

**Recent advances improving
outcome from cardiac arrest**

**Doubling survival
from cardiac arrest in Denmark**

The Capital Region of Denmark



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Disclosure

- No financial conflicts of interest
- Medical Advisor to the National Board of Health, Denmark
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Outline

- New national data on outcome from Out-of-Hospital Cardiac Arrest
- Why did we succeed in Denmark?
- New data from 2011
- Challenges and potentials for the near future

Emergency Medical Services (EMS) the Gate-keeper of High-Quality Patient Care



- ... the impressive reorganisation of EMS in Copenhagen over the last decade which has totally transformed its EMS provision, making it the ‘gatekeeper’ for high-quality patient care for all citizens seeking healthcare and a model of effective delivery that is fast becoming a blue-print for EMS providers around Europe.

Do AEDs save lives?

- NO!
- but people save lives by using AEDs
- And to support this we need system solutions



The past – did we succeed?

- Sasson et al in Circ Cardiovasc Qual Outcomes. 2010;3:63-81
- Predictors of Survival From Out-of-Hospital Cardiac Arrest. A Systematic Review and Meta-Analysis
- Period: 1950-2008
- Data: 142.740 patients in 79 studies

The past – did we succeed?

- Survival rate to hospital discharge: 7.6 %
(CI, 6.7- 8.4)
- Overall survival from OHCA has been unchanged for 3 decades
- The strong associations between key predictors and survival also unchanged.

Ref: Sasson 2010

New national data on survival from Denmark

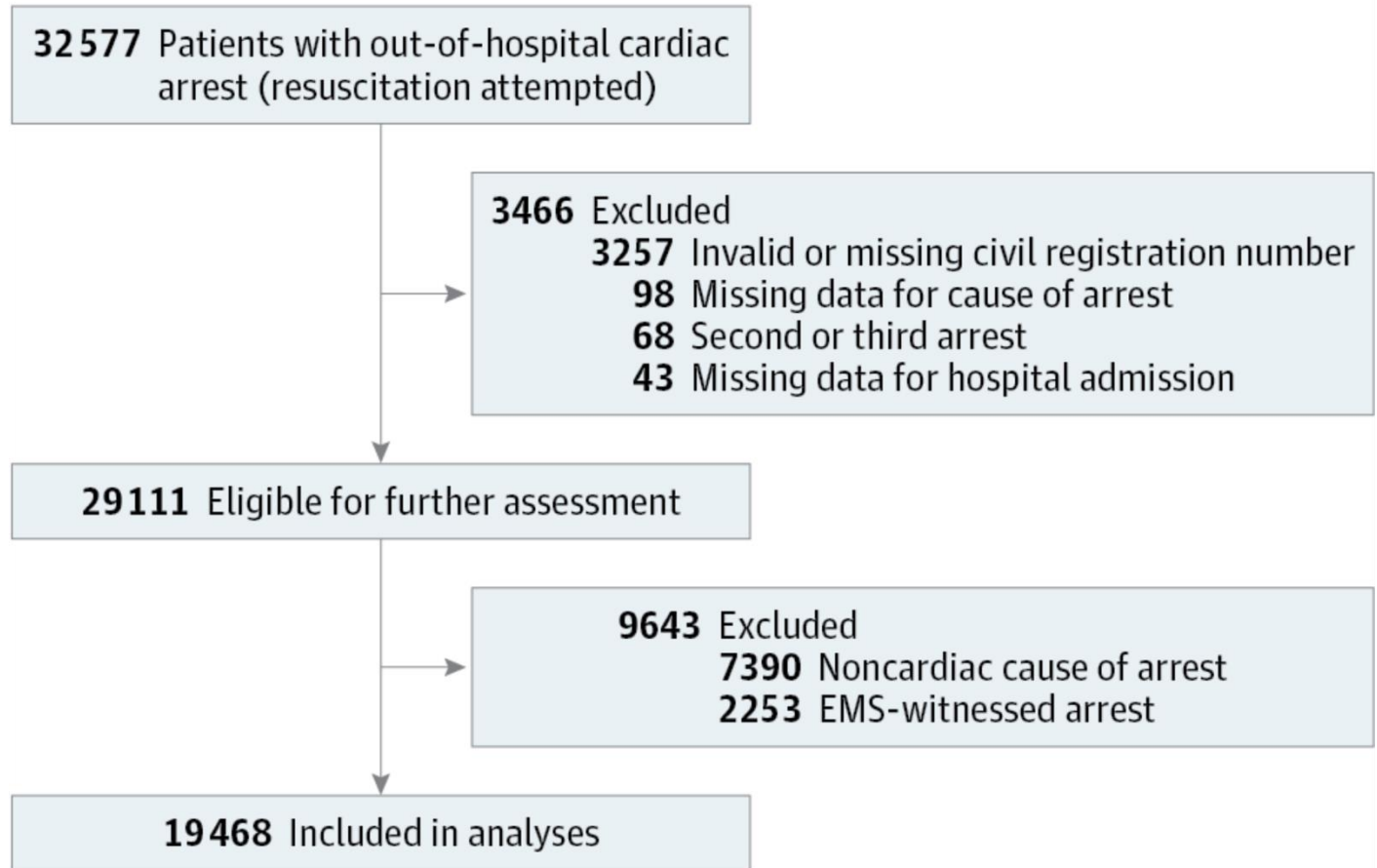


JAMA October 2013

- Association of National Initiatives to Improve Cardiac Arrest Management With Rates of Bystander Intervention and Patient Survival After Out-of-Hospital Cardiac Arrest
- Wissenberg et al
- JAMA. 2013;310(13):1377-1384.
doi:10.1001/jama.2013.278483

From: **Association of National Initiatives to Improve Cardiac Arrest Management With Rates of Bystander Intervention and Patient Survival After Out-of-Hospital Cardiac Arrest**

