

Get With The Guidelines[®]-Resuscitation is the American Heart Association's collaborative quality improvement program demonstrated to improve adherence to evidence-based care of patients who experience an in-hospital resuscitation event or received post cardiac arrest care following an in-hospital or out-of-hospital event. The program facilitates the efficient capture, analysis and reporting of data that empowers and supports the implementation of current guidelines, creation and dissemination of new knowledge, and development of next generation, evidence-based practice in resuscitation science. Hospitals are able to track data for Cardiopulmonary Arrest (CPA), Medical Emergency Team (MET), Post-Cardiac Arrest Care (PCAC) and Acute Respiratory Compromise (ARC) in the Web-based Patient Management Tool™ (powered by Quintiles Real-World & Late Phase Research). The PMT provides decision support, robust registry, real-time benchmarking capabilities and other performance improvement methodologies toward the goal of enhancing patient outcomes and saving lives.

The primary goal of Get With The Guidelines-Resuscitation is to save more lives by preventing in-hospital cardiac arrest and optimizing outcomes through benchmarking, quality improvement, knowledge translation, and research.

CARDIOPULMONARY ARREST

ADULT <i>age ≥18 years</i>	PEDIATRIC <i>age <18 years and ≥1 year</i>	NEONATE/INFANT <i>age <1 year and ≥24 hours old</i>	NEWLY BORN <i>event occurred at delivery (< 24 hours old)</i>
Confirmation of airway device placement in trachea: Percent of events who had confirmation of airway device placement in trachea.	Confirmation of airway device placement in trachea: Percent of events who had confirmation of airway device placement in trachea	Confirmation of airway device placement in trachea: Percent of events who had confirmation of airway device placement in trachea.	Confirmation of airway device placement in trachea: Percent of events who had confirmation of airway device placement in trachea.
Time to first shock ≤ 2 min for VF/pulseless VT first documented rhythm: Percent of events with VF/pulseless VT first documented rhythm in whom time to first shock ≤ 2 minutes of event recognition.	Time to first chest compressions ≤ 1 min in pediatric patients: Percent of events where time to first chest compressions ≤ 1 minute	Time to first chest compressions ≤ 1 min in pediatric patients: Percent of events where time to first chest compressions ≤ 1 minute	Advanced airway placed prior to the initiation of chest compressions: Percent of events who had an advanced airway (either laryngeal mask airway (LMA), endotracheal tube (ET) or tracheostomy tube) placed prior to initiation of chest compressions.
Time to IV/IO epinephrine ≤ 5 minutes for asystole or Pulseless Electrical Activity (PEA): Percent of events where time to epinephrine ≤ 5 minute of asystole or pulseless electrical activity.	Time to IV/IO epinephrine ≤ 5 minutes for asystole or Pulseless Electrical Activity (PEA): Percent of events where time to epinephrine ≤ 5 minute of asystole or pulseless electrical activity.	Time to IV/IO epinephrine ≤ 5 minutes for asystole or Pulseless Electrical Activity (PEA): Percent of events where time to epinephrine ≤ 5 minute of asystole or pulseless electrical activity.	Pulse oximetry in place prior to the initiation of chest compressions: Percent of events where pulse oximetry was in place prior to the initiation of chest compressions
Percent pulseless cardiac events monitored or witnessed: Percent of pulseless cardiac patient events were monitored or witnessed	Percent pulseless cardiac events occurring in an ICU setting: Percent of pulseless cardiac events occurring in an ICU setting (Adult ICU, PICU Pediatric Cardiac ICU, Neonatal ICU) versus a general inpatient area (General inpatient area, Step down/telemetry, Newborn Nursery)	Percent pulseless cardiac events occurring in an ICU setting: Percent of pulseless cardiac events occurring in an ICU setting (Adult ICU, PICU, Pediatric Cardiac ICU, Neonatal ICU) versus a general inpatient area (General inpatient area, Step down/telemetry, Newborn Nursery)	Time to positive pressure ventilation <1 minute from CPA recognition: Percent of events where the positive pressure ventilation was within 1 minute of event recognition.

QUALITY MEASURES

ACUTE RESPIRATORY COMPROMISE

ADULT

age ≥ 18 years

Device confirmation of correct endotracheal tube placement: Percent of events with an endotracheal tube placement confirmed to be correct

Time to first assisted ventilation ≤ 1 min: Percent of events with time to first assisted ventilation ≤ 1 minute

PEDIATRIC

age < 18 years and ≥ 1 year

Device confirmation of correct endotracheal tube placement: Percent of events with an endotracheal tube placement confirmed to be correct

Time to first assisted ventilation ≤ 1 min: Percent of events with time to first assisted ventilation ≤ 1 minute

NEWBORN/NEONATE/INFANT

age < 1 year

Device confirmation of correct endotracheal tube placement: Percent of events with an endotracheal tube placement confirmed to be correct

Invasive airway inserted in newborn/neonate events: Percent of events with an invasive airway inserted

Time to first assisted ventilation ≤ 1 min: Percent of events with time to first assisted ventilation ≤ 1 minute

Time to invasive airway ≤ 2 min in newborn/neonates: Percent of events with time to invasive airway ≤ 2 minutes

CARDIOPULMONARY ARREST

ADULT

age ≥ 18 years

Chest compressions provided: Percent of events with chest compressions provided

Defibrillation shock provided for VF/pulseless VT rhythm: Percent of VF/pulseless VT rhythm events provided with defibrillation shock

IV/IO Epinephrine/Vasopressin bolus administered to pulseless adults ≤ 5 min: Percent of events with first documented pulseless rhythm of Asystole or Pulseless Electrical Activity (PEA) for whom IV/IO Epinephrine/Vasopressin bolus was administered within 5 minutes of identification of pulselessness

Subsequent shock delivered ≥ 2 min after previous shock: Percent of events where any subsequent shock was delivered greater than or equal to 2 min after the previous shock

PEDIATRIC

age < 18 years and ≥ 1 year

Chest compressions provided: Percent of events with chest compressions provided

Defibrillation shock provided for VF/pulseless VT rhythm: Percent of VF/pulseless VT rhythm events provided with defibrillation shock

Initial shock energy ≥ 2 joules/kg (< 12 yrs old AND < 50 kg): Percent of events for patients less than 12 years old and 50 kg with initial shock energy ≥ 2 joules/kg

IV/IO Epinephrine/Vasopressin bolus administered to pediatric patients or newborn/neonates ≤ 5 min: Percent of events with first documented rhythm of Bradycardia or Asystole or Pulseless Electrical Activity (PEA) for whom IV/IO Epinephrine/Vasopressin bolus was administered within 5 minutes of first recognition of the need for chest compressions

NEWBORN/NEONATE/INFANT

age < 1 year

Chest compressions provided: Percent of events with chest compressions provided

Defibrillation shock provided for VF/pulseless VT rhythm: Percent of VF/pulseless VT rhythm events provided with defibrillation shock

Initial shock energy ≥ 2 joules/kg (< 12 yrs old AND < 50 kg): Percent of events for patients less than 12 years old and 50 kg with initial shock energy ≥ 2 joules/kg

Invasive airway inserted in newborn/neonates: Percent of events with insertion of an invasive airway

Percent pulseless cardiac events monitored or witnessed (newborn/ neonate patients): Percent of pulseless events monitored or witnessed

CARDIOPULMONARY ARREST (CONTINUED FROM PAGE 02)

ADULT

age ≥ 18 years

PEDIATRIC

age < 18 years and ≥ 1 year

NEWBORN/NEONATE/INFANT

age < 1 year

Shock energy ≤ 10 joules/kg (<12 yrs old AND <50 kg): Percent of events for patients less than 12 years old and 50 kg with appropriate shock energies less than or equal to 10 joules/kg

Subsequent shock delivered ≥ 2 min after previous shock: Percent of events where any subsequent shock was delivered greater than or equal to 2 min after the previous shock

Subsequent shock energy ≥ 4 joules/kg (<12 yrs old AND <50 kg): Percent of events for patients less than 12 years old and 50 kg with subsequent shock energy ≥ 4 joules/kg

Time to first shock ≤ 2 min for VF/pulseless VT first documented rhythm: Percent of initially pulseless events with VF/pulseless VT first documented rhythm with time to first shock ≤ 2 minutes

IV/IO Epinephrine bolus administered to pediatric patients or newborn/ neonates ≤ 5 min: Percent of events with first documented rhythm of Bradycardia or Asystole or Pulseless Electrical Activity (PEA) for whom IV/IO Epinephrine/ Vasopressin bolus was administered within 5 minutes of first recognition of the need for chest compressions

Shock energy ≤ 10 joules/kg (<12 yrs old AND <50 kg): Percent of events for patients less than 12 years old and 50 kg with appropriate shock energies less than or equal to 10 joules/kg

Subsequent shock delivered ≥ 2 min after previous shock: Percent of events where any subsequent shock was delivered greater than or equal to 2 min after the previous shock

Subsequent shock energy ≥ 4 joules/kg (<12 yrs old AND <50 kg): Percent of events for patients less than 12 years old and 50 kg with subsequent shock energy ≥ 4 joules/kg

Time to Bag mask ventilation <1 minute from CPA recognition in newborn/neonates <10 minutes old: Percent of events in patients <10 minutes old with bag mask ventilation within one minute of event recognition (date/time the need for chest compressions and/or defibrillation for VF/PVT was first recognized).

REPORTING MEASURES

ACUTE RESPIRATORY COMPROMISE

ADULT

age ≥ 18 years

Length of ARC Event: Time from the need for emergency assisted ventilation first recognized to time of the BEGINNING of sustained ROSV or control of ventilation or need for chest compression and/or defibrillation (CPA) first identified

Reason ARC event ended: Histogram breakdown of reason event ended

PEDIATRIC

age < 18 years and ≥ 1 year

Length of ARC Event: Time from the need for emergency assisted ventilation first recognized to time of the BEGINNING of sustained ROSV or control of ventilation or need for chest compression and/or defibrillation (CPA) first identified

Reason ARC event ended: Histogram breakdown of reason event ended

NEWBORN/NEONATE/INFANT

age < 1 year

Length of ARC Event: Time from the need for emergency assisted ventilation first recognized to time of the BEGINNING of sustained ROSV or control of ventilation or need for chest compression and/or defibrillation (CPA) first identified.

Reason ARC event ended: Histogram breakdown of reason event ended

CARDIOPULMONARY ARREST

ADULT

age ≥ 18 years

Adult and pediatric patients with pulseless cardiac events who died that had DNAR status declared and/ or life support withdrawn: Histogram breakdown of pulseless events where patients died and had DNAR status declared and/or life support withdrawn

Adult patients with pulseless cardiac event who survived and CPC scores at hospital discharge: Histogram breakdown of patients with pulseless events who survived and CPC scores at hospital discharge

Average ventilation rate: Percent of events with average ventilation rate of < 12 breaths/min

Chest compression depth: Percent of events with an average chest compression depth of ≥ 50 mm

Chest compression fraction: Percent of events with chest compression fraction of > 0.8 (80%)

Chest compression rate: Percent of events with an average chest compression rate of ≥ 100 /min

CPR performance debriefing: Percent of events in which a debriefing on the quality of CPR provided was completed after the event

PEDIATRIC

age < 18 years and ≥ 1 year

Adult and pediatric patients with pulseless cardiac events who died that had DNAR status declared and/ or life support withdrawn: Histogram breakdown of pulseless events where patients died and had DNAR status declared and/or life support withdrawn

Average ventilation rate: Percent of events with average ventilation rate of < 12 breaths/min

Chest compression fraction: Percent of events with chest compression fraction of > 0.8 (80%)

Chest compression rate: Percent of events with an average chest compression rate of ≥ 100 /min

CPR performance debriefing: Percent of event in which a debriefing on the quality of CPR provided was completed after the event

CPR performance method: Histogram breakdown of how CPR performance was monitored or guided

CPR performance, overall: Percent of events in which CPR performance was monitored or guided

CPR performance, physiological metrics: Percent of events in which CPR performance was monitored or guided using physiological metrics

NEWBORN/NEONATE/INFANT

age < 1 year

Average ventilation rate: Percent of events with average ventilation rate of < 12 breaths/min

Chest compression fraction: Percent of events with chest compression fraction of > 0.8 (80%)

Chest compression rate: Percent of events with an average chest compression rate of ≥ 100 /min

CPR performance debriefing: Percent of events in which a debriefing on the quality of CPR provided was completed after the event

CPR performance method: Histogram breakdown of how CPR performance was monitored or guided

CPR performance, overall: Percent of events in which CPR performance was monitored or guided

CPR performance, physiological metrics: Percent of events in which CPR performance was monitored or guided using physiological metrics

Length of CPA Event: Time from the need for chest compressions (or defibrillation when initial rhythm was VF or Pulseless VT) was FIRST recognized to time sustained ROC began lasting > 20 min OR resuscitation efforts were terminated (End of event)

CARDIOPULMONARY ARREST (CONTINUED FROM PAGE 4)

ADULT

age ≥ 18 years

CPR performance method: Histogram breakdown of how CPR performance was monitored or guided

CPR performance, overall: Percent of CPA events in which CPR performance was monitored or guided

CPR performance, physiological metrics: Percent of events in which CPR performance was monitored or guided using physiological metrics

Induced hypothermia initiated: Percent of events with induced hypothermia initiated

Length of CPA Event: Time from the need for chest compressions (or defibrillation when initial rhythm was VF or Pulseless VT) was FIRST recognized to time sustained ROC began lasting > 20 min OR resuscitation efforts were terminated (End of event)

ICU Discharge within 24 hours prior to CPA event: Percent of events with ICU discharge to inpatient ward within 24 hours of event.

