

Resuscitation Outcomes Consortium



A map of North America showing various research sites. Labels include Vancouver, Seattle, Data Coordinating Center, Seattle, Portland, San Diego, Milwaukee, Toronto, Ottawa, and Alabama.

What is the Role of Chest Compression Depth during Out-of-Hospital CPR?

Ian Stiell for
The ROC Investigators



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ROC Funding Partners



National Heart, Lung and Blood Institute



Canadian Institutes of Health Research



National Institute of Neurological Disorders and Stroke



Defence Research and Development Canada



United States Army



Heart and Stroke Foundation of Canada



American Heart Association



Background

- **A belief that quality and quantity of CPR correlates with better survival - including depth of compressions**
- **Current CPR compression depth guidelines empirically derived**
- **Human studies evaluating depth small and focused on VF patients**
- **Need larger studies to evaluate association of compression depth with survival in all rhythm groups**



Objectives

- 1. To study patterns of CPR compression depth in out-of-hospital cardiac arrest (OOHCA)**
- 2. To study association of compression depth with patient outcomes within the 3 major rhythm subgroups**

Methods

- **Adult OOHCA patients from ROC Epistry**
 - if EMS attempted treatment
 - if electronic CPR data available
 - 6 U.S. and Canadian sites
- **Used CPR process data:**
 - from proprietary accelerometer technology attached to the prehospital defibrillators
- **For each minute of CPR we calculated:**
 - Depth = anterior chest wall depression in mm
 - CCF = chest compression fraction = period of active CPR

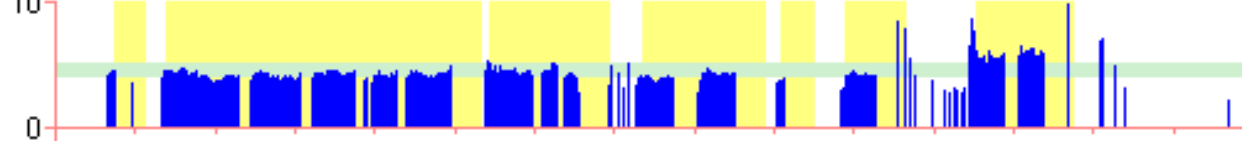


Current view: entire case

Shock Summary



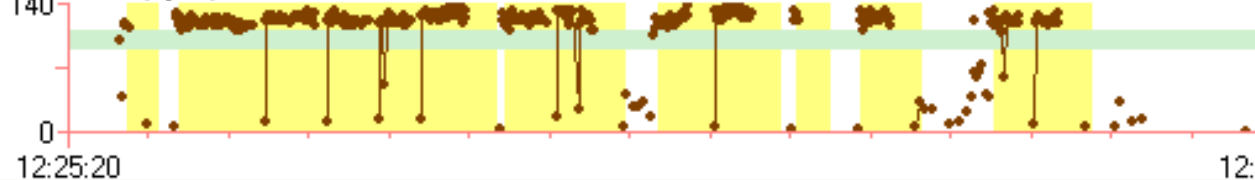
Depth (cm)



Compression Quality



Rate (cpm)



Key

CPR periods	AutoPulse active	Compression quality:	In target
Target zones	AutoPulse compressions		Out of target
			No compressions

