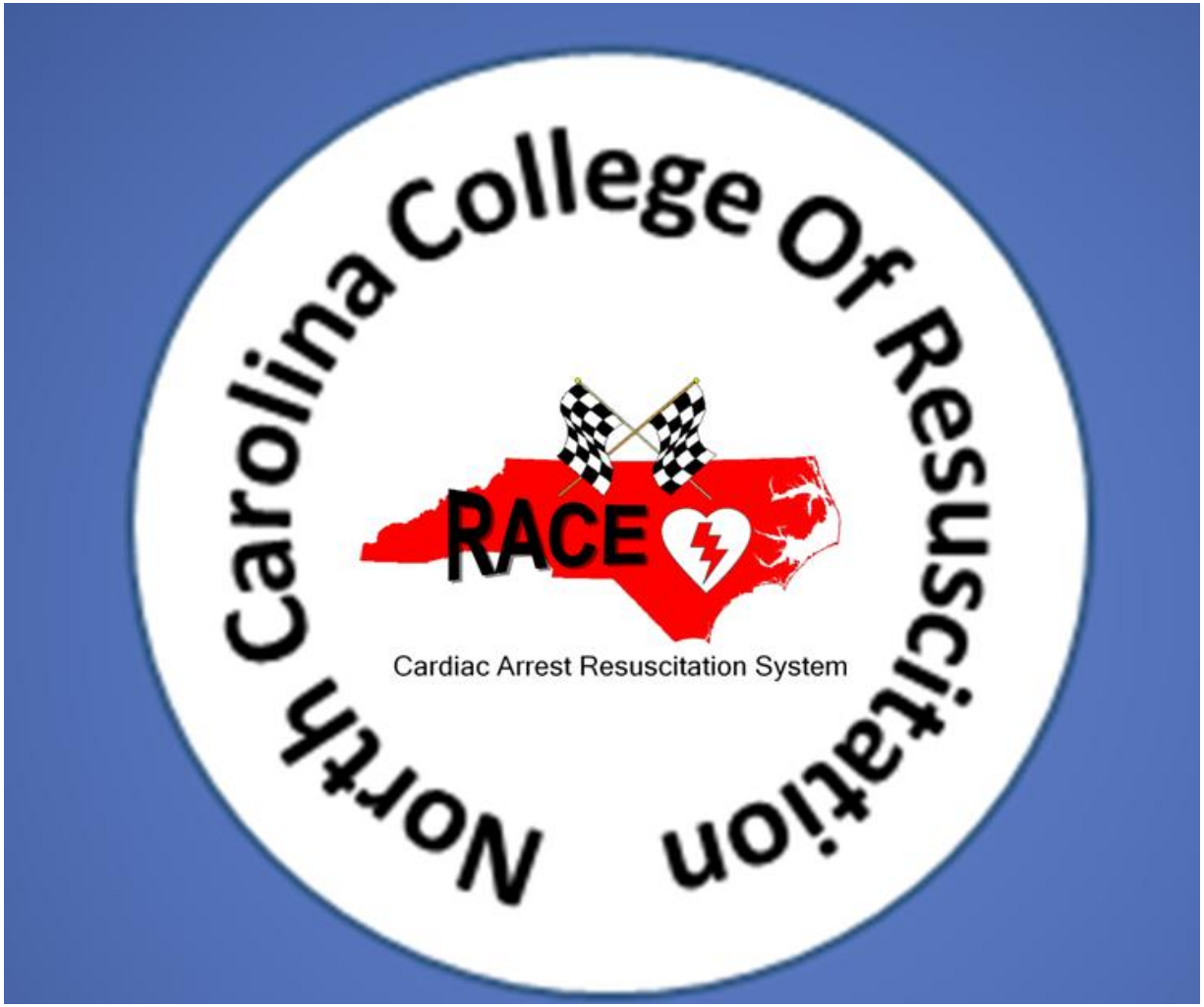
MODULE 1


North Carolina College Of Resuscitation
RACE
Cardiac Arrest Resuscitation System

Overview and Latest Research on Out of Hospital Cardiac Arrest

Jamie Jollis, MD

Co PI RACE CARS

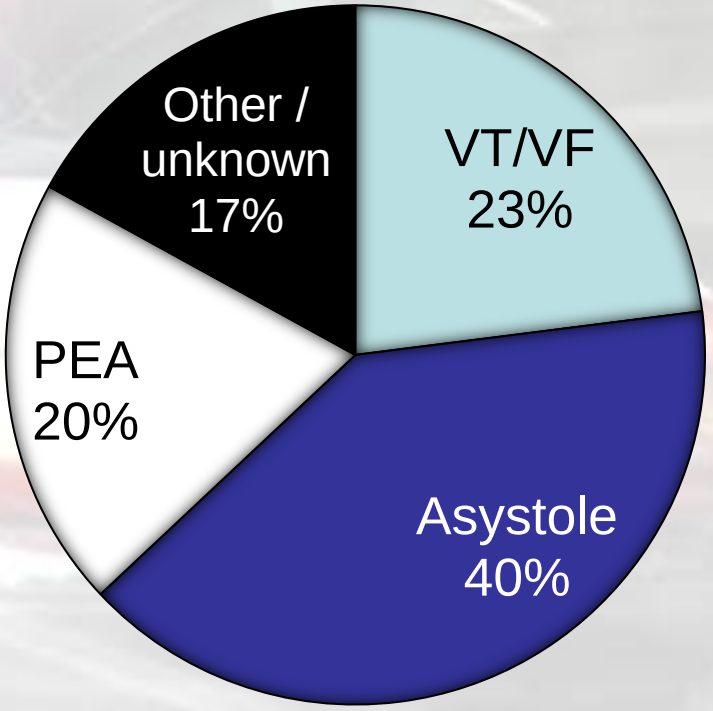
Out of Hospital Cardiac Arrest in U.S.

- 236 000 to 325 000 people in the United States each year
  - 600-1000 Americans will suffer OOHCA today
  - 20+ during this talk
- 3rd leading cause of death
- High morbidity and mortality
  - ~80% die before hospital admission

Epidemiology
EMS – treated cardiac arrest

Age	67 (IQ 53 – 79)
Female	36%
Location	
Home	82%
Public	16%
Other	2%

Initial rhythm



Nichol JAMA. 2008;300(12):1423-1431

Causes of cardiac arrest in patients with cardiac disease (~ 60%)

- Ischemic cardiac disease
- Non-atherosclerotic disease of coronary arteries
- Cardiomyopathies
- Valvular heart disease
- Infiltrative and inflammatory myocardial disease
- Congenital heart disease
- Primary electrical abnormalities

Causes of cardiac arrest in patients without cardiac disease (~40%)

- Trauma
- Bleeding
- Pulmonary embolism
- Suicide / drug overdose
- Lung disease
- Suffocation
- Drowning
- Malignancy
- SIDS

Epidemiology
Autopsy – witnessed arrest, Nottingham UK

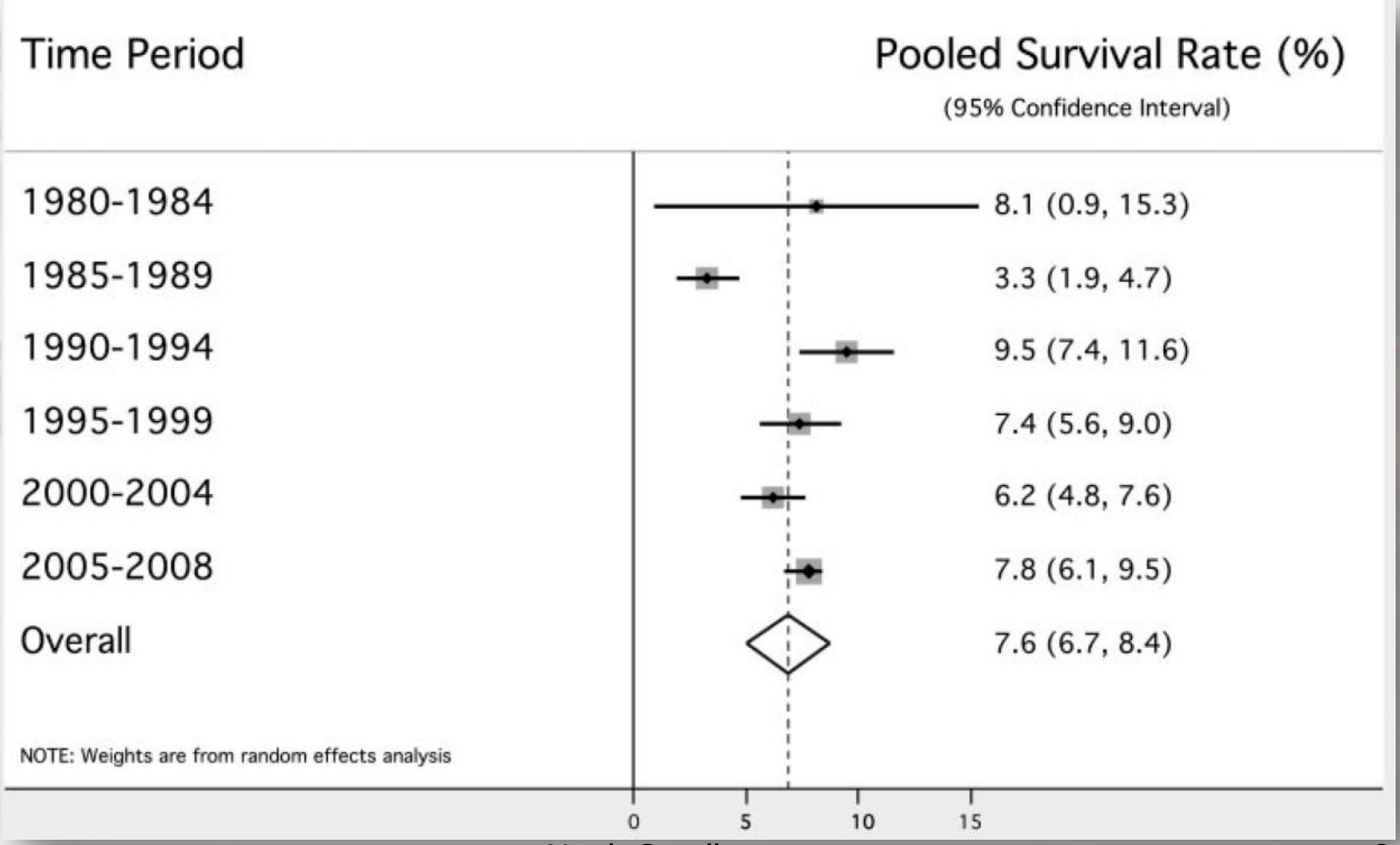
	VF	Other (Asystole, PEA)
Previous MI	53%	45%
CAD		
None - mild	7%	5%
1 Vessel	13%	10%
2 Vessel	23%	15%
3 Vessel	37%	41%
Thrombosis	31%	30%
LVH	53%	54%

Resuscitation 51 (2001) 257–264

OHCA survival to hospital discharge

by 5-year time periods n = 141,581

Overall 7.6%



Circ Cardiovasc Qual Outcomes. 2010;3:63-81

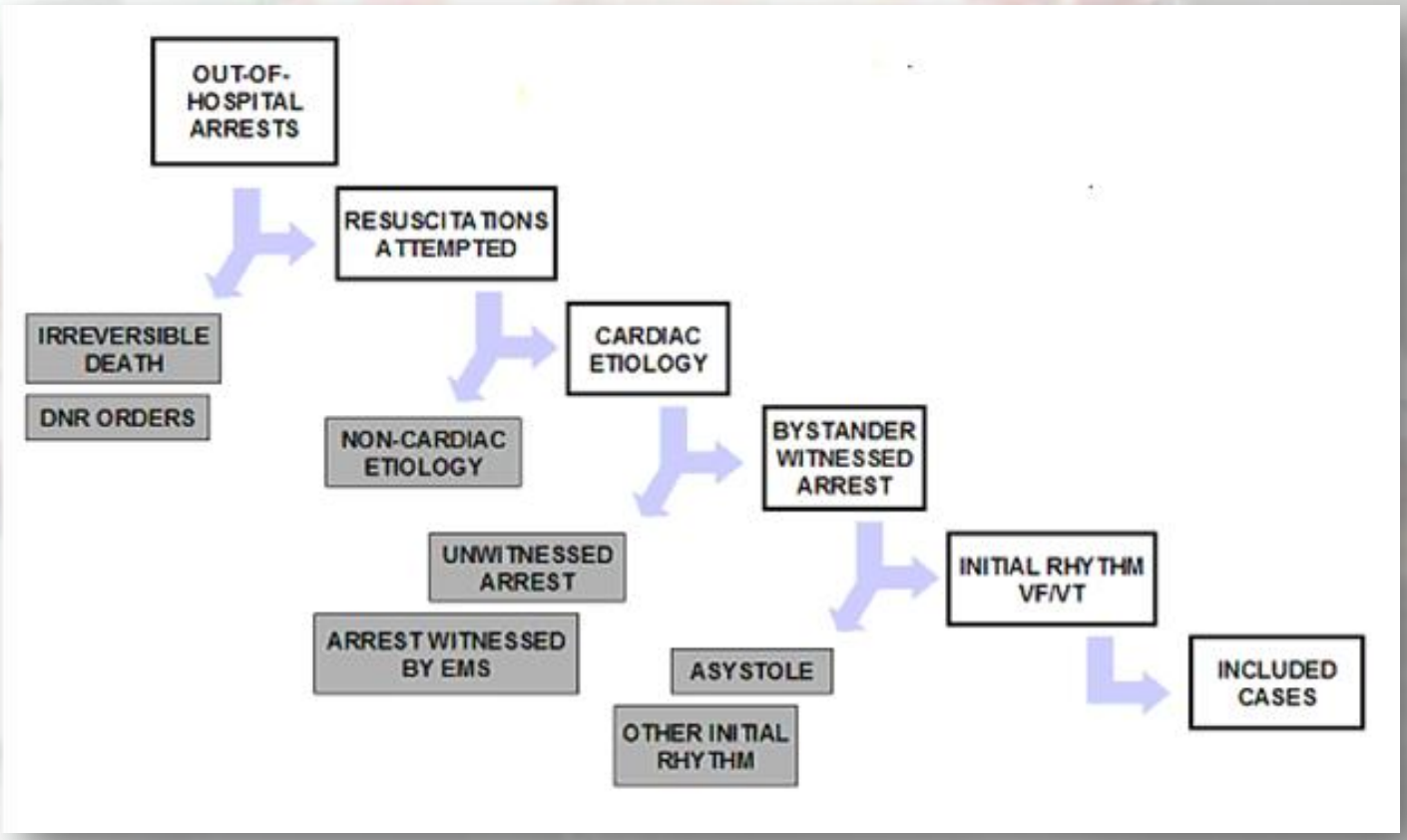
Cardiac Arrest in North Carolina:

