

Supplemental Material

Trends in Survival after Pediatric In-Hospital Cardiac Arrest in the United States

Mathias J. Holmberg, M.D., M.P.H., Sebastian Wiberg, M.D., Ph.D., Catherine E. Ross, M.D.,
Monica Kleinman, M.D., Anne Kirstine Hoyer-Nielsen, B.Sc., Michael W. Donnino, M.D., and
Lars W. Andersen, M.D., M.P.H., Ph.D., D.M.Sc., for the American Heart Association's
Get With The Guidelines®-Resuscitation Investigators

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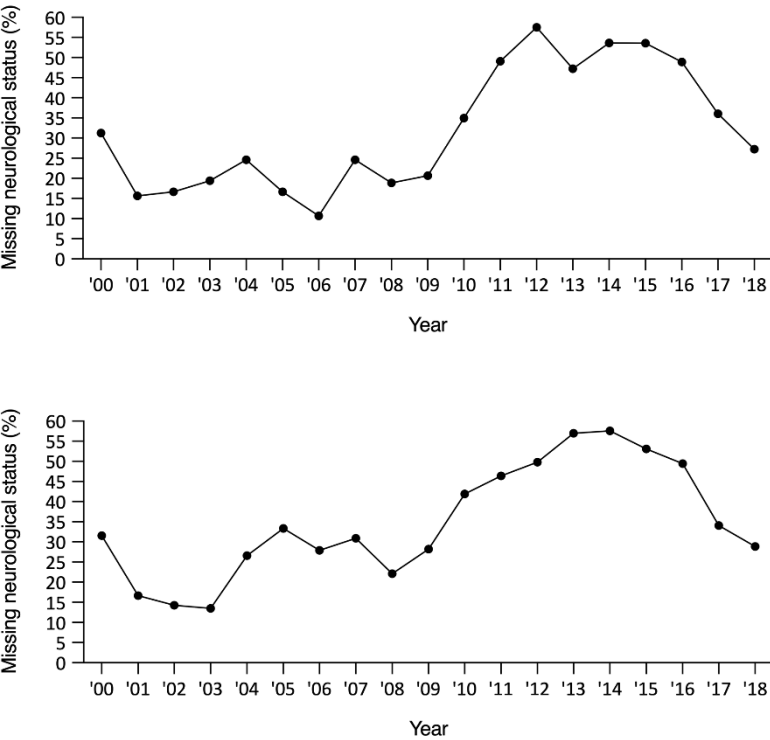


Figure S1. Missing data for neurological status in survivors to hospital discharge
The figure illustrates the proportion of missing data for neurological status (measured by the Pediatric Cerebral Performance Category score) per year in patients surviving to hospital discharge. The upper figure represents missing data in pediatric patients with a pulseless cardiac arrest. The lower figure represents missing data in pediatric patients with a non-pulseless event. *Non-pulseless events refer to events requiring cardiopulmonary resuscitation for bradycardia and poor perfusion.*

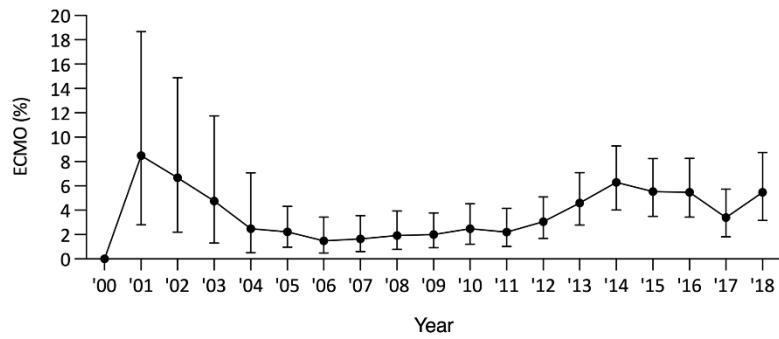
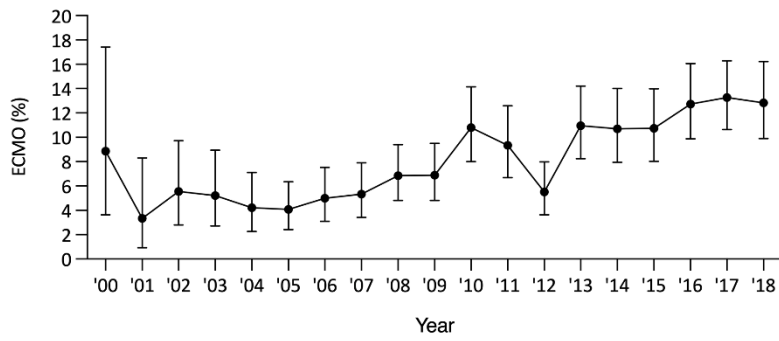


