

## Supplementary Appendix

### **Trends in Survival After In-hospital Cardiac Arrests: A Report from Get With The Guidelines-Resuscitation**

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**eTable 1. Characteristics of Study Hospitals**

<i>Hospital Characteristic, %</i>	<b>N=374</b>
Geographic Region*	
Northeast	52 (14.6)
Southeast	91 (25.3)
Midwest	80 (22.3)
Southwest	68 (18.9)
West	68 (18.9)
Location*	
Urban	322 (89.7)
Rural	37 (10.3)
Ownership*	
Private	47 (13.1)
Government	55 (15.3)
Non-profit	257 (71.6)
Hospital Bed Size**	
< 250	141 (39.0)
250-499	144 (39.9)
≥ 500	76 (21.1)
Academic Status**	
Hospital with fellowship program (Major)	76 (21.1)
Hospital with residency program (Minor)	116 (32.1)
Non-teaching hospital	169 (46.8)

\* Geographic Region, Location and Ownership data were missing for 15 (4.0%) hospitals.

\*\* Hospital Bed Size and Academic Status data were missing for 13 (3.5%) hospitals.

**eTable 2. Observed Rates of Survival and Neurological Outcomes By Calendar Year.** Unadjusted (crude) rates of survival to discharge, acute resuscitation survival, post-resuscitation survival, and neurological disability by calendar year are reported for overall cohort and by rhythm type.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
<b>OVERALL</b>	<b>N = 1405</b>	<b>N = 4524</b>	<b>N = 7687</b>	<b>N = 10,017</b>	<b>N = 10,794</b>	<b>N = 10,999</b>	<b>N = 10,810</b>	<b>N = 10,665</b>	<b>N = 10,959</b>	<b>N = 6765</b>
Survival to Discharge, n (%)	192 (13.7)	712 (15.7)	1219 (15.9)	1516 (15.1)	1741 (16.1)	1870 (17.0)	1859 (17.2)	1862 (17.5)	2128 (19.4)	1258 (18.6)
Acute Resuscitation Survival†, n (%)	600 (42.7)	2010 (44.4)	3477 (45.2)	4678 (46.7)	5217 (48.3)	5469 (49.7)	5548 (51.3)	5783 (54.2)	6335 (57.8)	3875 (57.3)
Post-Resuscitation Survival‡, %	32.0	35.4	35.1	32.4	33.4	34.2	33.5	32.2	33.6	32.5
Neurological Outcome in Survivors										
Significant Disability# (CPC > 1), n (%)	49 (32.9)	246 (46.9)	403 (42.3)	666 (51.4)	783 (54.1)	868 (51.5)	891 (52.7)	855 (52.8)	936 (49.8)	457 (40.8)
Severe Disability ¶¶ (CPC > 2), n (%)	15 (10.1)	84 (16.0)	139 (14.6)	225 (17.4)	286 (19.8)	324 (19.2)	298 (17.6)	350 (21.6)	367 (19.5)	184 (16.4)
<b>Asystole and PEA</b>	<b>N = 965</b>	<b>N = 3315</b>	<b>N = 5940</b>	<b>N = 7866</b>	<b>N = 8510</b>	<b>N = 8725</b>	<b>N = 8684</b>	<b>N = 8578</b>	<b>N = 8978</b>	<b>N = 5574</b>
Survival to Discharge, n (%)	66 (6.8)	331 (10.0)	629 (10.6)	786 (10.0)	958 (11.3)	1058 (12.1)	1108 (12.8)	1140 (13.3)	1370 (15.3)	782 (14.0)
Acute Resuscitation Survival†, n (%)	344 (35.7)	1279 (38.6)	2403 (40.5)	3331 (42.4)	3745 (44.0)	3985 (45.7)	4160 (47.9)	4354 (50.8)	4947 (55.1)	3019 (54.2)
Post-Resuscitation Survival‡, %	19.2	25.9	26.2	23.6	25.6	26.6	26.6	26.2	27.7	25.9