~ 5,000 – 8,000 per year

NC Office of EMS Preliminary data

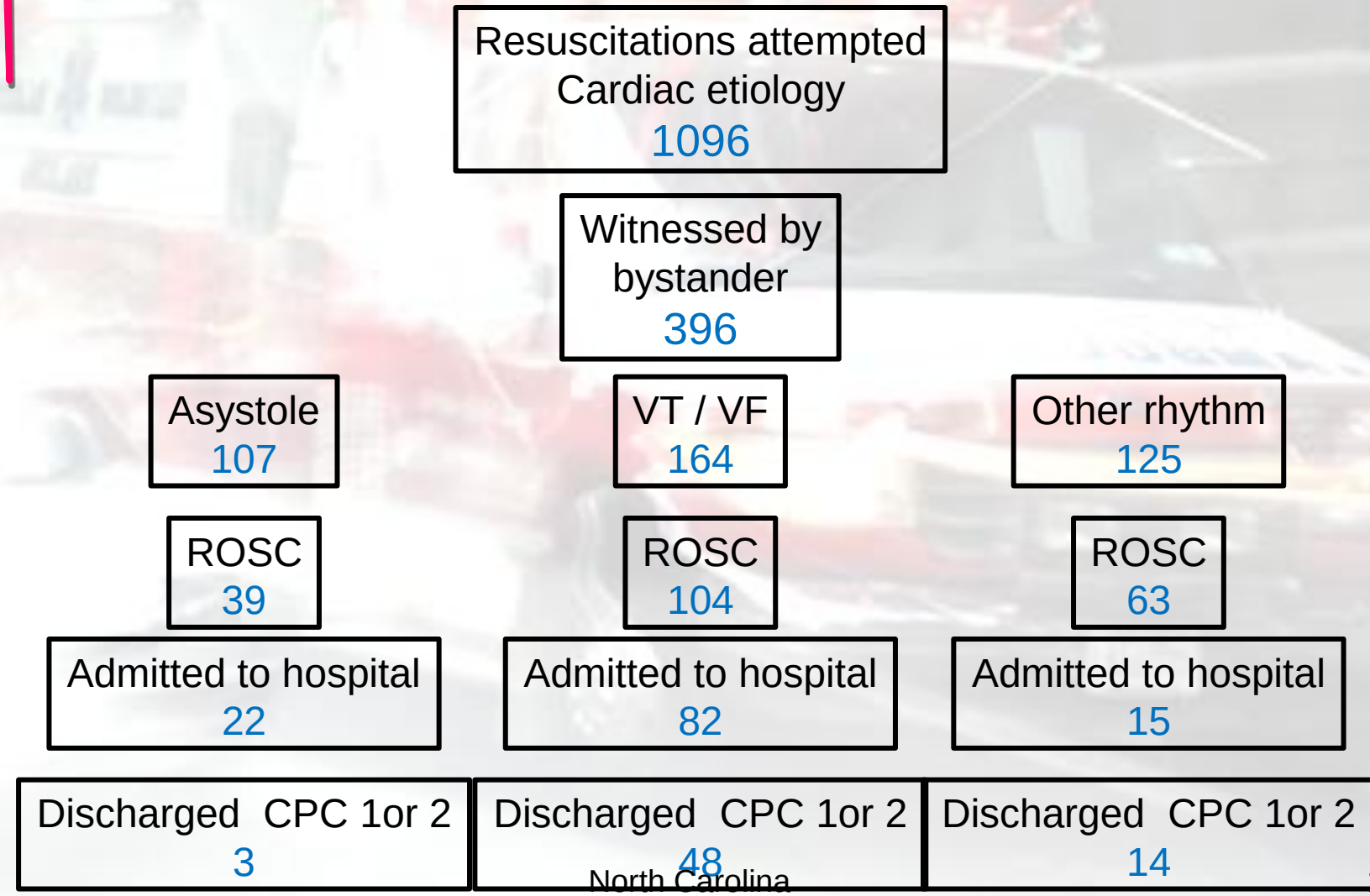
Statewide Cardiac Arrests:		5,213
EMS Return of Spontaneous Circulation:	35%	1,845
Arrived at Emergency Department Alive:	20%	1,034
Admitted to Hospital Alive:	11%	589
D/C from Hospital Alive :not available…	likely under 5%	

Survival
Utstein style reporting



"witnessed cardiac arrest due to presumed underlying heart disease with the initial rhythm of ventricular fibrillation"

Survival
CARES Registry 2010
3 leading NC metro EMS agencies



Survival

CARES Registry 2010

3 leading NC metro EMS agencies

Bystander Intervention (924)

AED %: 1.3% (12)

CPR %: 23.5% (217)

Cardiac Etiology Survival Rates

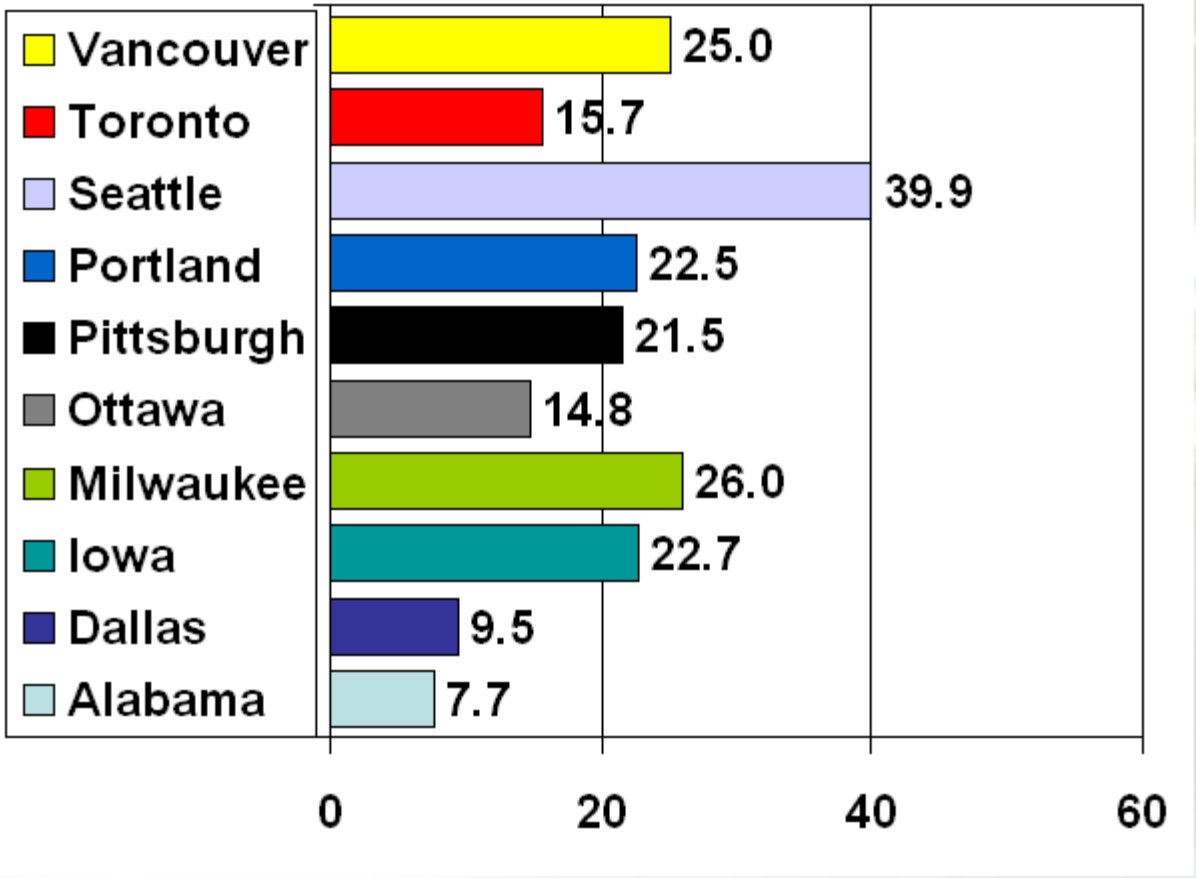
Overall:	11.8% (1096)
Bystander Wit'd:	18.7% (396)
Utstein:	31.7% (164)
Utstein Bystander:	28.7% (80)
EMS Witnessed:	19.8% (172)
Unwitnessed:	4.0% (528)
Shockable/Bystand:	41.4% (396)

Variation in survival VF arrest

Resuscitations Outcomes Consortium

Witnessed Utstein

Survival to discharge



Nichol JAMA. 2008;300(12):1423-1431

Who survives

Amy Jones

- 37 year old woman
- 9 months pregnant, 2 days to due date
- Husband noted agonal breathing, cyanosis, called 911, started CPR
- Fire department arrived 7 minutes later
- AED, regained weak pulse after 3rd shock

Amy Jones

- Two more shocks for ventricular arrhythmias in transport
- C-section, baby Elizabeth delivered
- Hypothermia x 24 hours per protocol
- Discharged day 10
- Slowly regained “mid-term memory”

Amy Jones

Elements of success

- Witnessed
- Recognition, 911
- Medical dispatch
- Bystander CPR
- 1st responder AED
- Hypothermia protocol

Who survives

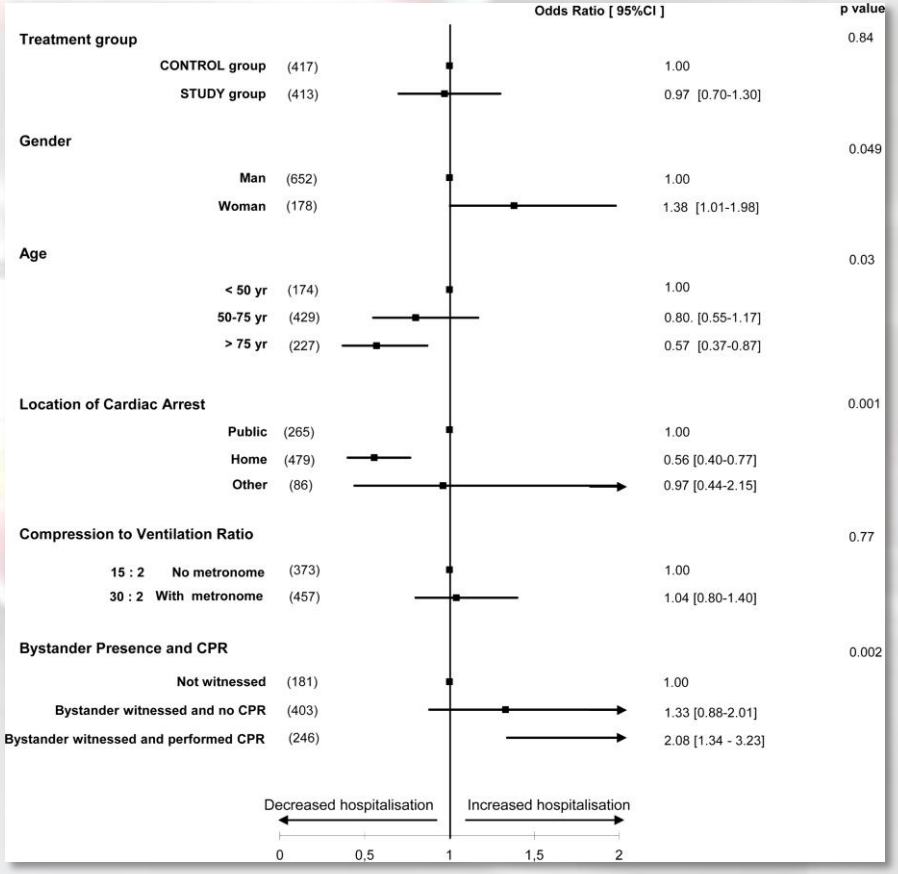
Factors associated with hospital admission, n= 830

