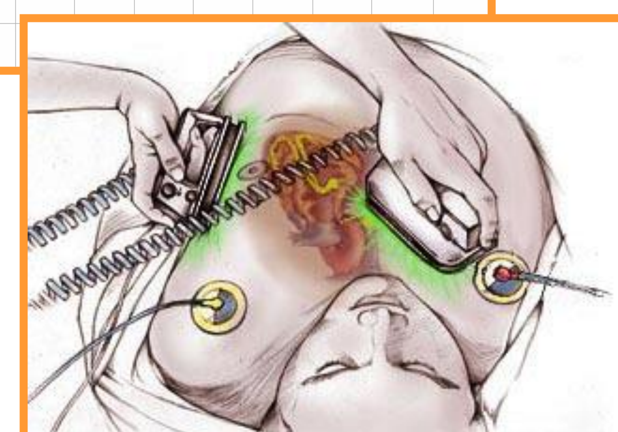
Automated External Defibrillator AED

- Automatically analyzes the patient’s heart rhythm
- Determines whether a shock is needed
- Uses voice and screen prompts to guide the rescuer through the process

Ventricular Fibrillation (VF)

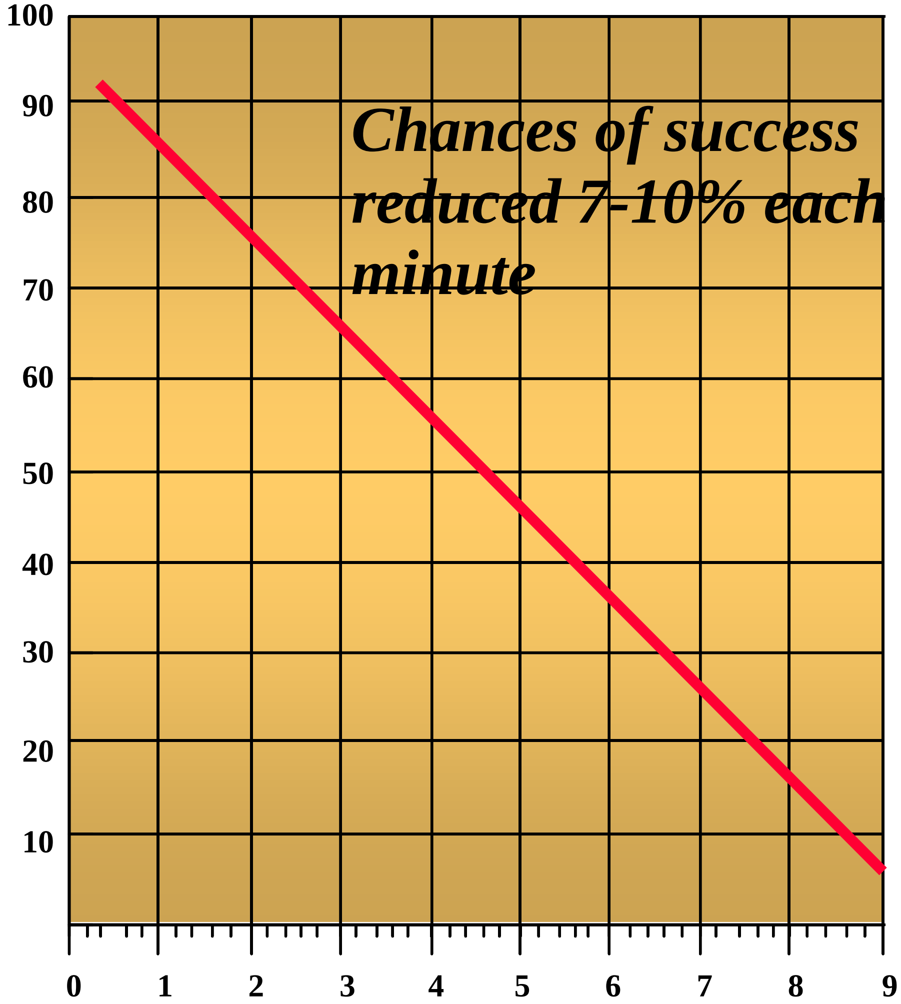






Defibrillation (electrical shock) is the primary solution (cannot be used in other lethal heart rhythms)