Patients with cardiac events with pulse who survived and discharge disposition: Histogram breakdown of patients with pulsed events who survived and discharge disposition

Patients with pulseless cardiac events who survived and discharge disposition: Histogram breakdown of patients with pulseless events who survived and discharge disposition

Percent of patients with pulseless cardiac events who survived to hospital discharge: Percent of patients with pulseless events who survived to hospital discharge

Reason CPA resuscitation ended: Histogram breakdown of reason resuscitation ended

PEDIATRIC

age < 18 years and ≥ 1 year

Length of CPA Event: Time from the need for chest compressions (or defibrillation when initial rhythm was VF or Pulseless VT) was FIRST recognized to time sustained ROC began lasting > 20 min OR resuscitation efforts were terminated (End of event)

Induced hypothermia initiated: Percent of events with induced hypothermia initiated

Patients with cardiac events with pulse who survived and discharge disposition: Histogram breakdown of patients with pulsed events who survived and discharge disposition

Patients with pulseless cardiac events who survived and discharge disposition: Histogram breakdown of patients with pulseless events who survived and discharge disposition

ICU Discharge within 24 hours prior to CPA event: Percent of events with ICU discharge to inpatient ward within 24 hours of CPA activation

Pediatric patients with pulseless cardiac event who survived and PCPC scores at hospital discharge: Histogram breakdown of patients with pulseless events who survived and PCPC scores at hospital discharge

Percent of patients with pulseless cardiac events who survived to hospital discharge: Percent of patients with pulseless events who survived to hospital discharge

Reason CPA resuscitation ended: Histogram breakdown of reason resuscitation ended

Survival to discharge by first documented rhythm: Histogram breakdown of survival to discharge by first documented rhythm of index (first) event

NEWBORN/NEONATE/INFANT

age < 1 year

Induced hypothermia initiated: Percent of events with induced hypothermia initiated

Newborn/neonatal patients who died that had DNAR status declared and/or life support withdrawn: Histogram breakdown of patients who died and had DNAR status declared and/or life support withdrawn

Newborn/neonatal patients who survived and PCPC scores at hospital discharge: Histogram breakdown of patients who survived and PCPC scores at hospital discharge

Patients with cardiac events with pulse who survived and discharge disposition: Histogram breakdown of patients with pulsed events who survived and discharge disposition

ICU Discharge within 24 hours prior to CPA event: Percent of events with ICU discharge to inpatient ward within 24 hours of event.

Patients with pulseless cardiac events who survived and discharge disposition: Histogram breakdown of patients with pulseless events who survived and discharge disposition

Percent of newborn/neonatal patients who survived to hospital discharge: Percent of patients who survived to hospital discharge

Reason CPA resuscitation ended: Histogram breakdown of reason resuscitation ended

Survival to discharge by first documented rhythm: Histogram breakdown of survival to discharge by first documented rhythm of index (first) event

CARDIOPULMONARY ARREST (CONTINUED FROM PAGE 5)

ADULT <i>age >=18 years</i>	PEDIATRIC <i>age <18 years and >=1 year</i>	NEWBORN/NEONATE/INFANT <i>age <1 year</i>
Survival to discharge by first documented rhythm: Histogram breakdown of survival to discharge by first documented rhythm of index (first) event	Variance in discharge survival rates of adult and pediatric patients with pulseless events: Variance in discharge survival rates between weekday day/evening and weekday night/weekend	Variance in discharge survival rates of newborn/neonatal patients: Variance in discharge survival rates between weekday day/evening and weekday night/weekend
Variance in discharge survival rates of adult and pediatric patients with pulseless events: Variance in discharge survival rates between weekday day/evening and weekday night/weekend	VF/Pulseless VT Shocks: Histogram breakdown of VF/Pulseless VT shocks	VF/Pulseless VT Shocks: Histogram breakdown of VF/Pulseless VT shocks
VF/Pulseless VT Shocks: Histogram breakdown of VF/Pulseless VT shocks		

CARDIOPULMONARY ARREST & ACCUTE RESPIRATORY COMPROMISE

ADULT <i>age >=18 years</i>	PEDIATRIC <i>age <18 years and >=1 year</i>	NEWBORN/NEONATE/INFANT <i>age <1 year</i>
Confirmation methods for correct airway placement: Histogram breakdown of confirmation methods	Confirmation methods for correct airway placement: Histogram breakdown of confirmation methods	Confirmation methods for correct airway placement: Histogram breakdown of confirmation methods
Resuscitation-related events and issues: Histogram breakdown of resuscitation related events and issues	Resuscitation-related events and issues: Histogram breakdown of resuscitation related events and issues	Resuscitation-related events and issues: Histogram breakdown of resuscitation related events and issues
Types of ventilation provided: Histogram breakdown of types of ventilation provided	Types of ventilation provided: Histogram breakdown of types of ventilation provided	Types of ventilation provided: Histogram breakdown of types of ventilation provided
Was any Endotracheal Tube (ET) or Tracheostomy tube inserted/re-inserted during event?: Histogram breakdown of whether or not an endotracheal tube or tracheostomy tube was inserted/re inserted during event	Was any Endotracheal Tube (ET) or Tracheostomy tube inserted/re-inserted during event?: Histogram breakdown of whether or not an endotracheal tube or tracheostomy tube was inserted/re inserted during event	Was any Endotracheal Tube (ET) or Tracheostomy tube inserted/re-inserted during event?: Histogram breakdown of whether or not an endotracheal tube or tracheostomy tube was inserted/re inserted during event

MEDICAL EMERGENCY TEAM

ADULT

*age ≥ 18 years***Activation triggers:** Histogram breakdown of MET activation triggers**Conscious/procedural sedation within 24 hrs prior to MET activation:** Percent of events with conscious/ procedural sedation within 24 hours prior to MET activation**Device confirmation of correct endotracheal tube confirmation:** Percent of events with endotracheal tube placement which was confirmed to be correct**ED discharge within 24hrs prior to MET activation:** Percent of events with ED discharge within 24 hours prior to MET activation**Endotracheal tube or tracheostomy tube placed during MET event:** Percent of events with endotracheal tube or tracheostomy tube placed/re-placed during the MET event**ICU discharge prior to MET activation:** Percent of events with ICU discharge prior to MET activation**Length of MET Event:** Time First MET Team Member Arrived to Time Last Team Member Departed**MET Team Response Time:** Time MET was activated to time First MET Team Member Arrived**MET Outcome:** Histogram breakdown of MET outcome**PACU discharge within 24 hrs to MET activation:** Percent of events with PACU discharge within 24 hours to MET activation**Patient transfer destination:** Histogram breakdown of MET patient transfer destination

PEDIATRIC

*age < 18 years and ≥ 1 year***Activation triggers:** Histogram breakdown of MET activation triggers**Conscious/procedural sedation within 24 hrs prior to MET activation:** Percent of events with conscious/ procedural sedation within 24 hours prior to MET activation**Device confirmation of correct endotracheal tube confirmation:** Percent of events with endotracheal tube placement which was confirmed to be correct**ED discharge within 24hrs prior to MET activation:** Percent of events with ED discharge within 24 hours prior to MET activation**Endotracheal tube or tracheostomy tube placed during MET event:** Percent of events with endotracheal tube or tracheostomy tube placed/re-placed during the MET event**ICU discharge prior to MET activation:** Percent of events with ICU discharge prior to MET activation**Length of MET Event:** Time First MET Team Member Arrived to Time Last Team Member Departed**MET Team Response Time:** Time MET was activated to time First MET Team Member Arrived**MET Outcome:** Histogram breakdown of MET outcome**PACU discharge within 24 hrs to MET activation:** Percent of events with PACU discharge within 24 hours to MET activation**Patient transfer destination:** Histogram breakdown of MET patient transfer destination

NEWBORN/NEONATE/INFANT

*age < 1 year***Activation triggers:** Histogram breakdown of MET activation triggers**Conscious/procedural sedation within 24 hrs prior to MET activation:** Percent of events with conscious/ procedural sedation within 24 hours prior to MET activation**Device confirmation of correct endotracheal tube confirmation:** Percent of events with endotracheal tube placement which was confirmed to be correct**ED discharge within 24hrs prior to MET activation:** Percent of events with ED discharge within 24 hours prior to MET activation**Endotracheal tube or tracheostomy tube placed during MET event:** Percent of events with endotracheal tube or tracheostomy tube placed/re-placed during the MET event**ICU discharge prior to MET activation:** Percent of events with ICU discharge prior to MET activation**Length of MET Event:** Time First MET Team Member Arrived to Time Last Team Member Departed**MET Team Response Time:** Time MET was activated to time First MET Team Member Arrived**MET Outcome:** Histogram breakdown of MET outcome**PACU discharge within 24 hrs to MET activation:** Percent of events with PACU discharge within 24 hours to MET activation**Patient transfer destination:** Histogram breakdown of MET patient transfer destination

MEDICAL EMERGENCY TEAM (CONTINUED FROM PAGE 7)

Pre-Event: Percent of events discharged from an ICU within 24 hours prior to this MET call OR discharged from a PACU within 24 hours prior to this MET call OR in the ED within 24 hours prior to this MET call OR received conscious/procedural sedation or general anesthesia within 24 hours prior to this MET call or were discharged from an ICU at any point during this admission and prior to this MET call

Prior MET event within 24 hrs: Percent of events with MET Team activation within 24 hrs prior to this MET call

Review of MET response: Histogram breakdown of review of MET response

Pre-Event: Percent of events discharged from an ICU within 24 hours prior to this MET call OR discharged from a PACU within 24 hours prior to this MET call OR in the ED within 24 hours prior to this MET call OR received conscious/procedural sedation or general anesthesia within 24 hours prior to this MET call or were discharged from an ICU at any point during this admission and prior to this MET call

Prior MET event within 24 hrs: Percent of events with MET Team activation within 24 hrs prior to this MET call

Review of MET response: Histogram breakdown of review of MET response

Pre-Event: Percent of events discharged from an ICU within 24 hours prior to this MET call OR discharged from a PACU within 24 hours prior to this MET call OR in the ED within 24 hours prior to this MET call OR received conscious/procedural sedation or general anesthesia within 24 hours prior to this MET call or were discharged from an ICU at any point during this admission and prior to this MET call

Prior MET event within 24 hrs: Percent of events with MET Team activation within 24 hrs prior to this MET call

Review of MET response: Histogram breakdown of review of MET response

OTHER REPORTING

ADULT

age ≥ 18 years

Targeted Temperature Management: Percent of events with a cardiac arrest event and return of spontaneous circulation (ROSC), who are not following commands at the time of the initial assessment, in whom Targeted Temperature Management was utilized.

Targeted Temperature Distribution: Patients grouped by targeted temperatures

Door to Cath Lab Times (STEMI): Time from arrival to cath lab for patients with STEMI (out of hospital events)

Oxygen Titration: Percent of patients with an arterial blood gas documented with PaO₂ maintained at less than 300mmHg within the first 24 hours after ROSC.

Hypotension Management: Percent of patients with a cardiac arrest event and return of spontaneous circulation (ROSC) with appropriate management of sustained hypotension

PEDIATRIC

age < 18 years and ≥ 1 year

Targeted Temperature Management: Percent of events with a cardiac arrest event and return of spontaneous circulation (ROSC), who are not following commands at the time of the initial assessment, in whom Targeted Temperature Management was utilized.

Targeted Temperature Distribution: Patients grouped by targeted temperatures

Door to Cath Lab Times (STEMI): Time from arrival to cath lab for patients with STEMI (out of hospital events)

Oxygen Titration: Percent of patients with an arterial blood gas documented with PaO₂ maintained at less than 300mmHg within the first 24 hours after ROSC.

Hypotension Management: Percent of patients with a cardiac arrest event and return of spontaneous circulation (ROSC) with appropriate management of sustained hypotension

NEWBORN/NEONATE/INFANT

age < 1 year

Fetal monitoring: Histogram breakdown of fetal monitoring

Maternal conditions: Histogram breakdown of maternal conditions

Special circumstances recognized at birth: Histogram breakdown of special circumstances recognized at birth

Oxygen Titration: Percent of patients with an arterial blood gas documented with PaO₂ maintained at less than 300mmHg within the first 24 hours after ROSC.

Hypotension Management: Percent of patients with a cardiac arrest event and return of spontaneous circulation (ROSC) with appropriate management of sustained hypotension

DESCRIPTIVE MEASURES

CARDIOPULMONARY ARREST AND ACUTE RESPIRATORY COMPROMISE AND MEDICAL EMERGENCY TEAM

ADULT

age ≥ 18 years

Age: Patients grouped by age

Discharge status: Histogram breakdown of admissions by discharge status (alive or dead)

Gender: Percent of female, male, and unknown patients

Event location: Histogram breakdown of event location

Pre-event data: Histogram breakdown of pre-event data

Race: Patients grouped by race and Hispanic ethnicity

PEDIATRIC

age < 18 years and ≥ 1 year

Age: Patients grouped by age

Discharge status: Histogram breakdown of admissions by discharge status (alive or dead)

Gender: Percent of female, male, and unknown patients

Event location: Histogram breakdown of event location

Pre-event data: Histogram breakdown of pre-event data

Race: Patients grouped by race and Hispanic ethnicity

NEWBORN/NEONATE/INFANT

age < 1 year

Age: Patients grouped by age

Discharge status: Histogram breakdown of admissions by discharge status (alive or dead)

Gender: Percent of female, male, and unknown patients

Event location: Histogram breakdown of event location

Pre-event data: Histogram breakdown of pre-event data

Race: Patients grouped by race and Hispanic ethnicity

HOW RECOGNITION AND QUALITY MEASURES ARE DETERMINED

Recognition and quality measures provide the basis for evaluating and improving treatment of In-hospital Cardiac Arrest patients. Formulating those measures begins with a detailed review of American Heart Association's Guidelines for CPR and ECC.