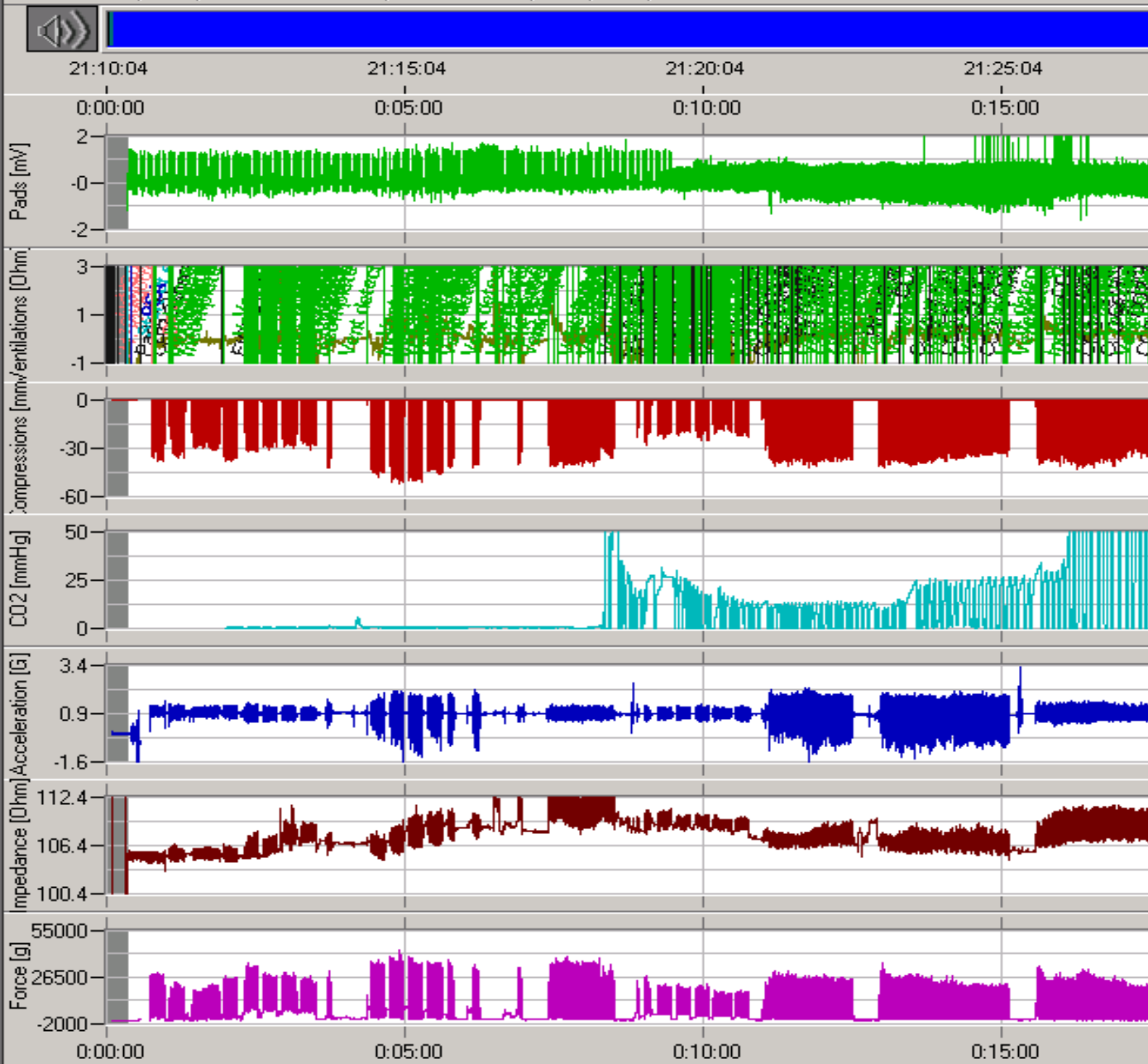
Target zones

Depth: from: to:

Rate: from: to: cpm

CPR periods

Mode: Total periods: 7 Show CPR periods on graphs



Methods: Analysis

- **Outcomes:**
 - a) ROSC, b) Survival to one day, c) Survival to discharge
- **Effect of Compression Depth on outcomes**
- **Adjusted for covariates:**
 - a) Age, b) Sex, c) Public location, d) Bystander CPR, e) CPR fraction, f) Chest compression rate, g) Time 911 to AED on, h) Site
- **Secondary analyses:**
 - a) Only 1st 3 minutes, b) Only cases with rate 80-120, c) Adjusting for rhythm



Subject Selection

EMS treated arrests = 22,757

No PAD = 22,402

No obvious cause = 20,803

Depth data available = 724

**< 5 min CPR prior to pad placement
= 673**

Study cohort = 665

**PAD defibrillator =
355**

**Obvious cause of
arrest = 1,599**

**No depth data =
20,079**

**> 5 min CPR prior to
pad placement = 51**

Missing data = 8

Case Characteristics (N = 665)

	N=665
Age – mean years	69.0
Male - (%)	64%
Public location – (%)	12%
Bystander witnessed – (%)	44%
EMS witnessed – (%)	6%
Bystander CPR – (%)	33%
ALS first on scene – (%)	27%
ALS on scene – (%)	98%
Time intervals – median minutes	
911 - scene	5.6
911 - analysis	10.8

Characteristics cont'd

	N=665
<u>CPR Process Measures</u>	
CPR prior to first analysis – %	64%
CPR fraction – median	67%
Chest compression rate / min – median	104
<u>First Rhythm – (%)</u>	
VF/VT	27%
PEA	17%
Asystole	41%
Cannot determine	15%
<u>Outcomes – (%)</u>	
Any prehospital ROSC	59%
Survival to one day	19%
Hospital discharge	5%

Compression Depth Characteristics

	N=665
<u>Average depth – mean mm (SD)</u>	38.8 (10.3)
Range - mm	11.7 – 83.7
<u>Average depth subgroups – (%)</u>	
< 38 mm	49.2%
38-51 mm	39.7%
> 51	11.1%
<u>Minutes in compliance (%)</u>	49.8%
<u>Cases depth compliant (%)</u> **	43.6%

**** Average depth \geq 38 mm \geq 60% of minutes with CPR process measures**

Compression Rate Versus Compression Depth (P < 0.0001)