More likely to be hospitalized

- Women (1.4)
- Bystander witnessed and CPR (2.1)

Less likely to be hospitalized

- Over age 75 (0.6)
- Arrest at home (0.6)



Jost, D. et al. Circulation 2010;121:1614-1622

Who survives

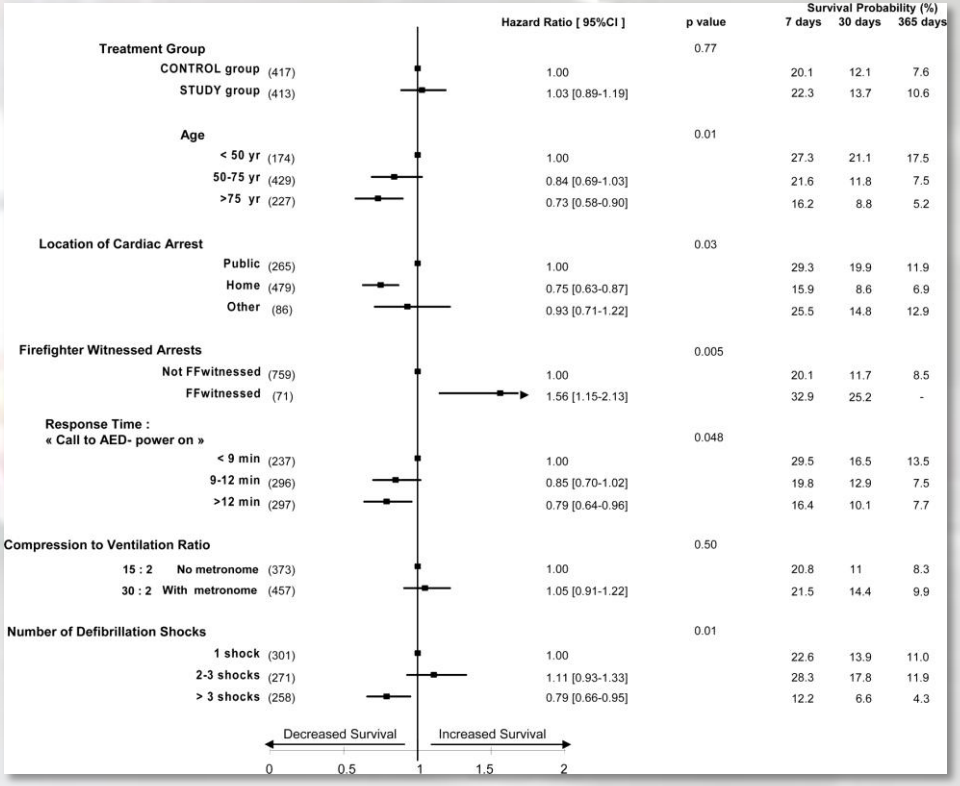
Factors associated with survival to 1 year, n= 830

More likely to survive

- Firefighter witnessed (1.5)

Less likely to survive

- Over age 75 (0.7)
- Arrest at home (0.8)
- Response > 12 minutes (0.8)
- 4+ shocks (0.8)



Jost, D. et al. Circulation 2010;121:1614-1622

Who survives

Things we can't change

- Witnessed
- Younger age

Things we can change

- Bystander CPR
- Response time < 9 minutes

Jost, D. et al. Circulation 2010;121:1614-1622

Strategies for improving survival

Adult Chain of Survival

1. Immediate recognition of cardiac arrest and activation of the emergency response system
2. Early CPR with an emphasis on chest compressions
3. Rapid defibrillation
4. Effective advanced life support
5. Integrated post–cardiac arrest care

Strategies for improving survival

AHA Consensus Statement

Implementation Strategies for Improving Survival After Out-of-Hospital Cardiac Arrest in the United States

Consensus Recommendations From the 2009 American Heart Association Cardiac Arrest Survival Summit

Robert W. Neumar, MD, PhD, Chair; Janice M. Barnhart, MD, MS; Robert A. Berg, MD, FAHA; Paul S. Chan, MD, MSc; Romergryko G. Geocadin, MD; Russell V. Luepker, MD, MS, FAHA; L. Kristin Newby, MD, MHS; Michael R. Sayre, MD, FAHA; Graham Nichol, MD, MPH, FAHA; on behalf of the American Heart Association Emergency Cardiovascular Care Committee, Council on Cardiopulmonary, Critical Care, Perioperative, and Resuscitation, Council on Clinical Cardiology, Council on Epidemiology and Prevention; Council on Quality of Care and Outcomes Research and Advocacy Coordinating Committee

Endorsed by the Neurocritical Care Society

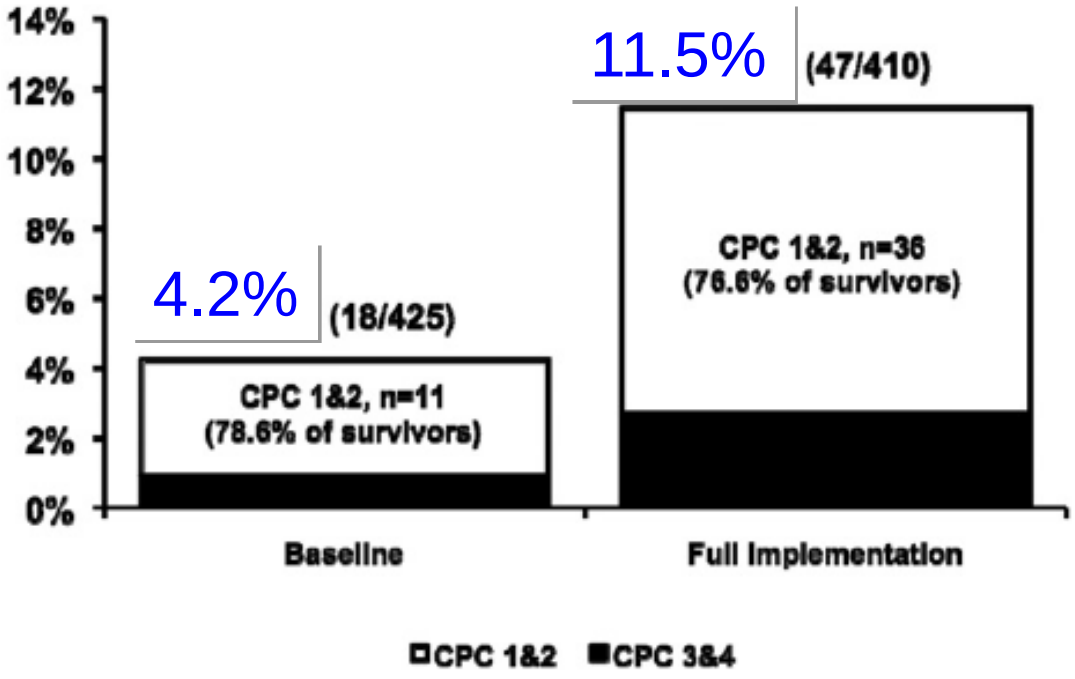
Circulation. 2011;123:2898-2910

Strategies for improving survival

- Medical leadership
- Community
  - Bystander CPR
  - Public access defibrillation
- 911 dispatch
  - Rapid first response
  - Dispatch assisted CPR
- EMS
  - High quality CPR
  - Early defibrillation
- Hospital
  - Specialized centers for treating post–cardiac arrest patients
  - Multidisciplinary post–cardiac arrest care treatment plan
  - Early PCI
  - Therapeutic hypothermia
  - Early hemodynamic optimization
  - AICD placement

Circulation. 2011;123:2898-2910

Wake County



*Neurologic status is represented by Cerebral Performance Category (CPC); 1&2 denote "good" and "moderate" cerebral performance; 3&4 denote "poor" and "vegetative" cerebral performance; 5 denotes "brain death" and thus is not represented in this survivor to hospital discharge bar chart. ** Survivors in baseline phase where CPC score available = 14.

Figure 3. Overall survival to hospital discharge and neurologic status* of survivors of out-of-hospital cardiac arrest between baseline (N=425) and full implementation (N=410) of 2005 AHA guidelines (phase 3).

PUBLIC ACCESS AED AND TRAINING

Public-Access Defibrillation and Survival after Out-of-Hospital Cardiac Arrest

- 993 community units in 24 North American regions
- 250 adults over age 50 for 16 hours a day
- Ability to supply AED in 3 minutes
- Randomly assigned shopping malls and apartment complexes
- Emergency-response training involving CPR alone or CPR / AED

Table 5. Number of Survivors of Out-of-Hospital Cardiac Arrest.

Characteristic	CPR Only	CPR plus AED	P Value	
			Unadjusted	Adjusted
Definite cardiac arrests — no.	107	128	0.09*	
Residential units	37	33		
Public units	70	95		
Survivors of definite arrest — no.	15	30	0.03†	0.03*‡
Residential units	1	1		
Public units	14	29		
Survivors of definite or uncertain arrest — no.	16	31		0.03*‡
Cerebral performance category of survivors of definite arrest — no. (%)§			0.90¶	
Normal	10 (71.4)	22 (73.3)		
Mildly impaired	3 (21.4)	5 (16.7)		
Moderately impaired	1 (7.1)	3 (10.0)		

Hallstrom AP et al. N Engl J Med. 2004 ;351:637-46.

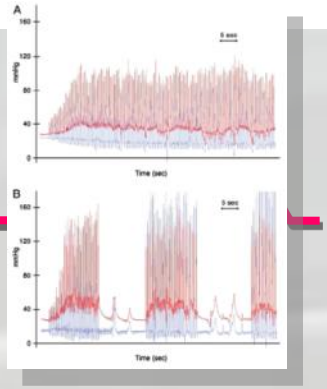
Public-Access Defibrillation and Survival after Out-of-Hospital Cardiac Arrest

- AED's combined with trained volunteer response save lives,
  - Particularly in public places with more than 250 adults over age 50

Hallstrom AP et al. N Engl J Med. 2004 ;351:637-46.

HIGH PERFORMANCE CPR

Chest compression only CPR



- Bystanders more willing to initiate
- Arterial blood is adequately oxygenated at onset of ***primary cardiac arrest***
- Less likely to cause regurgitation of stomach contents
- Rescue breathing interrupts critical chest compressions
- Easier to teach
- Observational evidence of improved survival

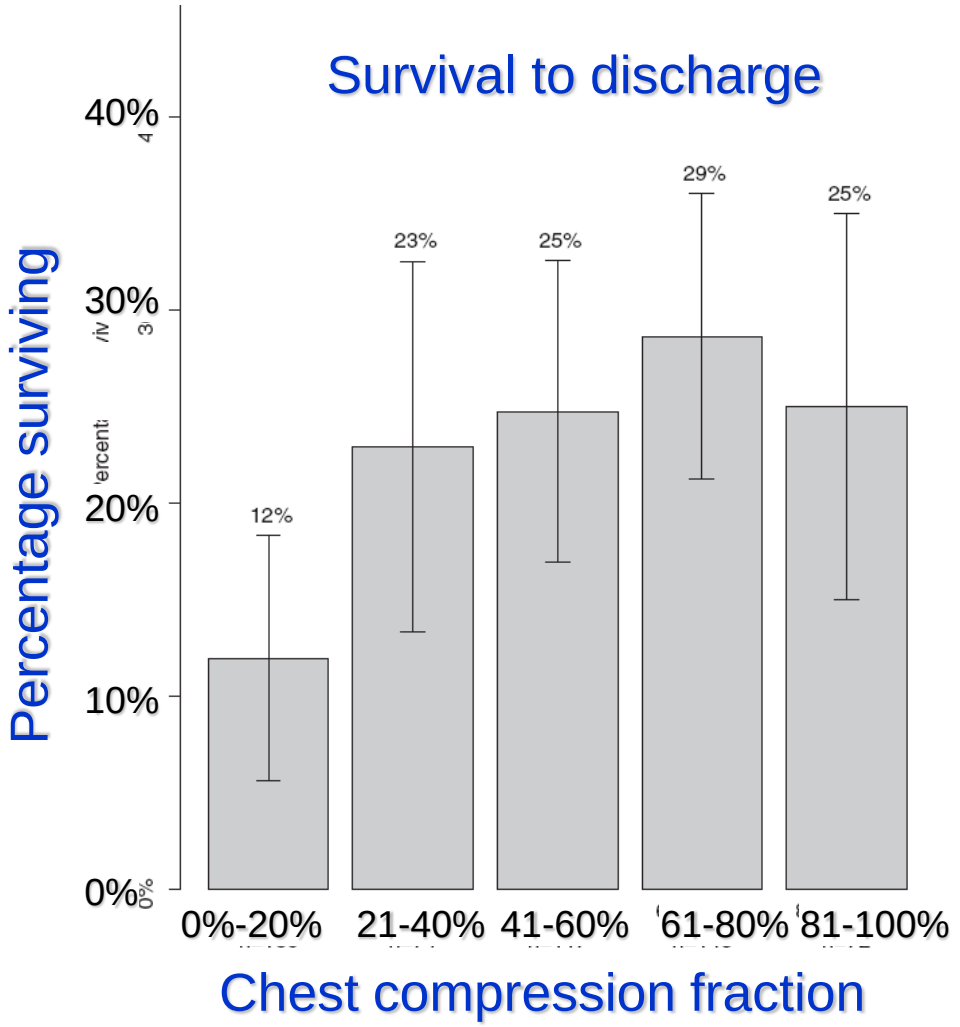
Ramaraj R, Ewy GA. Heart 2009;95:1978–1982.