Figure S2. Trends in extracorporeal membrane oxygenation

The figure illustrates trends in the use of extracorporeal membrane oxygenation from 2000 to 2018. The upper figure reflects trends in pediatric patients with a pulseless cardiac arrest. The lower figure reflects trends in pediatric patients with a non-pulseless event. *Non-pulseless events refer to events requiring cardiopulmonary resuscitation for bradycardia and poor perfusion.*

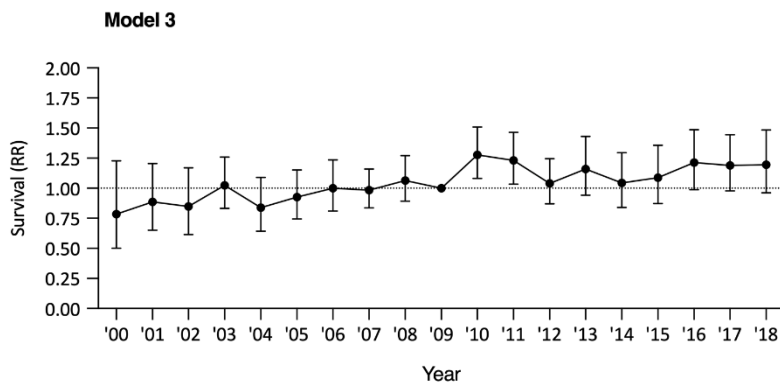
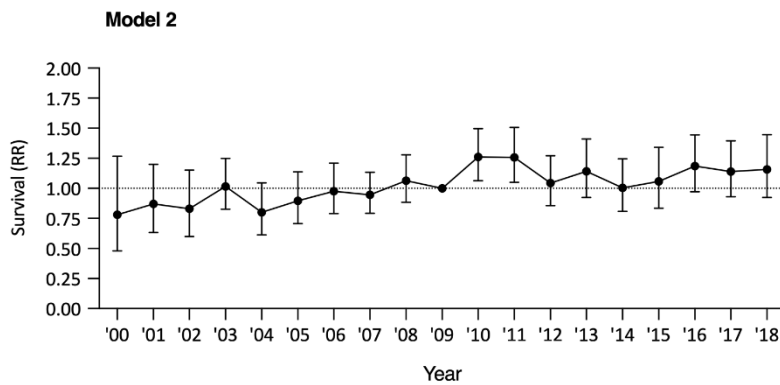
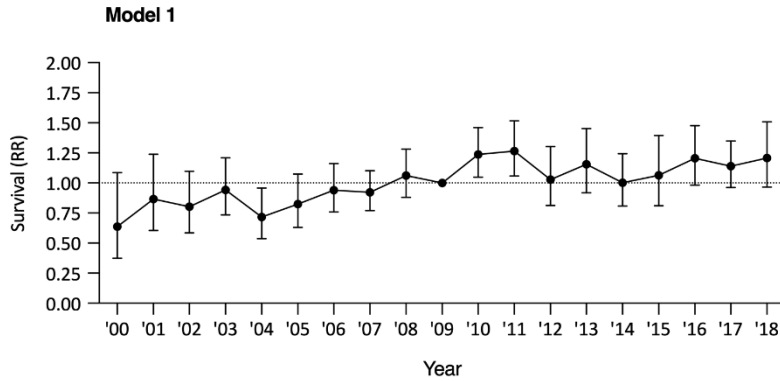


Figure S3. Relative trends in survival for pulseless cardiac arrests

The figures illustrate trends in survival to hospital discharge from 2000 to 2018. Results are reported as relative risk ratios with 95% confidence intervals. Year 2009 was used as the reference category and the dashed line represents a relative risk ratio of one. Model 1:

Unadjusted results. Model 2: Adjusted for patient demographics and hospital characteristics.