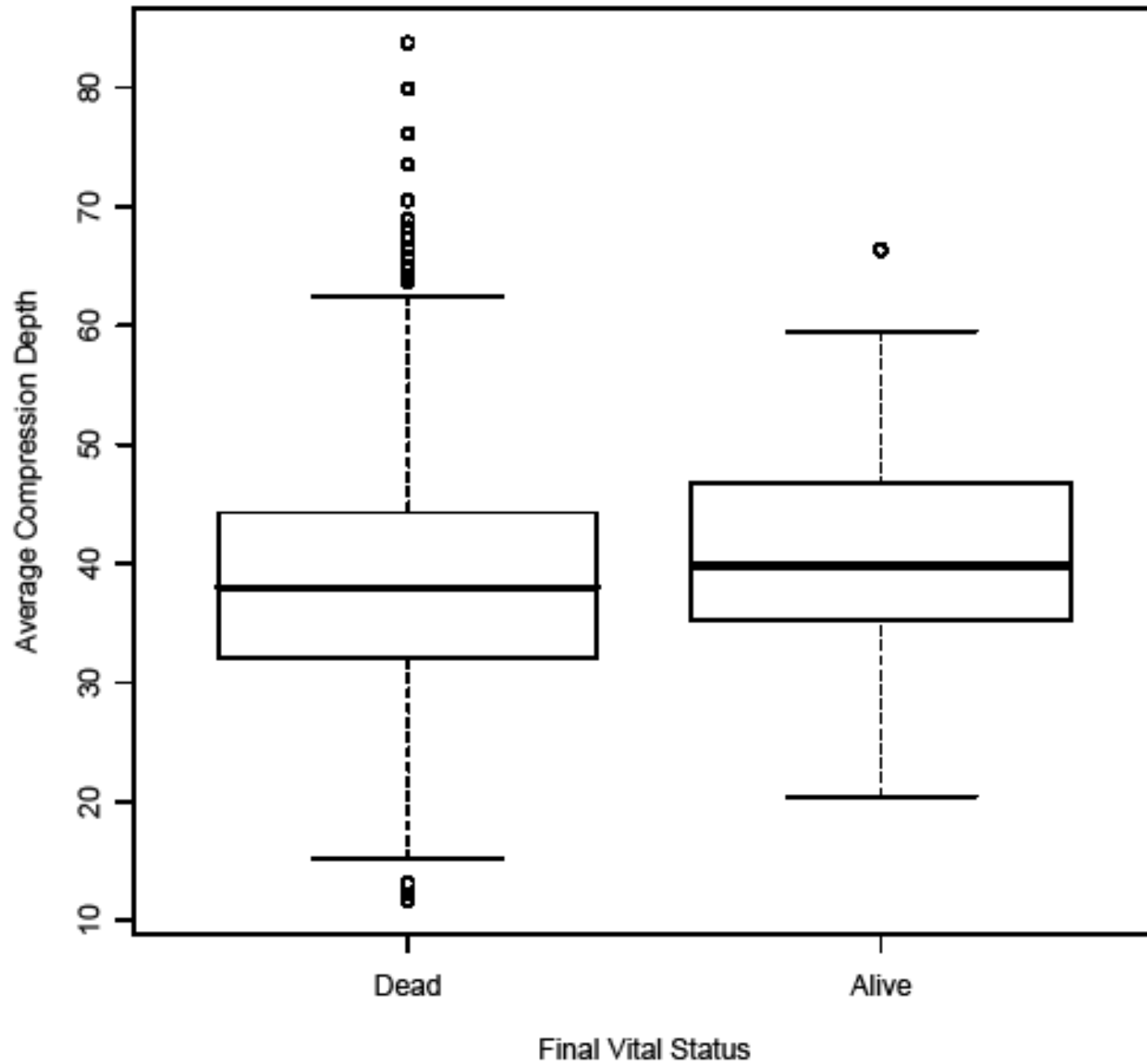
		<u>Average Compression Rate/Min</u>		
		0 to 80 (N=65)	81 to 120 (N=478)	121+ (N=122)
<u>Average Compression Depth</u>	<38 mm	49%	44%	69%
	38-51 mm	28%	44%	30%
	>51 mm	23%	12%	2%



Characteristics by Survival Status

	Deaths N=629	Survivors N=36
Age - mean	69.4	62.8
Public location – (%)	5%	36%
Bystander witnessed – (%)	42%	79%
EMS witnessed – (%)	5%	19%
Bystander CPR – (%)	32%	39%
ALS first on scene – (%)	26%	36%
CPR fraction – median	67%	63%
Chest compression rate – median	104	99
911 call to scene – median	5.6	5.4
First rhythm – (%)		
VF/VT	23%	81%
PEA	17%	11%
Asystole	44%	3%

Distribution of Compression Depth by Final Vital Status



Predictors of Survival to Hospital Discharge

	Unadjusted OR (CI)
<u>Compression Depth (per 5mm)</u>	1.14 (0.98, 1.33)
<u>Compression Depth Category</u>	
<38 mm	ref
38-51 mm	1.77 (0.85, 3.68)
>51 mm	1.75 (0.60, 5.07)
<u>Depth Compliant</u>	1.66 (0.85, 3.27)
<u>% minutes in compliance (per 10%)</u>	1.07 (0.99, 1.16)
Age (per year)	0.98 (0.96, 1.00)
Male	1.51 (0.71, 3.19)
Public location	4.66 (2.26, 9.63)
Bystander CPR	1.33 (0.66, 2.64)
CPR Fraction (10% increase)	0.76 (0.63, 0.91)
Compression rate (10/min increase)	0.83 (0.72, 0.96)
Time from 911 call to AED turned on	0.93 (0.78, 1.10)