JAMA. 2013;310(13):1377-1384. doi:10.1001/jama.2013.278483



Setting and population

Period: From 2001 to 2010



Total Cardiac Arrests: 29.111

Cardiac presumed non-cardiac cause: 7390

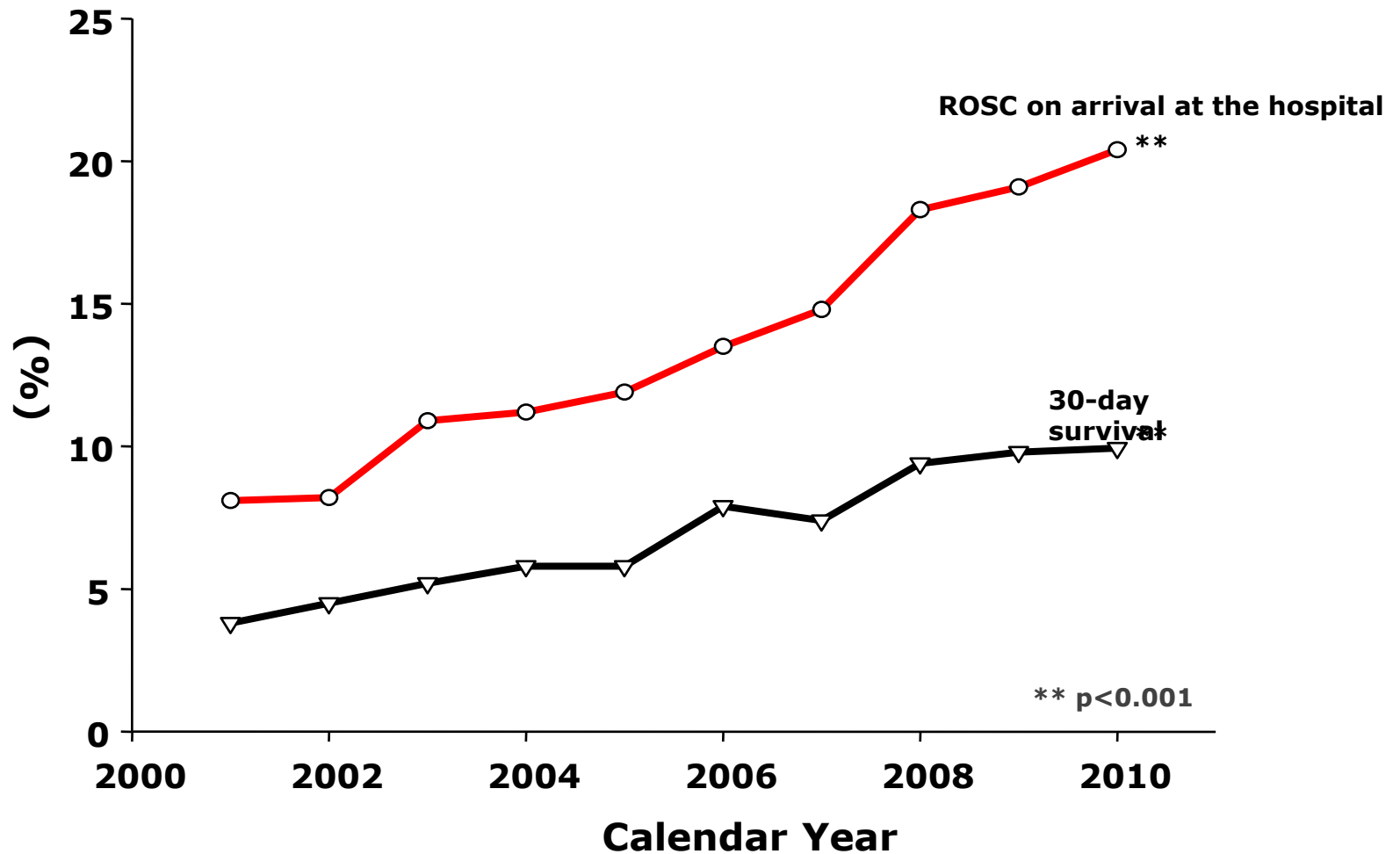
EMS witnessed: 2253

Study population: 19.468 patients

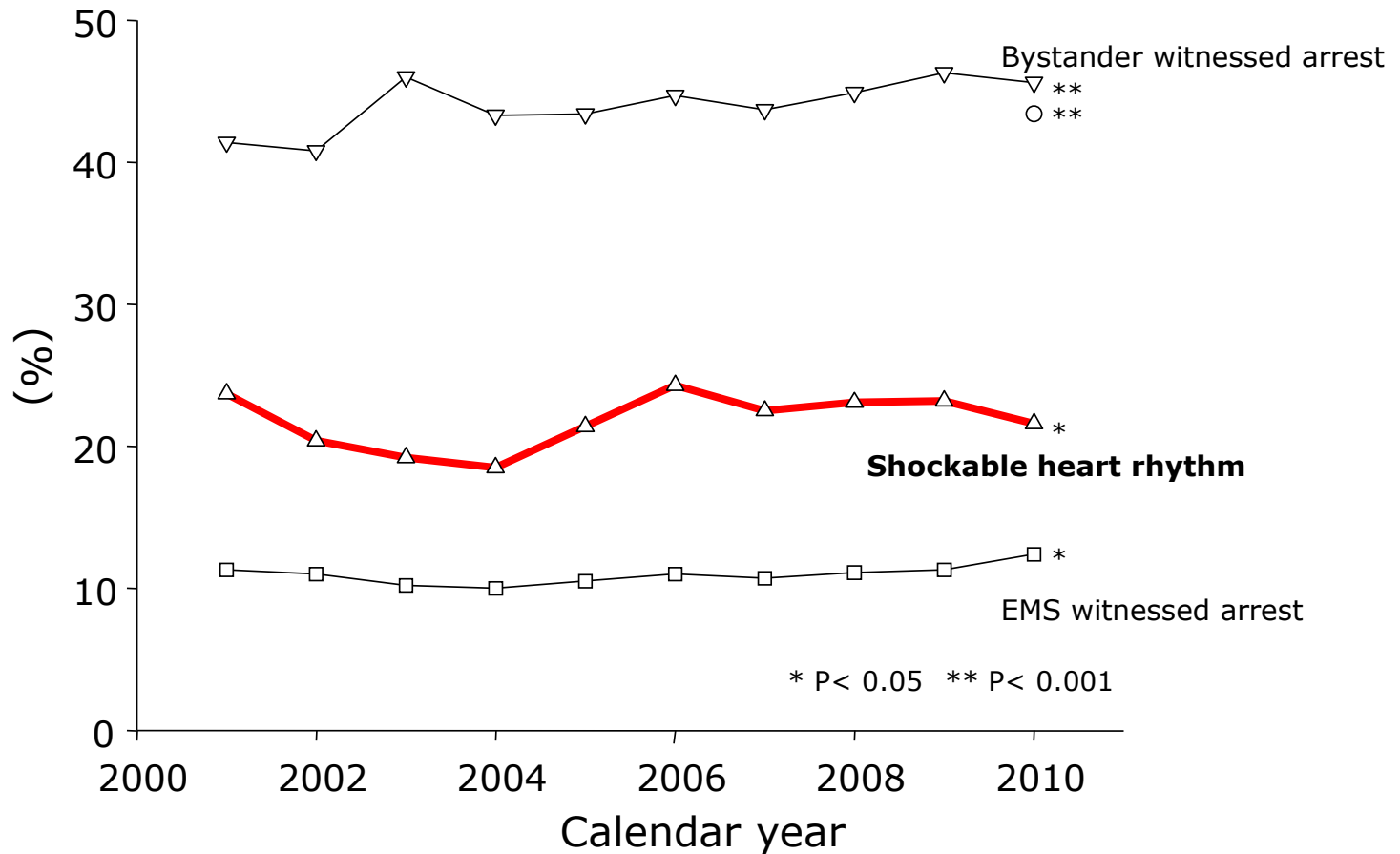
Results

- Bystander CPR increased from 21.1% to 44.9 %
- Survival to hospital increased from 7.9% to 21.8%
- 30 days survival increased from 3.5% to 10.8 %
- 1 year survival increased from 3.5% to 10.2%