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Neurological Outcome in Survivors										
Significant Disability# (CPC > 1), n (%)	16 (34.0)	137 (56.6)	244 (50.8)	389 (58.4)	479 (61.5)	573 (61.0)	592 (59.3)	552 (56.7)	659 (54.7)	334 (48.3)
Severe Disability ¶¶ (CPC > 2), n (%)	7 (14.9)	55 (22.7)	95 (19.8)	149 (22.4)	205 (26.3)	240 (25.5)	235 (23.5)	232 (23.8)	277 (23.0)	149 (21.6)
<b>VF and Pulseless VT</b>	<b>N = 440</b>	<b>N = 1209</b>	<b>N = 1747</b>	<b>N = 2151</b>	<b>N = 2284</b>	<b>N = 2274</b>	<b>N = 2126</b>	<b>N = 2087</b>	<b>N = 1981</b>	<b>N = 1191</b>
Survival to Discharge, n (%)	126 (28.6)	381 (31.5)	590 (33.8)	730 (33.9)	783 (34.3)	812 (35.7)	751 (35.3)	722 (34.6)	758 (38.3)	476 (40.0)
Acute Resuscitation Survival†, n (%)	256 (58.2)	731 (60.5)	1074 (61.5)	1347 (62.6)	1472 (64.5)	1484 (65.3)	1388 (65.3)	1429 (68.5)	1388 (70.1)	856 (71.9)
Post-Resuscitation Survival‡, %	49.2	52.1	54.9	54.2	53.2	54.7	54.1	50.5	54.6	55.6
Neurological Outcome in Survivors										
Significant Disability# (CPC > 1), n (%)	33 (32.4)	109 (38.7)	159 (33.6)	277 (44.0)	304 (45.5)	295 (39.7)	299 (43.2)	303 (46.9)	277 (40.9)	123 (28.7)
Severe Disability ¶¶ (CPC > 2), n (%)	8 (7.8)	29 (10.3)	44 (9.3)	76 (12.1)	81 (12.1)	84 (11.3)	63 (9.1)	118 (18.3)	90 (13.3)	35 (8.2)

**Abbreviations:** CI, confidence interval; CPC, cerebral performance category; PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia.

† Acute Resuscitation Survival was determined by the number of patients with return of spontaneous circulation for at least 20 minutes divided by the number of patients with a cardiac arrest.

‡ Post-resuscitation Survival was determined by the number surviving to hospital discharge divided by the number surviving the acute resuscitation.

# Significant Disability was defined as the proportion of patients surviving to hospital discharge with a CPC Score of > 1.

¶¶ Severe Disability was defined as the proportion of patients surviving to hospital discharge with a CPC Score of > 2.

**eTable 3. Independent Predictors of Survival to Hospital Discharge for In-hospital**

**Cardiac Arrest.** Adjusted risk ratio, 95% confidence intervals and *P* values are provided for all model covariates included in the multivariable model for survival to discharge in the overall cohort.

<i>Variable</i>	<b>Risk Ratio</b>	<b>95% CI</b>	<b><i>P</i> value</b>
Calendar Year			
2001 vs. 2000	1.25	1.08, 1.45	0.002
2002 vs. 2000	1.33	1.16, 1.52	< 0.001
2003 vs. 2000	1.30	1.13, 1.50	< 0.001
2004 vs. 2000	1.38	1.19, 1.60	< 0.001
2005 vs. 2000	1.46	1.25, 1.70	< 0.001
2006 vs. 2000	1.49	1.27, 1.76	< 0.001
2007 vs. 2000	1.55	1.31, 1.83	< 0.001
2008 vs. 2000	1.70	1.42, 2.04	< 0.001
2009 vs. 2000	1.63	1.35, 1.97	< 0.001
Age (per 1-year)	0.99	0.99, 0.99	< 0.001
Sex (Female vs. Male)	1.06	1.03, 1.09	< 0.001
Race			
Black vs. White	0.86	0.82, 0.90	< 0.001
Other vs. White	0.94	0.86, 1.03	0.19
Initial Cardiac Arrest Rhythm			
PEA vs. Asystole	1.07	1.02, 1.13	0.005
VF vs. Asystole	2.50	2.37, 2.62	< 0.001
VT vs. Asystole	2.47	2.34, 2.61	< 0.001
Amiodarone Use during Resuscitation	0.86	0.83, 0.90	< 0.001
Assessed with AED	1.06	1.01, 1.11	0.02
Arrest at Night	0.84	0.81, 0.86	< 0.001
Arrest on Weekend	0.92	0.89, 0.94	< 0.001
Hospital Location			
Monitored Unit vs. ICU	0.97	0.93, 1.01	0.11
Non-Monitored Unit vs. ICU	0.58	0.54, 0.62	< 0.001