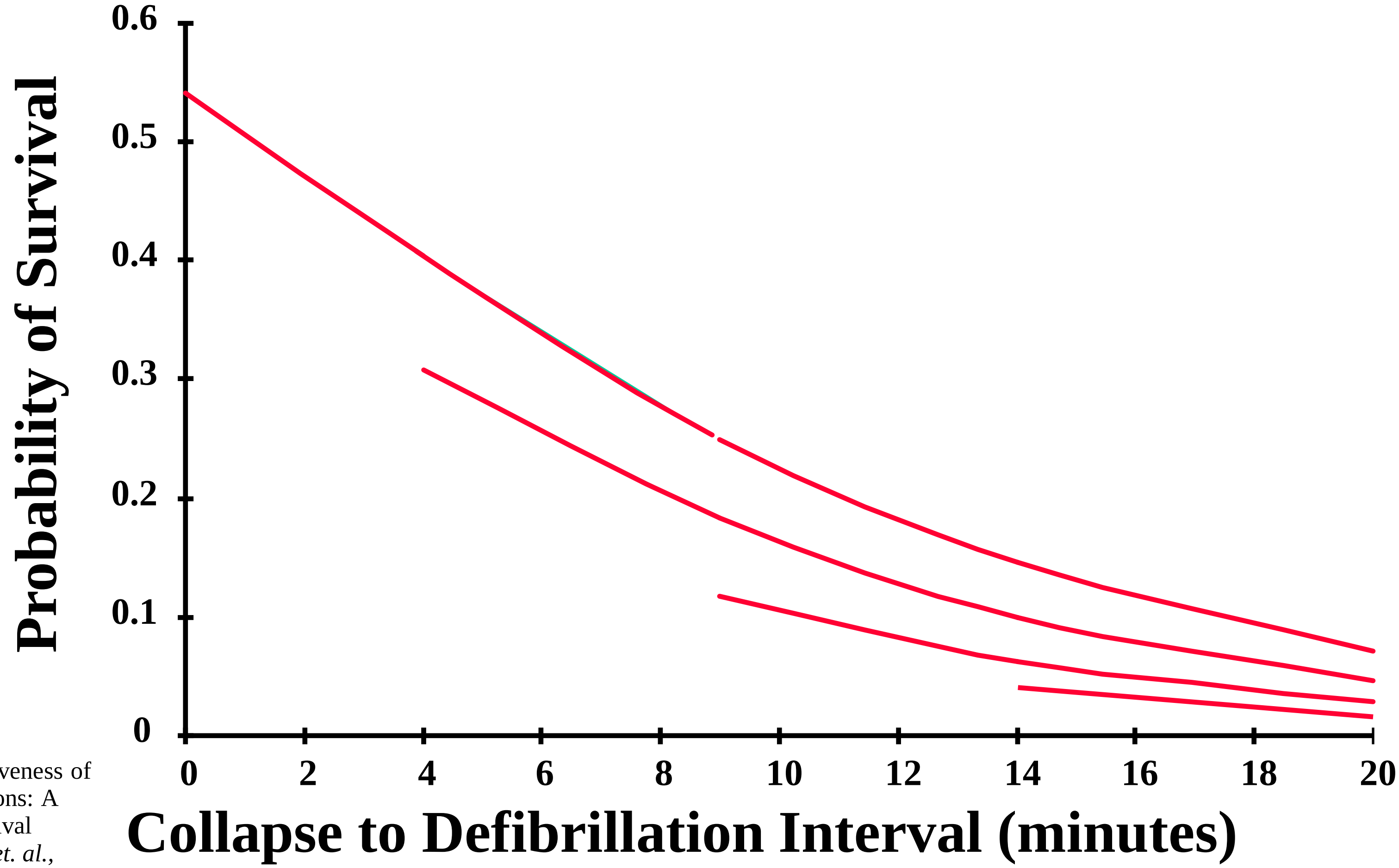
REACT: Cardiac Care



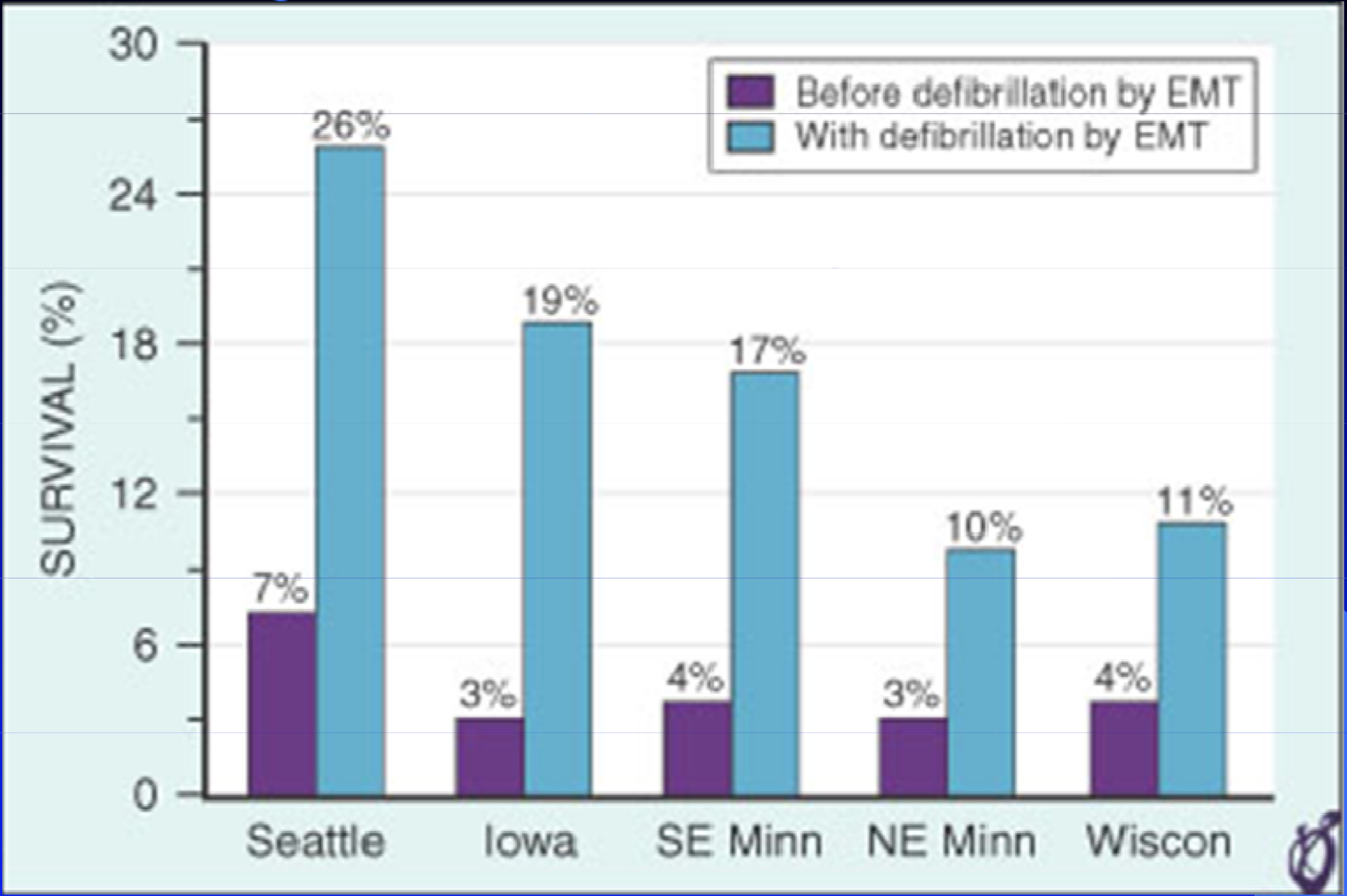
- Single greatest determinate of survival following SCA is the time from collapse to defibrillation, with survival rates declining 7-10% per minute for every minute defibrillation is delayed
- Survival rates as high 49 to 75% with CPR plus defibrillation within 3-5 minutes of collapse