Model 3: Adjusted for patient, hospital, and event characteristics. The relative change in survival to hospital discharge per unit increase in year was 1.02 (95% CI, 1.01–1.03; $p < 0.001$; Table S5)

for the first model, 1.02 (95% CI, 1.00–1.03; $p = 0.02$; Table S5) for the second model, and 1.02 (95% CI, 1.00–1.03; $p = 0.01$; Table S5) for third model. *RR* denotes *relative risk ratio*.

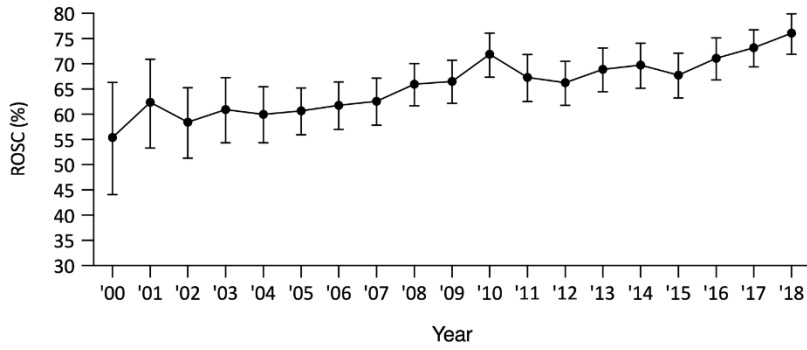


Figure S4. Absolute trends in ROSC for pulseless cardiac arrests

The figure illustrates unadjusted trends in ROSC from 2000 to 2018. Results are reported as absolute risks with 95% confidence intervals. The absolute change in ROSC was 0.83% (95% CI, 0.53%–1.14%; $p < 0.001$; Table S4) per unit increase in year. *ROSC denotes return of spontaneous circulation.*