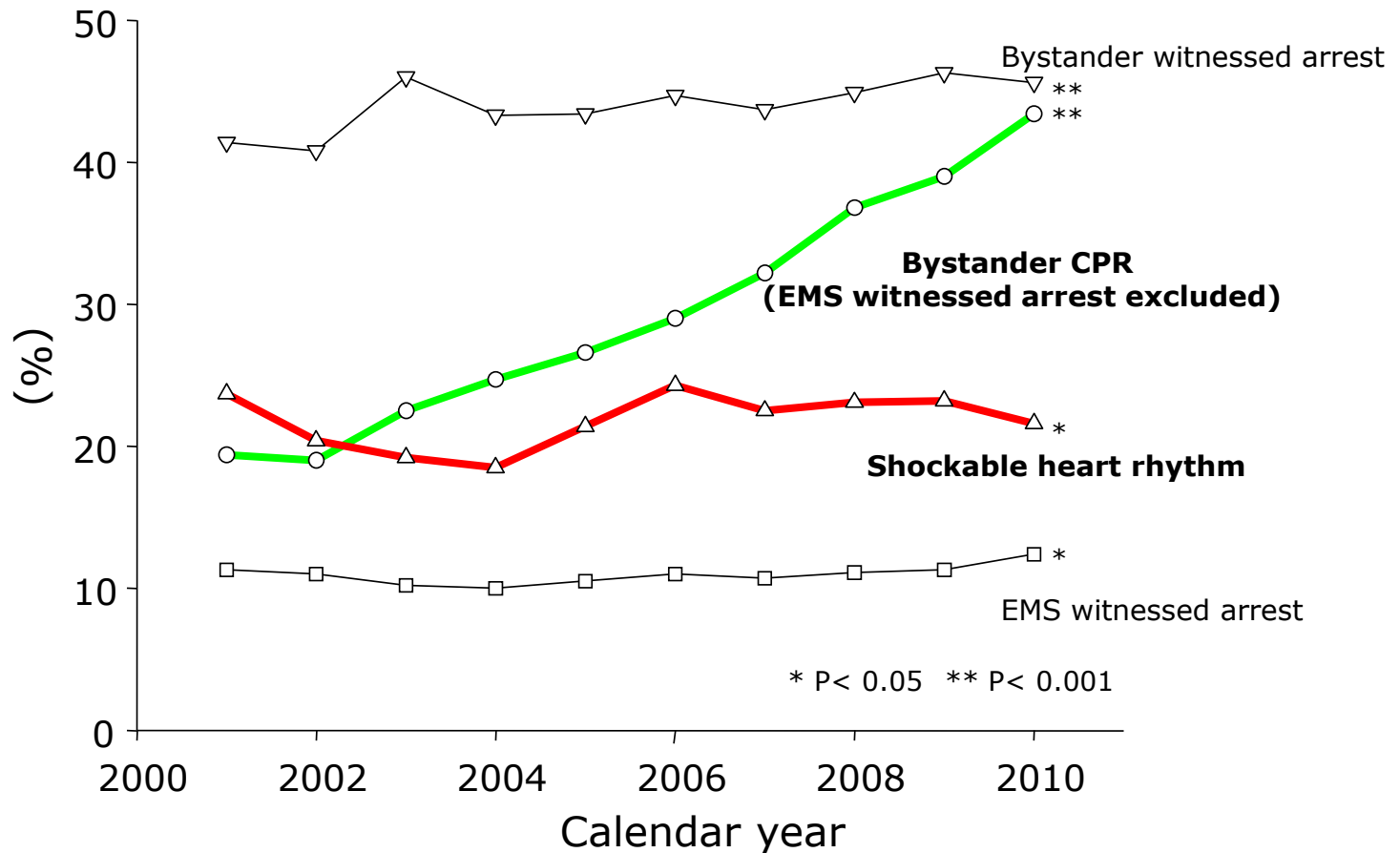
Temporal trends in ROSC on arrival at the hospital and 30-day survival