Standard CPR 15:2

Coronary Perfusion pressure (Ao diastolic- RA diastolic)

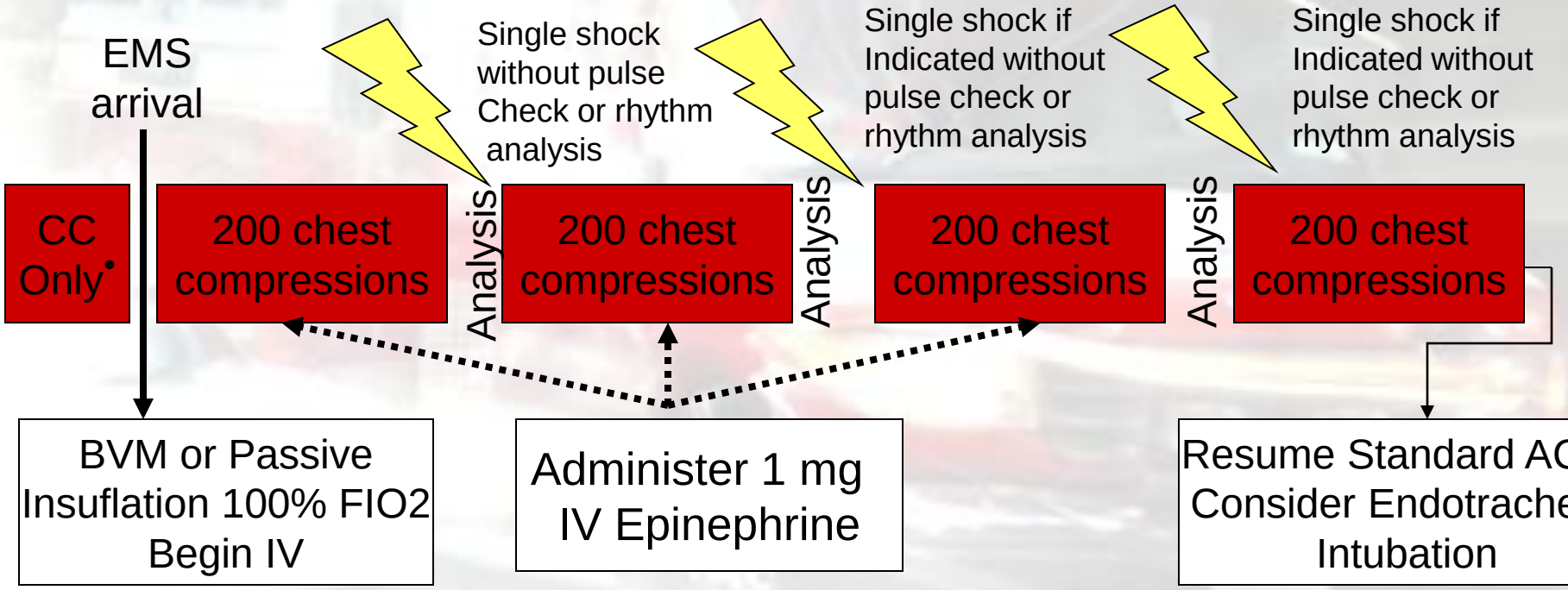
Chest compression fraction and survival

- 506 patients with VF / VT and no defib. before EMS arrival.
- Electronically recorded cardiopulmonary resuscitation before the first shock.
- Age 64, 80% male
- 51% bystander CPR
- 6 minutes call to scene
- 11 minutes call to first shock.
- ROSC 72%
- Survived to discharge 23%



Resuscitation Outcomes Consortium Investigators *Circulation*. 2009;120:1241-1247.

Cardiocerebral Resuscitation

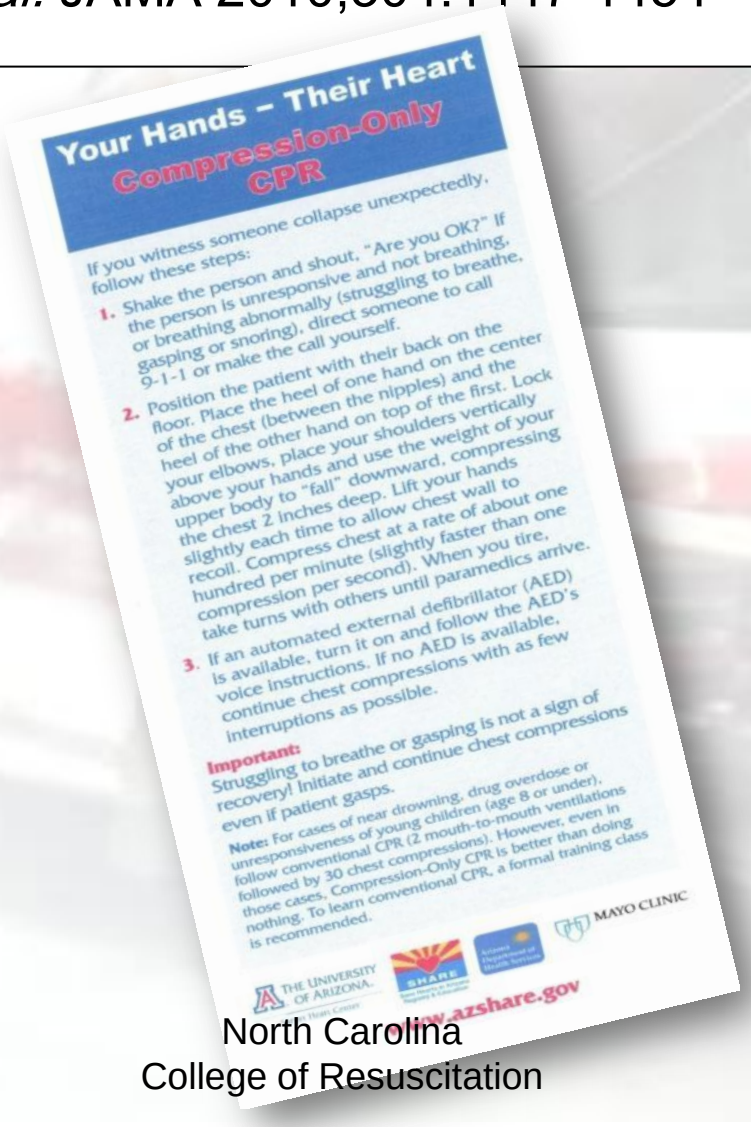


• If adequate bystander chest compressions are provided, EMS providers perform immediate rhythm analysis

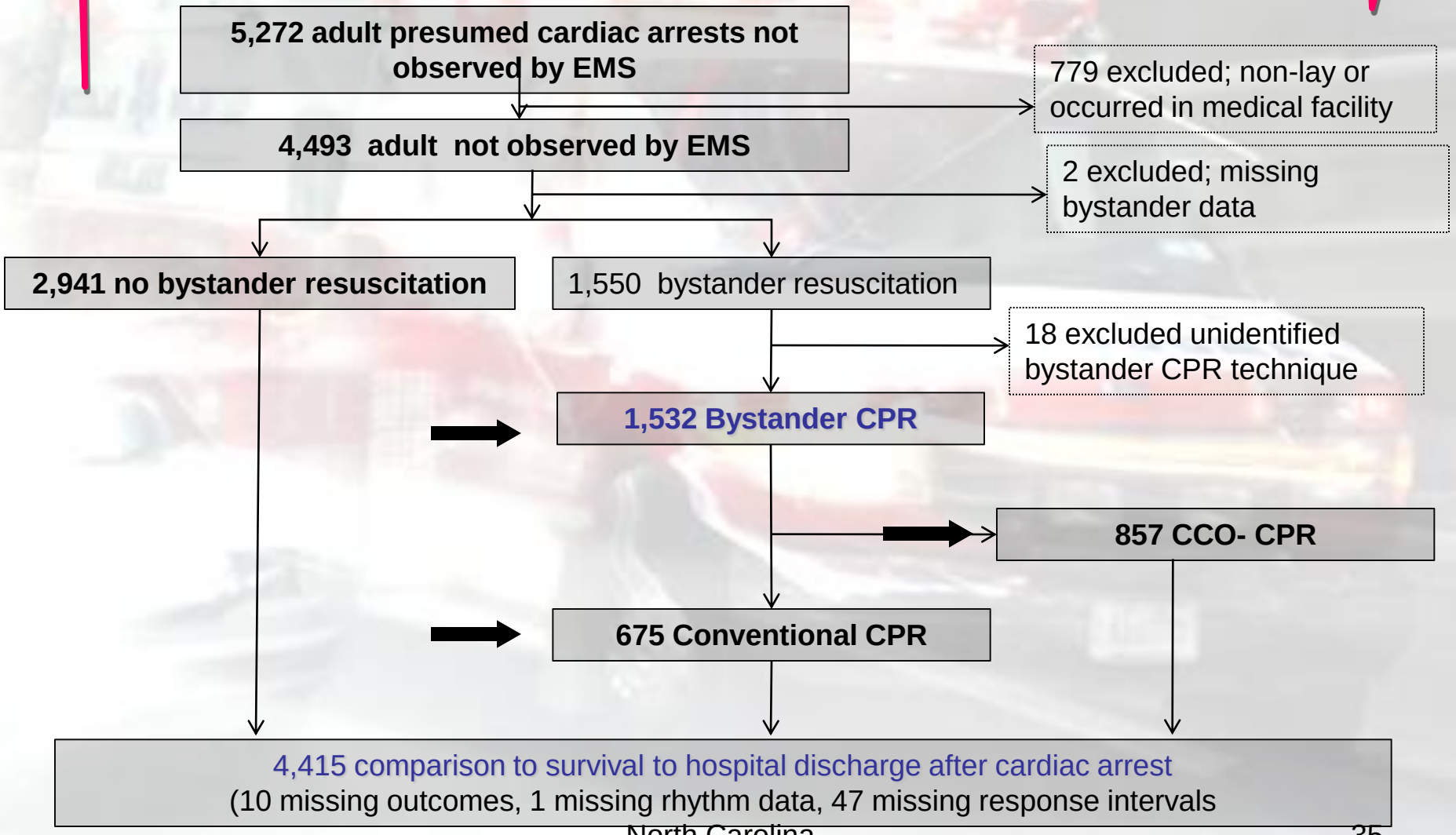
JAMA ORIGIONAL CONTRIBUTION

Chest Compression-Only CPR by Lay Rescuers and Survival From Out-of-Hospital Cardiac Arrest

Bobrow *et al.* JAMA 2010;304:1447-1454

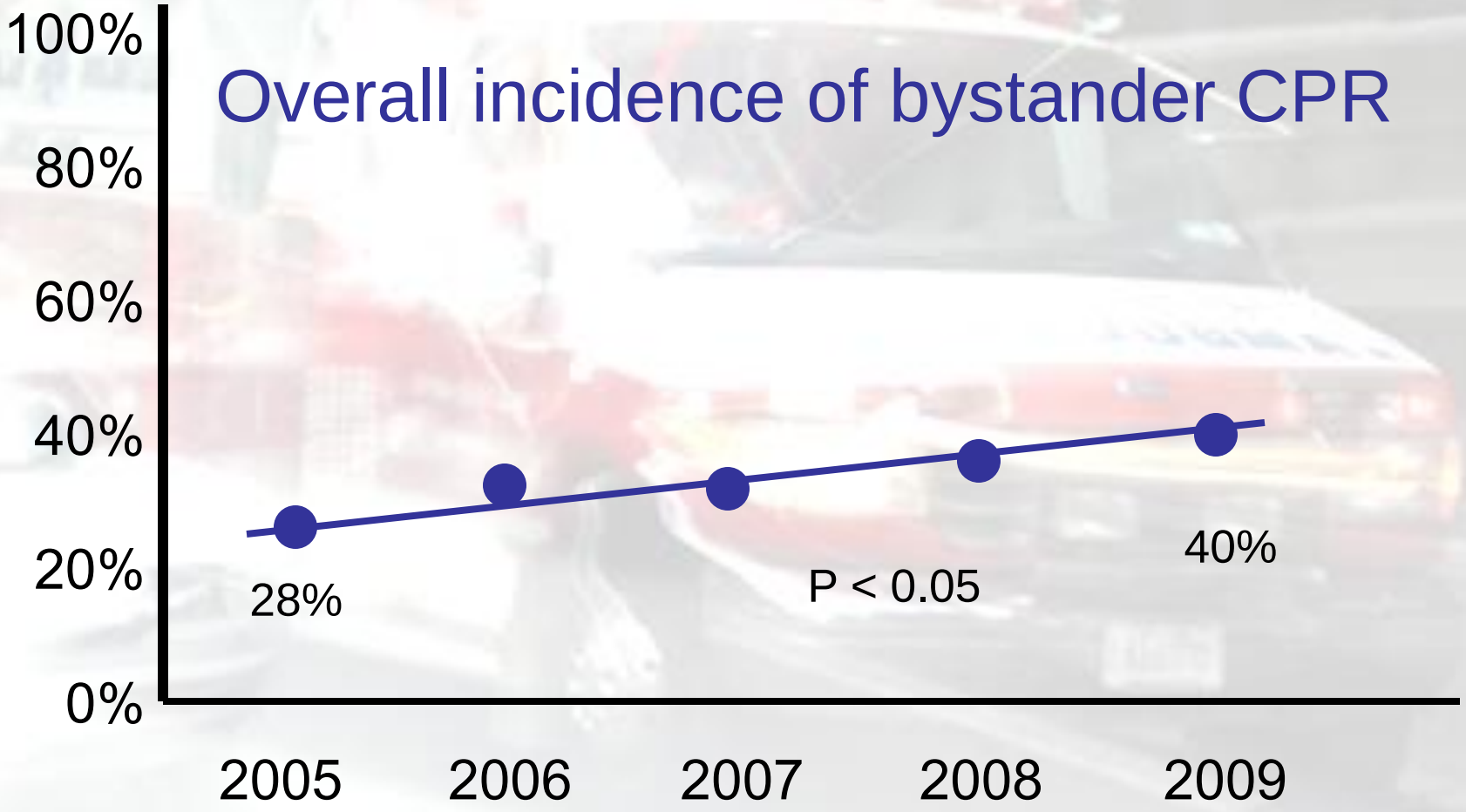


Bystander CPR for OHCA in Arizona (2005 to 2010)