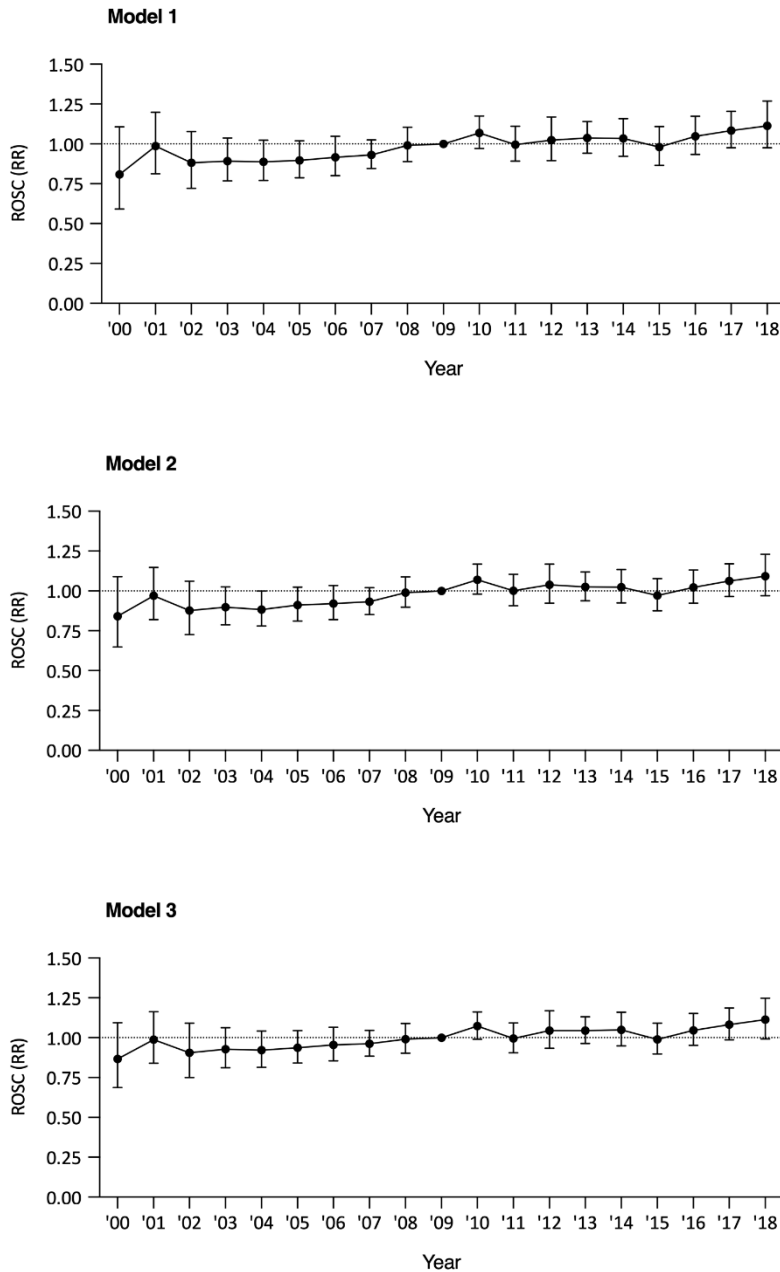


Figure S5. Relative trends in ROSC for pulseless cardiac arrests

The figures illustrate trends in ROSC from 2000 to 2018. Results are reported as relative risk ratios with 95% confidence intervals. Year 2009 was used as the reference category and the dashed line represents a relative risk ratio of one. Model 1: Unadjusted results. Model 2: Adjusted for patient demographics and hospital characteristics. Model 3: Adjusted for patient, hospital, and event characteristics. The relative change in ROSC per unit increase in year was 1.01 (95% CI, 1.01–1.02; $p < 0.001$; Table S6) for the first model, 1.01 (95% CI, 1.01–1.02; p

<0.001; Table S6) for the second model and 1.01 (95% CI, 1.01–1.02; p <0.001; Table S6) for third model. *ROSC denotes return of spontaneous circulation; RR denotes relative risk ratio.*