Temporal trends in Bystander CPR, Witnessed status and Shockable heart rhythm



Temporal trends in Bystander CPR, Witnessed status and Shockable heart rhythm



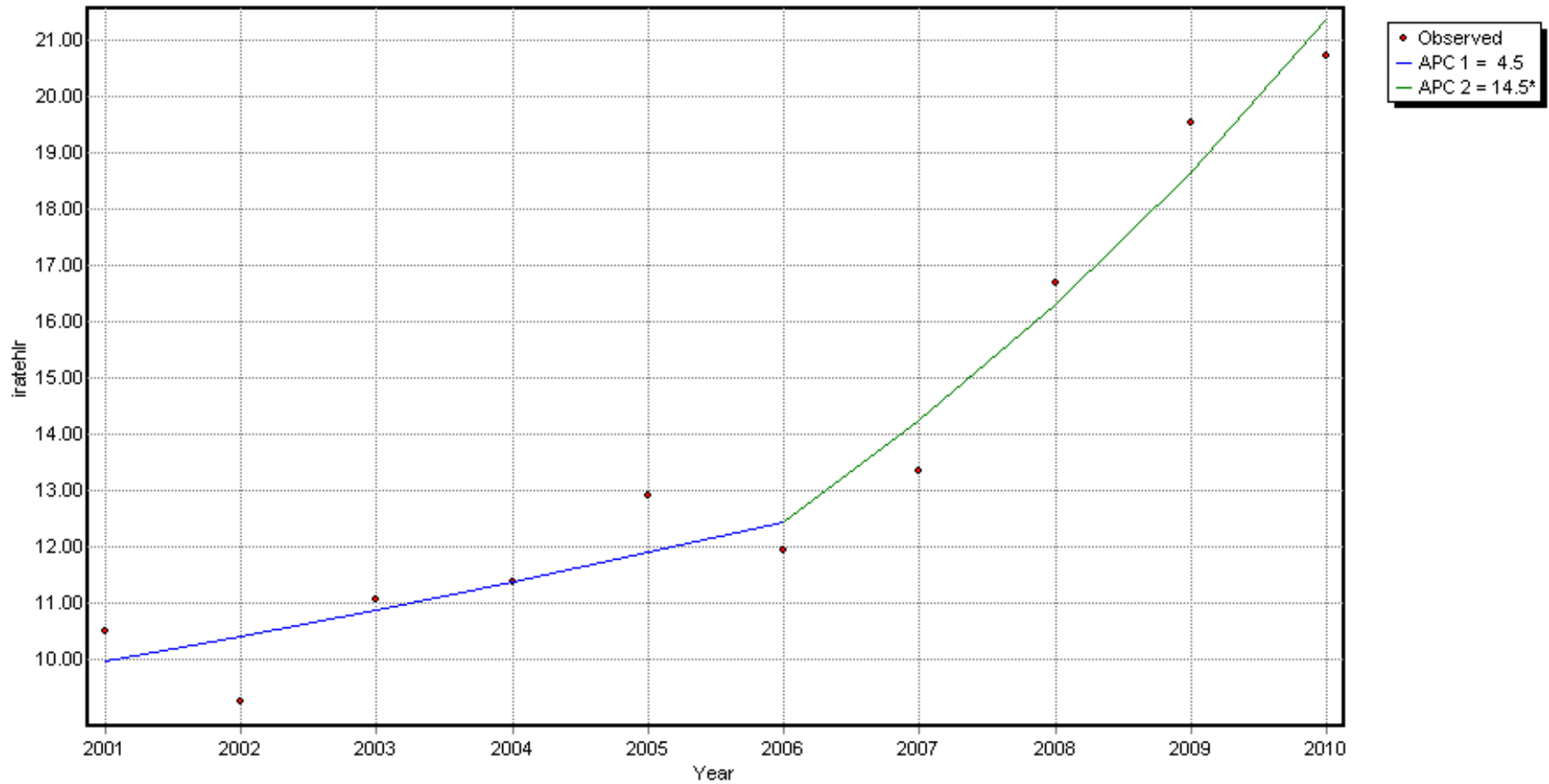


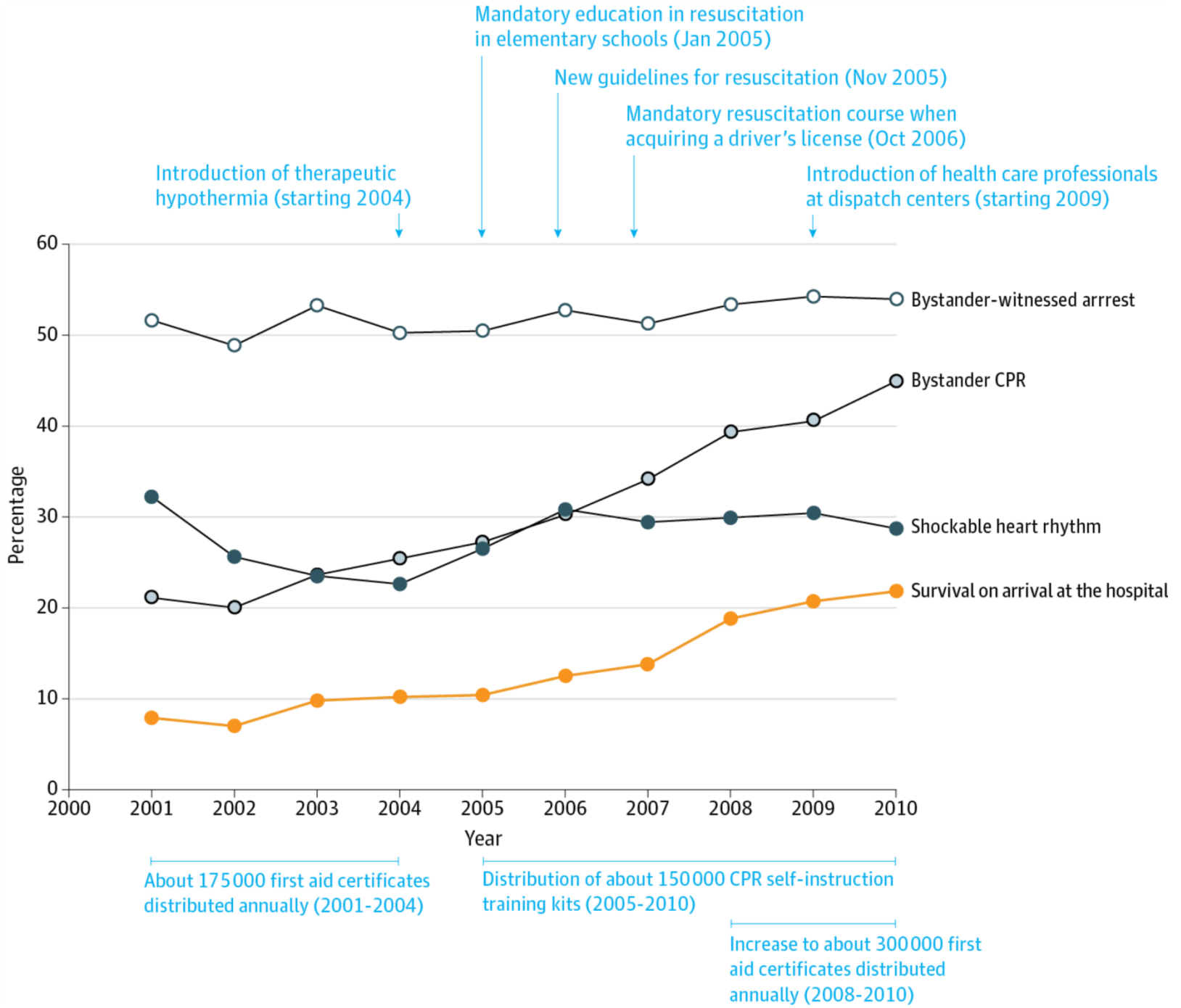
Results

- Cardiac arrest ~ 57,4 per 100.000 inhabitants
- Number of survivals per 100.000 inhabitants increased significantly from 1.4 % to 3.7 %
- Number of lives saved per year increased from 75 in 2002 to 195 2010 (one year survival)
- For witness cardiac survival rate was 6.1% for arrests without bystander CPR and 19.4% for arrest with bystander CPR.

Incidence of patients receiving bystander CPR

All : 1 Joinpoint







National initiatives

- 2004: Therapeutic hypothermia introduced
- 2005: Elementary school curriculum – mandatory
- 2005: New ERC guidelines
- 2006: Mandatory CPR courses for driver's license
- 2009: Introducing health care professionals to dispatch centres
- Distribution of 150.000 CPR self-instruction training kits in 2005-2010
- CPR course certificates increase from 175.000 annually in 2001-2004 to 300.000 annually 2008-2010