Bobrow, et al. JAMA 2010;304:1447-1454

Bystander CPR for OHCA in Arizona (2005 to 2010)



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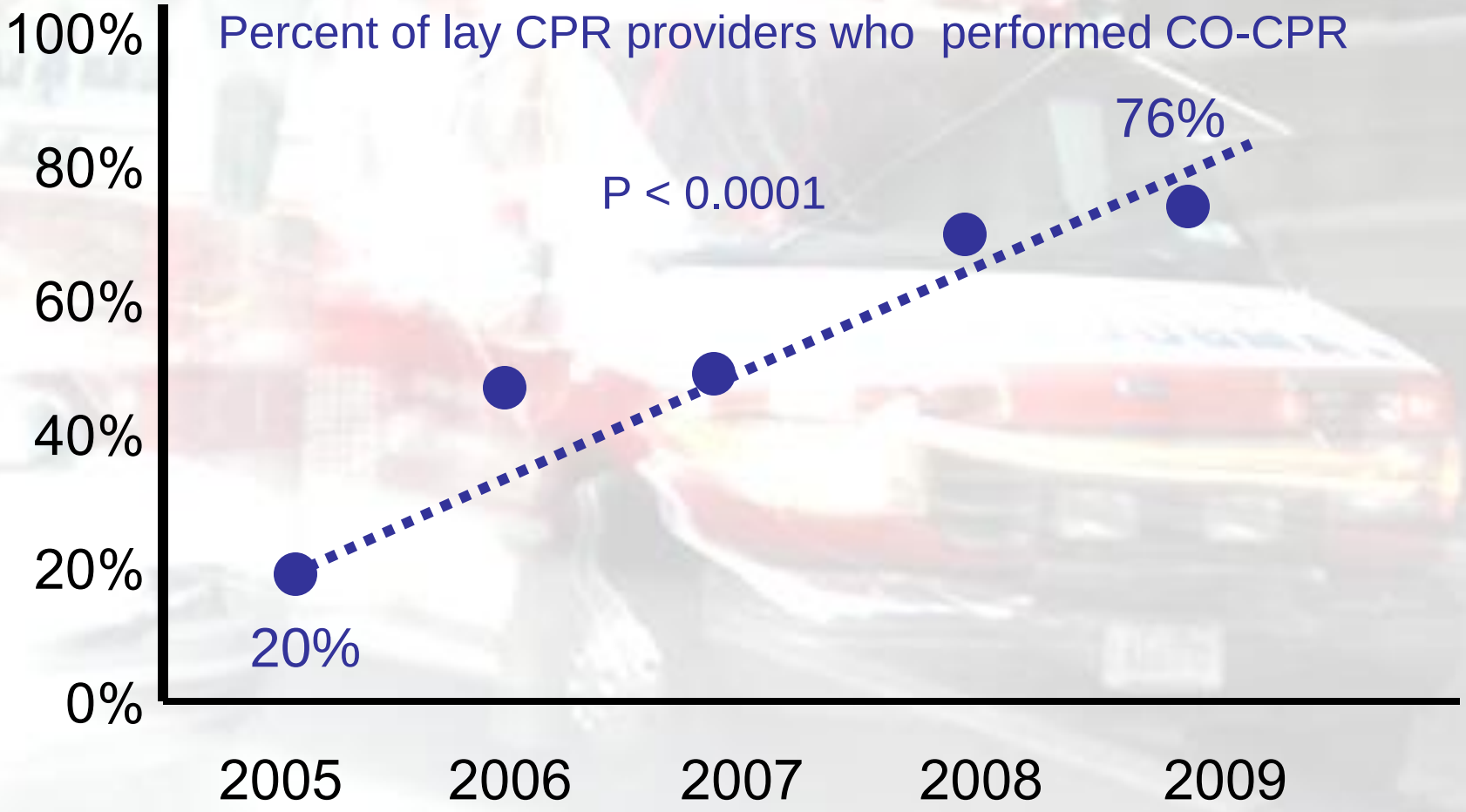

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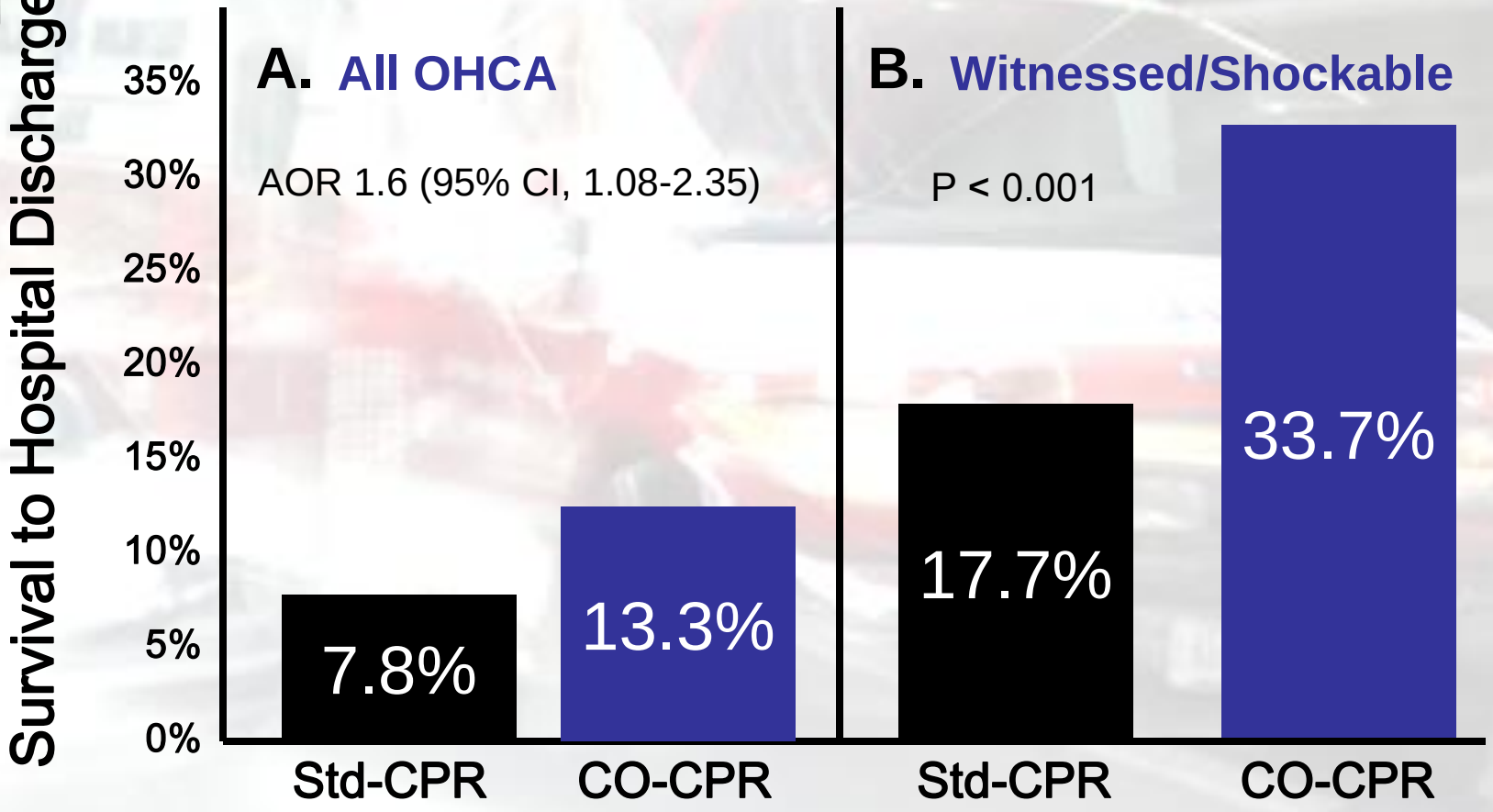


Bobrow, et al. JAMA 2010;304:1447-1454

DISPATCH

Resuscitation Science

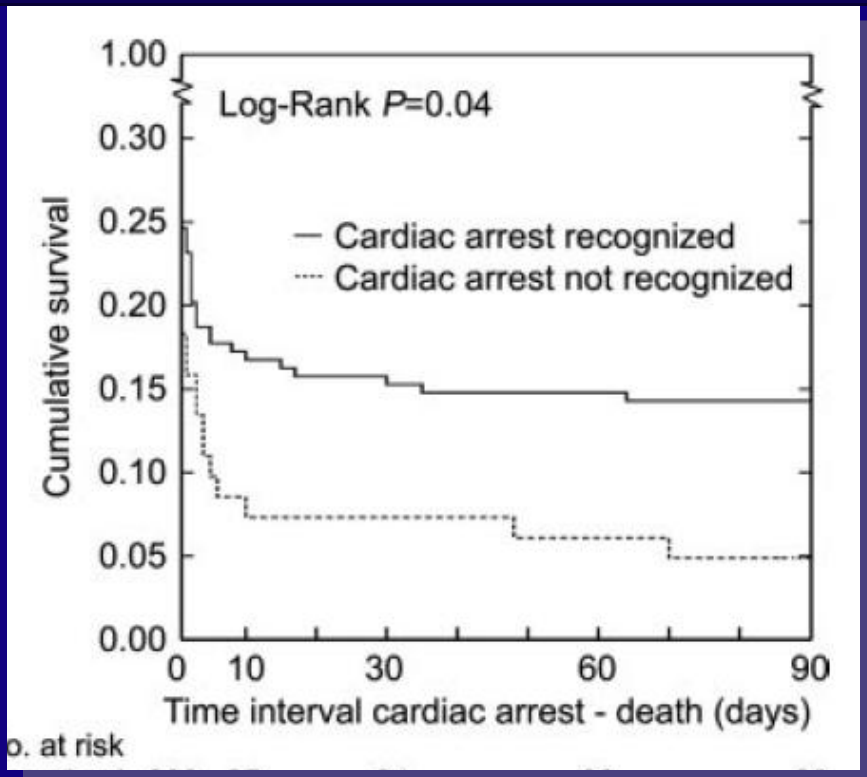
Importance of the First Link

Description and Recognition of an Out-of-Hospital Cardiac Arrest in an Emergency Call

Jocelyn Berdowski, MS, MSE; Freerk Beekhuis, RN; Aeilko H. Zwinderman, PhD; Jan G.P. Tijssen, PhD; Rudolph W. Koster, MD, PhD

- Amsterdam dispatch
- 506 cardiac arrest emergency calls (3%)
- Unrecognized, dispatch 0.9 min later, on scene 1.4 minute later
- Call to arrival - 8.5 vs. 9.9 min
- Main reason for not recognizing the cardiac arrest was not asking if the patient was breathing (42 of 82) / describe the type of breathing