When evidence for a process or aspect of care is so strong that failure to act on it reduces the likelihood of an optimal patient outcome, a recognition measure may be developed regarding that process or aspect of care. Recognition measure data are continually collected and results are monitored over time to determine when new initiatives or revised processes should be incorporated. As such, recognition measures help speed the translation of strong clinical evidence into practice.

Quality measures apply to processes and aspects of care that are strongly supported by science. Application of quality measures may not, however, be as universally indicated as recognition measures.

The Get With The Guidelines® team follows a strict set of criteria in creating recognition and quality measures. We make every effort to ensure compatibility with existing performance measures from other organizations.

RESUSCITATION AWARDS - RECOGNITION FOR YOUR PERFORMANCE

Hospital teams that participate actively and consistently in Get With The Guidelines-Resuscitation are rewarded with public recognition that helps hospitals hone a competitive edge in the marketplace by providing patients and stakeholders with tangible evidence of their commitment to improving Resuscitation care.

Bronze, Silver and Gold award-winning Get With The Guidelines-Resuscitation hospitals are honored at national recognition events during Scientific Sessions and listed by name in advertisements that appear annually in Circulation and in the "Best Hospitals" issue of U.S. News & World Report. Moreover, all award-winning hospitals are provided with customizable marketing materials they can use to announce their achievements locally.

GWTG RESUSCITATION

GWTG Resuscitation draws from the American Heart Association's vast collection of content-rich resources for patients and healthcare professionals, including educational tools, prevention programs, treatment guidelines, quality initiatives and outcome-based programs.

To learn more about GWTG-Resuscitation go to heart.org/Resuscitation

Visit heart.org/quality for more information.

Web-based Patient Management Tool™ provided by Quintiles Real-World & Late Phase Research

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

OPTIONAL: Local Event ID: _____

Did pt. receive chest compressions and/or defibrillation during this event? ☐ Yes ☐ No/Not Documented (does NOT meet inclusion criteria)

Date/Time the need for chest compressions (or defibrillation when initial rhythm was VF or Pulseless VT) was FIRST recognized: _____ ☐ Time Not Documented

CPA 2.1 Pre-Event

Pre-Event Tab

OPTIONAL: Was patient discharged from an Intensive Care Unit (ICU) within 24 hours prior to this CPA event? ☐ Yes ☐ No

OPTIONAL: If yes, date admitted to non-ICU unit (after ICU discharge): ____/____/____

OPTIONAL: Was patient discharged from a Post Anesthesia Care Unit (PACU) within 24 hrs prior to this CPA event?

☐ Yes

☐ No

OPTIONAL: Was patient in the ED within 24 hours prior to this CPA event?

☐ Yes

☐ No

OPTIONAL: Did patient receive conscious/procedural sedation or general anesthesia within 24 hrs prior to this CPA event?

☐ Yes

☐ No

OPTIONAL: Enter vital signs taken in the 4 hours prior to the CPA event (up to 4 sets)

☐ Pre-Event VS Unknown/Not Documented

Date/ Time	Heart Rate		Systolic BP		Diastolic BP		Respiratory Rate		SpO2		Temp	Units	
		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		C F	<input type="checkbox"/> ND
		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		C F	<input type="checkbox"/> ND
		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		C F	<input type="checkbox"/> ND
		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		<input type="checkbox"/> ND		C F	<input type="checkbox"/> ND

CPA 2.2 Pre-Existing Conditions

Pre-Event Tab

Did patient have an out-of-hospital arrest leading to this admission? ☐ Yes ☐ No/Not documented

Pre-existing Conditions at Time of Event (check all that apply):

- ☐ None (review options below carefully)
- ☐ Acute CNS non-stroke event
- ☐ Acute stroke
- ☐ Baseline depression in CNS function
- ☐ Cardiac malformation/abnormality – acyanotic (pediatric and newborn/neonate only)
- ☐ Cardiac malformation/abnormality – cyanotic (pediatric and newborn/neonate only)
- ☐ Congenital malformation/abnormality (Non-Cardiac) (pediatric and newborn/neonate only)
- ☐ Congestive heart failure (this admission)
- ☐ Congestive heart failure (prior to this admission)
- ☐ Diabetes mellitus
- ☐ Hepatic insufficiency
- ☐ Hypotension/hypoperfusion
- ☐ Major trauma
- ☐ Metastatic or hematologic malignancy
- ☐ Metabolic/electrolyte abnormality
- ☐ Myocardial ischemia/infarction (this admission)
- ☐ Myocardial ischemia/infarction (prior to admit)
- ☐ Pneumonia
- ☐ Renal insufficiency
- ☐ Respiratory insufficiency
- ☐ Septicemia

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

CPA 2.3 Interventions Already in Place

Pre-Event Tab

Interventions **ALREADY IN PLACE** when need for chest compressions and/or defibrillation was first recognized (check all that apply):

Part A: ☐ None

- ☐ Non-invasive assisted ventilation
 - ☐ Bag-Valve-Mask
 - ☐ Mask and/or Nasal CPAP
 - ☐ Mouth-to-Barrier Device
 - ☐ Mouth-to-Mouth
 - ☐ Laryngeal Mask Airway (LMA)
 - ☐ Other Non-Invasive Ventilation: (specify) _____
- ☐ Invasive airway assisted ventilation, via an:
 - ☐ Endotracheal Tube (ET)
 - ☐ Tracheostomy Tube
- ☐ Intra-arterial catheter
- ☐ Conscious/procedural sedation
- ☐ End Tidal CO₂ (ETCO₂) Monitoring
- ☐ Supplemental oxygen (cannula, mask, hood, or tent)

Monitoring (Specify):

- ☐ ECG
- ☐ Pulse oximetry

Vascular access : ☐ Yes ☐ No/Not Documented

Any vasoactive agent in place? ☐ Yes ☐ No/Not Documented

OPTIONAL: Part B: ☐ None

- ☐ IV/IO continuous infusion of antiarrhythmic(s)
- ☐ Dialysis/extracorporeal filtration therapy (ongoing)
- ☐ Implantable cardiac defibrillator (ICD)
- ☐ Extracorporeal membrane oxygenation (ECMO)

CPA 3.1 Event

Event Tab

Date/Time of Birth: ____/____/____ : ____

Age at Event: _____ in years | months | weeks | days | hours | minutes

☐ Estimated?

☐ Age Unknown/Not Documented

Subject Type

- ☐ Ambulatory/Outpatient
- ☐ Emergency Department
- ☐ Hospital Inpatient – (rehab, skilled nursing, mental health wards)
- ☐ Rehab Facility Inpatient
- ☐ Skilled Nursing Facility Inpatient
- ☐ Mental Health Facility Inpatient
- ☐ Visitor or Employee

Illness Category

- ☐ Medical-Cardiac
- ☐ Medical-Noncardiac
- ☐ Surgical-Cardiac
- ☐ Surgical-Noncardiac
- ☐ Obstetric
- ☐ Trauma
- ☐ Other (Visitor/Employee)

Event Location (area)

- | | | |
|--|---|---|
| <input type="checkbox"/> Ambulatory/Outpatient Area | <input type="checkbox"/> Adult Coronary Care Unit (CCU) | <input type="checkbox"/> Adult ICU |
| <input type="checkbox"/> Cardiac Catheterization Lab | <input type="checkbox"/> Delivery Suite | <input type="checkbox"/> Diagnostic/Intervention. Area
(excludes Cath Lab) |
| <input type="checkbox"/> Emergency Department (ED) | <input type="checkbox"/> General Inpatient Area | <input type="checkbox"/> Neonatal ICU (NICU) |

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

- | | | |
|---|---|---|
| <input type="checkbox"/> Newborn Nursery | <input type="checkbox"/> Operating Room (OR) | <input type="checkbox"/> Pediatric ICU (PICU) |
| <input type="checkbox"/> Pediatric Cardiac Intensive Care | <input type="checkbox"/> Post-Anesthesia Recovery Room (PACU) | <input type="checkbox"/> Rehab, Skilled Nursing, or Mental Health Unit/Facility |
| <input type="checkbox"/> Same-day surgical area | <input type="checkbox"/> Telemetry unit or Step-down unit | <input type="checkbox"/> Other |
| <input type="checkbox"/> Unknown/Not Documented | | |

Event Location (name): _____

Event Witnessed?

- ☐ Yes
☐ No/Not Documented

Was a hospital-wide resuscitation response activated?

- ☐ Yes
☐ No/Not Documented

CPA 4.1 Initial Condition

Initial Condition/Defibrillation/Ventilation Tab

Condition that best describes this event:

- ☐ Patient was PULSELESS when need for chest compressions and/or need for defibrillation of initial rhythm VF/Pulseless VT was first identified
☐ Patient had a pulse (poor perfusion) requiring chest compressions PRIOR to becoming pulseless
☐ Patient had a pulse (poor perfusion) requiring chest compressions, but did NOT become pulseless at any time during this event

Did patient receive chest compressions (includes open cardiac massage)?

- ☐ Yes
☐ No/Not Documented
☐ No, Per Advance Directive

Compression Method(s) used (check all that apply):

- ☐ Standard Manual Compression
☐ IAC-CPR (interposed abdominal compression cardiopulmonary resuscitation)
☐ Automatic Compressor
☐ Open chest CPR (direct [internal] cardiac compression)
☐ Unknown/Not Documented

Date/Time compressions started: ____/____/____ ____:____ ☐ Time Not Documented

If compressions provided while pulse present:

Rhythm when the patient with a pulse FIRST received chest compressions during event

- ☐ Accelerated idioventricular rhythm (AIVR)
☐ Bradycardia
☐ Pacemaker
☐ Sinus (including sinus tachycardia)
☐ Supraventricular tachyarrhythmia (SVTarrhy)
☐ Ventricular Tachycardia (VT) with a pulse
☐ Unknown/Not Documented

If pulseless at ANY time during event:

Date/Time pulselessness was first identified: ____/____/____ ____:____ ☐ Time Not Documented

First documented pulseless rhythm:

- ☐ Asystole
☐ Pulseless Electrical Activity (PEA)
☐ Pulseless Ventricular Tachycardia
☐ Ventricular Fibrillation (VF)
☐ Unknown/Not Documented

CPA 4.2 AED and VF/Pulseless VT

Initial Condition/Defibrillation/Ventilation Tab

Was automated external defibrillator (AED) applied or manual defibrillator in AED/Shock Advisory mode applied?

- ☐ Yes
☐ No/Not Documented

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

☐ Not Applicable (not used by facility)

Date/Time AED or manual defibrillator in AED/Shock Advisory mode applied: ____/____/____ ____:____ ☐ Unknown/Not documented

Did the patient have Ventricular Fibrillation (VF) OR Pulseless Ventricular Tachycardia ANY time during this event?

☐ Yes

☐ No/Not Documented

Date/Time of Ventricular Fibrillation (VF) OR Pulseless Ventricular Tachycardia: ____/____/____ ____:____ ☐ Unknown/Not Documented

Was Defibrillation shock provided for Ventricular Fibrillation (VF) OR Pulseless Ventricular Tachycardia?

☐ Yes

☐ No/Not Documented

☐ No, Per Advance Directive

Total # of shocks: _____ ☐ Unknown/Not documented

Details of Each Shock (maximum of 4):

Date/Time	Energy (joules)
____/____/____ ____:____ <input type="checkbox"/> Not Documented	_____ <input type="checkbox"/> Not Documented
____/____/____ ____:____ <input type="checkbox"/> Not Documented	_____ <input type="checkbox"/> Not Documented
____/____/____ ____:____ <input type="checkbox"/> Not Documented	_____ <input type="checkbox"/> Not Documented
____/____/____ ____:____ <input type="checkbox"/> Not Documented	_____ <input type="checkbox"/> Not Documented

Documented reason (s) (patient, medical, hospital related or other) for not providing defibrillation shock for Ventricular Fibrillation (VF) or Pulseless Ventricular Tachycardia (VT) in first two minutes?

☐ Yes

☐ No

Patient Reason(s):

☐ Initial Refusal (e.g. family refused)

Medical Reason(s):

☐ ICD in place which shocked patient within first 2 minutes of identification of VF or Pulseless VT

☐ LVAD or BIVAD in place

☐ Rhythm change to non-shockable rhythm within 2 minutes of identification of VF or Pulseless VT

☐ Spontaneous Return of Circulation within first 2 minutes of identification of VF or Pulseless VT

Hospital Related or Other Reason(s):

☐ Equipment related delay (e.g., defibrillator not available, pad not attached)

☐ In-hospital time delay (e.g. code team delays, personnel not familiar with protocol or equipment, unable to locate hospital defibrillator)

☐ Other → Please Specify: _____

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

Types of Ventilation/Airways used

- ☐ None
☐ Unknown/Not Documented

Ventilation/Airways Used (select all that apply):

- ☐ Bag-Valve-Mask
☐ Mask and/or Nasal CPAP/BiPAP
☐ Mouth-to-Barrier Device
☐ Mouth-to-Mouth
☐ Laryngeal Mask Airway (LMA)
☐ Endotracheal Tube (ET)
☐ Tracheostomy Tube
☐ Other Non-Invasive Ventilation: (specify) _____

Was Bag-Valve-Mask ventilation initiated during the event?