Predictors of Survival to One Day

	Adjusted OR (CI)
<u>Compression Depth (per 5mm)</u>	1.04 (0.94, 1.15)
<u>Compression Depth Category</u>	
<38 mm	ref
38-51 mm	0.85 (0.54, 1.32)
>51 mm	1.03 (0.51, 2.10)
<u>Depth Compliant</u>	1.20 (0.78, 1.83)
<u>% minutes in compliance</u>	1.03 (0.98, 1.08)

Predictors of Prehospital ROSC

	Adjusted OR (CI)
<u>Compression Depth (per 5mm)</u>	1.05 (0.96, 1.14)
<u>Compression Depth Category</u>	
<38 mm	ref
38-51 mm	1.14 (0.80, 1.63)
>51 mm	1.35 (0.76, 2.38)
<u>Depth Compliant</u>	1.16 (0.82, 1.63)
<u>% minutes compliance (per 10%)</u>	1.01 (0.97, 1.06)

Secondary Analyses

- **Using only first 3 minutes CPR data:**
 - Same results
- **Using only cases with compression rate 80-120:**
 - Same results
- **Adding initial rhythm to adjustment model:**
 - Same results

Limitations

- **Selected sample determined by submission of digital recordings**
- **No record of CPR prior to pad placement**
- **No data on patient weight or chest compliance**
- **Limited sample size**
- **CCF not associated with better outcomes, possibly because of non-VF cases**



Conclusions

- **Half of patients received less than the recommended compression depth**
- **An inverse association between compression depth and rate**
- **A trend towards an association between increased compression depth and better outcomes**
- **Insufficient numbers to prove association**



Conclusions

- **Further study required to determine:**
 - **the optimum chest compression depth**
 - **interaction of depth with rate and CCF in order to maximize outcomes**

Acknowledgements

- **We thank the many EMS and fire services and their providers for invaluable help with the study**



Purpose of the ROC

To evaluate the treatment of people with out-of-hospital cardiac arrest or life-threatening injury

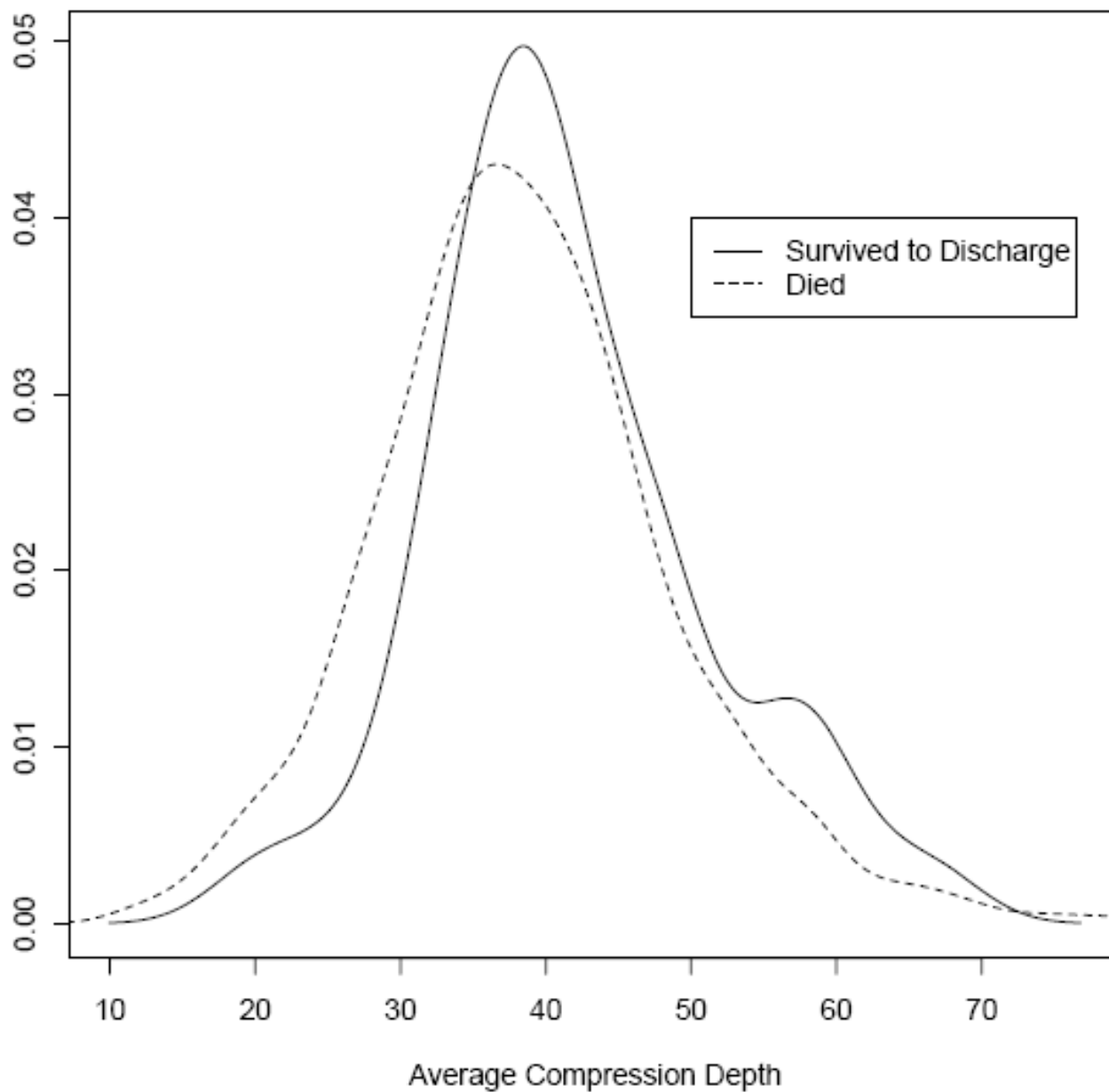
To conduct large trials of promising scientific and clinical advances designed to improve resuscitation outcomes