Cummins RO. Ann Emer Med. 1989. 18:1269-1275

REACT: Cardiac Care



From "Estimating Effectiveness of Cardiac Arrest Interventions: A Logistic Regression Survival Model," TD Valenzuela *et. al.*, *Circulation* 1997; 96:3308



Impact of emergency rescue system on out-of-hospital cardiac arrest survival

Journal of the American Heart Association
OPEN ACCESS

American Heart Association | American Stroke Association®

Outcomes of Out–of–Hospital Cardiac Arrest by Public Location in the Public–Access Defibrillation Era

Yukiko Murakami, Taku Iwami, Tetsuhisa Kitamura, Chika Nishiyama, Tatsuya Nishiuchi, Yasuyuki Hayashi, Takashi Kawamura and the Utstein Osaka Project

J Am Heart Assoc. 2014;3:e000533; originally published April 22, 2014;
doi: 10.1161/JAHA.113.000533

Table 4. Outcomes After Bystander-Witnessed Out-of-Hospital Cardiac Arrest of Cardiac Origin at Public Places According to the Location

	Railway Stations (n=118)	Sports Facilities (n=93)	Public Buildings (n=86)	Schools (n=31)	Airports (n=4)	Other Public Spaces (n=562)	*P* Value*
Prehospital ROSC, n (%)	35 (29.7)	46 (49.5)	20 (23.3)	11 (35.5)	1 (25.0)	131 (23.3)	<0.001
Total ROSC, n (%)	69 (58.5)	64 (68.8)	44 (51.2)	19 (61.3)	4 (100.0)	296 (52.7)	0.018
Hospital admission, n (%)	63 (53.4)	65 (69.9)	40 (46.5)	19 (61.3)	4 (100.0)	257 (45.7)	<0.001
1-month survival, n (%)	42 (35.6)	50 (53.8)	27 (31.4)	15 (48.4)	2 (50.0)	146 (26.1)	<0.001
Neurologically favorable outcome, n (%)	33 (28.0)	48 (51.6)	20 (23.3)	13 (41.9)	2 (50.0)	76 (13.6)	<0.001

ROSC indicates return of spontaneous circulation.
**P* values are calculated to test the homogeneity among the 6 location groups.