<b>Variable</b>	<b>Risk Ratio</b>	<b>95% CI</b>	<b>P value</b>
Hospital wide response activated	0.95	0.89, 1.00	0.06
CPC category on admission			
CPC 2 vs. CPC 1	0.99	0.93, 1.04	0.60
CPC 3 vs. CPC 1	0.87	0.81, 0.94	< 0.001
CPC 4 vs. CPC 1	0.74	0.65, 0.85	< 0.001
Heart Failure, this admission	1.03	0.99, 1.07	0.13
Prior Heart Failure	0.96	0.93, 0.99	0.02
Myocardial Infarction, this admission	1.10	1.05, 1.15	< 0.001
Prior Myocardial Infarction	1.01	0.97, 1.05	0.52
Arrhythmia	1.20	1.16, 1.24	< 0.001
Hypotension	0.71	0.68, 0.74	< 0.001
Respiratory Insufficiency	0.99	0.96, 1.03	0.75
Renal Insufficiency	0.83	0.80, 0.86	< 0.001
Hepatic Insufficiency	0.65	0.59, 0.70	< 0.001
Metabolic or Electrolyte Abnormality	0.86	0.81, 0.91	< 0.001
Diabetes Mellitus	1.13	1.09, 1.16	< 0.001
Baseline Depression in CNS Function	0.95	0.90, 0.995	0.03
Acute Stroke	0.91	0.85, 0.98	0.02
Pneumonia	0.95	0.90, 0.997	0.04
Septicemia	0.75	0.71, 0.79	< 0.001
Major Trauma	0.92	0.83, 1.02	0.10
Cancer	0.58	0.54, 0.62	< 0.001
Mechanical Ventilation	0.65	0.62, 0.69	< 0.001
Intravenous Antiarrhythmic Therapy	1.22	1.16, 1.28	< 0.001
Intravenous Vasopressor Medication	0.60	0.57, 0.63	< 0.001
Dialysis	0.80	0.72, 0.90	< 0.001
Intra-Aortic Balloon Pump	0.99	0.89, 1.10	0.85
Pulmonary Artery Catheter	1.56	1.45, 1.67	< 0.001
Length of participation in GWTG-Resuscitation (per 1-year)	1.01	0.99, 1.02	0.46

<b>Variable</b>	<b>Risk Ratio</b>	<b>95% CI</b>	<b>P value</b>
Geographic Region			
Southeast vs. Northeast	1.05	0.95, 1.16	0.32
Midwest vs. Northeast	1.18	1.07, 1.30	< 0.001
Southwest vs. Northeast	1.03	0.94, 1.14	0.51
West vs. Northeast	1.15	1.04, 1.27	0.005
Location (Rural vs. Urban)	1.05	0.97, 1.14	0.22
Ownership status			
Government vs. Private	1.00	0.92, 1.09	0.99
Non-Profit vs. Private	1.06	0.99, 1.14	0.08
Hospital Bed Size			
250-499 vs. < 250	1.10	1.03, 1.17	0.004
≥ 500 vs. < 250	1.11	1.03, 1.19	0.008
Teaching status			
Minor teaching vs. Major	0.98	0.92, 1.06	0.67
Non-teaching vs. Major	1.00	0.93, 1.08	0.91

**Abbreviations:** AED, automated external defibrillator; CI, confidence interval; CNS, central nervous system; CPC, cerebral performance category; ICU, Intensive Care Unit; GWTG-Resuscitation, Get With The Guidelines-Resuscitation; PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia.