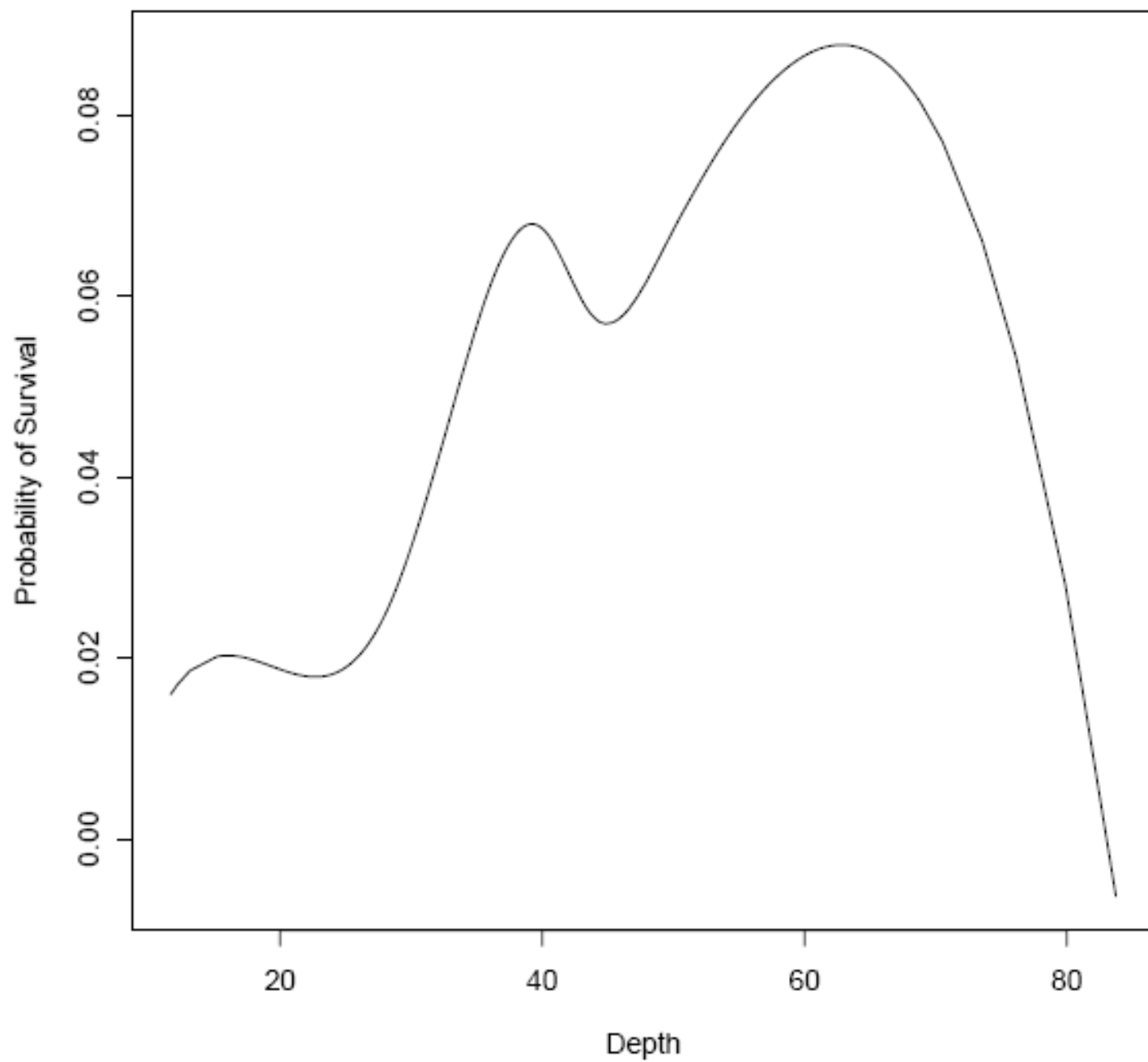
References

- (1) **Wik L, et al.** Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. *JAMA* 2005; 293(3):299-304.
- (2) **Abella BS, et al.** Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. *JAMA* 2005; 293(3):305-310.
- (3) **Edelson DP, et al.** Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest. *Resuscitation* 2006; 71(2):137-145.
- (4) **Kramer-Johansen J, et al.** Quality of out-of-hospital cardiopulmonary resuscitation with real time automated feedback: A prospective interventional study. *Resuscitation* 2006; 71(3):283-292.
- (5) **Ornato JP, Peberdy MA.** Measuring Progress in Resuscitation: It's Time for a Better Tool. *Circulation* 2006; 114(25):2754-2756.