- ☐ Yes ☐ No ☐ Not Documented

If yes, enter Date and Time

____/____/____ :____ ☐ Time Not Documented

Was any Endotracheal Tube (ET) or Tracheostomy Tube inserted/re-inserted during event?

- ☐ Yes
☐ No

Date/Time Endotracheal Tube (ET) or Tracheostomy Tube inserted if not already in place and/or re-inserted during event:

____/____/____ :____ ☐ Time Not Documented

Method(s) of confirmation used to ensure correct placement of Endotracheal Tube (ET) or Tracheostomy Tube placement in trachea (check all that apply):

- ☐ Waveform capnography (waveform ETCO₂)
☐ Capnometry (numeric ETCO₂)
☐ Exhaled CO₂ colorimetric monitor (ETCO₂ by color change)
☐ Esophageal detection devices
☐ Revisualization with direct laryngoscopy
☐ None of the above
☐ Not Documented

CPA 5.1 Epinephrine**Other Interventions Tab**

Was IV/IO Epinephrine BOLUS administered?

- ☐ Yes
☐ No/Not Documented

Date/Time of FIRST IV/IO bolus dose: ____/____/____ :____ ☐ Time Not Documented

Total Number of Doses: _____ ☐ Unknown / Not Documented

If IV/IO Epinephrine was not administered within the first five minutes of the event, was there a documented patient, medical, hospital related or other reason for not providing Epinephrine-bolus?

- ☐ Yes
☐ No

Patient Reason(s):

- ☐ Initial Refusal (e.g. family refused)

Medical Reason(s):

- ☐ Patient already receiving vasopressor (e.g. Epinephrine) as a continuous IV infusion prior to and during arrest
☐ Spontaneous Return of Circulation within first 5 minutes of the date/time pulselessness was first identified (or the need for chest compressions was first recognized (pediatric only))
☐ Medication allergy

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

Hospital Related or Other Reason(s):

- ☐ In-hospital time delay (e.g., delay in locating medication)
☐ No route to deliver medication (e.g. no IV/IO access)
☐ Other → Please Specify: _____

CPA 5.2 Other Drug Interventions

Other Interventions Tab

Select all either initiated, or if already in place immediately prior to, continued during event.

- ☐ None (select only after careful review of options below)
- ☐ Antiarrhythmic medication(s):
☐ Adenosine/Adenocard
☐ Amiodarone/Cordarone
☐ Lidocaine
☐ Procainamide
☐ Other antiarrhythmics: _____
- ☐ Vasopressor(s) other than epinephrine bolus bolus:
☐ Dobutamine
☐ Dopamine > 3 mcg/kg/min
☐ Epinephrine, IV/IO continuous infusion
☐ Norepinephrine
☐ Phenylephrine
☐ Other vasopressors: _____
- ☐ Atropine
☐ Calcium chloride/Calcium gluconate
☐ Dextrose bolus
☐ Magnesium sulfate
☐ Reversal agent (e.g., naloxone/Narcan, flumazenil/Romazicon, neostigmine/Prostigim)
☐ Sodium bicarbonate
☐ Other drug interventions: _____

CPA 5.3 Non-Drug Interventions

Other Interventions Tab

Select each intervention that was employed during the resuscitation event

- ☐ None (review options below carefully)
☐ Cardiopulmonary bypass / extracorporeal CPR (ECPR)
☐ Chest tube(s) inserted
☐ Needle thoracostomy
☐ Pacemaker, transcutaneous
☐ Pacemaker, transvenous or epicardial
☐ Pericardiocentesis
☐ Other non-drug interventions: _____

CPA 6.1 Event Outcome

Event Outcome Tab

Was ANY documented return of adequate circulation [ROC] (in the absence of ongoing chest compressions return of adequate pulse/heart rate by palpation, auscultation, Doppler, arterial blood pressure waveform, or documented blood pressure) achieved during the event?

- ☐ Yes
☐ No/Not Documented

Date/Time of FIRST adequate return of circulation (ROC): ____/____/____ ____:____ ☐ Time Not Documented

Reason resuscitation ended:

- ☐ Survived – ROC
☐ Died – Efforts terminated, no sustained ROC

Date/Time sustained ROC **began (lasting > 20 min)** OR resuscitation efforts were terminated (End of event):

____/____/____ ____:____ ☐ Time Not Documented

CPA 6.2 Post-ROC Care

Event Outcome Tab

Highest patient temperatures during first 24 hrs after ROC

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

Highest

Temperature/Units _____ C | F ☐ Temperature Not Documented

Site: Axillary | Bladder | Blood | Brain | Oral | Rectal | Surface (skin, temporal) | Tympanic | Other | Unknown/not Documented

Date/Time Recorded: ____/____/____ : ____ ☐ Time Not Documented

CPA 7.1 CPR Quality**CPR Quality Tab**

Was performance of CPR monitored or guided using any of the following? (Check all that apply)

☐ None

- ☐ Waveform Capnography /End Tidal CO2 (ETCO2)
- ☐ Arterial Wave Form /Diastolic Pressure
- ☐ CPR mechanics device (e.g. accelerometer, force transducer, TFI device)
- ☐ CPR quality coach
- ☐ Metronome
- ☐ Other, Specify: _____

If CPR mechanics device (e.g. accelerometer, force transducer, TFI device) used:

Average compression rate: _____ (per minute) ☐ Not Documented

Average compression depth: _____ ☐ mm ☐ cm ☐ inches ☐ Not Documented

Compression fraction: _____ (enter number between 0 and 1) ☐ Not Documented

Percent of Chest Compressions with complete release: _____ (%) ☐ Not Documented

Average Ventilation Rate: _____ (per minute) ☐ Not Documented

Longest Pre-shock pause _____ (seconds) ☐ Not Documented

Was a team debriefing on the quality of CPR provided completed after the event? ☐ Yes ☐ No ☐ Not Documented

CPA 7.2 Resuscitation-Related Events and Issues (OPTIONAL)**CPR Quality Tab**

☐ No/Not Documented

Universal Precautions

☐ Not followed by all team members (specify in comments section)

Documentation

- ☐ Signature of code team leader not on code sheet
- ☐ Missing other signatures
- ☐ Initial ECG rhythm not documented
- ☐ Medication route(s) not documented
- ☐ Incomplete documentation
- ☐ Other (specify in comments section)

Alerting Hospital-Wide Resuscitation Response

- ☐ Delay
- ☐ Pager issue(s)
- ☐ Other (specify in comments section)

Airway

- ☐ Aspiration related to provision of airway
- ☐ Delay
- ☐ Delayed recognition of airway misplacement/displacement

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

- ☐ Intubation attempted, not achieved
☐ Multiple intubation attempts → Number of attempts: _____ ☐ Unknown/Not Documented
☐ Other (specify in comments section)

Vascular Access

- ☐ Delay
☐ Inadvertent arterial cannulation
☐ Infiltration/Disconnection
☐ Other (specify in comments section)

Chest Compression

- ☐ Delay
☐ No back board
☐ Other (specify in comments section)

Defibrillation(s)

- ☐ Energy level lower / higher than recommended
☐ Initial delay, personnel not available to operate defibrillator
☐ Initial delay, issue with defibrillator access to patient
☐ Initial delay, issue with pad or paddle placement
☐ Equipment malfunction
☐ Given, not indicated
☐ Indicated, not given
☐ Other (specify in comments section)

Medications

- ☐ Delay
☐ Route
☐ Dose
☐ Selection
☐ Other (specify in comments section)

Leadership

- ☐ Delay in identifying leader
☐ Knowledge of equipment
☐ Knowledge of medications/protocols
☐ Knowledge of roles
☐ Team oversight
☐ Too many team members
☐ Other (specify in comments section)

Protocol Deviation

- ☐ ALS/PALS
☐ NRP
☐ Other (specify in comments section)

Equipment

- ☐ Availability
☐ Function
☐ Other (specify in comments section)

Was this cardiac arrest event the patient's index (first) event?

- ☐ Yes
☐ No/Not Documented

Comments & Optional Fields: Do not enter any Personal Health Information/Protected Health Information into this section.

Field 1	Field 2
Field 3	Field 4
Field 5	Field 6
Field 7	Field 8

Note: Optional data elements appear in the Get With The Guidelines ® - Resuscitation PMT as dark grey shaded areas.

Field 9	Field 10
Field 11	Field 12
Field 13 ____/____/____ __:____	Field 14 ____/____/____ __:____

Get with the Guidelines Resuscitation In-Hospital Cardiac Arrest Survival Report Interpretation Guide

HOW CAN THIS REPORT BE HELPFUL TO MY SITE?

To facilitate more meaningful hospital comparisons of survival for cardiac arrests occurring in hospitals, GWTG-Resuscitation has developed models to risk-standardize rates of survival to hospital discharge for patients with in-hospital cardiac arrest (IHCA). The survival rate is risk-adjusted, so that we can compare similarly ill patients across hospitals. The risk-adjustment is based on a previously validated and published model and accounts for 9 key factors:

- Age (<50, 50-59 60-69, 70-79, >80)
- Initial cardiac arrest rhythm (VF, pulseless VT, asystole, PEA)
- Hospital Location (ICU, monitored/telemetry, non-monitored, procedural, ER, other)
- Hypotension prior to cardiac arrest
- Sepsis
- Metastatic or Hematologic Malignancy
- Hepatic Insufficiency
- On Mechanical Ventilation at time of cardiac arrest
- On intravenous vasopressors at time of cardiac arrest

REPORT PRESENTATION

This report now provides you information on your hospital's risk-standardized survival rate for IHCA. For adult events, these are reported for 2016, as well as for each year from 2012 to 2016 to provide insights into your hospital's trends in cardiac arrest survival. For pediatric events, this report will provide your hospital's performance for the combined period of 2015-2016, as well as your hospital's rate for the combined periods of 2012-2013, 2013-2014 and 2014-2015. (Please note that the time trend report for pediatrics may show less discernable change as they share data for 2013, 2014 and 2015.)

In this report, you will see your hospital's risk-standardized survival rate, percentile rank, and survival performance quintile. For instance, hospitals in quintile 5 have risk-standardized survival rates that are better than $\geq 80\%$ of GWTG-Resuscitation hospitals, as quintile 5 includes hospitals with percentile rankings of 81% to 99% (see table below)

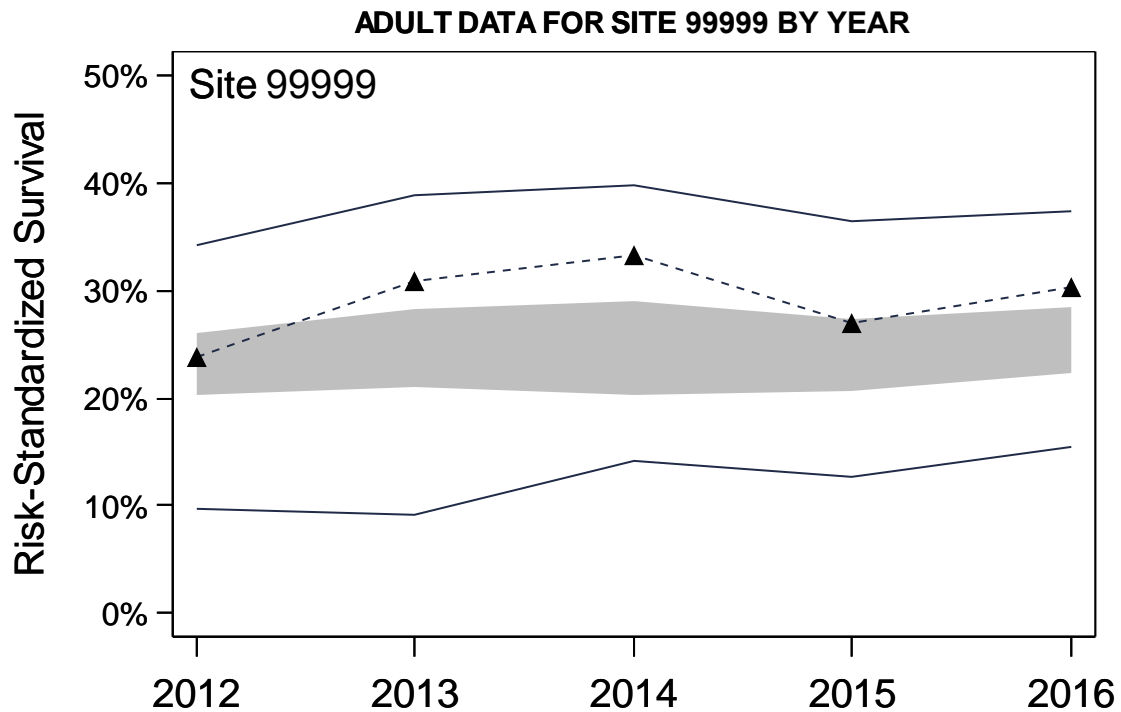
Your Hospital's Survival Rate is		
Quintile	In this Percentile Range	And is Better than at least
5	81-99	80% of hospitals
4	61-80	60% of hospitals
3	41-60	40% of hospitals
2	21-40	20% of hospitals
1	1-20	N/A

In addition, we also graphically display your hospital's risk-standardized survival rate for IHCA on a number line, so that you can visually see the median risk-standardized hospital survival rate and the cut points for each survival quintile.