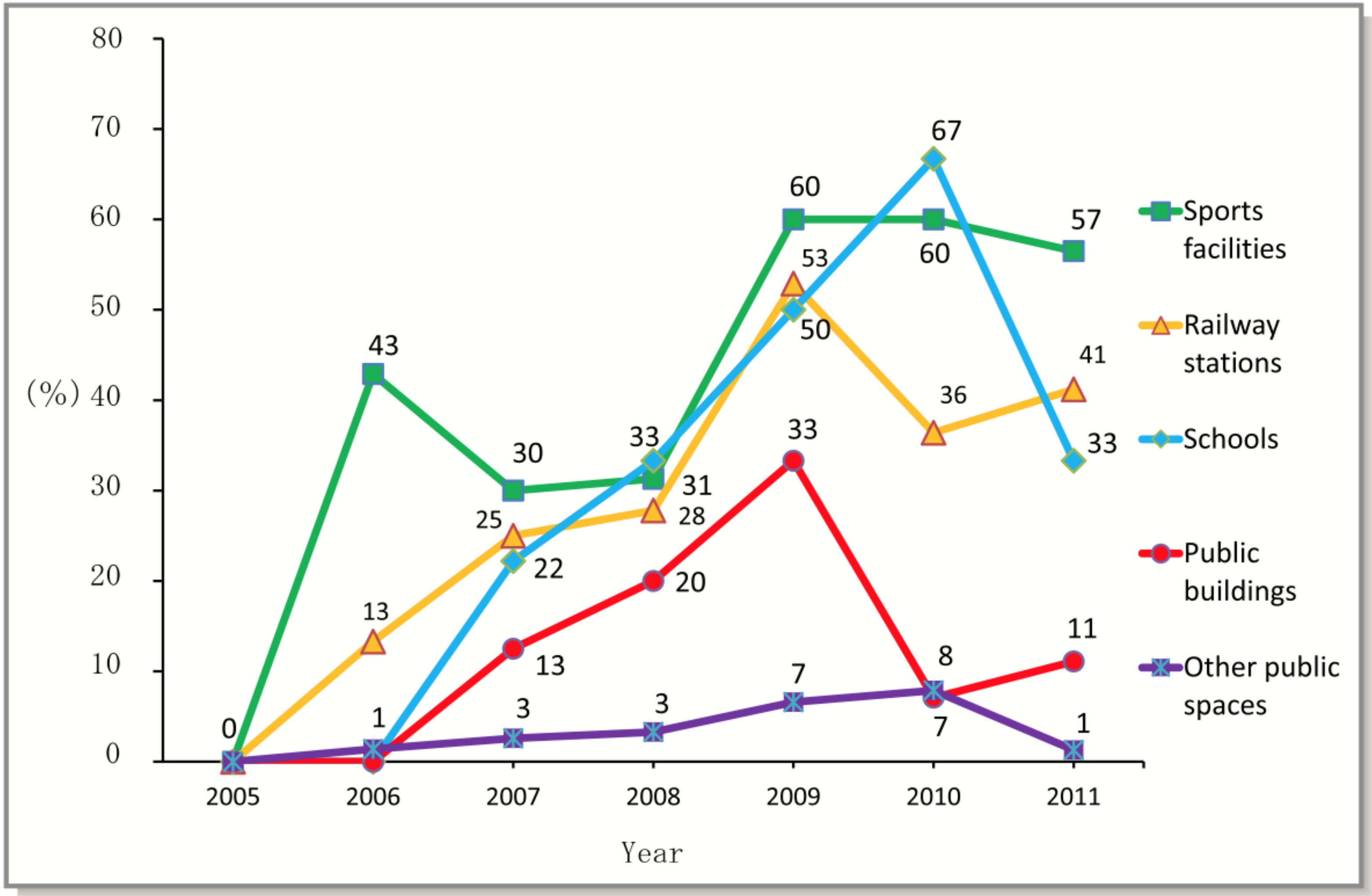


Figure 2. Trends in the proportion of public-access AED use by laypersons among bystander-witnessed OHCAs of cardiac origin in public places according to the location. AED indicates automated external defibrillation; OHCAs, out-of-hospital cardiac arrests.