- (6) **Kramer-Johansen J, et al.** Uniform reporting of measured quality of cardiopulmonary resuscitation (CPR). *Resuscitation* 2007; 74(3):406-417.

**Distribution of Average Compression Depth
by Survival Status**



Smoothing Spline of Survival on Depth



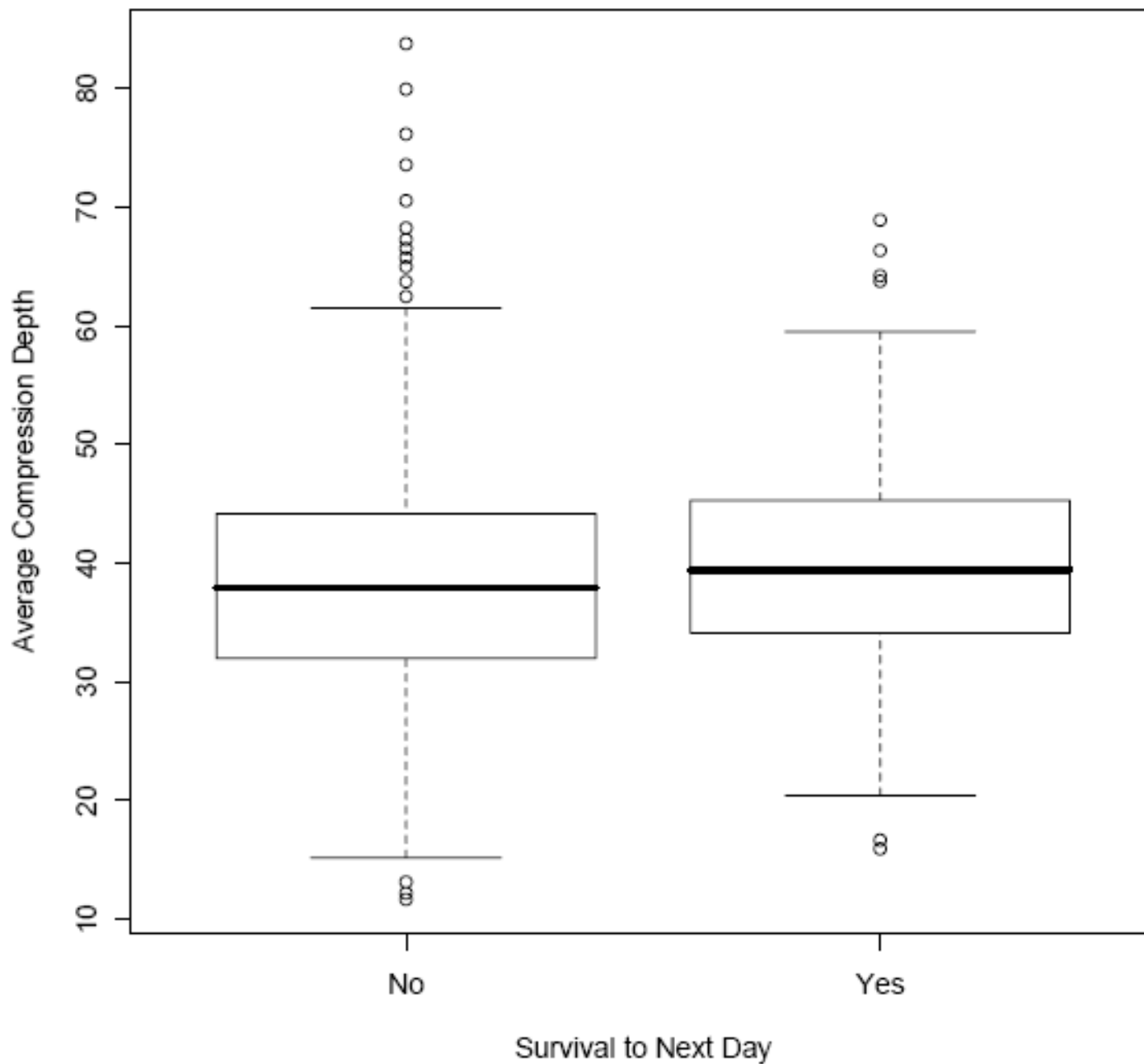
Predictors of Survival to One Day

	Adjusted OR (CI)
Compression Depth (per 5mm)	1.04 (0.94, 1.15)
Compression Depth Category	
<38 mm	ref
38-51 mm	0.85 (0.54, 1.32)
>51 mm	1.03 (0.51, 2.10)
Depth Compliant	1.20 (0.78, 1.83)
% minutes in compliance	1.03 (0.98, 1.08)
Age (per year increase)	0.99 (0.98, 1.01)
Male	0.94 (0.60, 1.49)
Public location	2.37 (1.36, 4.14)
Bystander CPR	1.03 (0.65, 1.62)
CPR Fraction (10% increase)	0.93 (0.80, 1.07)
Compression rate (10/min increase)	0.94 (0.84, 1.06)
Time from 911 call to EMS on scene	0.89 (0.80, 0.99)