Get With The Guidelines - Resuscitation - Risk-Standardized Survival for ADULT CPA

Hospital ID: 99999
ADL DATA FOR SITE 99999 BY YEAR

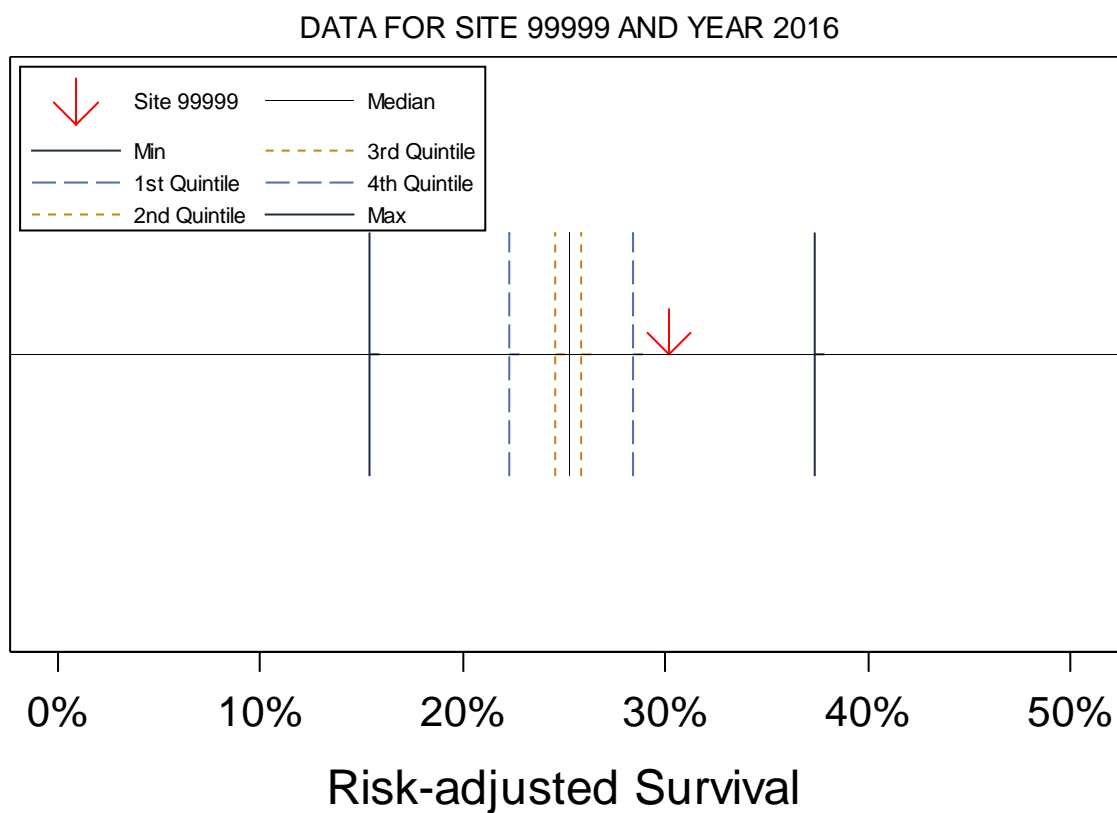
<i>Risk Adjusted Survival</i>			
<i>Year</i>	<i>Adjusted Rate%</i>	<i>Rank (out of 100)</i>	<i>Quintile</i>
2012	23.9%	62	4
2013	30.8%	89	5
2014	33.3%	95	5
2015	27.0%	77	4
2016	30.2%	92	5



Lines are min and max, Shaded area represents quintiles 2-4

DATA FOR SITE 99999 AND YEAR 2016

	Year 2016
Risk-Standardized Survival	30.2%
Risk-Standardized Survival Quintile	5

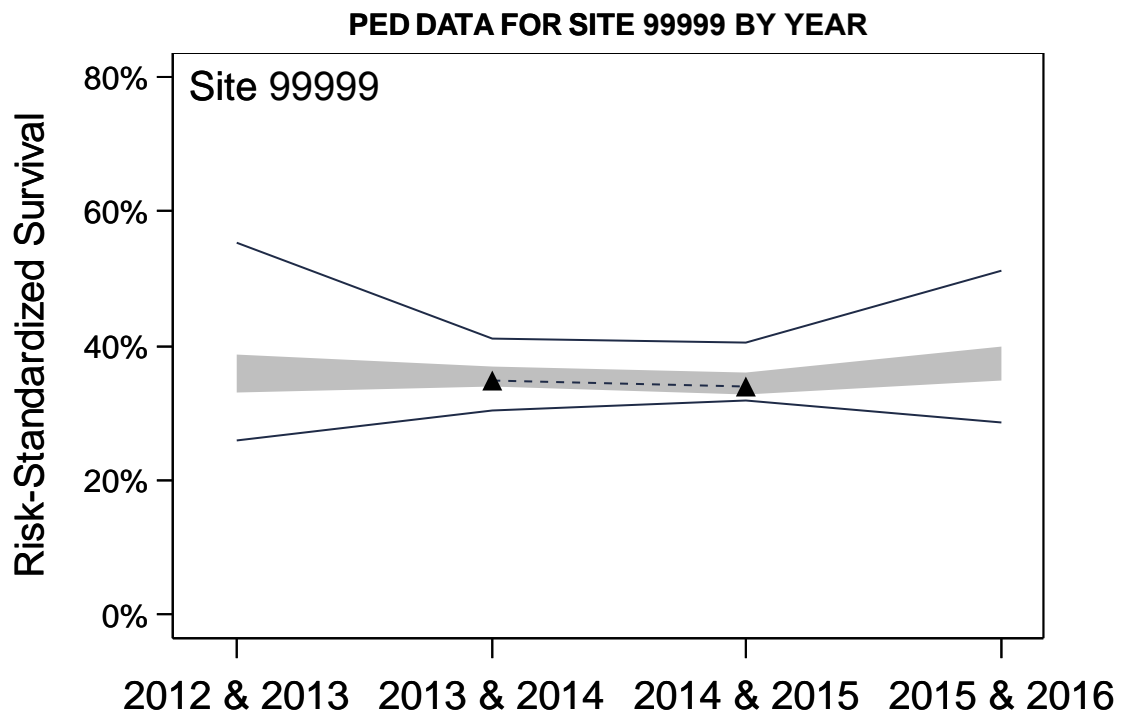


Get With The Guidelines - Resuscitation - Risk-Standardized Survival for PEDIATRIC CPA

Hospital ID: 99999

PED DATA FOR SITE 99999 BY YEAR

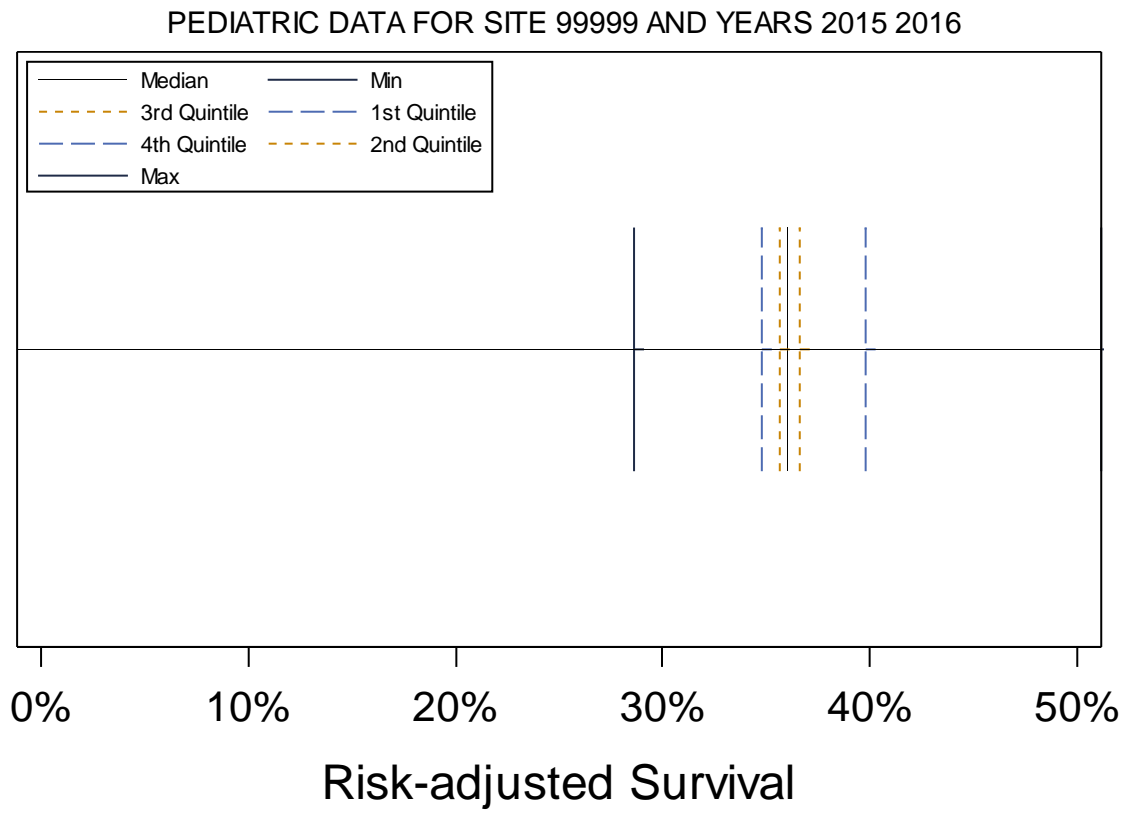
Risk Adjusted Survival			
Year	Adjusted Rate%	Rank (out of 100)	Quintile
2012 & 2013	.	.	.
2013 & 2014	34.8%	48	3
2014 & 2015	33.8%	54	3
2015 & 2016	.	.	.



Lines are min and max, Shaded area represents quintiles 2-4

PEDIATRIC DATA FOR SITE 99999 AND YEARS 2015 2016

	<i>SITE 99999</i>
	<i>Years 2015 & 2016</i>
Risk-Standardized Survival	.
Risk-Standardized Survival Quintile	.



Get with the Guidelines Resuscitation In-Hospital Cardiac Arrest Survival Report Interpretation Guide

HOW CAN THIS REPORT BE HELPFUL TO MY SITE?

To facilitate more meaningful hospital comparisons of survival for cardiac arrests occurring in hospitals, GWTG-Resuscitation has developed models to risk-standardize rates of survival to hospital discharge for patients with in-hospital cardiac arrest (IHCA). The survival rate is risk-adjusted, so that we can compare similarly ill patients across hospitals. The risk-adjustment is based on a previously validated and published model and accounts for 9 key factors:

- Age (<50, 50-59 60-69, 70-79, >80)
- Initial cardiac arrest rhythm (VF, pulseless VT, asystole, PEA)
- Hospital Location (ICU, monitored/telemetry, non-monitored, procedural, ER, other)
- Hypotension prior to cardiac arrest
- Sepsis
- Metastatic or Hematologic Malignancy
- Hepatic Insufficiency
- On Mechanical Ventilation at time of cardiac arrest
- On intravenous vasopressors at time of cardiac arrest

REPORT PRESENTATION

This report now provides you information on your hospital's risk-standardized survival rate for IHCA. For adult events, these are reported for 2016, as well as for each year from 2012 to 2016 to provide insights into your hospital's trends in cardiac arrest survival. For pediatric events, this report will provide your hospital's performance for the combined period of 2015-2016, as well as your hospital's rate for the combined periods of 2012-2013, 2013-2014 and 2014-2015. (Please note that the time trend report for pediatrics may show less discernable change as they share data for 2013, 2014 and 2015.)

In this report, you will see your hospital's risk-standardized survival rate, percentile rank, and survival performance quintile. For instance, hospitals in quintile 5 have risk-standardized survival rates that are better than $\geq 80\%$ of GWTG-Resuscitation hospitals, as quintile 5 includes hospitals with percentile rankings of 81% to 99% (see table below)

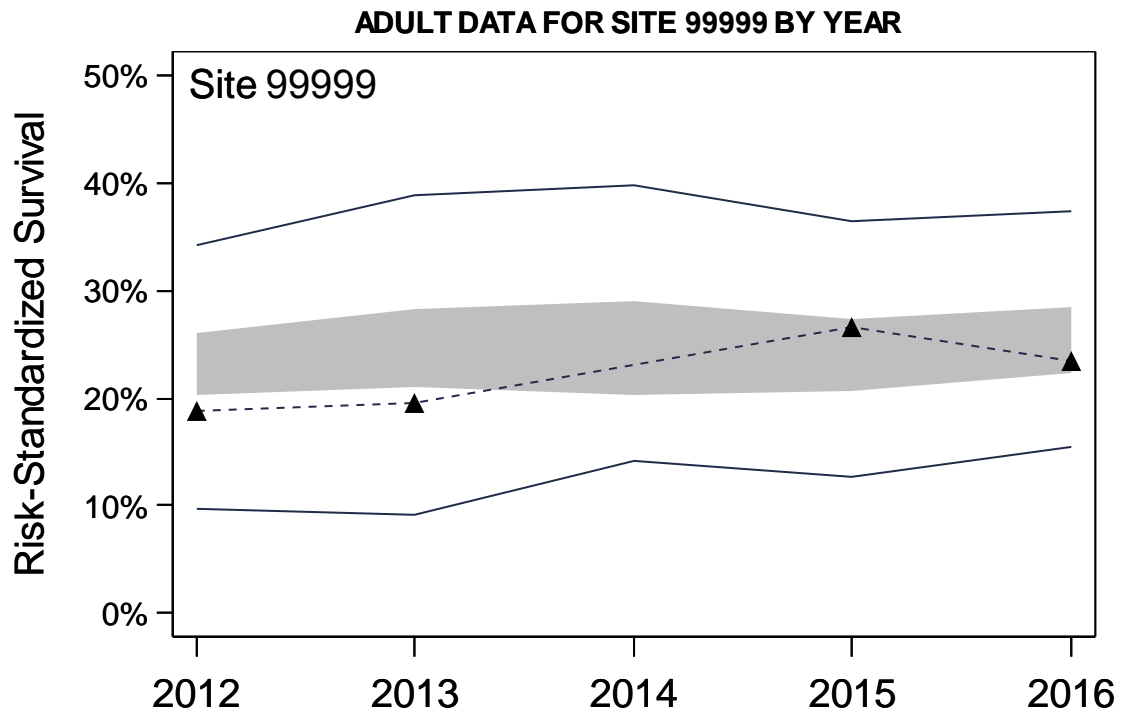
Your Hospital's Survival Rate is		
Quintile	In this Percentile Range	And is Better than at least
5	81-99	80% of hospitals
4	61-80	60% of hospitals
3	41-60	40% of hospitals
2	21-40	20% of hospitals
1	1-20	N/A

In addition, we also graphically display your hospital's risk-standardized survival rate for IHCA on a number line, so that you can visually see the median risk-standardized hospital survival rate and the cut points for each survival quintile.