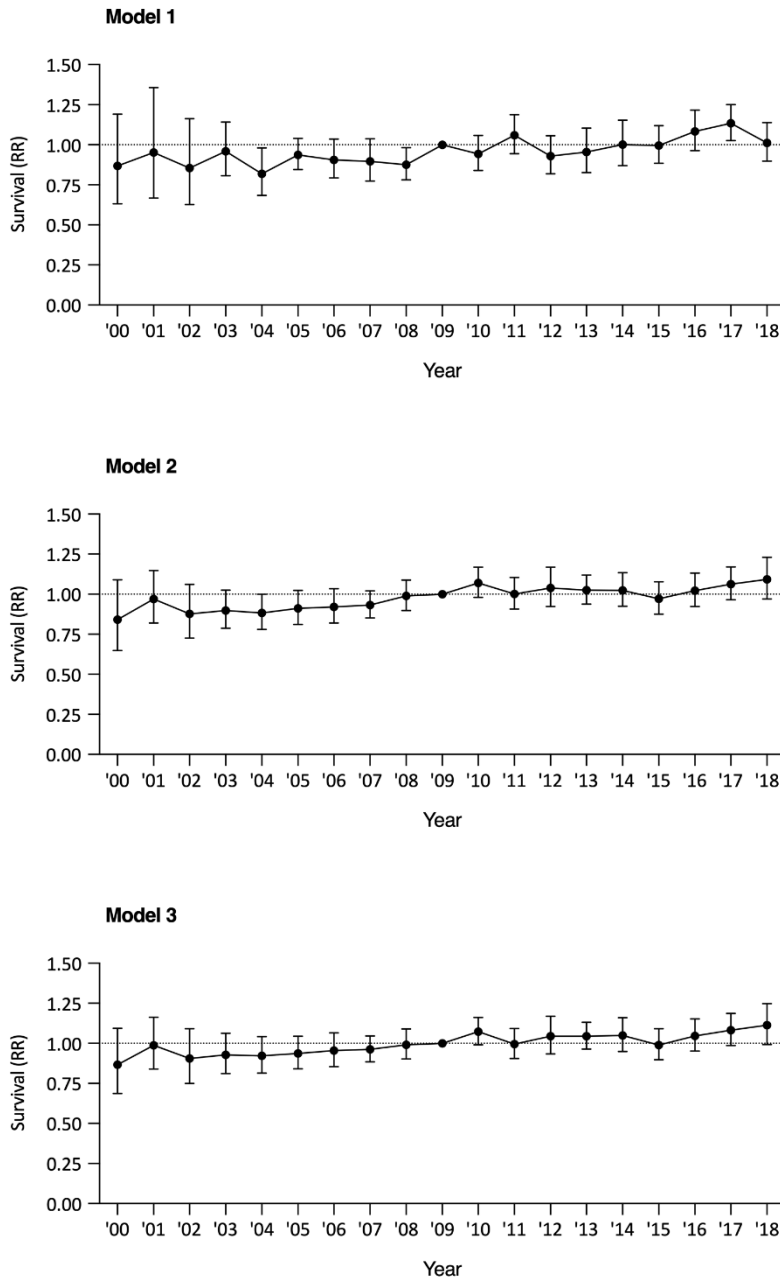


Figure S6. Relative trends in survival for non-pulseless events

The figures illustrate trends in survival to hospital discharge from 2000 to 2018. Results are reported as relative risk ratios with 95% confidence intervals. Year 2009 was used as the reference category and the dashed line represents a relative risk ratio of one. Model 1:

Unadjusted results. Model 2: Adjusted for patient demographics and hospital characteristics.

Model 3: Adjusted for patient, hospital, and event characteristics. The relative change in survival to hospital discharge per unit increase in year was 1.01 (95% CI, 1.01–1.02; p = 0.001; Table S8) for the first model, 1.01 (95% CI, 0.99–1.02; p = 0.32; Table S8) for the second model, and 1.01

(95% CI, 1.00–1.02; $p = 0.26$; Table S8) for third model. *Non-pulseless events refer to events requiring cardiopulmonary resuscitation for bradycardia and poor perfusion, RR denotes relative risk ratio.*

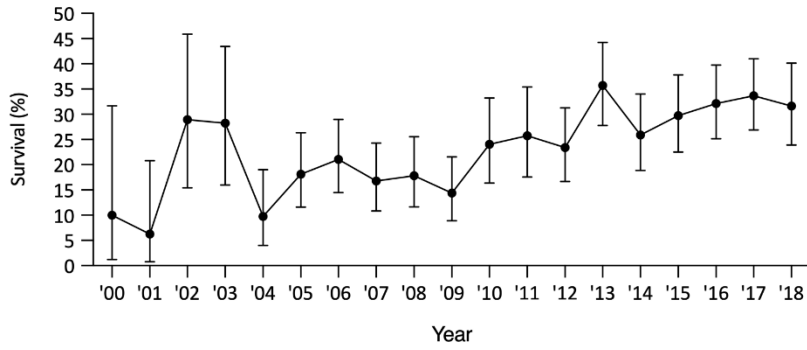


Figure S7. Absolute trends in survival for events progressing into cardiac arrest

The figure illustrates unadjusted trends in survival to hospital discharge from 2000 to 2018. Results are reported as absolute risks with 95% confidence intervals. The absolute change in survival to hospital discharge was 0.88% (95% CI, 0.42%–1.35%; $p < 0.001$) per unit increase in year.

Supplemental Tables

Table S1. Missing data for pediatric patients meeting all inclusion criteria		
	Pulseless cardiac arrests	Non-pulseless events
Demographics		
Sex	3 (>1)	1 (<1)
Age group	6 (<1)	0 (0)
Illness category	18 (<1)	1 (<1)
Pre-existing conditions	939 (9)	23 (<1)
Location and Time of Event		
Location of event	12 (<1)	5 (<1)
Time of week	0 (0)	0 (0)
Time of day	262 (2)	142 (2)
Event Characteristics		
Witnessed	8 (<1)	1 (<1)
Monitored	7 (<1)	2 (<1)
Pulseless rhythm	924 (9)	NA
Initial pulseless rhythm	2753 (25)	NA
Hospital Characteristics		
Years of GWTG participation	0 (0)	0 (0)
Geographic region	518 (5)	270 (4)
Geographical area	540 (5)	299 (5)
Ownership	518 (5)	270 (4)
Teaching status	540 (5)	299 (5)

NA denotes not applicable.