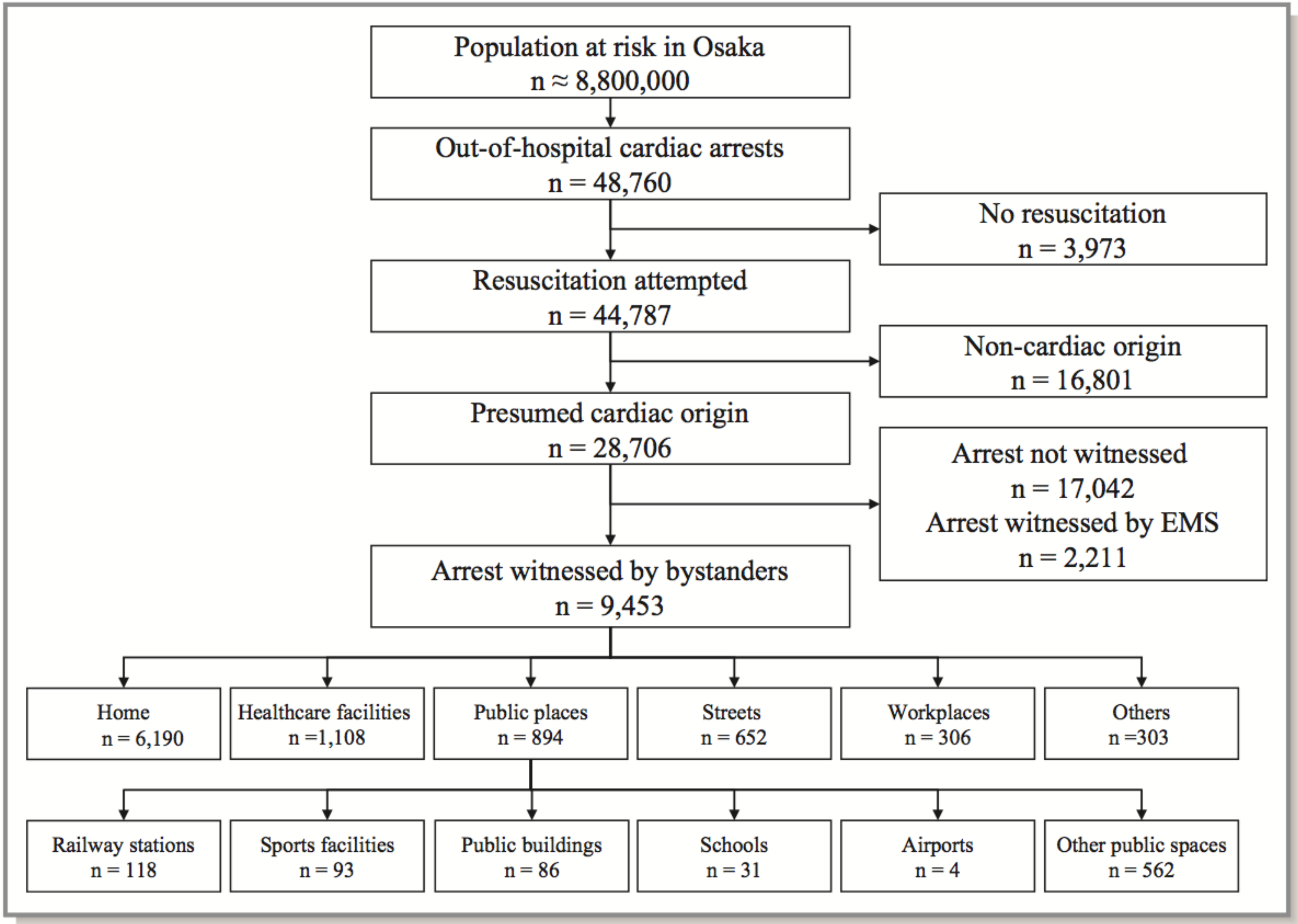


Figure 1. Overview of emergency medical service (EMS)-treated cardiac arrests with an abridged Utstein template from January 1, 2005 to December 31, 2011. EMS indicates emergency medical service.

Conclusions—This large, population-based OHCA registry demonstrated that earlier shock, irrespective the shock provider (bystander or EMS personnel), contributed to improving outcome, and a public-access defibrillation program was successfully implemented so that shocks with public-access AEDs were delivered to over 40% of bystander-witnessed OHCAs and time to shock was shortened in some kinds of public places. **(*J Am Heart Assoc*. 2014;3:e000533 doi: 10.1161/JAHA.113.000533)**

Intensive Care Med (2014) 40:846–854
DOI 10.1007/s00134-014-3252-5

ORIGINAL

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Characteristics and prognosis of sudden cardiac death in Greater Paris

Population-based approach from the Paris Sudden Death Expertise Center (Paris—SDEC)