Get With The Guidelines - Resuscitation - Risk-Standardized Survival for ADULT CPA

Hospital ID: 99999
ADL DATA FOR SITE 99999 BY YEAR

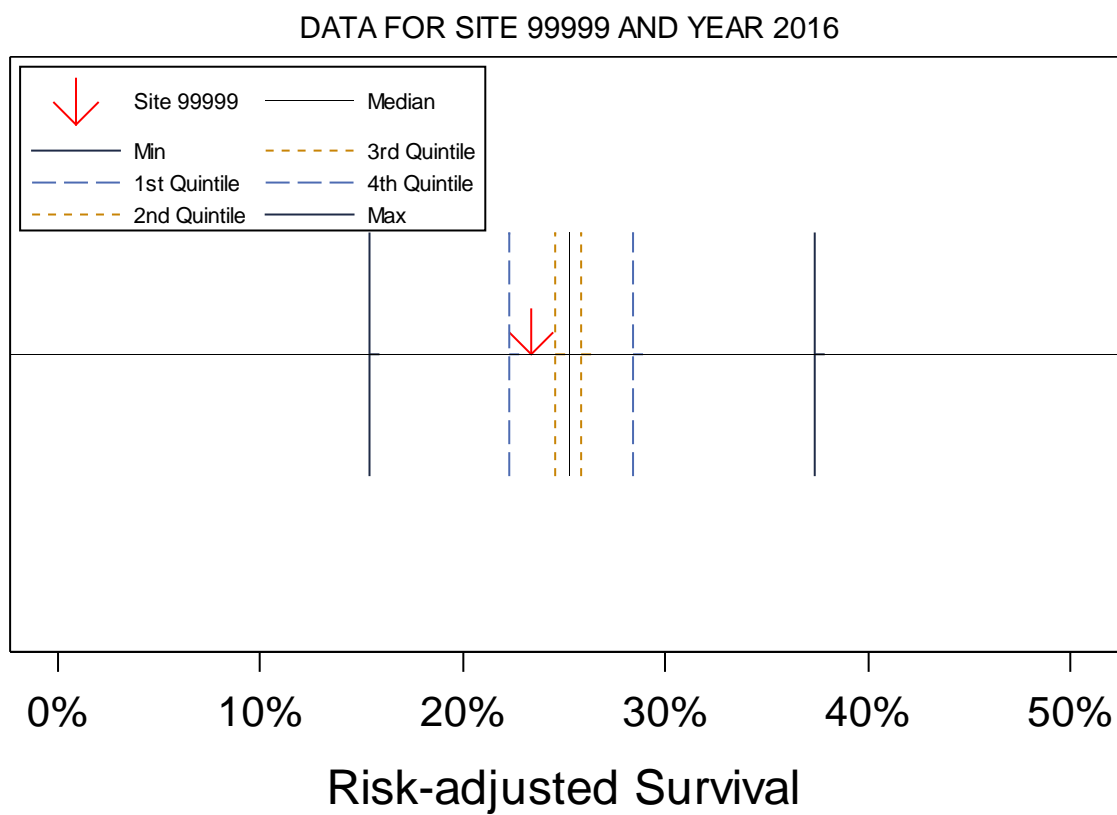
Risk Adjusted Survival			
Year	Adjusted Rate%	Rank (out of 100)	Quintile
2012	18.8%	11	1
2013	19.6%	14	1
2014	.	.	.
2015	26.7%	74	4
2016	23.4%	28	2



Lines are min and max, Shaded area represents quintiles 2-4

DATA FOR SITE 99999 AND YEAR 2016

	Year 2016
Risk-Standardized Survival	23.4%
Risk-Standardized Survival Quintile	2

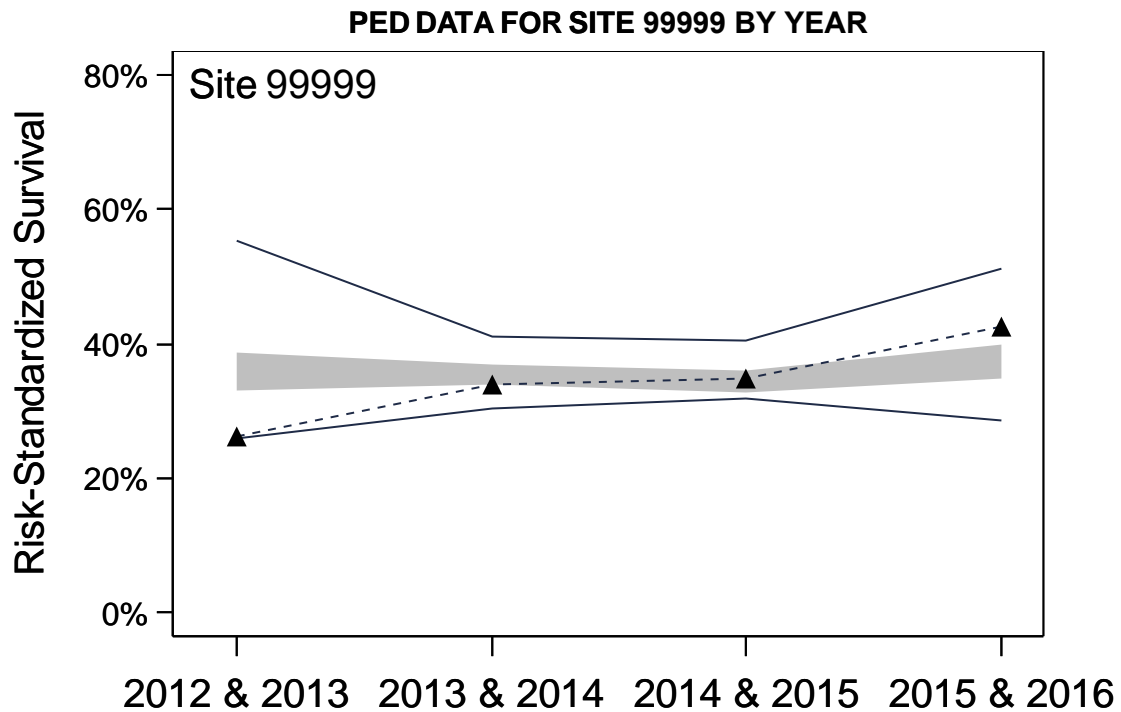


Get With The Guidelines - Resuscitation - Risk-Standardized Survival for PEDIATRIC CPA

Hospital ID: 99999

PED DATA FOR SITE 99999 BY YEAR

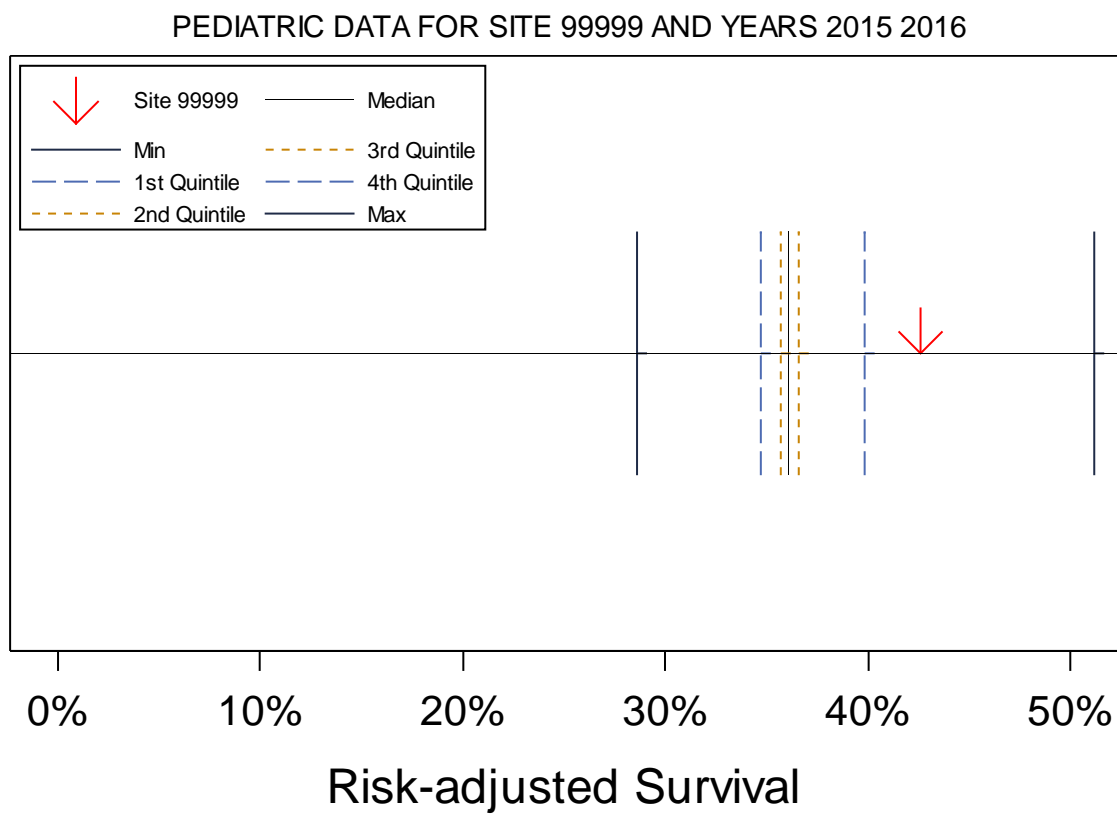
Risk Adjusted Survival				
Year	Adjusted Rate%	Rank (out of 100)	Quintile	
2012 & 2013	26.3%	2	1	
2013 & 2014	33.9%	27	2	
2014 & 2015	34.8%	67	4	
2015 & 2016	42.6%	92	5	



Lines are min and max, Shaded area represents quintiles 2-4

PEDIATRIC DATA FOR SITE 99999 AND YEARS 2015 2016

	<i>SITE 99999</i>
	<i>Years 2015 & 2016</i>
Risk-Standardized Survival	42.6%
Risk-Standardized Survival Quintile	5



Risk-Standardizing Survival for In-Hospital Cardiac Arrest to Facilitate Hospital Comparisons

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Kansas City, Missouri; Philadelphia, Pennsylvania; Boston, Massachusetts; Los Angeles and Palo Alto, California; and Ann Arbor, Michigan

Objectives	The purpose of this study is to develop a method for risk-standardizing hospital survival after cardiac arrest.
Background	A foundation with which hospitals can improve quality is to be able to benchmark their risk-adjusted performance against other hospitals, something that cannot currently be done for survival after in-hospital cardiac arrest.
Methods	Within the Get With The Guidelines (GWTG)-Resuscitation registry, we identified 48,841 patients admitted between 2007 and 2010 with an in-hospital cardiac arrest. Using hierarchical logistic regression, we derived and validated a model for survival to hospital discharge and calculated risk-standardized survival rates (RSSRs) for 272 hospitals with at least 10 cardiac arrest cases.
Results	The survival rate was 21.0% and 21.2% for the derivation and validation cohorts, respectively. The model had good discrimination (C-statistic 0.74) and excellent calibration. Eighteen variables were associated with survival to discharge, and a parsimonious model contained 9 variables with minimal change in model discrimination. Before risk adjustment, the median hospital survival rate was 20% (interquartile range: 14% to 26%), with a wide range (0% to 85%). After adjustment, the distribution of RSSRs was substantially narrower: median of 21% (interquartile range: 19% to 23%; range 11% to 35%). More than half (143 [52.6%]) of hospitals had at least a 10% positive or negative absolute change in percentile rank after risk standardization, and 50 (23.2%) had a $\geq 20\%$ absolute change in percentile rank.
Conclusions	We have derived and validated a model to risk-standardize hospital rates of survival for in-hospital cardiac arrest. Use of this model can support efforts to compare hospitals in resuscitation outcomes as a foundation for quality assessment and improvement. (J Am Coll Cardiol 2013;62:601–9) © 2013 by the American College of Cardiology Foundation

In-hospital cardiac arrest is common, affecting approximately 200,000 patients annually in the United States (1). Rates of survival, however, can vary substantially across hospitals (2). As a foundation for improving quality in their cardiovascular registries, the American Heart Association (AHA) and the American College of Cardiology have developed methods to risk-standardize hospital outcomes

for other conditions and procedures. More recently, the Joint Commission and the AHA have expressed interest in developing performance metrics for in-hospital cardiac arrest to facilitate benchmarking and comparison of survival outcomes among hospitals.