3 month survival by dispatch recognition



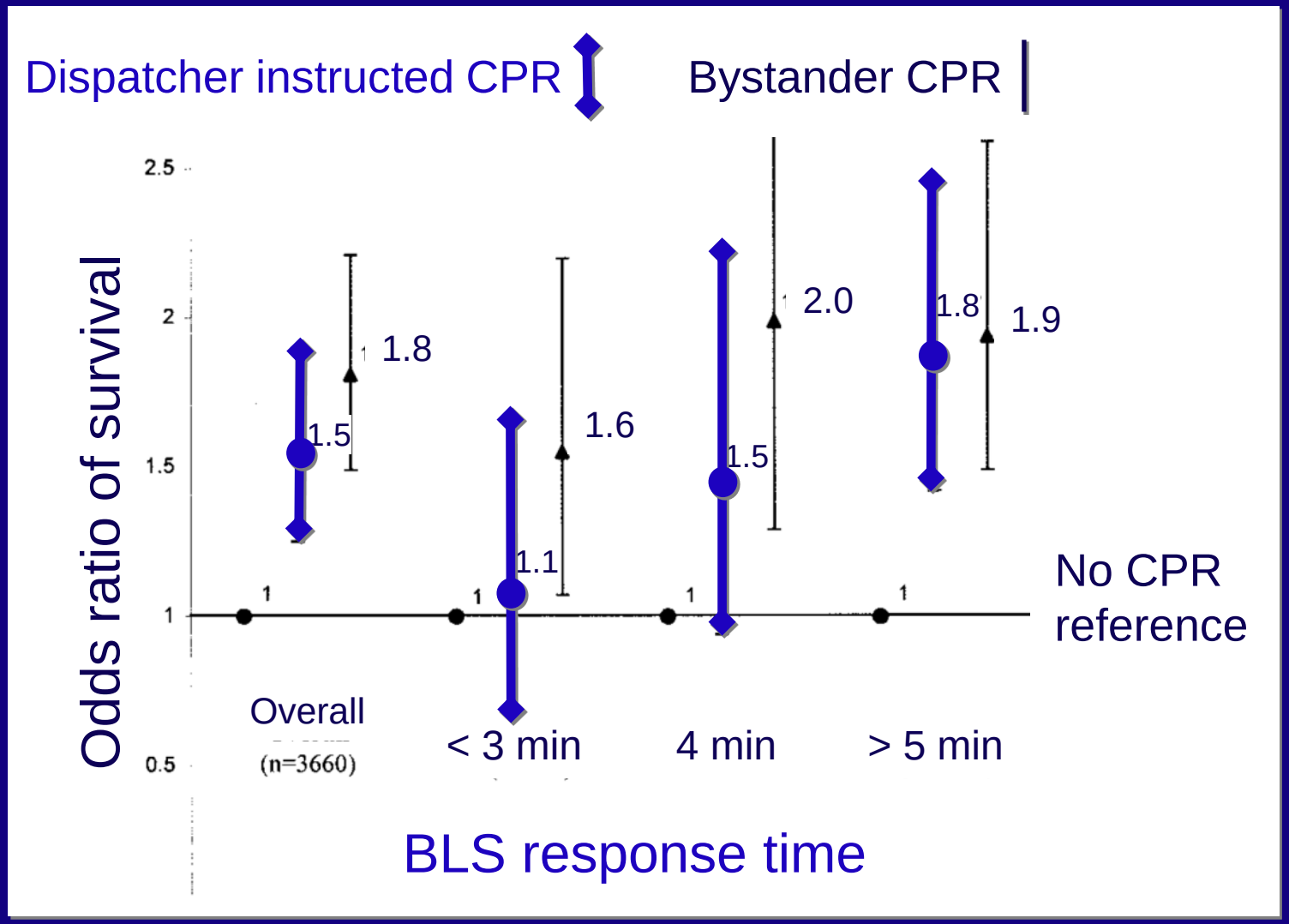
Berdowski, *J. Circulation*. 2009;119:2096-2102

Duke

Agonal breathing

Odds ratio of survival by CPR status and BLS response time

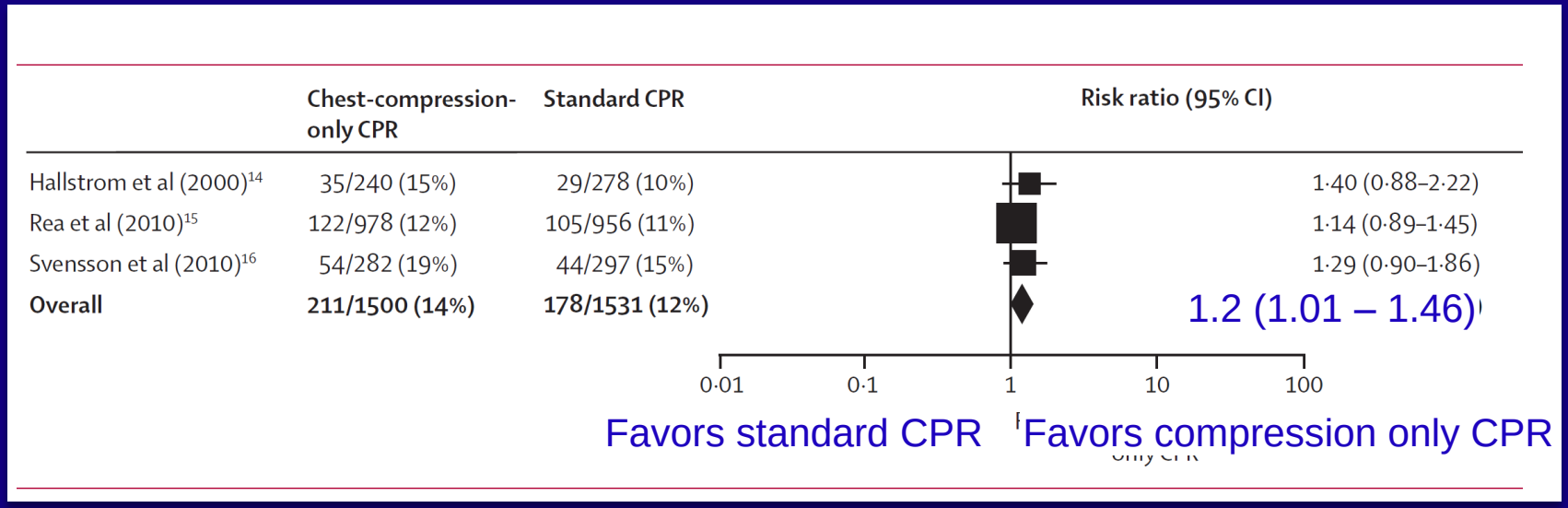
Witnessed cardiac arrest, King County 1983 – 2000, n = 7265



Rea TD *et al. Circulation. 2001;104:* 2513-2516.

Chest-compression-only vs. standard CPR
Meta-analysis of randomized dispatch instruction

Survival to hospital discharge in 3 trials



P = 0.04

Lancet 2010; 376: 1552–57

Essential Elements of Dispatch CPR Instruction

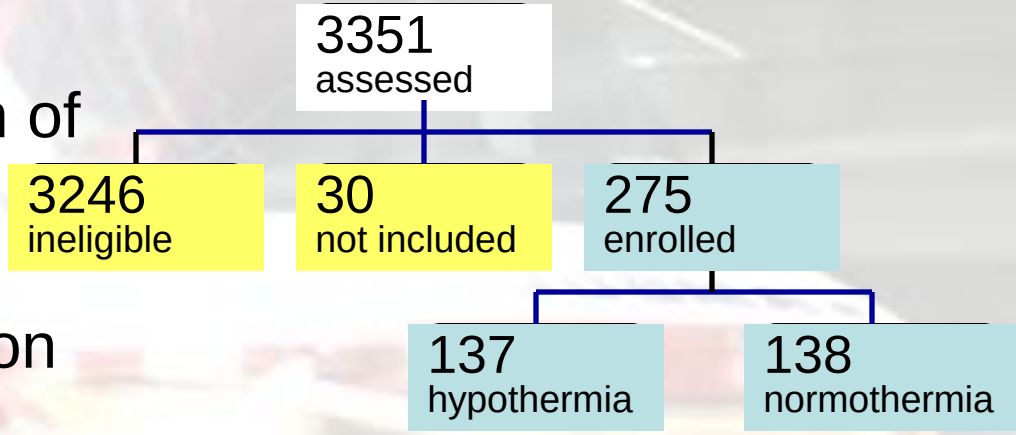
- Training
- QI
- Feedback
- Performance Standards
  - Time to recognize cardiac arrest
  - Time to start chest compressions
  - Percent of cardiac arrests that receive telephone CPR

HYPOTHERMIA

Hypothermia After Cardiac Arrest Study Group

- 275 patients VT/VF
- 5-15 minutes to initiation of resuscitation
- <60 minutes to restoration
- 24 hour temp 32-34 degrees
- 8 hours to achieve target temp

Cooling blankets, ice packs



N Engl J Med 2002;346:549-56

Hypothermia After Cardiac Arrest Study Group

Survival and Neurologic Outcome at Discharge

	Hypothermia	Normothermia
Survival p=0.02	**64**% 87/137	**50**% 69/138
Favorable neurologic outcome p=0.009	**47**% 64/134	**31**% 42/135

N Engl J Med 2002;346:549-56

Melbourne Australia Hypothermia

- 77 patients VF
- Return of spontaneous circulation
- Persistent coma
- Randomized odd / even days
- 12 hour temp 33 degrees
- Cooling begun pre-hospital
- 2.5 hours to achieve target temp

  chemical / ice packs

	Hypo-thermia	Normo-thermia
Favorable neurologic outcome	**49**% 15/43	**26**% 7/34

p=0.046

Bernard SA, et al. N Engl J Med 2002;346:57-63

Hypothermia

- Hypothermia saves lives
- Questions remain
  - Who, How, When to start, How long, What temperature, Rewarming, When to assess neurological recovery.

Minneapolis Heart Institute
Regional System for Therapeutic Hypothermia

- 140 patients
  - 106 in transfer
- Return of spontaneous circulation and unresponsive
- Discharged alive 56%
- Good. neuro. outcome 51%

ROSC to 1st Cooling

	Good neuro. Outcome
0 – 39 min	**60%** 26/43
40 – 102 min	**49%** 21/43
>102 min	**45%** 19/42

P<0.05

"every 1 hour in delay to initiation of cooling, the risk of death increased by 20%"

Mooney et al. Circulation. 2011;124:206-214.

Definitions

Cardiac Arrest

(also known as cardiopulmonary arrest):

Is the cessation of normal circulation
of the blood
due to failure of the heart
to contract effectively.

Cardiac Arrest

(also known as cardiopulmonary arrest):

Victims become limp and unresponsive.

They may stop breathing, have very slow deep breaths (agonal breathing), or gasp.

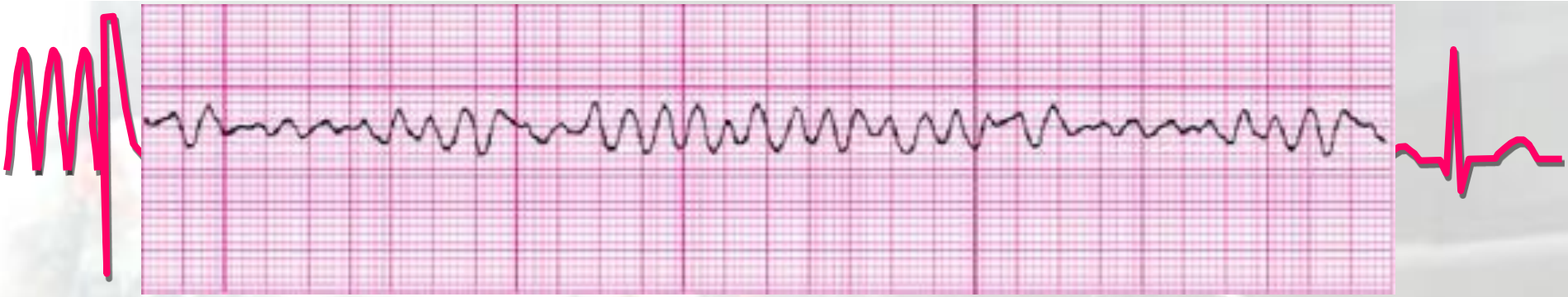
Cardiac Arrest

(also known as cardiopulmonary arrest):

Other conditions that may resemble cardiac arrest include:

- severely low blood sugar
- brain seizures
- respiratory arrest
- or anaphylactic shock

Cardiac arrest is more common in adults and older children who do not have lung disease.



Ventricular Fibrillation (VF):

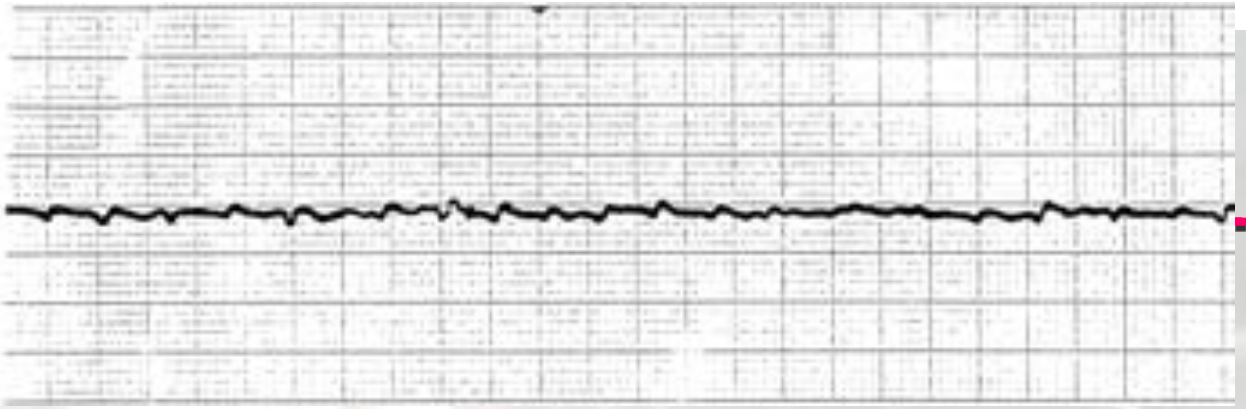
pulseless, chaotic activity of the heart muscle manifested by a disorganized and erratic ECG.