Fig. 1 Flow chart of patients included during a 2 years period

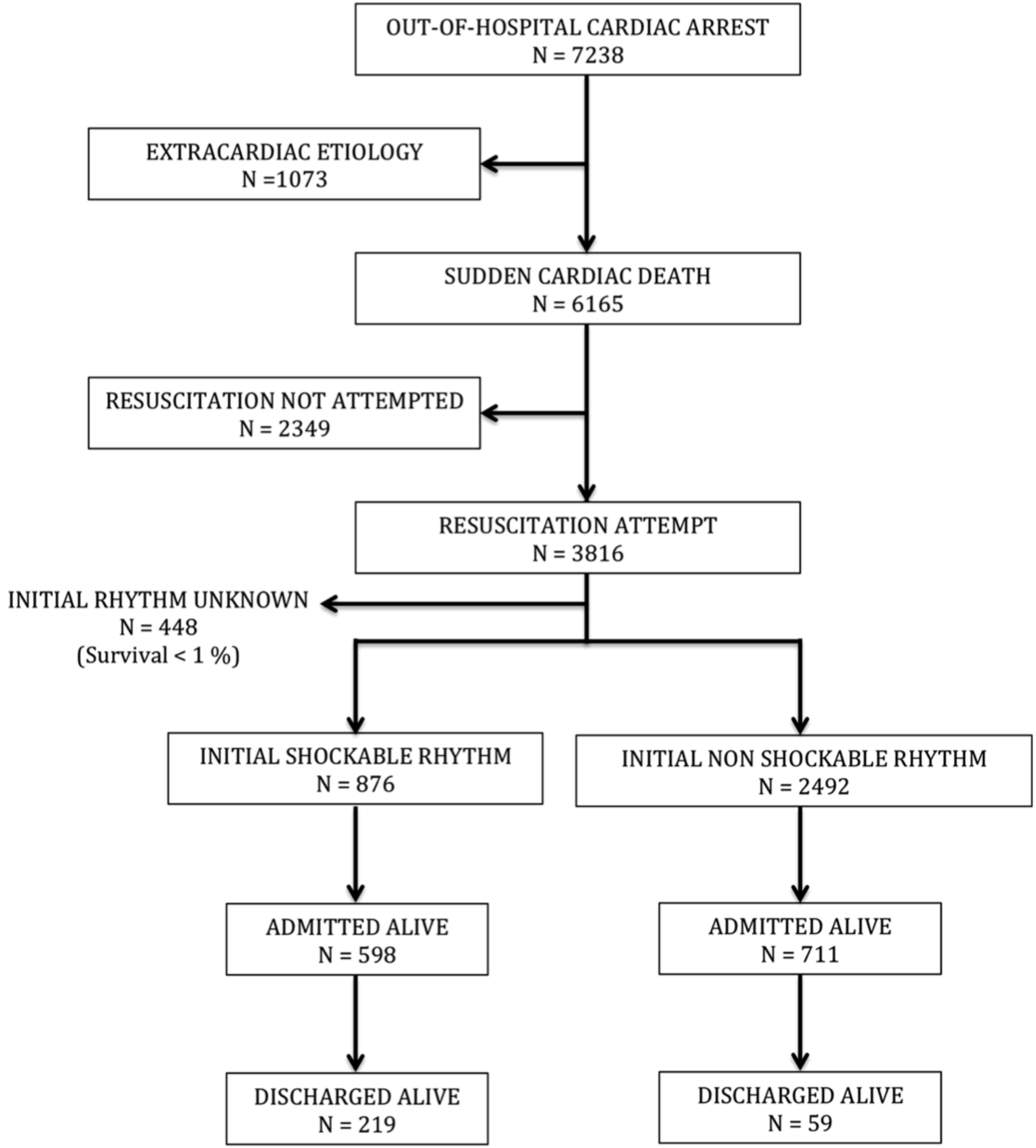


Table 4 Univariate and multivariate analysis of prognosis factors associated with survival at hospital discharge

	Univariate analysis		Multivariate analysis	
	OR (95 % CI)	*P*	OR (95 % CI)	*P*
Male sex	1.4 (1.1–1.9)	0.01	0.9 (0.6–1.3)	0.61
Age, per year	0.97 (0.96–0.97)	<0.001	0.97 (0.96–0.98)	<0.001
Home location	0.18 (0.1–0.2)	<0.001	0.4 (0.3–0.6)	<0.001
Bystander CPR	2.7 (2.0–3.6)	<0.001	2.1 (1.5–3.1)	<0.001
Response time, per min	0.93 (0.90–0.97)	<0.001	0.93 (0.89–0.97)	0.002
Initial shockable rhythm	14.3 (10.6–19.3)	<0.001	11.5 (7.6–17.3)	<0.001
Epinephrine dose >3 mg	0.06 (0.04–0.1)	<0.001	0.05 (0.03–0.08)	<0.001