**eTable 4. Trends in Survival and Neurological Outcomes by Rhythm Type.** Risk-adjusted rates of survival to discharge, acute resuscitation survival, post-resuscitation survival, and neurological disability for each calendar year are reported separately for patients with non-shockable rhythms (asystole and PEA) and shockable rhythms (VF and pulseless VT). Rates are adjusted for temporal changes in patient and hospital characteristics.

	Risk-Adjusted Rates*										Adjusted RR per 1-year (95% CI)**	P for Trend**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009		
<b>Asystole and PEA</b>												
Survival to Discharge, %	6.8	9.7	10.0	9.5	10.4	11.4	11.9	12.7	14.3	13.3	1.06 (1.04, 1.08)	< 0.001
Acute Resuscitation Survival†, %	35.7	38.4	39.3	40.5	41.2	42.9	44.4	47.2	50.2	49.0	1.04 (1.03, 1.05)	< 0.001
Post-Resuscitation Survival‡, %	19.2	25.6	25.8	23.8	25.6	27.4	27.4	27.3	28.9	27.9	1.02 (1.01, 1.04)	0.006
Neurological Outcome in Survivors, %												
Significant Disability# (CPC > 1), %	34.0	48.4	43.4	46.2	46.0	46.6	44.6	44.0	45.0	40.1	0.99 (0.98, 1.01)	0.21
Severe Disability¶ (CPC > 2), %	14.9	17.4	15.3	16.1	18.3	18.0	15.9	17.3	18.1	16.9	1.01 (0.98, 1.04)	0.63
<b>VF and Pulseless VT</b>												
Survival to Discharge, %	28.6	32.8	35.2	36.2	37.3	37.7	38.0	37.8	41.7	41.5	1.03 (1.01, 1.04)	< 0.001
Acute Resuscitation Survival†, %	58.2	61.0	60.5	60.5	62.5	62.9	63.4	66.2	68.1	68.2	1.02 (1.01, 1.03)	< 0.001
Post-Resuscitation Survival‡, %	49.2	53.4	56.5	58.4	58.8	58.6	59.1	56.4	60.4	60.4	1.01 (1.00, 1.02)	0.05
Neurological Outcome in Survivors, %												
Significant Disability# (CPC > 1), %	32.4	32.4	28.8	31.5	31.1	28.5	30.5	30.8	26.5	22.7	0.98 (0.96, 0.99)	0.01
Severe Disability¶ (CPC > 2), %	7.8	7.7	8.6	8.5	8.7	8.6	6.4	12.0	8.7	7.4	1.02 (0.96, 1.07)	0.57



Abbreviations: CI, confidence interval; CPC, cerebral performance category; PEA, pulseless electrical activity; RR, rate-ratio; VF, ventricular fibrillation; VT, ventricular tachycardia.

\* Risk-adjusted rates for each calendar year were obtained by multiplying the observed rate for the reference year (2000) by the corresponding rate-ratios for 2001 through 2009 from a model evaluating calendar year as a categorical variable

\*\* Determined from a model evaluating calendar year as a continuous variable

† Acute Resuscitation Survival was determined by the number of patients with return of spontaneous circulation for at least 20 minutes divided by the number of patients with a cardiac arrest.

‡ Post-resuscitation Survival was determined by the number surviving to hospital discharge divided by the number surviving the acute resuscitation.

# Significant Disability was defined as the proportion of patients surviving to hospital discharge with a CPC Score of > 1.