Table S2. Additional characteristics of pulseless cardiac arrests				
	2000–2005 (n = 1403)	2006–2010 (n = 2288)	2011–2015 (n = 2212)	2016–2018 (n = 1530)
Event Characteristics				
Length of resuscitation (min)	22 (11, 41)	19 (7, 37)	16 (6, 35)	16 (6, 36)
Interventions in place at time of event				
Mechanical ventilation	944 (67)	1580 (69)	1575 (71)	1227 (80)
Vasopressors	475 (34)	831 (36)	744 (34)	633 (41)
Arterial line	360 (26)	646 (28)	596 (27)	498 (33)
Interventions during the event				
ECMO	65 (5)	159 (7)	208 (9)	198 (13)
Intubation	483 (34)	743 (32)	697 (32)	432 (28)
Epinephrine	1261 (90)	1994 (87)	1923 (87)	1326 (87)
Antiarrhythmic	254 (18)	248 (11)	188 (9)	127 (8)
Atropine	574 (41)	704 (31)	388 (18)	190 (12)

ECMO denotes extracorporeal membrane oxygenation.

Table S3. Additional characteristics of non-pulseless events				
	2000–2005 (n = 736)	2006–2010 (n = 1914)	2011–2015 (n = 2043)	2016–2018 (n = 1058)
Event Characteristics				
Length of resuscitation (min)	8 (4, 21)	7 (3, 19)	5 (3, 12)	4 (2, 7)
Interventions in place at time of event				
Mechanical ventilation	509 (69)	1282 (67)	1451 (71)	874 (83)
Vasopressors	195 (26)	479 (25)	444 (22)	250 (24)
Arterial line	199 (27)	369 (19)	442 (22)	219 (21)
Interventions during the event				
ECMO	25 (3)	37 (2)	87 (4)	50 (5)
Intubation	275 (37)	749 (39)	729 (36)	280 (26)
Epinephrine	443 (60)	1098 (57)	1163 (57)	533 (50)
Atropine	194 (26)	280 (15)	247 (12)	88 (8)

ECMO denotes extracorporeal membrane oxygenation.

Table S4. Outcomes for pulseless cardiac arrests (absolute risk)				
Year	Survival to hospital discharge		Return of spontaneous circulation	
	Events/ Total	Absolute risk (95% confidence interval)	Events/ Total	Absolute risk (95% confidence interval)
2000	16/83	19 (11–29)	46/83	55 (44–66)
2001	32/125	26 (18–34)	78/125	62 (53–71)
2002	48/202	24 (18–30)	118/202	58 (51–65)
2003	67/233	29 (23–35)	142/233	61 (54–67)
2004	69/315	22 (17–27)	189/315	60 (54–65)
2005	114/445	26 (22–30)	270/445	61 (56–65)
2006	122/424	29 (25–33)	262/424	62 (57–66)
2007	122/433	28 (24–33)	271/433	63 (58–67)
2008	164/511	32 (28–36)	337/511	66 (62–70)
2009	150/493	30 (26–35)	328/493	67 (62–71)
2010	163/427	38 (34–43)	307/427	72 (67–76)
2011	161/407	40 (35–44)	274/407	67 (63–72)
2012	146/471	31 (27–35)	312/471	66 (62–71)
2013	163/457	36 (31–40)	315/457	69 (64–73)
2014	138/430	32 (28–37)	300/430	70 (65–74)
2015	153/447	34 (30–39)	303/447	68 (63–72)
2016	182/481	38 (33–42)	342/481	71 (67–75)
2017	208/589	35 (31–39)	431/589	73 (69–77)
2018	176/460	38 (34–43)	350/460	76 (72–80)

Table S5. Survival for pulseless cardiac arrests (relative risk)