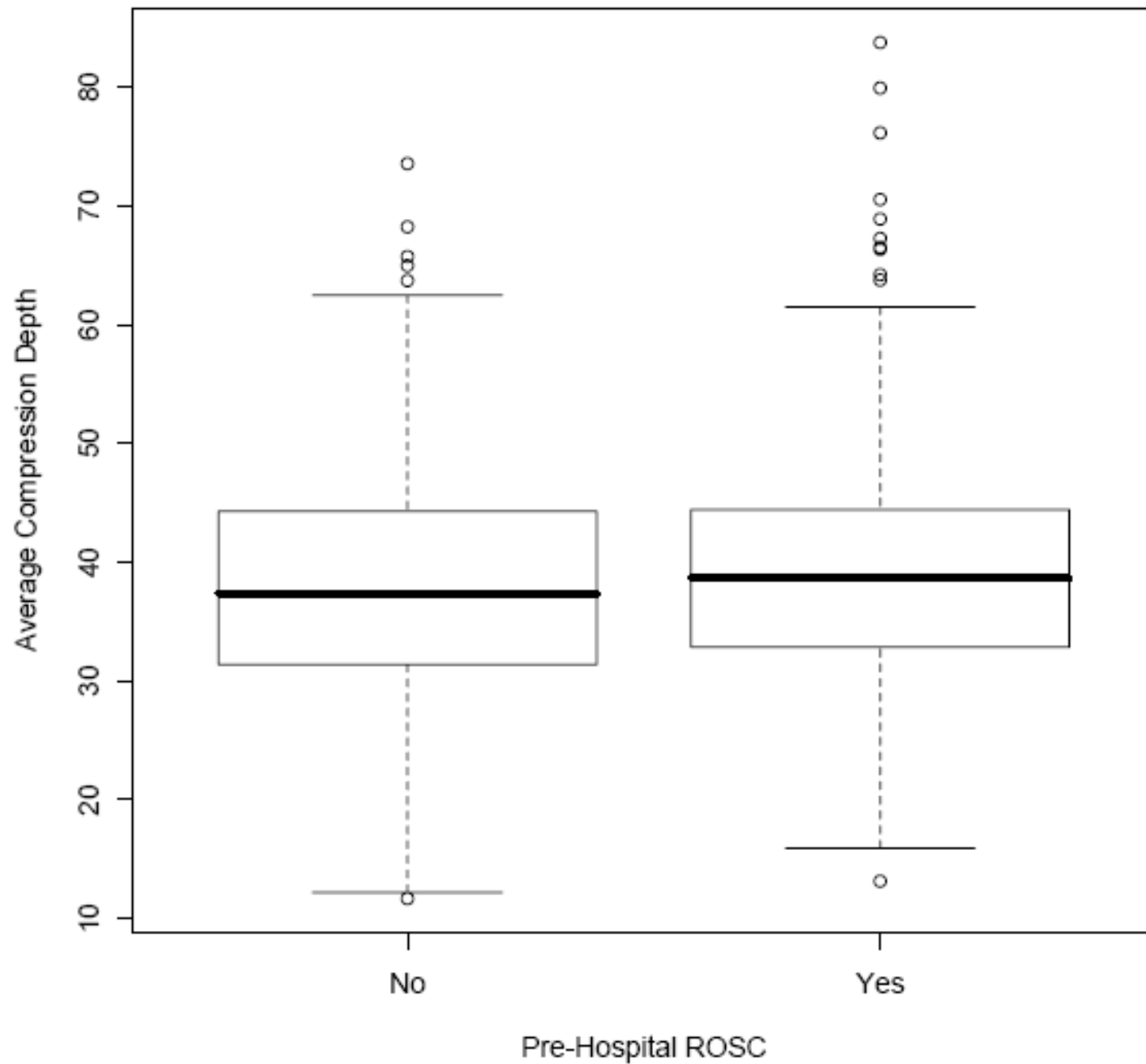
Predictors of Prehospital ROSC

	Adjusted OR (CI)
Compression Depth (per 5mm)	1.05 (0.96, 1.14)
Compression Depth Category	
<38 mm	ref
38-51 mm	1.14 (0.80, 1.63)
>51 mm	1.35 (0.76, 2.38)
Depth Compliant	1.16 (0.82, 1.63)
% minutes compliance (per 10%)	1.01 (0.97, 1.06)
Age (per year)	1.00 (0.99, 1.02)
Male	1.15 (0.81, 1.64)
Public location	1.22 (0.72, 2.05)
Bystander CPR	0.83 (0.58, 1.19)
CPR Fraction (10% increase)	0.94 (0.84, 1.06)
Compression rate (10/min increase)	0.94 (0.86, 1.03)
Time 911 to EMS on scene	0.93 (0.86, 0.99)