Ventricular Tachycardia (VT):

depolarization of the heart that originates in the ventricle manifested by a wide and regular ECG rhythm faster than 120 beats per minute.

Pulseless electrical activity (PEA):

any heart rhythm observed by ECG that should be producing a pulse with the absence of a pulse.



Asystole:

cardiac standstill manifested by a “flat line” ECG rhythm and absence of a pulse.

Return of Spontaneous Circulation (ROSC):

the return of a pulse following resuscitation.

Hypothermia:

cooling a patient to 32 – 34 degrees Celsius (90 – 93 degrees Fahrenheit).

After cardiac arrest, this process reduces swelling and inflammation and has been shown to improve brain recovery.

The HeartRescue Project:

Re-thinking Cardiac Arrest

HeartRescue PROJECT

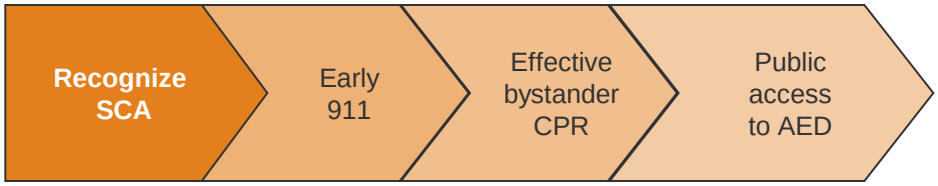
Vision

Every American who suffers from Sudden Cardiac Arrest will receive life-saving, state-of-the-art care at the scene, en route to and in the hospital.

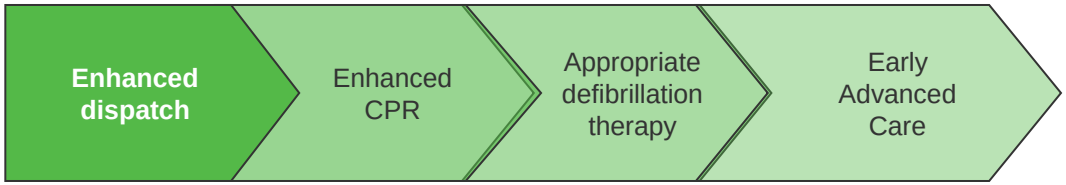
HeartRescue PROJECT

Goal: Improve out of hospital cardiac arrest survival by 50% over 5 years.

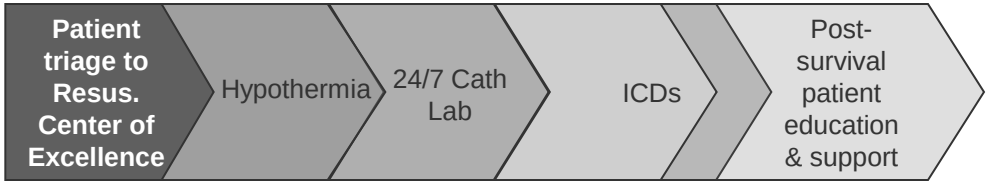
1: Community Response

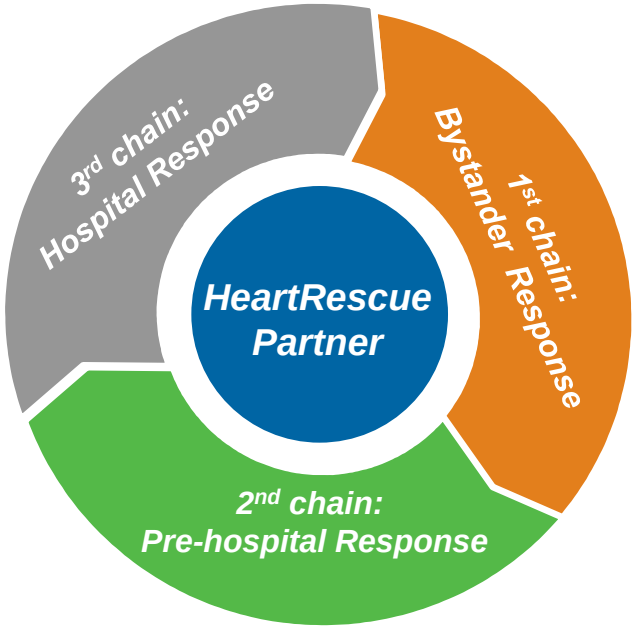


2: Pre-hospital Response



3: Hospital Response





HeartRescue PROJECT

HeartRescue Partners

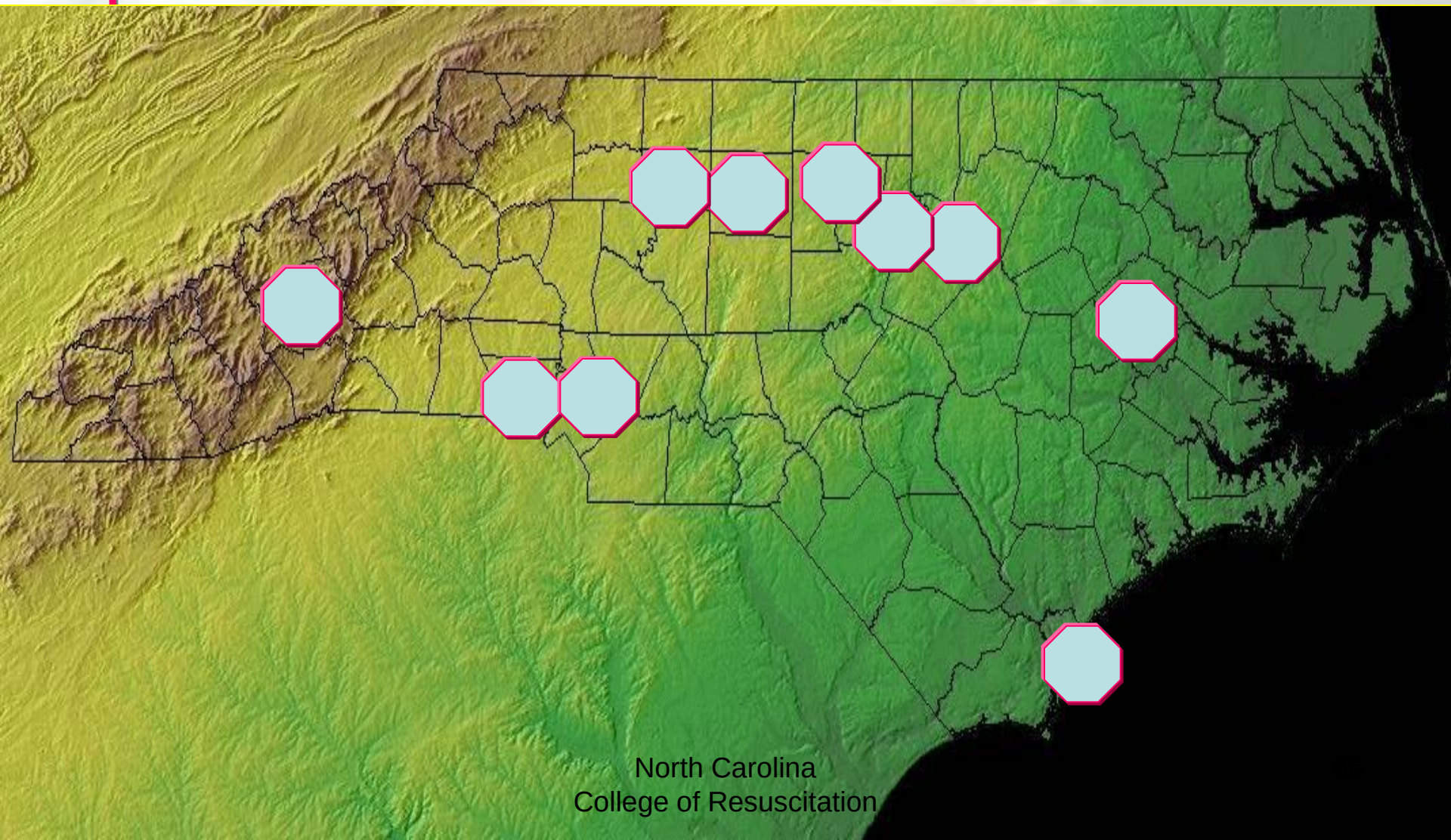
North Carolina College of Resuscitation

Medtronic FOUNDATION

Cardiac Arrest Resuscitation System

North Carolina
College of Resuscitation

Hospital / EMS cardiac arrest programs



RACE *Cardiac Arrest Resuscitation System*

2) Establish REGIONAL *CARDIAC ARREST* CENTERS

1) Develop leadership, funding, data structure

Measurement & Feedback

4) Improve system

3c) Community by community cardiac arrest training/AED placement

3a) HOSPITAL by hospital establishment of cardiac arrest plan (review, consensus, training)

3b) EMS by EMS establishment of cardiac arrest plan (review, consensus, training)

Community Response:

- NC Standard Course of Study and Grade Level Competencies
  - CPR and AED training by 8th grade
- Heart patients on discharge
- All hospital employees

Recognize cardiac arrest, MI, stroke; call 911; hands only CPR; AED

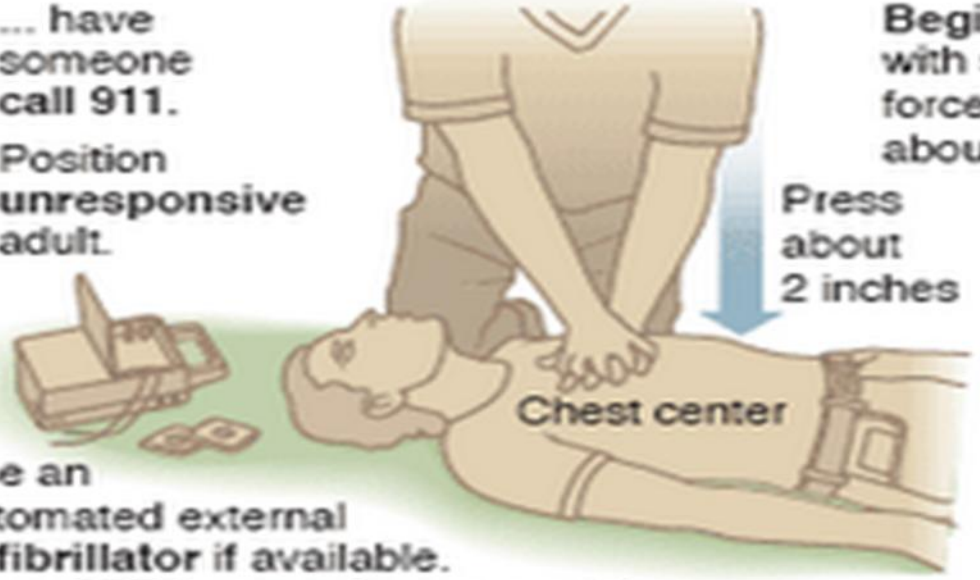
Simplifying to hands-only CPR

Experts now believe an adult who suddenly collapses due to cardiac arrest has enough air in his lungs and blood during CPR and doesn't need mouth-to-mouth breathing.

If you see someone collapse ...

... have someone **call 911.**

Position **unresponsive** adult.



Begin hands-only CPR with straight arms and forceful compressions at about 100 a minute.

Lift hands slightly after each to allow chest to recoil.

Take turns with a bystander until emergency medical services arrive.

Use an automated external **defibrillator** if available.

Keep CPR interruptions to a minimum.