Year	Model 1			Model 2			Model 3		
	RR	95% CI	p-value	RR	95% CI	P-value	RR	95% CI	P-value
2000	0.64	0.37–1.09	0.10	0.78	0.48–1.27	0.32	0.79	0.50–1.23	0.29
2001	0.87	0.61–1.24	0.43	0.87	0.63–1.20	0.40	0.89	0.65–1.21	0.44
2002	0.80	0.59–1.10	0.17	0.83	0.60–1.15	0.27	0.85	0.61–1.17	0.31
2003	0.94	0.73–1.21	0.64	1.02	0.83–1.25	0.88	1.02	0.83–1.26	0.82
2004	0.72	0.54–0.96	0.03	0.80	0.61–1.05	0.10	0.84	0.64–1.09	0.19
2005	0.82	0.63–1.07	0.15	0.90	0.71–1.14	0.37	0.93	0.75–1.15	0.49
2006	0.94	0.76–1.16	0.56	0.98	0.79–1.21	0.83	1.00	0.81–1.24	1.00
2007	0.92	0.77–1.10	0.37	0.95	0.79–1.13	0.55	0.98	0.84–1.16	0.85
2008	1.06	0.88–1.28	0.53	1.06	0.89–1.28	0.51	1.06	0.89–1.27	0.49
2009	1.00 (Reference)			1.00 (Reference)			1.00 (Reference)		
2010	1.24	1.05–1.46	0.01	1.26	1.06–1.50	0.01	1.28	1.08–1.51	0.004
2011	1.27	1.06–1.52	0.01	1.26	1.05–1.51	0.01	1.23	1.03–1.46	0.02
2012	1.03	0.81–1.30	0.82	1.04	0.86–1.27	0.67	1.04	0.87–1.24	0.67
2013	1.16	0.92–1.45	0.22	1.14	0.92–1.41	0.22	1.16	0.94–1.43	0.16
2014	1.00	0.81–1.24	0.98	1.00	0.81–1.25	0.98	1.04	0.84–1.30	0.70
2015	1.06	0.81–1.40	0.65	1.06	0.84–1.34	0.64	1.09	0.87–1.36	0.46
2016	1.20	0.98–1.48	0.07	1.19	0.97–1.45	0.09	1.21	0.99–1.49	0.06
2017	1.14	0.96–1.35	0.13	1.14	0.93–1.39	0.21	1.19	0.98–1.45	0.08
2018	1.21	0.97–1.51	0.10	1.16	0.93–1.45	0.20	1.20	0.96–1.48	0.11

RR denotes relative risk ratio; 95% CI denotes 95% confidence intervals.

Table S6. ROSC for pulseless cardiac arrests (relative risk)

Year	Model 1			Model 2			Model 3		
	RR	95% CI	p-value	RR	95% CI	P-value	RR	95% CI	P-value
2000	0.81	0.59–1.11	0.19	0.84	0.65–1.09	0.19	0.87	0.69–1.09	0.23
2001	0.99	0.81–1.20	0.89	0.97	0.82–1.15	0.72	0.99	0.84–1.16	0.89
2002	0.88	0.72–1.08	0.22	0.88	0.73–1.06	0.18	0.91	0.75–1.09	0.30
2003	0.89	0.77–1.04	0.14	0.90	0.79–1.02	0.11	0.93	0.81–1.06	0.28
2004	0.89	0.77–1.02	0.10	0.88	0.78–1.00	0.05	0.92	0.82–1.04	0.19
2005	0.90	0.79–1.02	0.10	0.91	0.81–1.02	0.12	0.94	0.84–1.04	0.24
2006	0.92	0.80–1.05	0.20	0.92	0.82–1.03	0.16	0.95	0.85–1.07	0.41
2007	0.93	0.85–1.02	0.14	0.93	0.85–1.02	0.13	0.96	0.89–1.05	0.37
2008	0.99	0.89–1.10	0.86	0.99	0.90–1.09	0.82	0.99	0.90–1.09	0.85
2009	1.00 (Reference)			1.00 (Reference)			1.00 (Reference)		
2010	1.07	0.97–1.17	0.18	1.07	0.98–1.17	0.13	1.07	0.99–1.16	0.08
2011	1.00	0.89–1.11	0.93	1.00	0.91–1.10	0.99	0.99	0.91–1.09	0.91
2012	1.02	0.90–1.17	0.74	1.04	0.92–1.17	0.53	1.04	0.93–1.17	0.44
2013	1.04	0.94–1.14	0.46	1.03	0.94–1.12	0.58	1.04	0.96–1.13	0.29
2014	1.03	0.92–1.16	0.57	1.02	0.92–1.13	0.65	1.05	0.95–1.16	0.35
2015	0.98	0.87–1.11	0.75	0.97	0.88–1.08	0.58	0.99	0.90–1.09	0.84
2016	1.05	0.93–1.17	0.43	1.02	0.92–1.13	0.68	1.05	0.95–1.15	0.35
2017	1.08	0.98–1.20	0.13	1.06	0.97–1.17	0.22	1.08	0.99–1.19	0.10
2018	1.11	0.98–1.27	0.11	1.09	0.97–1.23	0.15	1.11	0.99–1.25	0.07

ROSC denotes return of spontaneous circulation; RR denotes relative risk ratio; 95% CI denotes 95% confidence intervals