¶ Severe Disability was defined as the proportion of patients surviving to hospital discharge with a CPC Score of > 2.

**eTable 5. Trends in Risk-Adjusted Rates of Survival to Discharge by Calendar Year Among Patients at Hospitals Participating for at least 8 years in Get With The Guidelines-Resuscitation.** Risk-adjusted rates of survival to discharge by calendar year are reported for the overall cohort and by rhythm type for 33,464 patients at 85 hospitals that participated in the registry for at least 8 years during 2000-2009.

	Risk-Adjusted Rates*										Adjusted RR per 1-year** (95% CI)	P for Trend**
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009		
<b>OVERALL</b>	<b>N=563</b>	<b>N=1690</b>	<b>N=3202</b>	<b>N=4206</b>	<b>N=4085</b>	<b>N=4439</b>	<b>N=4409</b>	<b>N=3987</b>	<b>N=4121</b>	<b>N=2762</b>		
Survival to Discharge, %	13.9	16.2	17.2	17.7	20.1	22.1	21.3	21.8	24.9	23.7	1.05 (1.04, 1.07)	<0.001
<b>Asystole and PEA</b>	<b>N=396</b>	<b>N=1231</b>	<b>N=2473</b>	<b>N=3296</b>	<b>N=3212</b>	<b>N=3550</b>	<b>N=3602</b>	<b>N=3261</b>	<b>N=3418</b>	<b>N=2293</b>		
Survival to Discharge, %	8.6	8.6	9.4	9.7	10.9	13.0	12.1	13.0	14.6	13.7	1.06 (1.04, 1.08)	<0.001
<b>VF and Pulseless VT</b>	<b>N=167</b>	<b>N=459</b>	<b>N=729</b>	<b>N=910</b>	<b>N=873</b>	<b>N=889</b>	<b>N=807</b>	<b>N=726</b>	<b>N=703</b>	<b>N=469</b>		
Survival to Discharge, %	26.4	33.2	33.8	35.3	40.0	39.0	39.7	38.2	45.9	42.5	1.04 (1.02, 1.05)	<0.001

Abbreviations: CI, confidence interval; PEA, pulseless electrical activity; RR, rate-ratio; VF, ventricular fibrillation; VT, ventricular tachycardia.

\* Risk-adjusted rates for each calendar year were determined by multiplying the observed rate for the reference year (2000) by the corresponding rate-ratios for 2001 through 2009 from a model evaluating calendar year as a categorical variable