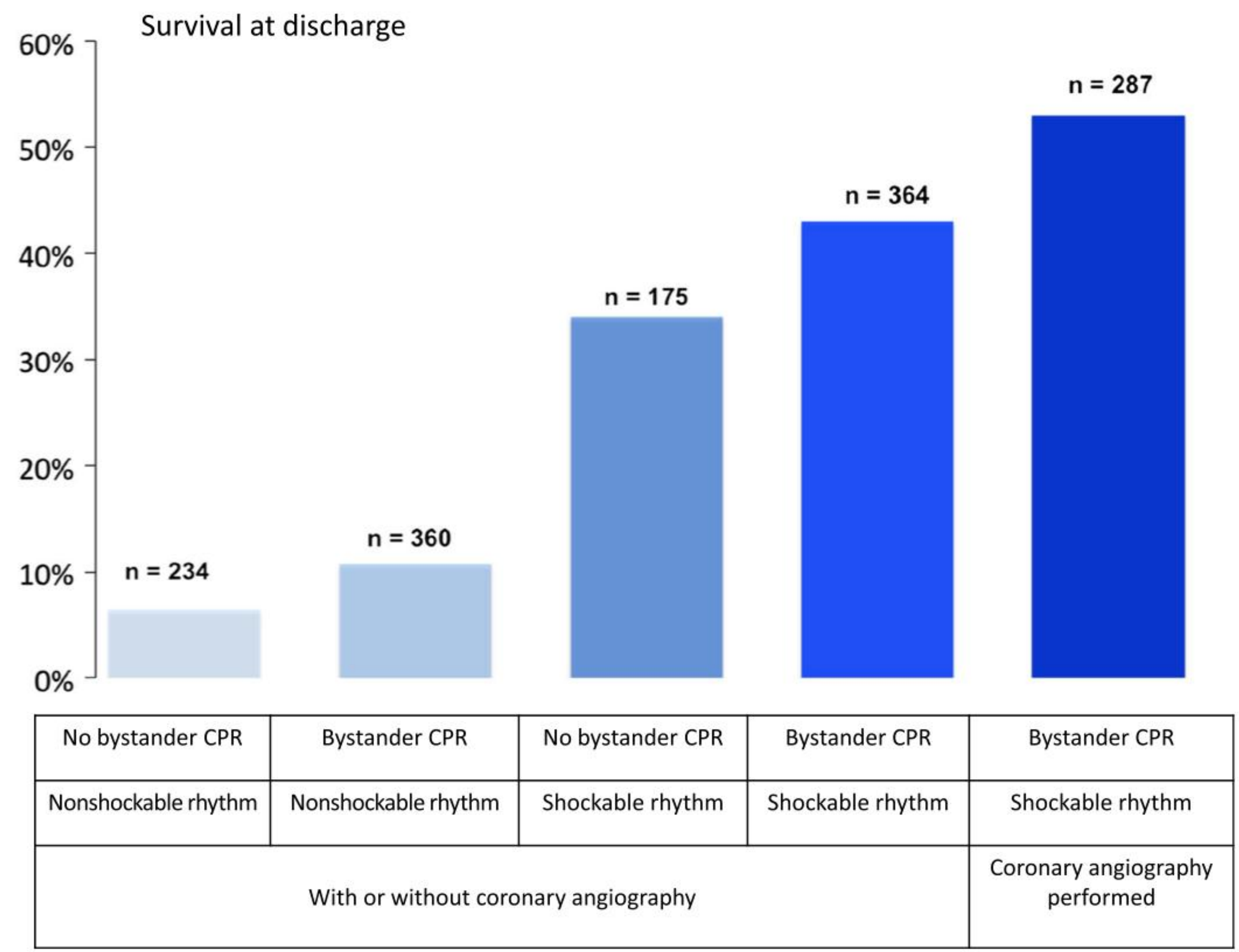


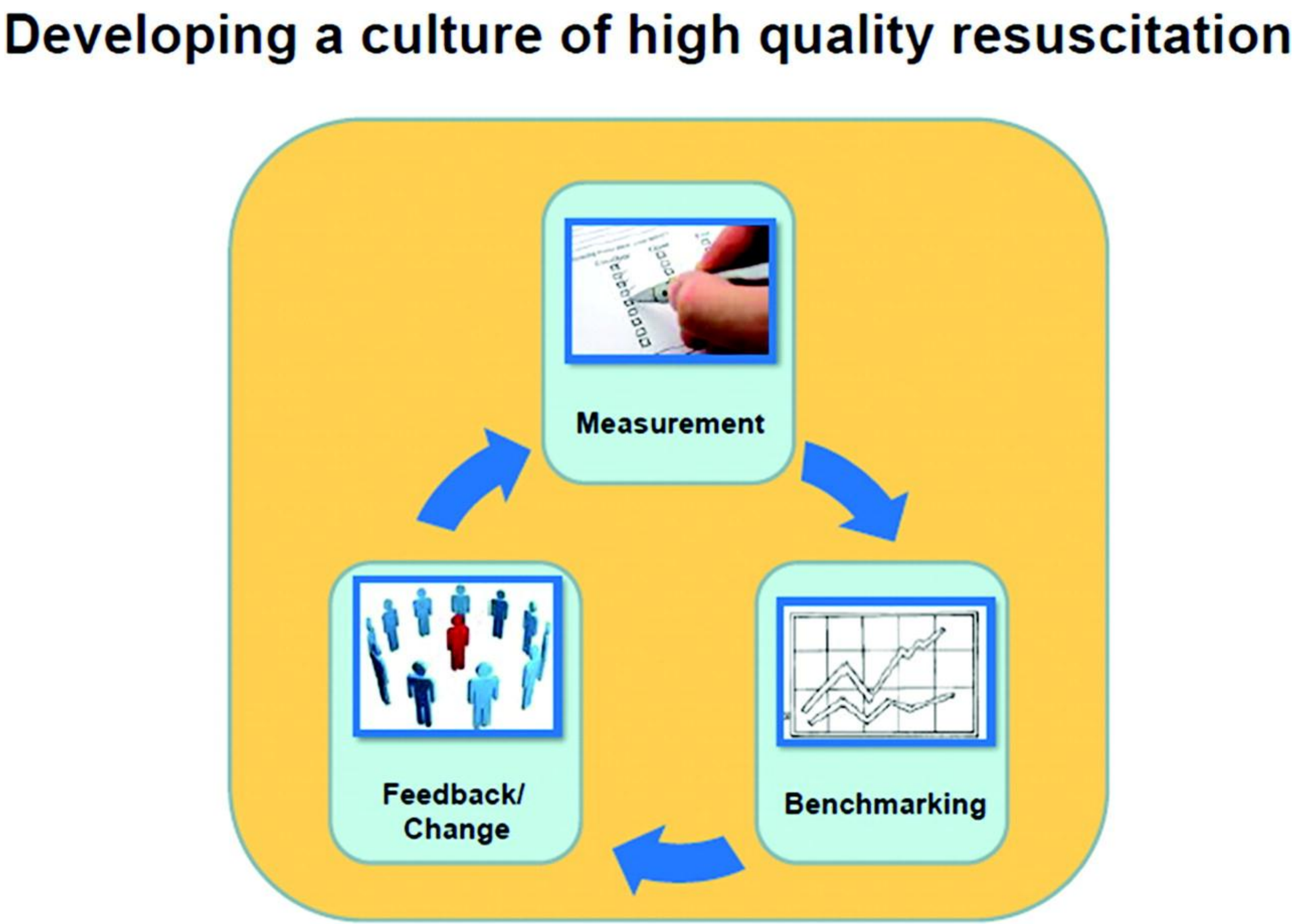
Fig. 2 Survival at hospital discharge among patients admitted alive, according to main prognostic factors

Chain of Survival

Early Recognition + Early CPR + Early AED =

Improved Survival

Quality Improvement Elements of a Resuscitation System.