Unlike process-of-care measures for resuscitation (e.g., timely defibrillation), which do not require risk adjustment as

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University of Michigan, Ann Arbor, Michigan. The American Heart Association (AHA) Get With the Guidelines-Resuscitation Investigators (formerly, the National Registry of Cardiopulmonary Resuscitation) are listed in the [Online Appendix](#). The underlying research reported in the article was funded by the U.S. National Institutes of Health. Drs. Chan (K23HL102224) and Merchant (K23109083) are supported by Career Development Grant Awards from the National Heart Lung and Blood Institute (NHLBI). Dr. Chan is also supported by funding from the AHA. GWTG-Resuscitation is sponsored by the AHA. Dr. Schwamm is the Chair of the AHA's GWTG National Steering Committee. Dr. Bhatt is on the advisory board of Medscape Cardiology; the Board of Directors of Boston VA Research Institute and the Society of

Abbreviations and Acronyms

AHA = American Heart Association
DNR = do not resuscitate
GWTG = Get With The Guidelines

their performance should be independent of patient characteristics, survival measures require risk standardization to account for variations in patient case-mix across sites so as to facilitate a more unbiased comparison across hospitals (3). Although risk-adjustment models for survival already exist for other medical conditions, such as acute myocardial infarction, heart failure, and community-acquired pneumonia (4,5), a validated model to risk-standardize survival after in-hospital cardiac arrest has not been developed. This current deficiency in the methodology for in-hospital cardiac arrest is a significant barrier to identifying high and low performing hospitals to disseminate best practices and promote quality improvement.

To address this current gap in knowledge, we derived and validated a hierarchical regression model to calculate risk-standardized hospital rates of survival after in-hospital cardiac arrest. We used data from Get With The Guidelines (GWTG)-Resuscitation—the largest repository of data on hospitalized patients with cardiac arrest. We also assessed the stability of the model over time by examining model performance in multiple years and different time periods. Creating this outcome model can assist ongoing efforts to support ongoing quality assessment and improvement efforts.

Methods

Study population. GWTG-Resuscitation, formerly known as the National Registry of Cardiopulmonary Resuscitation, is a large, prospective, national quality-improvement registry of in-hospital cardiac arrest and is sponsored by the AHA. Its design has been described in detail previously (6). In brief, trained quality-improvement hospital personnel enroll all patients with a cardiac arrest (defined as the absence of a palpable central pulse, apnea, and unresponsiveness) treated with resuscitation efforts and without do-not-resuscitate

(DNR) orders. Cases are identified by multiple methods, including centralized collection of cardiac arrest flow sheets, reviews of hospital paging system logs, and routine checks of code carts, pharmacy tracer drug records, and hospital billing charges for resuscitation medications (6). The registry uses standardized “Utstein-style” definitions for all patient variables and outcomes to facilitate uniform reporting across hospitals (7,8). In addition, data accuracy is ensured by rigorous certification of hospital staff and use of standardized software with data checks for completeness and accuracy, and a prior report had determined an error rate in data abstraction of 2.4% (6).

From 2000 to 2010, a total of 122,746 patients 18 years of age or older with an index in-hospital cardiac arrest were enrolled in GWTG-Resuscitation. Since in-hospital survival rates have improved over time (9), we restricted our study population to 48,841 patients from 356 hospitals enrolled between 2007 and 2010 to ensure that our risk models were based on a contemporary cohort of patients.

Study outcome and variables. The primary outcome of interest was survival to hospital discharge, which was obtained from the GWTG-Resuscitation registry.

In all, 26 baseline characteristics were screened as candidate predictors for the study outcome. These included age (categorized in 10-year intervals of <50, 50 to 59, 60 to 69, 70 to 79, and ≥80), sex, location of arrest (categorized as intensive care, monitored unit, nonmonitored unit, emergency room, procedural/surgical area, and other), and initial cardiac arrest rhythm (ventricular fibrillation, pulseless ventricular tachycardia, asystole, pulseless electrical activity). In addition, the following comorbidities or medical conditions present before cardiac arrest were evaluated for the model: heart failure, myocardial infarction, or diabetes mellitus; renal, hepatic, or respiratory insufficiency; baseline evidence of motor, cognitive, or functional deficits (CNS depression); acute stroke; acute non-stroke neurologic disorder; pneumonia; hypotension; sepsis; major trauma; metabolic or electrolyte abnormality; and metastatic or hematologic malignancy. Finally, we considered for model inclusion several critical care interventions (mechanical ventilation, intravenous vasopressor support, pulmonary artery catheter, intra-aortic balloon pump, or dialysis) already in place at the time of cardiac arrest. Race was not considered for model inclusion, as prior studies have found that racial differences in survival after in-hospital cardiac arrest are partly mediated by differences in hospital care quality for blacks and whites (3,10).

Model development and validation. We randomly selected two-thirds of the study population for the derivation cohort and one-third for the validation cohort. We confirmed that a similar proportion of patients from each hospital and calendar year were represented in the derivation and validation cohorts. Baseline differences between patients in the derivation and validation cohorts were evaluated using chi-square tests for categorical variables and Student *t* tests for continuous variables. Because of the large sample size, we also evaluated for significant differences between the 2 cohorts

Chest Pain Centers; is Chair of the AHA GWTG Science Subcommittee; has received honoraria from the American College of Cardiology (Editor, Clinical Trials, Cardiosource), Duke Clinical Research Institute (clinical trial steering committees), Slack Publications (Chief Medical Editor, *Cardiology Today Intervention*), WebMD (CME steering committees); is the Senior Associate Editor, *Journal of Invasive Cardiology*; has received research grants from Amarin, AstraZeneca, Bristol-Myers Squibb, Eisai, Ethicon, Medtronic, Sanofi Aventis, and The Medicines Company; and has received unfunded research from FlowCo, PLx Pharma, and Takeda. Dr. Fonarow has received grant funding from the NHLBI and AHRQ; and consulting for Novartis and Medtronic. Dr. Spertus has received grant funding from the NIH, AHA, Lilly, Amoryte, and Genentech; serves on Scientific Advisory Boards for United Healthcare, St. Jude Medical, and Genentech; and serves as a paid editor for *Circulation: Cardiovascular Quality and Outcomes*; has intellectual property rights for the Seattle Angina Questionnaire, Kansas City Cardiomyopathy Questionnaire, Peripheral Artery Questionnaire; and has equity interest in Health Outcomes Sciences. Dr. Merchant has received grant funding from NIH, K23 Grant 10714038, Physio-Control, Zoll Medical, Cardiac Science, and Philips Medical. All other authors have reported they have no relationships relevant to the contents of this paper to disclose.

Manuscript received April 1, 2013; revised manuscript received May 22, 2013, accepted May 28, 2013.

by computing standardized differences for each covariate. Based on prior work, a standardized difference of >10 was used to define a significant difference (11).

Within the derivation sample, multivariable models were constructed to identify significant predictors of in-hospital survival. Because our primary objective was to derive risk-standardized survival rates for each hospital, which would require us to account for clustering of observations within hospitals, we used hierarchical logistic regression models for our analyses (12). By using hierarchical models to estimate the log-odds of in-hospital survival as a function of demographic and clinical variables (both fixed effects) and a random effect for each hospital, this approach allowed us to assess for hospital variation in risk-standardized survival rates after accounting for patient case-mix.

We considered for model inclusion the candidate variables previously described in the Study Outcome and Variables section. Multicollinearity between covariates was assessed for each variable before inclusion (13). To ensure parsimony and inclusion of only those variables that provided incremental prognostic value, we employed the approximation of full model methodology for model reduction (14). The contribution of each significant model predictor was ranked, and variables with the smallest contribution to the model were sequentially eliminated. This was an iterative process until further variable elimination led to a greater than 5% loss in model prediction as compared with the initial full model.

Model discrimination was assessed with the C-statistic, and model validation was performed in the remaining one-third of the study cohort by examining observed versus predicted plots. We also evaluated the robustness of our findings by reconstructing the models with data from: 1) only 2010; 2) 2009 to 2010; and 3) 2008 to 2010, and comparing the predictors and estimates of these models with that from the main study period (from 2007 to 2010). On validation of the model, we pooled patients from the derivation and validation cohorts and reconstructed a final hierarchical regression model to derive estimates from the entire study sample for risk standardization.

Hospital risk-standardized survival rates. Using the hospital-specific estimates (i.e., random intercepts) from the hierarchical models, we then calculated risk-standardized survival rates for the 272 hospitals with at least 10 cardiac arrest cases by multiplying the registry's unadjusted survival rate by the ratio of a hospital's predicted to expected survival rate. We used the ratio of predicted to expected outcomes (described in the following text) instead of the ratio of observed to expected outcomes to overcome analytical issues that have been described for the latter approach (15–17). Specifically, our approach ensured that all hospitals, including those with relatively small case volumes, would have appropriate risk standardization of their cardiac arrest survival rates.

For these calculations, the expected hospital number of cardiac arrest survivors is the number of cardiac arrest survivors expected at the hospital if the hospital's patients

were treated at a “reference” hospital (i.e., the average hospital-level intercept from all hospitals in GWTG-Resuscitation). This was determined by regressing patients' risk factors and characteristics on in-hospital survival with all hospitals in the sample, then applying the subsequent estimated regression coefficients to the patient characteristics observed at a given hospital, and then summing the expected number of deaths. In effect, the expected rate is a form of indirect standardization. In contrast, the predicted hospital outcome is the number of survivors at a specific hospital. It is determined in the same way that the expected number of deaths is calculated, except that the hospital's individual random effect intercept is used. The risk-standardized survival rate was then calculated by the ratio of predicted to expected survival rate, multiplied by the unadjusted rate for the entire study sample.

The effects of risk standardization on unadjusted hospital rates of survival were then illustrated with descriptive plots and statistics. In addition, we examined the absolute change (either positive or negative) in percentile rank for each hospital after risk standardization. This approach overcomes the inherent limitation of just examining the proportion of hospitals that are reclassified out of the top quintile with risk standardization, as some hospitals may be reclassified with only a 1% decrease in percentile rank (e.g., from 80% percentile to 79% percentile), whereas other hospitals would require up to a 20% decrease in percentile rank to be reclassified (e.g., hospitals with an unadjusted 99% percentile rank).

Because rates of do-not-resuscitate (DNR) orders may vary across hospitals and influence rates of in-hospital cardiac arrest survival, we conducted the following sensitivity analysis to examine the robustness of our findings. For hospitals in the lower 2 quartiles of risk-standardized survival, we assumed that the rate of DNR status for all admissions was 5%. We then assigned DNR rates at hospitals in the top and second highest quartiles to be 100% and 50%, respectively, greater than that of the lower 2 quartiles. We assumed that the rate of in-hospital cardiac arrest for DNR patients to be 5% and calculated the number of cardiac arrests at each hospital that would have occurred if no patients were made DNR. For instance, for a hospital in the highest quartile of survival with 10,000 annual admissions, an additional 50 cardiac arrests ($10,000 \times 0.10$ [DNR rate] $\times 0.05$ [rate of cardiac arrest]) were added to the denominator for each year of data submission.

For each of these “imputed” patients, we assigned an age of ≥ 80 years and 1 of the following characteristics: renal insufficiency, cancer, or hypotension. We then recalculated risk-standardized survival rates for the entire hospital sample and examined what proportion of hospitals in the original analysis was no longer classified in their quartile of risk-standardized hospital survival rates. If only a minority of hospitals were recategorized into a different quartile, that would suggest that our classification of hospitals in the top 2 quartiles was robust and persisted despite a higher DNR rate for their admitted patients.

All study analyses were performed with SAS version 9.2 (SAS Institute, Cary, North Carolina) and R version 2.10.0 (18). The hierarchical models were fitted with the use of the GLIMMIX macro in SAS.

Dr. Chan had full access to the data and takes responsibility for its integrity. All authors have read and agree to the manuscript as written. The institutional review board of the Mid America Heart Institute waived the requirement of informed consent, and the AHA approved the final manuscript draft.

Results

Of 48,841 patients in the study cohort, 32,560 were randomly selected for the derivation cohort and 16,281 for the validation cohort. Baseline characteristics of the patients in the derivation and validation cohorts were similar, based on comparisons of both p-values and standardized differences (Table 1). The mean patient age in the overall cohort was 65.6 ± 16.1 years, 58% were male, and 21% were black. More than 80% of patients had a nonshockable cardiac arrest rhythm of asystole or pulseless electrical activity, and nearly half were already in an intensive care unit during the arrest. Respiratory insufficiency and renal insufficiency were the most prevalent comorbidities, whereas one-quarter of patients were hypotensive and one-third were receiving mechanical ventilation at the time of cardiac arrest.