Table 1. Changes in Characteristics for Patients During the Study Period

Characteristic	Year										P Value ^b	No. (%)	
	2001 ^a	2002	2003	2004	2005	2006	2007	2008	2009	2010		2001-2010	Missing Data
OHCA, No. (%)	1262 (6.5)	2282 (11.7)	2278 (11.7)	2100 (10.8)	2095 (10.8)	1890 (9.7)	1819 (9.3)	1849 (9.5)	1987 (10.2)	1906 (9.8)		19 468 (100)	
Age, median (IQR), y	71 (62-80)	71 (61-80)	71 (61-80)	72 (61-81)	72 (62-80)	72 (61-80)	72 (61-81)	71 (60-80)	72 (62-81)	73 (63-81)	<.001	72 (61-80)	0 ^c
Men	71 (61-78)	70 (59-78)	70 (59-79)	70 (60-79)	70 (61-79)	71 (60-78)	70 (60-79)	69 (59-79)	70 (61-79)	70 (61-79)	.60	70 (60-79)	0 ^c
Women	73 (63-82)	75 (65-82)	73 (64-83)	75 (65-83)	75 (64-84)	75 (65-83)	77 (66-84)	75 (64-83)	76 (65-85)	77 (66-85)	<.001	75 (65-83)	0 ^c
Men, No. (%)	884 (70.1)	1509 (66.1)	1531 (67.2)	1386 (66.0)	1432 (68.4)	1297 (68.6)	1207 (66.4)	1252 (67.7)	1355 (68.2)	1258 (66.0)	.73	13 111 (67.4)	0 ^c
Cardiac arrest in private home, No. (%)	601 (69.6)	1243 (72.2)	1309 (72.4)	1279 (73.7)	1331 (74.1)	1080 (77.2)	1146 (75.8)	1260 (74.6)	1447 (75.7)	1387 (75.0)	<.001	12 083 (74.2)	3182 (16.3)
Bystander-witnessed arrest, No. (%)	599 (51.6)	992 (48.8)	1113 (53.2)	971 (50.2)	996 (50.4)	898 (52.7)	844 (51.2)	972 (53.3)	1069 (54.2)	1020 (53.9)	.001	9474 (52.0)	1231 (6.3)
Bystander CPR, No. (%)	247 (21.1)	408 (20.0)	496 (23.6)	492 (25.4)	539 (27.2)	514 (30.2)	563 (34.1)	714 (39.3)	799 (40.5)	849 (44.9)	<.001	5621 (30.8)	1193 (6.1)
AED use by bystander, No. (%)	13 (1.1)	23 (1.1)	21 (1.0)	18 (0.9)	33 (1.7)	22 (1.3)	29 (1.8)	22 (1.3)	24 (1.4)	36 (2.2)	.003	241 (1.4)	1829 (9.4)
Time interval, median (IQR), min ^d	11 (6-19)	11 (6-18)	10 (5-17)	10 (6-17)	11 (6-20)	11 (6-19)	11 (6-19)	11 (7-18)	12 (7-19)	13 (8-20)	<.001	11 (6-18)	3394 (17.4)
Shockable heart rhythm, No. (%)	351 (32.2)	498 (25.6)	484 (23.5)	457 (22.6)	542 (26.5)	559 (30.8)	488 (29.4)	513 (29.9)	570 (30.4)	519 (28.7)	<.001	4981 (27.6)	1429 (7.3)
Survival, No. (%)													
On arrival at hospital	91 (7.9)	140 (7.0)	202 (9.8)	193 (10.2)	203 (10.4)	211 (12.5)	217 (13.8)	310 (18.8)	362 (20.7)	354 (21.8)	<.001	2283 (13.2)	2145 (11.0)
30-d	44 (3.5)	86 (3.8)	102 (4.5)	102 (4.9)	104 (5.0)	143 (7.6)	136 (7.5)	189 (10.2)	203 (10.2)	206 (10.8)	<.001	1315 (6.8)	0 ^c
1-y	37 (2.9)	75 (3.3)	90 (4.0)	87 (4.1)	100 (4.8)	133 (7.0)	122 (6.7)	173 (9.4)	184 (9.3)	195 (10.2)	<.001	1196 (6.1)	0 ^c

Abbreviations: AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; IQR, interquartile range; OHCA, out-of-hospital cardiac arrest.

^a 2001 consists of 7 months from June to December.

^b $P < .05$ considered statistically significant.

^c Patients with invalid or missing civil registration number, used to link

information on patient's age, sex, and survival status, were excluded from the analysis.

^d Estimated time interval from recognition of OHCA to rhythm analysis by emergency medical service.

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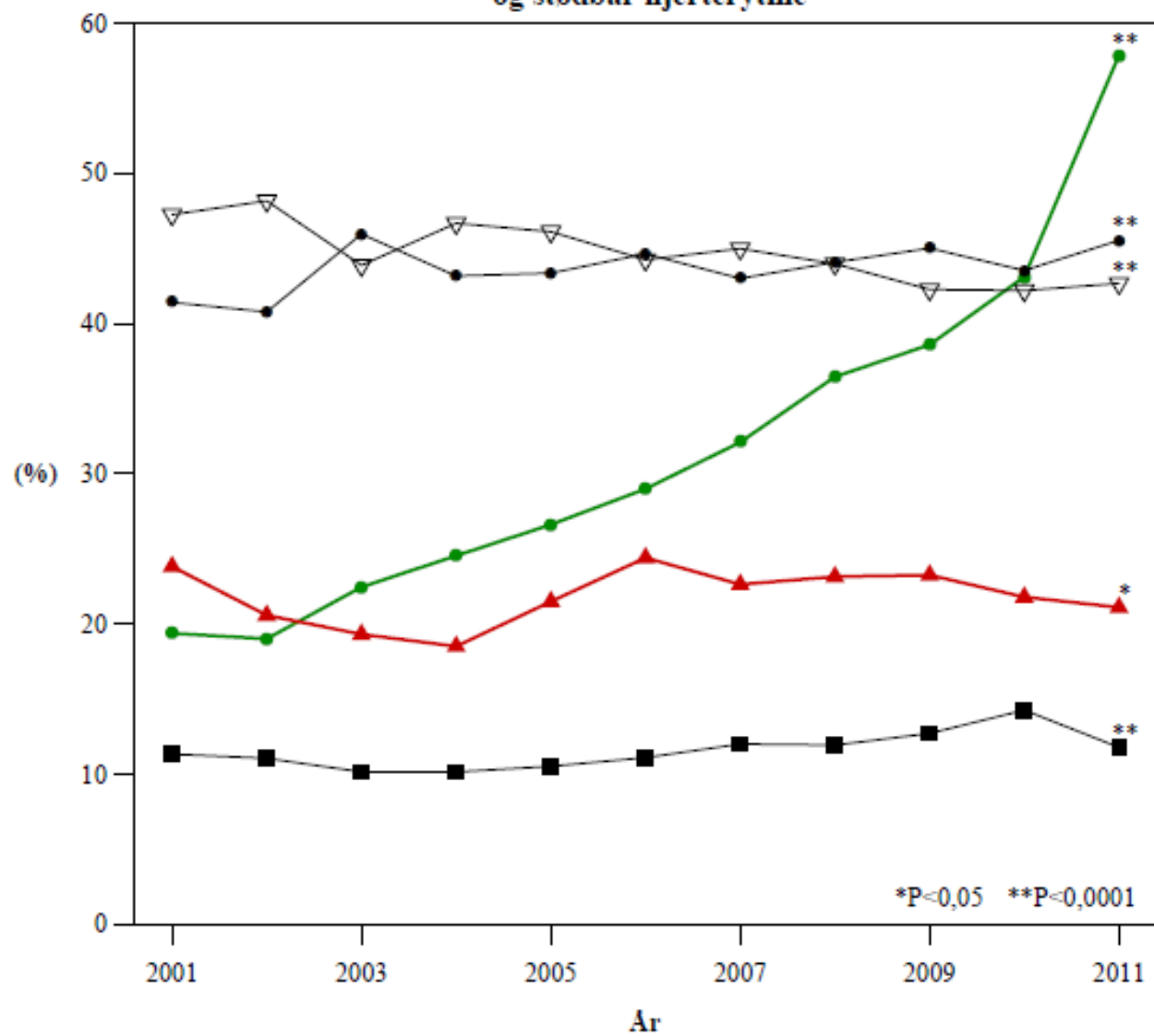
New Data from 2011