Travers A H et al. Circulation. 2010;122:S676-S684

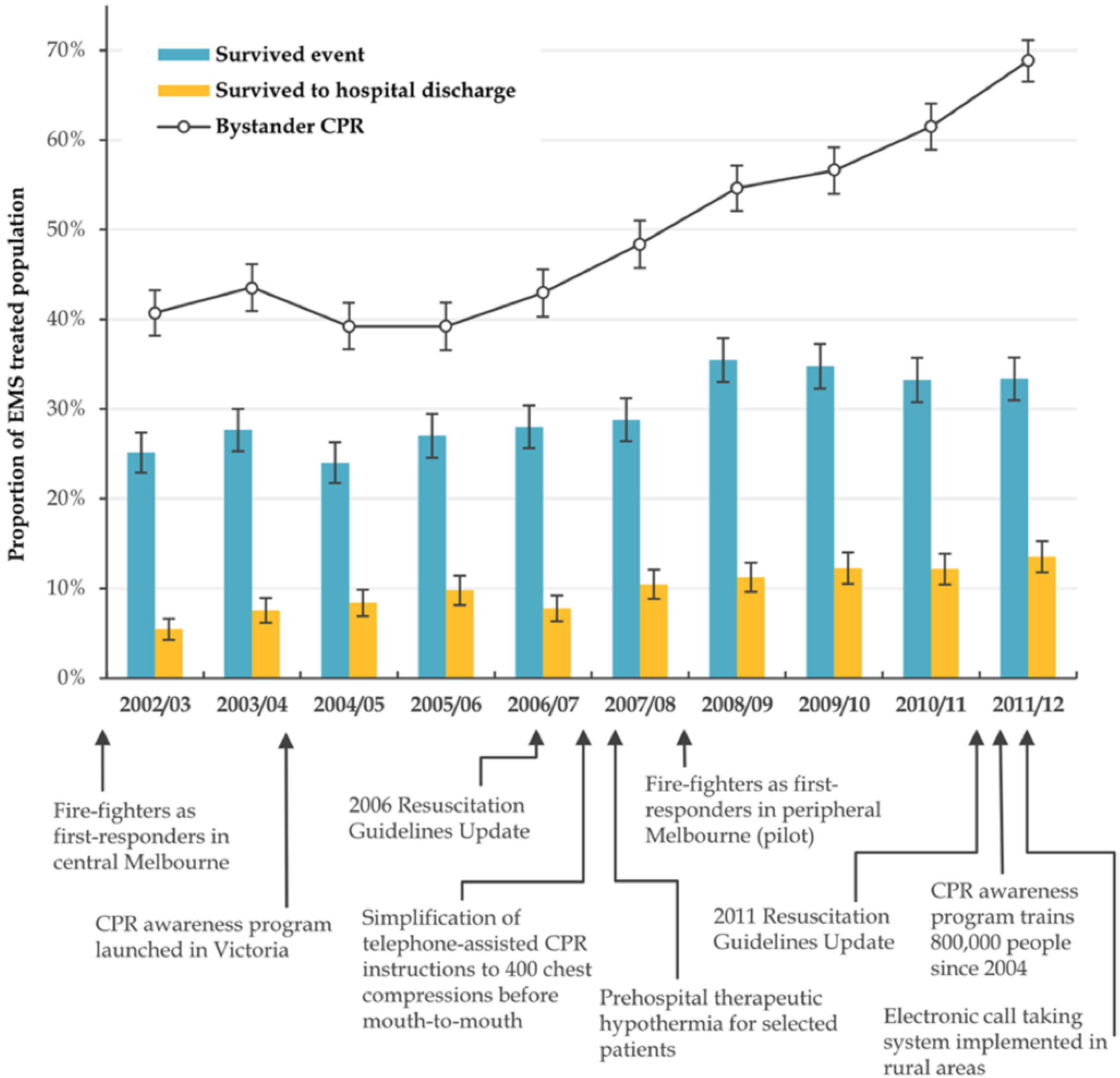


Figure 2. Ten-year unadjusted trends in bystander cardiopulmonary resuscitation (CPR) and survival in the emergency medical service (EMS)–treated adult presumed cardiac out-of-hospital cardiac arrest population in Victoria, Australia, 2002 to 2012 (*P* trend <0.001 for all). Error bars represent 95% confidence intervals for proportions.

Cochrane Database Syst Rev. 2014 Sep 12;9:CD009803. doi: 10.1002/14651858.CD009803.pub2.

Cardiopulmonary resuscitation (CPR) plus delayed defibrillation versus immediate defibrillation for out-of-hospital cardiac arrest.

Huang Y et al.

AUTHORS' CONCLUSIONS:

Owing to the low quality of available evidence, we have been unable to determine conclusively whether immediate defibrillation and one and one-half to three minutes of CPR as initial therapy before defibrillation have similar effects on rates of return of spontaneous circulation, survival to discharge or neurological insult.We have also been unable to conclude whether either treatment approach provides a degree of superiority in OHCA.We propose that this is an area that needs further rigorous research through additional high-quality RCTs, including larger sample sizes and proper subgroup analysis.