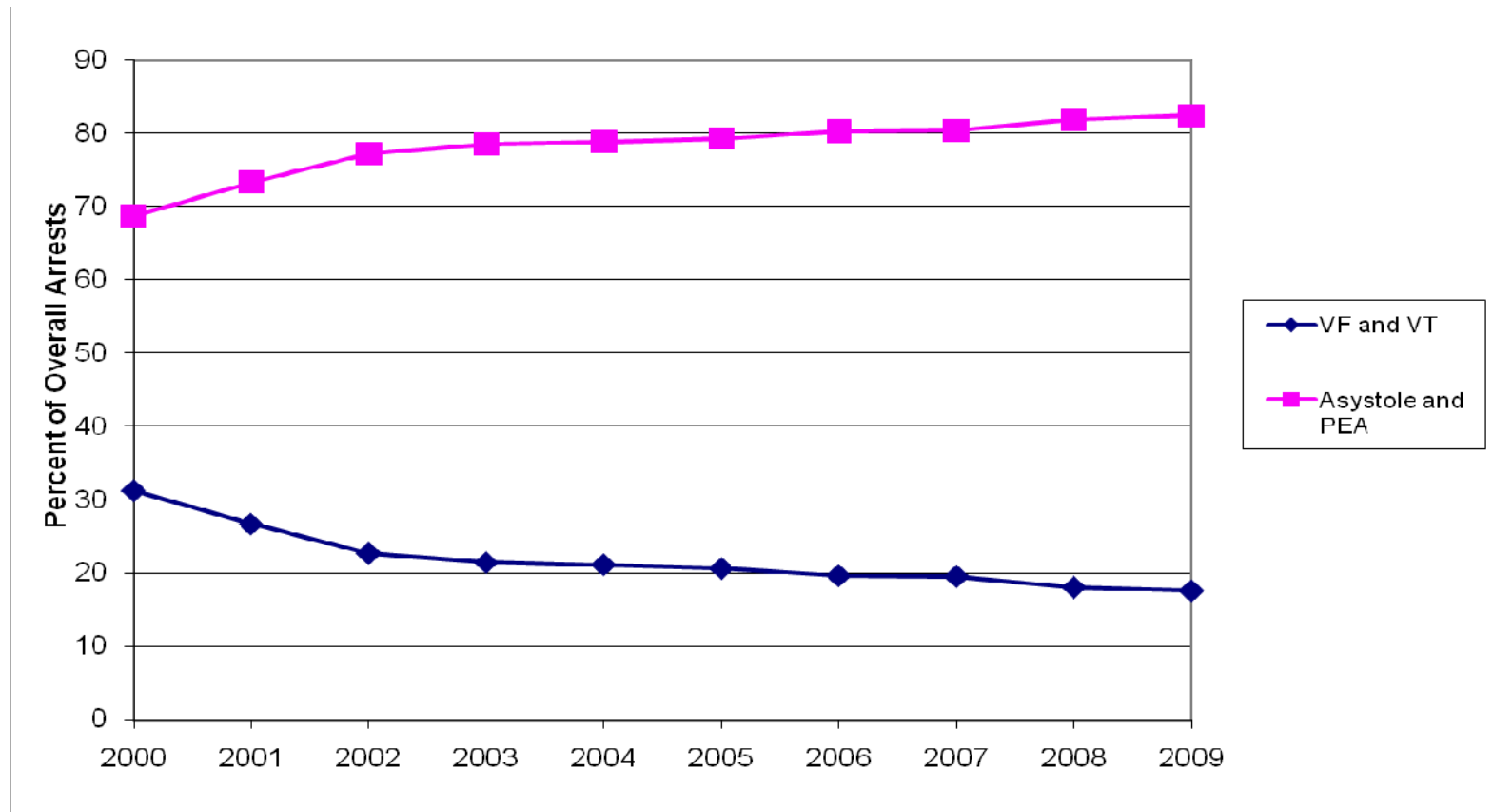
\*\* Determined from a model evaluating calendar year as a continuous variable

## Figure Legend

**eFigure 1. Proportion of Cardiac Arrests Due to Asystole or Pulseless Electrical Activity (PEA) and Ventricular Fibrillation (VF) or Pulseless Ventricular Tachycardia (VT) by Calendar Year.** Over the past decade, the proportion of cardiac arrests treatable by defibrillation (VF and pulseless VT) has decreased ( $P$  for trend  $<0.001$ ).

**eFigure 2. Time to Defibrillation in Patients with Ventricular Fibrillation (VF) or Pulseless Ventricular Tachycardia (VT) by Calendar Year.** Over the past decade, mean time to defibrillation among patients with VF and pulseless VT has not changed ( $P$  for trend = 0.08).

**eFigure 1. Proportion of Cardiac Arrests Due to Asystole or Pulseless Electrical Activity (PEA) and Ventricular Fibrillation (VF) or Pulseless Ventricular Tachycardia (VT) by Calendar Year.** Over the past decade, the proportion of cardiac arrests treatable by defibrillation (VF and pulseless VT) has decreased ( $P$  for trend  $<0.001$ ).



Abbreviations: PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia.

**eFigure 2. Time to Defibrillation in Patients with Ventricular Fibrillation (VF) or Pulseless Ventricular**

**Tachycardia (VT) by Calendar Year.** Over the past decade, mean time to defibrillation among patients with VF and pulseless VT has not changed ( $P$  for trend = 0.08).