Data from 2011 compared to 2010 – All causes (cardiac and non-cardiac)

- Bystander CPR increased from 43.1 % to 57.9%
- 30 days survival 9.7 % to 10.1%
- Number of survivor from 324 to 337 lives
- Use of an AED before EMS arrival: 1.7 % to 2.5%

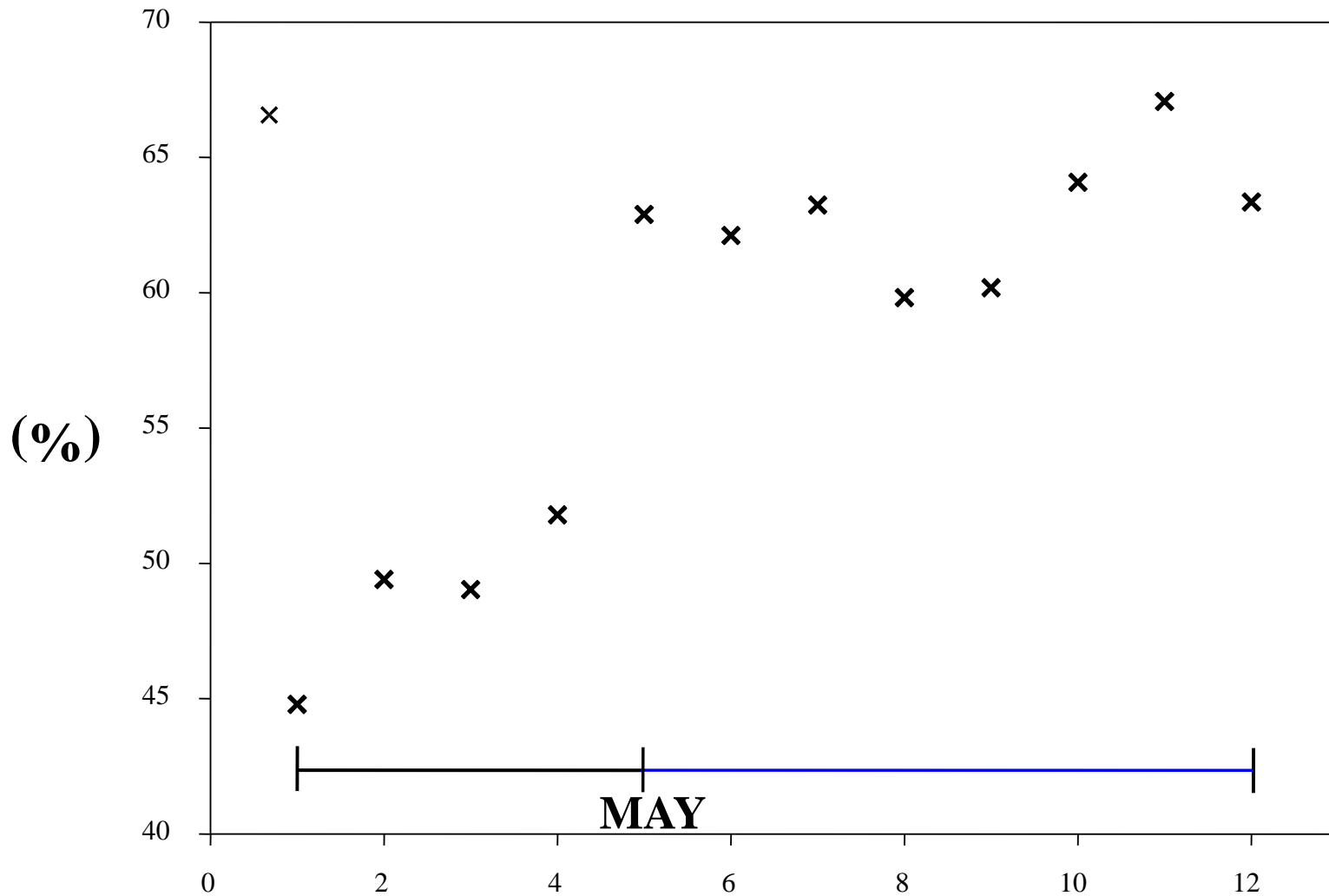
- Shockable 23 %
- Chance of survival if VF/pVT: increased from 12.3 % in 2001 to 35.2 % in 2011

Figur 2. Tidsmæssig udvikling i HLR inden ambulancens ankomst, bevidnet status og stødbar hjerterytme



- HLR inden ambulancens ankomst
- Bevidnet hjertestop
- Ikke bevidnet hjertestop
- Stødbar hjerterytme
- Ambulancetjeneste bevidnet hjertestop

Bystander CPR in 2011



By Months in 2011

Why did we succeed

- We had the interest and wanted to change the future
- We used data and research
- We found new solutions
- We did the implementation of the new solutions
- We engaged the media and the public
- We presented the data and the solution to the national board of health
- We had financial support from a private foundation (www.trygfonden.dk)

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The successful story from Copenhagen

Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart
Association®



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Location of Cardiac Arrest in a City Center: Strategic Placement of Automated External Defibrillators in Public Locations

Fredrik Folke, Freddy Knudsen Lippert, Søren Loumann Nielsen, Gunnar Hilmar Gislason, Morten Lock Hansen, Tina Ken Schramm, Rikke Sørensen, Emil Loldrup Fosbøl, Søren Skott Andersen, Søren Rasmussen, Lars Køber and Christian Torp-Pedersen

Circulation 2009;120;510-517; originally published online Jul 27, 2009;

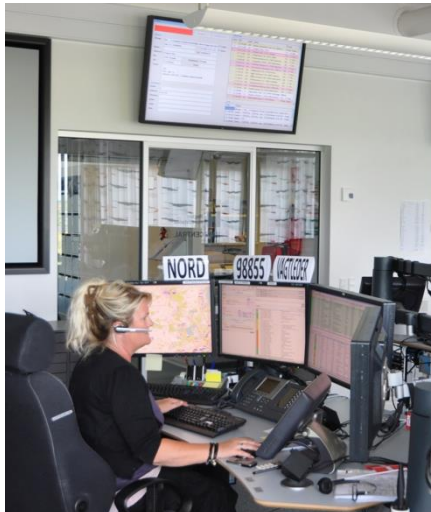
- A population based cohort study of OHCA in Copenhagen during 1994-2005
- 4828 OHCA occurred, of these 1274 occurred in public locations
- Analysing the location of cardiac arrest and location of AED for public access defibrillation