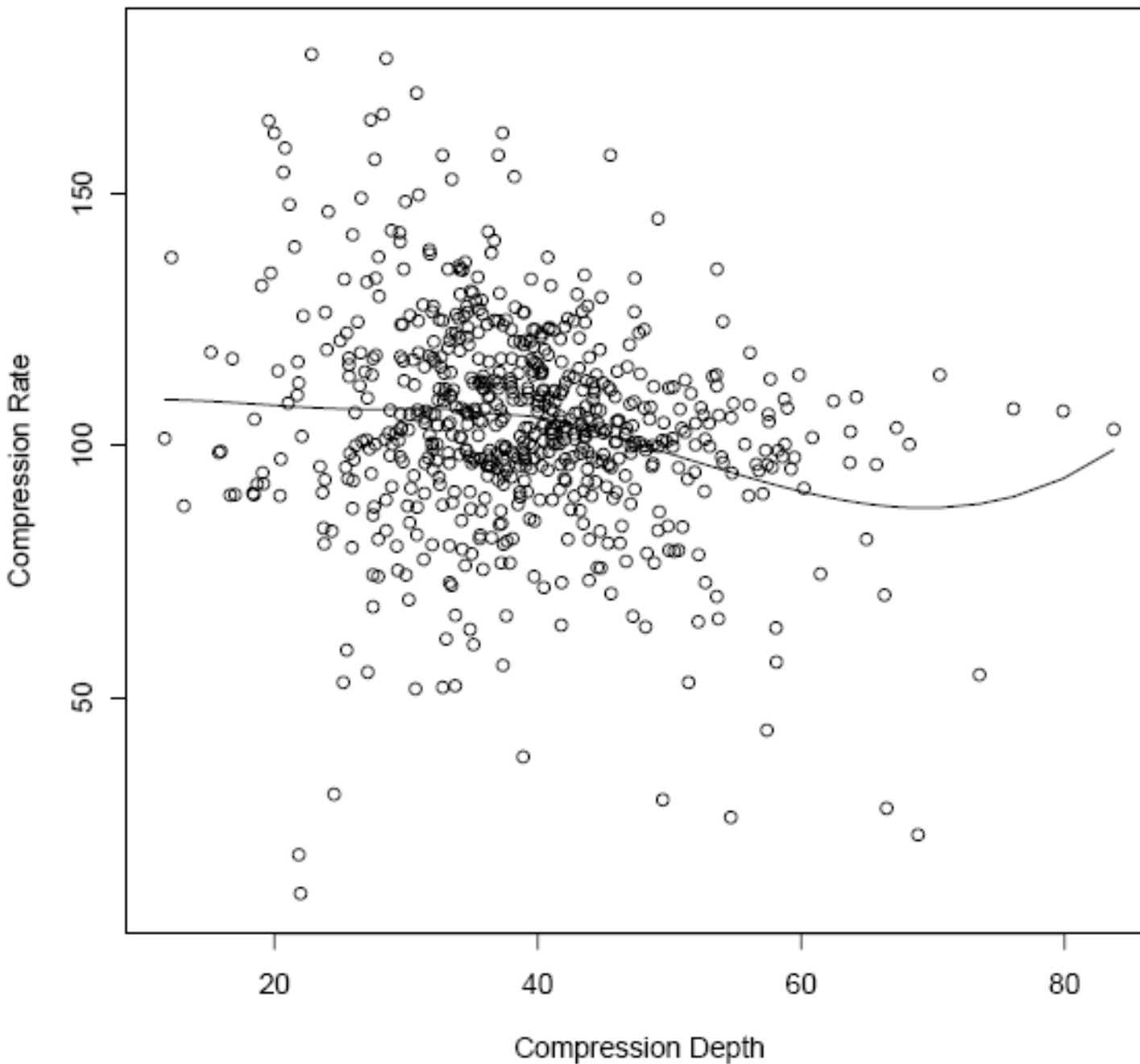
Distribution of Compression Depth by Survival to Next Day



Distribution of Compression Depth by Pre-Hospital ROSC



Smoothing Spline of Compression Rate on Compression Depth



*smoothing spline:
a non-parametric
"best fit" line
created by piece-
wise cubic
regression with
constraints that
enforce
smoothness*

Conflict of interest

- **none**

ROC Site Map



The ROC EPISTRY - Cardiac Arrest

Approximate Population: 23,700,000

- 1. To facilitate ROC trials**
- 2. To define incidence and outcome**
- 3. To describe the relationships between resuscitation performance and EMS**
- 4. To evaluate the relationships between outcome and other factors**