Table S7. Survival for non-pulseless events (absolute risk)		
Survival to hospital discharge		
Year	Events/ Total	Absolute risk (95% confidence interval)
2000	19/33	58 (39–75)
2001	36/59	61 (47–73)
2002	42/76	55 (43–67)
2003	52/84	62 (51–72)
2004	64/121	53 (44–62)
2005	222/363	61 (56–66)
2006	197/337	58 (53–64)
2007	207/365	57 (51–62)
2008	199/362	55 (50–60)
2009	287/448	64 (59–69)
2010	241/402	60 (55–65)
2011	276/408	68 (63–72)
2012	271/457	59 (55–64)
2013	251/413	61 (56–66)
2014	238/366	65 (60–70)
2015	258/399	65 (60–69)
2016	269/383	70 (65–75)
2017	282/383	74 (69–78)
2018	194/292	66 (61–72)

Table S8. Survival for non-pulseless events (relative risk)

Year	Model 1			Model 2			Model 3		
	RR	95% CI	p-value	RR	95% CI	P-value	RR	95% CI	P-value
2000	0.87	0.63–1.19	0.38	0.92	0.75–1.14	0.44	0.90	0.74–1.11	0.33
2001	0.95	0.67–1.36	0.78	0.88	0.65–1.20	0.43	0.89	0.67–1.20	0.45
2002	0.85	0.63–1.16	0.32	0.87	0.61–1.25	0.45	0.89	0.62–1.27	0.51
2003	0.96	0.81–1.14	0.64	0.91	0.78–1.05	0.19	0.90	0.77–1.05	0.17
2004	0.82	0.68–0.98	0.03	0.87	0.72–1.05	0.15	0.86	0.71–1.03	0.11
2005	0.94	0.85–1.04	0.22	1.00	0.90–1.12	0.96	1.00	0.89–1.11	0.94
2006	0.91	0.79–1.04	0.15	0.95	0.82–1.09	0.46	0.95	0.83–1.09	0.50
2007	0.90	0.77–1.04	0.14	0.91	0.79–1.05	0.18	0.91	0.80–1.04	0.16
2008	0.88	0.78–0.98	0.02	0.89	0.80–1.00	0.05	0.89	0.80–0.99	0.03
2009	1.00 (Reference)			1.00 (Reference)			1.00 (Reference)		
2010	0.94	0.84–1.06	0.32	0.95	0.86–1.06	0.39	0.95	0.86–1.05	0.32
2011	1.06	0.94–1.19	0.32	1.05	0.93–1.18	0.45	1.04	0.92–1.17	0.56
2012	0.93	0.82–1.06	0.27	0.93	0.82–1.07	0.32	0.93	0.81–1.07	0.30
2013	0.96	0.83–1.10	0.54	0.96	0.83–1.10	0.53	0.95	0.83–1.09	0.49
2014	1.00	0.87–1.15	0.98	0.98	0.83–1.14	0.76	0.99	0.84–1.16	0.89
2015	0.99	0.88–1.12	0.93	0.96	0.84–1.10	0.55	0.97	0.84–1.11	0.63
2016	1.08	0.96–1.22	0.18	1.01	0.88–1.16	0.93	1.00	0.87–1.15	0.98
2017	1.13	1.03–1.25	0.01	1.09	0.96–1.23	0.19	1.09	0.96–1.23	0.17
2018	1.01	0.90–1.14	0.86	0.95	0.84–1.07	0.40	0.95	0.85–1.07	0.43

RR denotes relative risk ratio; 95% CI denotes 95% confidence intervals.

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Besides the author Monica Kleinman, M.D., members of the Get With The Guidelines®-Resuscitation Pediatric Research Task Force include: Anne-Marie Guerguerian, M.D., Ph.D., F.R.C.P.C., Dianne Atkins, M.D., Elizabeth Foglia, M.D., M.S.C.E., Jordan Duval-Arnould, M.P.H., Dr.P.H. Ericka Fink, M.D., Javier J. Lasa, M.D., F.A.A.P., Joan Roberts, M.D., Melanie Bembea, M.D., M.P.H., Michael Gaies, M.D., M.P.H., M.Sc., Punkaj Gupta, M.B.B.S., Robert Sutton, M.D., M.S.C.E., Taylor Sawyer, D.O.Med.