Cardiac arrest and Public Access Defibrillation

	Copenhagen 2005	ERC 2005 Guidelines
AEDs needed	104	125
OHCAs covered	29	249
% of all OHCAs	2%	20%
% of city area	1%	1%

Solution: Linking AEDs to Cardiac Arrest

- The bystander calls 112
- The dispatcher identify Cardiac Arrest
- The dispatcher identify nearest AED
- The dispatcher provides guidance on bystander CPR and on location of the nearest AED



National AED Network/Registry

- A national network based upon voluntary participation
- Information of AED-location electronically available at the Emergency Medical Dispatch Centre
- Information about AED-availability

National implementation of PAD network

- www.hjertestarter.dk

Link to maps

- <http://www.hjertestarter.dk/Kort>

Public AEDs in Denmark



KORTET

HJERTESTART

HISTORIER

I SKOLEN

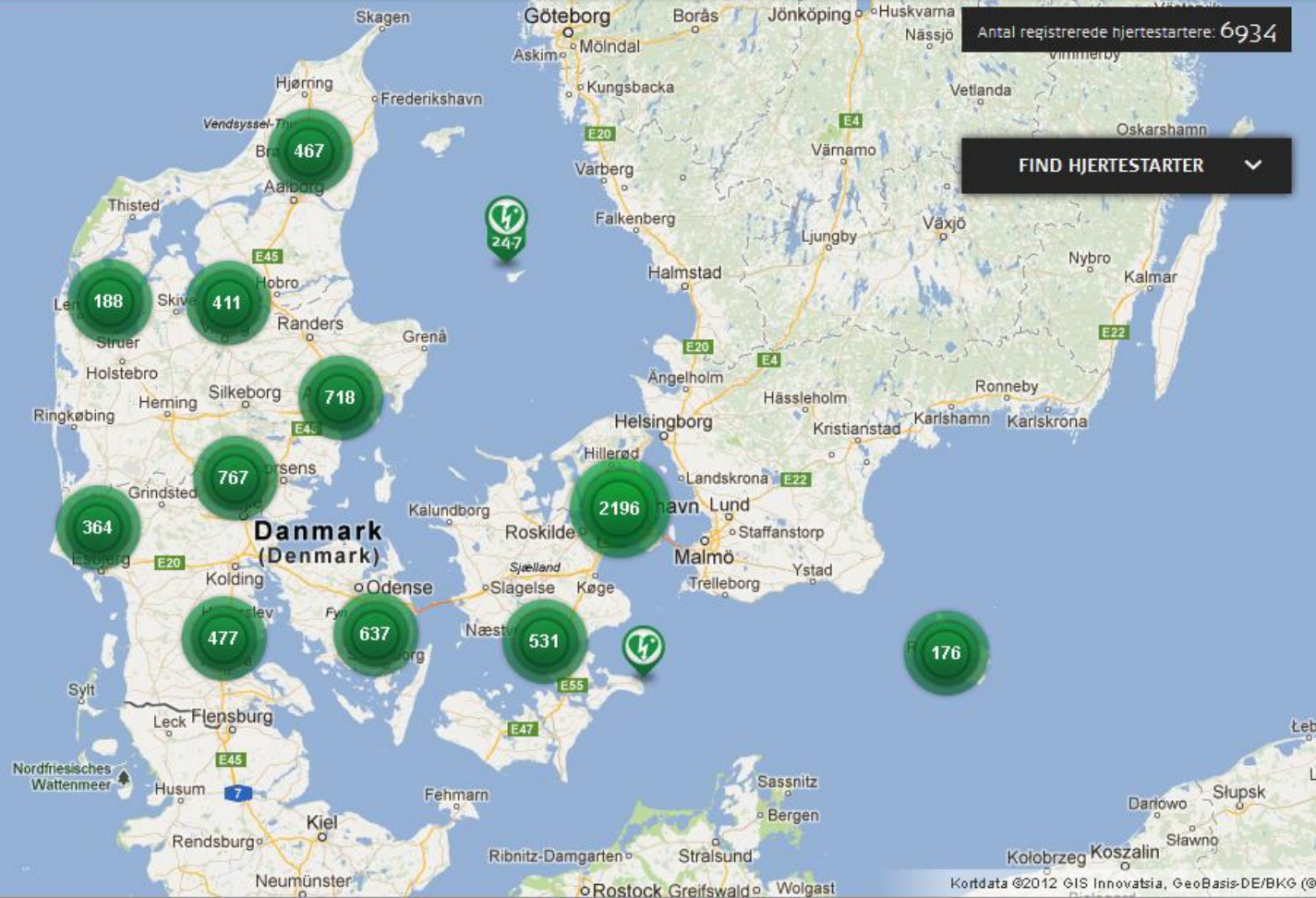
INSTRUKTIONSFILM

LITTERATUR

REGISTRER DIN HJERTESTARTER

Antal registrerede hjertestartere: 6934

FIND HJERTESTARTER



Public AEDs in Denmark

TrygFonden
Hjertestart

Om hjertestarter.dk | Kontakt | Login | Registrer

KORTET | HJERTESTART | HISTORIER | I SKOLEN | INSTRUKTIONSFILM | LITTERATUR | **REGISTRER DIN HJERTESTARTER**

Antal registrerede hjertestartere: 6934

FIND HJERTESTARTER

Google 100 m 500 feet

Kortdata ©2012 Google - Servicevilkår

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TrygFonden
Hjerterstart

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KORTET HJERTESTART HISTORIER I SKOLEN INSTRUKTIONSFILM LITTERATUR **REGISTRER DIN HJERTESTARTER**