SOURCES: University of Arizona Sarver Heart Center; American Heart Association

AP


CPR
CPR

Pre Hospital:

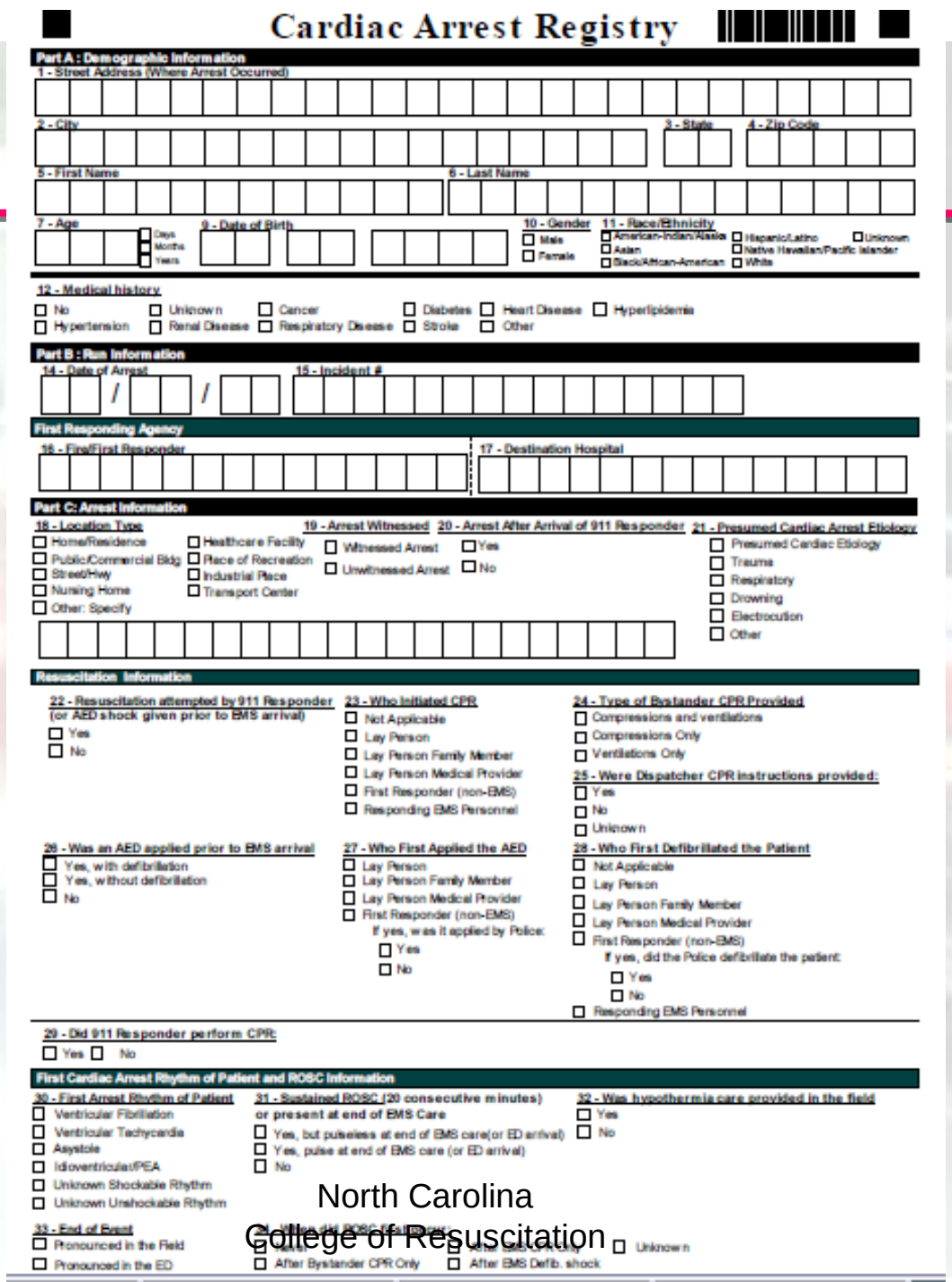
- Rapid dispatch
  - Medical dispatcher
  - Dispatcher CPR instruction
- Effective resuscitation
  - Uninterrupted chest compression
  - ACLS team approach
- In the field cooling
- CARES Registry

Hospital:

- Post cardiac arrest care
  - Strong physician leader
  - Cardiac arrest team / coordinator
  - ICU / hypothermia / cath. / neurology protocols
  - Limited data measurement and feedback
- EP evaluation / Implantable defibrillators
- Community support / training

CARES Registry:

- Created 2004 agreement between CDC and Emory
- Help EMS Identify:
  - When, where, what part of the system is functioning properly, and where there are opportunities to improve
- Consolidates all essential elements
- Quick and easy data collection
- Track ongoing performance
- Create reports for benchmarking



Cardiac Arrest Registry

Part A : Demographic Information

1 - Street Address (Where Arrest Occurred)

2 - City | 3 - State | 4 - Zip Code

5 - First Name | 6 - Last Name

7 - Age ☐ Days ☐ Months ☐ Years | 9 - Date of Birth | 10 - Gender ☐ Male ☐ Female | 11 - Race/Ethnicity ☐ American-Indian/Alaska ☐ Asian ☐ Black/African-American ☐ Hispanic/Latino ☐ Native Hawaiian/Pacific Islander ☐ White ☐ Unknown

12 - Medical history

☐ No ☐ Unknown ☐ Cancer ☐ Diabetes ☐ Heart Disease ☐ Hyperlipidemia
☐ Hypertension ☐ Renal Disease ☐ Respiratory Disease ☐ Stroke ☐ Other

Part B : Run Information

14 - Date of Arrest / / | 15 - Incident #

First Responding Agency

16 - Fire/First Responder | 17 - Destination Hospital

Part C: Arrest Information

18 - Location Type
☐ Home/Residence ☐ Healthcare Facility
☐ Public/Commercial Bldg ☐ Place of Recreation
☐ Street/Hwy ☐ Industrial Place
☐ Nursing Home ☐ Transport Center
☐ Other: Specify

19 - Arrest Witnessed ☐ Witnessed Arrest ☐ Unwitnessed Arrest

20 - Arrest After Arrival of 911 Responder ☐ Yes ☐ No

21 - Presumed Cardiac Arrest Etiology
☐ Presumed Cardiac Etiology
☐ Trauma
☐ Respiratory
☐ Drowning
☐ Electrocution
☐ Other

Resuscitation Information

22 - Resuscitation attempted by 911 Responder (or AED shock given prior to EMS arrival)
☐ Yes ☐ No

23 - Who Initiated CPR
☐ Not Applicable
☐ Lay Person
☐ Lay Person Family Member
☐ Lay Person Medical Provider
☐ First Responder (non-EMS)
☐ Responding EMS Personnel

24 - Type of Bystander CPR Provided
☐ Compressions and ventilations
☐ Compressions Only
☐ Ventilations Only

25 - Were Dispatcher CPR instructions provided:
☐ Yes ☐ No ☐ Unknown

26 - Was an AED applied prior to EMS arrival
☐ Yes, with defibrillation
☐ Yes, without defibrillation
☐ No

27 - Who First Applied the AED
☐ Lay Person
☐ Lay Person Family Member
☐ Lay Person Medical Provider
☐ First Responder (non-EMS)
If yes, was it applied by Police:
☐ Yes ☐ No

28 - Who First Defibrillated the Patient
☐ Not Applicable
☐ Lay Person
☐ Lay Person Family Member
☐ Lay Person Medical Provider
☐ First Responder (non-EMS)
If yes, did the Police defibrillate the patient:
☐ Yes ☐ No
☐ Responding EMS Personnel

29 - Did 911 Responder perform CPR:
☐ Yes ☐ No

First Cardiac Arrest Rhythm of Patient and ROSC Information

30 - First Arrest Rhythm of Patient
☐ Ventricular Fibrillation
☐ Ventricular Tachycardia
☐ Asystole
☐ Idioventricular/PEA
☐ Unknown Shockable Rhythm
☐ Unknown Unshockable Rhythm

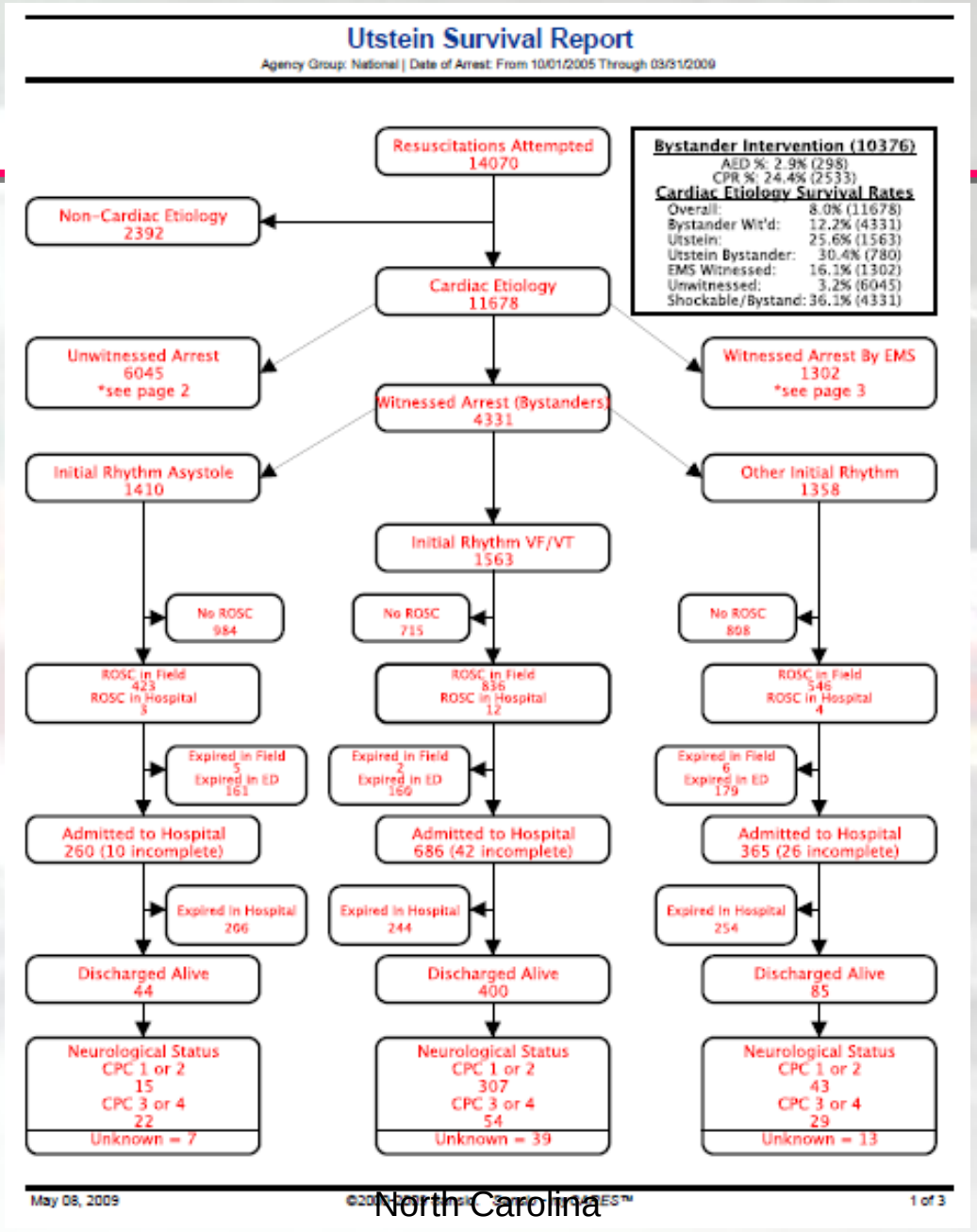
31 - Sustained ROSC (20 consecutive minutes) or present at end of EMS Care
☐ Yes, but pulseless at end of EMS care(or ED arrival)
☐ Yes, pulse at end of EMS care (or ED arrival)
☐ No

32 - Was hypothermia care provided in the field
☐ Yes ☐ No

33 - End of Event
☐ Pronounced in the Field
☐ Pronounced in the ED

☐ After Bystander CPR Only ☐ After EMS Defib. shock ☐ Unknown

North Carolina College of Resuscitation


Utstein Survival Report
Agency Group: National | Date of Arrest: From 10/01/2005 Through 03/31/2009
Resuscitations Attempted
14070
Non-Cardiac Etiology
2392
Cardiac Etiology
11678
Unwitnessed Arrest
6045
*see page 2
Witnessed Arrest (Bystanders)
4331
Witnessed Arrest By EMS
1302
*see page 3
Initial Rhythm Asystole
1410
Initial Rhythm VF/VT
1563
Other Initial Rhythm
1358
Bystander Intervention (10376)
AED %: 2.9% (298)
CPR %: 24.4% (2533)
Cardiac Etiology Survival Rates
Overall: 8.0% (11678)
Bystander Wit'd: 12.2% (4331)
Utstein: 25.6% (1563)
Utstein Bystander: 30.4% (780)
EMS Witnessed: 16.1% (1302)
Unwitnessed: 3.2% (6045)
Shockable/Bystand: 36.1% (4331)
No ROSC
984
No ROSC
715
No ROSC
808
ROSC in Field
423
ROSC in Hospital
8
ROSC in Field
836
ROSC in Hospital
12
ROSC in Field
546
ROSC in Hospital
4
Expired in Field
5
Expired in ED
161
Expired in Field
2
Expired in ED
169
Expired in Field
6
Expired in ED
179
Admitted to Hospital
260 (10 incomplete)
Admitted to Hospital
686 (42 incomplete)
Admitted to Hospital
365 (26 incomplete)
Expired in Hospital
266
Expired in Hospital
244
Expired in Hospital
254
Discharged Alive
44
Discharged Alive
400
Discharged Alive
85
Neurological Status
CPC 1 or 2
15
CPC 3 or 4
22
Unknown = 7
Neurological Status
CPC 1 or 2
307
CPC 3 or 4
54
Unknown = 39
Neurological Status
CPC 1 or 2
43
CPC 3 or 4
29
Unknown = 13
May 08, 2009
1 of 3

CARES Registry:
HIPAA / PHI

- CDC Registry – Federal exempt
- Duke IRB approved
- Business Associate Agreement can be executed.
- Direct identifiers removed

CARDIAC ARREST:

is the sudden loss of adequate blood flow to the brain due to a heart rhythm problem. Victims become unresponsive and limp.

- Other conditions that may resemble cardiac arrest include severely low blood sugar
- brain seizures
- respiratory arrest
- or anaphylactic shock.

Cardiac arrest is more common in adults and older children who do not have lung disease.