Antal registrerede hjerterstartere: 6934

FIND HJERTESTARTER

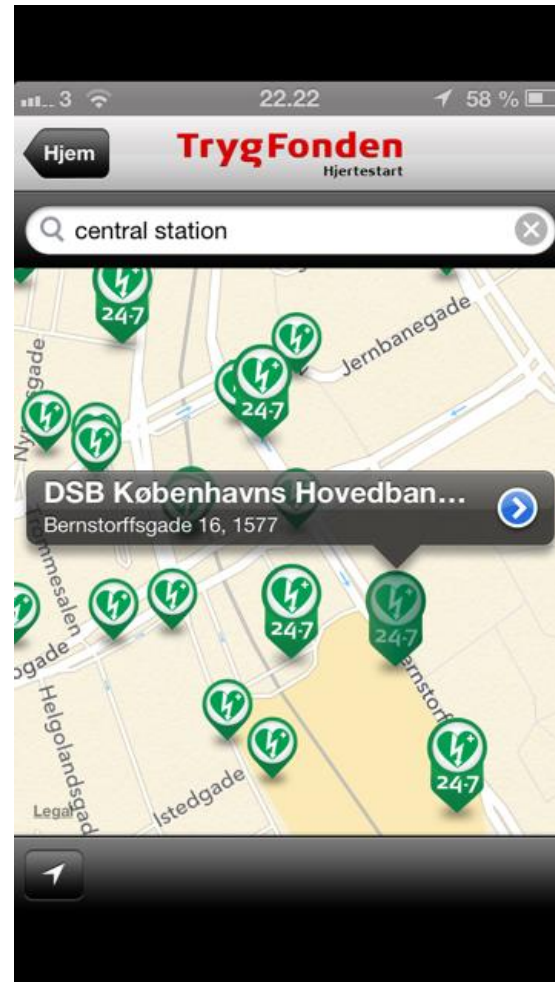
DSB KØBENHAVNS HOVEDBANEGÅRD TRAFIKHALLEN
Bernstorffsgade 16, 1577

PLACERING	ÅBNINGSTIDER	BILLEDER
Trafikhallen Spør siden mellem 5-6 og 7-8		

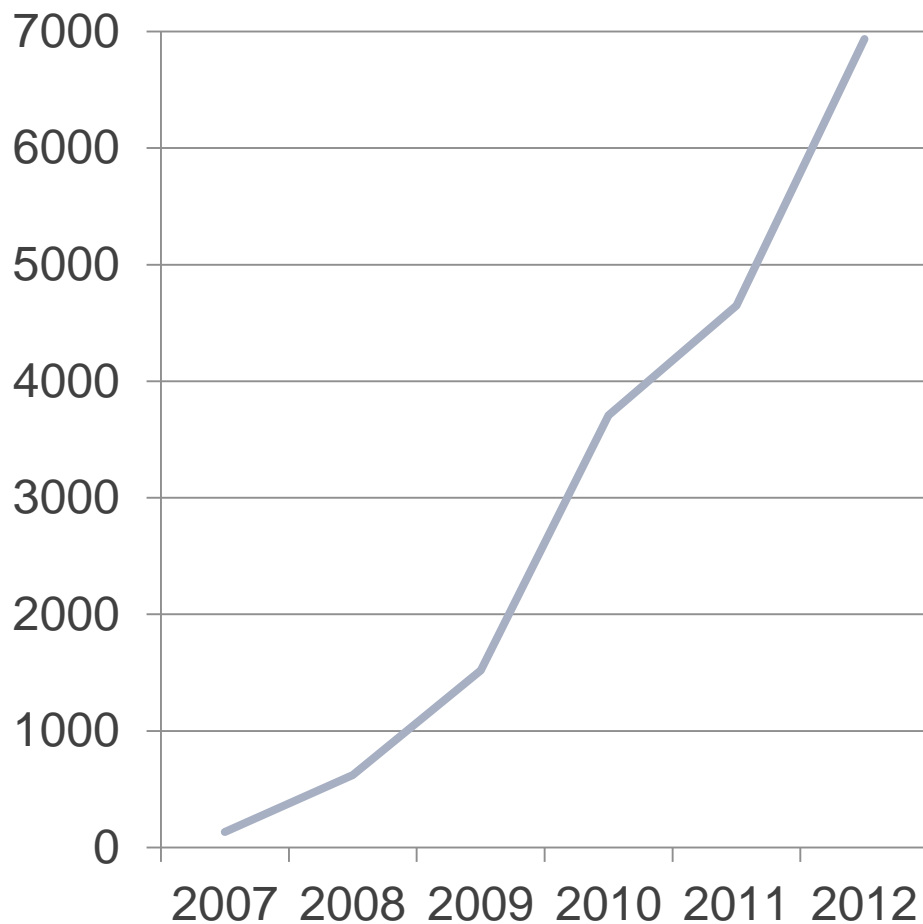
100 m / 500 fod

Kortdata ©2012 Google - Servicevilkår

AED app to smartphones



Public available AEDs in Denmark



No of public available
AEDs according to year
in Denmark

National Danish PAD Network

- AEDs available for PAD: 8662 October 14. 2013
for a population of 5.6 million
i.e. 1 AED per 646 citizens

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Public Access Defibrillation Data on Survival



Follow-up of use of PAD

- Anne Møller Nielsen et al
- Use and benefits of public access defibrillation in a nation-wide network
- Resuscitation 2013: 84(4): 430-434



Follow-up of PAD

- 28 month follow-up of use of 807 AEDs
- 48 cases
- 29 (60%) had shockable rhythms, 20 had ROSC
- For shockable rhythms: 30 days survival 69%
- 22 lives saved - CPC 1 in all cases



Follow-up on PAD

	OHCA with initial VF/VT (n=31)	OHCA with initial PEA/AS (n=13)
Condition upon arrival of EMS		
ROSC, conscious	26%	8%
ROSC, unconscious	39%	0%
No ROSC	35%	92%
30-day survival	69%	15%

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Challenges and potentials

The challenges and potentials

Barriers to success

- Cardiac Arrest identified by Emergency Medical Dispatch Centre (?)
- Witnessed (about 50 %)
- Bystander CPR (50%)
- Cardiac arrest in public places (25 %)
- Shockable initial rhythms (25%)
- AED nearby (?)
- AED available (?)
- ROSC is 70% if an AED is used by bystanders in witnessed cardiac arrest with a shockable initial rhythm

Linking AEDs to Cardiac Arrest using EMD

- Bystander calls 112
- Dispatcher identify Cardiac Arrest
- Dispatcher identify nearest AED
- Dispatcher guidance on bystander CPR
- Dispatcher guidance on location of nearest AED



The Future - Solutions?

- Further to increase public awareness of sudden cardiac arrest
- To increase awareness of AEDs
- To disseminate more AEDs for public use and make them available 24/7
- To use new solutions linking AEDs to Cardiac Arrest
- What happens before the bystander call 112 and how can we optimize the interaction between bystanders and emergency medical dispatcher

Summary

- We succeed in changing the future in Denmark
- By research, data and the media
- A national AED network linked to emergency medical dispatch centre
- We need to focus further on bystanders and PAD
- Make the location of the nearest AED known, visible and accessible
- New solution with emergency medical dispatch, SMS and apps to engage laypersons
- Huge potential for victims with VF

Key persons in Copenhagen in resuscitation and PAD-development and research

- Fredrik Folke
- Mads Wissenberg Jørgensen
- Anne Møller Nielsen
- Dan Isbye
- Jens Rosenberg
- Carolina Malta Hansen
- Helle Søholm
- Christian Hassager
- Thea Palsgaard Møller
- Martin Fjordholt Collin
- ChristianTorp-Pedersen
- Grethe Thomas (TrygFonden)
- TrygFonden www.trygfonden.dk

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www.regionh.dk/praehospital**



**Emergency
Medical Services**