Overall, 10,290 (21.1%) patients with an in-hospital cardiac arrest survived to hospital discharge. The survival rates were similar in the derivation ($n = 6,844$; 21.0%) and validation cohorts ($n = 3,446$; 21.2%). A comparison of baseline characteristics between patients who survived and did not survive to hospital discharge is provided in Online Table 1. In general, patients who survived were younger, more frequently white, more likely to have an initial cardiac arrest rhythm of ventricular fibrillation or pulseless ventricular tachycardia, and to have fewer comorbidities or interventions in place (e.g., intravenous vasopressors) at the time of cardiac arrest.

Initially, 18 independent predictors were identified in the derivation cohort with the multivariable model, resulting in a model C-statistic of 0.738 (Table 2; see Online Table 2 for variable definitions). After model reduction to generate a parsimonious model with no more than 5% loss in model prediction, our final model comprised 9 variables, with only a small change in the C-statistic (0.734). The predictors in the final model included age, initial cardiac arrest rhythm, hospital location of arrest, hypotension, septicemia, metastatic or hematologic malignancy, hepatic insufficiency, and requirement for mechanical ventilation or intravenous vasopressor before cardiac arrest. The beta-coefficient estimates and adjusted odds ratios are summarized in Table 3. Importantly, there was no evidence of multicollinearity between any of these variables (all variance inflation factors < 1.5).

When the model was tested in the independent validation cohort, model discrimination was similar (C-statistic of

0.737). Calibration was confirmed with observed versus predicted plots in both the derivation and validation cohorts (R^2 of 0.99 for both). When we repeated the analyses using data from year 2010 only, 2009 to 2010, and 2008 to 2010, our model predictors were unchanged, and the estimates of effect for each predictor were similar.

Figure 1 depicts the unadjusted and risk-standardized distribution of hospital rates of cardiac arrest survival (see Online Table 3 for calculations of the risk-standardized rates). The mean unadjusted hospital survival rate was $21 \pm 13\%$, whereas the mean risk-standardized hospital survival rate of $21 \pm 4\%$ showed a much narrower distribution. Similarly, the median unadjusted hospital survival rate was 20% (interquartile range 14% to 26%; range 0% to 85%), whereas the interquartile range and range for the risk-standardized hospital survival rates were substantially smaller: median of 21% (interquartile range: 19% to 23%; range 11% to 35%). Nine (3.3%) of the 272 hospitals had risk-standardized survival rates of $\geq 30\%$, or $\sim 50\%$ higher than the average hospital.

To examine the effect of risk standardization at individual hospitals, the change in percentile rank for each hospital was examined (Fig. 2). Of 272 hospitals, 143 (52.6%) had at least a 10% positive or negative absolute change in percentile rank after risk standardization (e.g., hospital ranked at 39% percentile before and at 53% percentile after risk standardization). Moreover, 50 hospitals (23.2%) had a substantial $\geq 20\%$ absolute change in percentile rank, with 24 having a 20% or greater increase and 26 having a 20% or greater decrease.

Finally, we found that our study findings were unlikely to be influenced by higher rates of DNR at hospitals with higher risk-standardized survival. Only 1 of 68 hospitals in the top quartile of risk-standardized survival was reclassified to a different quartile, even after assuming that hospitals in the top quartile had DNR rates that were twice the DNR rate of the lower 2 quartiles. Similarly, only 1 of 68 hospitals in the second highest quartile of risk-standardized survival was reclassified, even after assuming that these hospitals had DNR rates that were 50% higher than those in the lower 2 quartiles (Online Table 4).

Discussion

Within a large national registry, we derived and validated a risk-adjustment model for survival after in-hospital cardiac arrest. The model was based on 9 clinical variables that are easy to identify and collect. Moreover, the model had good discrimination and excellent calibration. Importantly, our model adhered to recommended standards to be employed for public reporting, including the use of hierarchical models, timely and high-quality data, and clearly defined study population and outcomes (3). As a result, we believe this model provides a mechanism to generate risk-standardized survival rates to facilitate more accurate comparisons of resuscitation outcomes across hospitals.

Table 1 Characteristics of the Derivation and Validation Cohorts

	Derivation Cohort (n = 32,560)	Validation Cohort (n = 16,281)	p Value	Standardized Difference*
Demographics				
Age, yrs	65.6 ± 16.1	65.6 ± 16.0	0.91	0.10
Age, yrs, by deciles			0.54	
18 to <50	5,269 (16.2%)	2,594 (15.9%)		
50 to 59	5,476 (16.8%)	2,832 (17.4%)		
60 to 69	7,137 (21.9%)	3,556 (21.8%)		
70 to 79	7,562 (23.2%)	3,793 (23.3%)		
80 to 89	7,116 (21.9%)	3,506 (21.5%)		
≥90				
Male	18,996 (58.3%)	9,500 (58.4%)	0.99	0.02
Race			0.77	
White	22,576 (69.3%)	11,337 (69.6%)		
Black	6,678 (20.5%)	3,288 (20.2%)		
Other	1,268 (3.9%)	618 (3.8%)		
Unknown	2,038 (6.3%)	1,038 (6.4%)		
Hispanic	2,254 (6.9%)	1,060 (6.5%)	0.09	1.65
Pre-existing conditions				
Respiratory insufficiency	13,301 (40.9%)	6,640 (40.8%)	0.89	0.14
Renal insufficiency	10,850 (33.3%)	5,358 (32.9%)	0.36	0.88
Arrhythmia	9,974 (30.6%)	4,973 (30.5%)	0.84	0.19
Diabetes mellitus	10,001 (30.7%)	4,928 (30.3%)	0.31	0.97
Hypotension	8,413 (25.8%)	4,308 (26.5%)	0.14	1.42
Heart failure this admission	5,370 (16.5%)	2,678 (16.4%)	0.90	0.12
Prior heart failure	6,278 (19.3%)	3,094 (19.0%)	0.46	0.71
Myocardial infarction this admission	5,184 (15.9%)	2,501 (15.4%)	0.11	1.54
Prior myocardial infarction	4,791 (14.7%)	2,319 (14.2%)	0.16	1.34
Metabolic or electrolyte abnormality	4,765 (14.6%)	2,280 (14.0%)	0.06	1.80
Septicemia	5,519 (17.0%)	2,777 (17.1%)	0.77	0.28
Pneumonia	4,342 (13.3%)	2,239 (13.8%)	0.20	1.22
Metastatic or hematologic malignancy	4,046 (12.4%)	1,997 (12.3%)	0.61	0.49
Hepatic insufficiency	2,474 (7.6%)	1,175 (7.2%)	0.13	1.46
Baseline depression in CNS function	3,640 (11.2%)	1,853 (11.4%)	0.51	0.64
Acute CNS non-stroke event	2,250 (6.9%)	1,139 (7.0%)	0.73	0.34
Acute stroke	1,234 (3.8%)	605 (3.7%)	0.69	0.39
Major trauma	1,399 (4.3%)	668 (4.1%)	0.32	0.97
Characteristics of arrest				
Cardiac arrest rhythm			0.99	
Asystole	10,997 (33.8%)	5,491 (33.7%)		
Pulseless electrical activity	15,327 (47.1%)	7,653 (47.0%)		
Ventricular fibrillation	3,691 (11.3%)	1,862 (11.4%)		
Pulseless ventricular tachycardia	2,545 (7.8%)	1,275 (7.8%)		
Location			0.92	
Intensive care unit	15,780 (48.5%)	7,809 (48.0%)		
Monitored unit	5,034 (15.5%)	2,539 (15.6%)		
Nonmonitored unit	5,632 (17.3%)	2,824 (17.3%)		
Emergency room	3,307 (10.2%)	1,687 (10.4%)		
Procedural or surgical area	2,132 (6.5%)	1,073 (6.6%)		
Other	675 (2.1%)	349 (2.1%)		
Interventions in place				
Mechanical ventilation	10,747 (33.0%)	5,422 (33.3%)	0.51	0.63
Intravenous vasopressor	9,549 (29.3%)	4,800 (29.5%)	0.72	0.34
Pulmonary artery catheter	833 (2.6%)	378 (2.3%)	0.11	1.53
Dialysis	1,163 (3.6%)	598 (3.7%)	0.57	0.54
Intra-aortic balloon pump	482 (1.5%)	228 (1.4%)	0.49	0.67

Values are mean ± SD or n (%). *For binary variables, because of the large sample size, standardized differences of >10 indicate a significant difference between groups.

Table 2 Full Model for Predictors of Survival to Hospital Discharge

Predictor	Beta-Weight Estimate	Odds Ratio	95% CI
Age, yrs			
<50	0	Reference	Reference
50–59	–0.0202	0.98	0.88–1.08
60–69	–0.0408	0.96	0.87–1.05
70–79	–0.2877	0.75	0.68–0.83
≥80	–0.6931	0.50	0.46–0.56
Male	–0.0834	0.92	0.87–0.98
Hospital location			
Nonmonitored unit	0	Reference	Reference
Intensive care unit	0.5653	1.76	1.59–1.93
Monitored unit	0.4700	1.60	1.45–1.78
Emergency room	0.5188	1.68	1.49–1.89
Procedural or surgical area	1.1217	3.07	2.71–3.49
Other	0.6259	1.87	1.54–2.26
Initial cardiac arrest rhythm			
Asystole	0	Reference	Reference
Pulseless electrical activity	0.0392	1.04	0.97–1.12
Ventricular fibrillation	1.2238	3.40	3.10–3.72
Pulseless ventricular tachycardia	1.1086	3.03	2.73–3.36
Myocardial infarction this admission	0.1484	1.16	1.07–1.25
Prior heart failure	–0.0619	0.94	0.87–1.01
Renal insufficiency	–0.2231	0.80	0.75–0.86
Hepatic insufficiency	–0.6539	0.52	0.45–0.59
Hypotension	–0.4463	0.64	0.59–0.69
Septicemia	–0.4308	0.65	0.59–0.71
Acute stroke	–0.3147	0.73	0.63–0.86
Diabetes mellitus	0.1310	1.14	1.06–1.21
Metabolic/electrolyte abnormality	–0.1625	0.85	0.77–0.94
Metastatic or hematologic malignancy	–0.7550	0.47	0.42–0.53
Major trauma	–0.3425	0.71	0.60–0.83
Mechanical ventilation	–0.5447	0.58	0.54–0.63
Dialysis	–0.3011	0.74	0.61–0.90
Intravenous vasopressor	–0.7340	0.48	0.44–0.52

CI = confidence interval.

Because substantial variation in hospital survival rates after in-hospital cardiac arrest exists (2), there are currently efforts to measure hospital performance for this condition. The Joint Commission, for instance, is developing a number of metrics to assess hospital performance in resuscitation. The AHA's GWTG-Resuscitation national registry has also developed a number of target benchmarks to highlight hospitals with exceptional performance. Most of these performance metrics are process-oriented, such as time to defibrillation and time to initiation of cardiopulmonary resuscitation, and are therefore independent of confounding by patient case-mix. However, both organizations also plan to profile survival outcomes after cardiac arrest.

In contrast to process measures, several key challenges exist in comparing survival outcomes across hospitals. First, and most important, hospital variation in survival may be

Table 3 Final Reduced Model for Predictors of Survival to Discharge

Predictor	Beta-Weight Estimate	Odds Ratio	95% CI
Age, yrs			
<50	0	Reference	Reference
50–59	0.0031	1.00	0.91–1.11
60–69	–0.0096	0.99	0.90–1.09
70–79	–0.2560	0.77	0.70–0.85
≥80	–0.6562	0.52	0.47–0.57
Initial cardiac arrest rhythm			
Asystole	0	Reference	Reference
Pulseless electrical activity	0.0478	1.05	0.98–1.13
Ventricular fibrillation	1.2631	3.54	3.24–3.86
Pulseless ventricular tachycardia	1.1289	3.09	2.79–3.43
Hospital location			
Nonmonitored unit	0	Reference	Reference
Intensive care unit	0.5643	1.76	1.60–1.93
Monitored unit	0.4816	1.62	1.46–1.79
Emergency room	0.5618	1.75	1.56–1.97
Procedural or surgical area	1.1550	3.17	2.80–3.60
Other	0.6210	1.86	1.54–2.25
Hypotension	–0.4749	0.62	0.57–0.67
Sepsis	–0.4879	0.61	0.56–0.68
Metastatic or hematologic malignancy	–0.7345	0.48	0.43–0.53
Hepatic insufficiency	–0.7240	0.48	0.42–0.56
Mechanical ventilation	–0.5662	0.57	0.53–0.61
Intravenous vasopressor	–0.7329	0.48	0.44–0.52

CI = confidence interval.

simply due to heterogeneity in patients' case-mix. Hospitals with cardiac arrest patients who have higher illness acuity may have lower survival rates. To date, a risk-adjustment model that uses appropriate analytical techniques to account for nesting of data within hospitals (i.e., hierarchical models) has not been derived and validated. Although several multivariable models for in-hospital cardiac arrest exist (19,20), these have not been validated, were based on less contemporary cohorts of patients, and used analytical approaches that do not adequately account for clustering of patients within hospitals. Therefore, these other models may have under-estimated standard errors, which can lead to type I errors in inferences regarding statistical significance and inappropriately label certain hospitals as performing better, or worse, than average (21). Moreover, unlike hierarchical models used in this study, these other approaches do not have a mechanism to weight the number of observations contributed by each hospital to account for differences in the sample sizes across hospitals.

Second, prior efforts in risk standardization for other disease conditions have been based on the ratio of observed to expected outcomes. This approach has significant limitations (16,17), especially the inability to risk-standardize rates for sites with low case volumes. In this study, we overcame both of these barriers by deriving and validating a risk-adjustment model using hierarchical random-effects

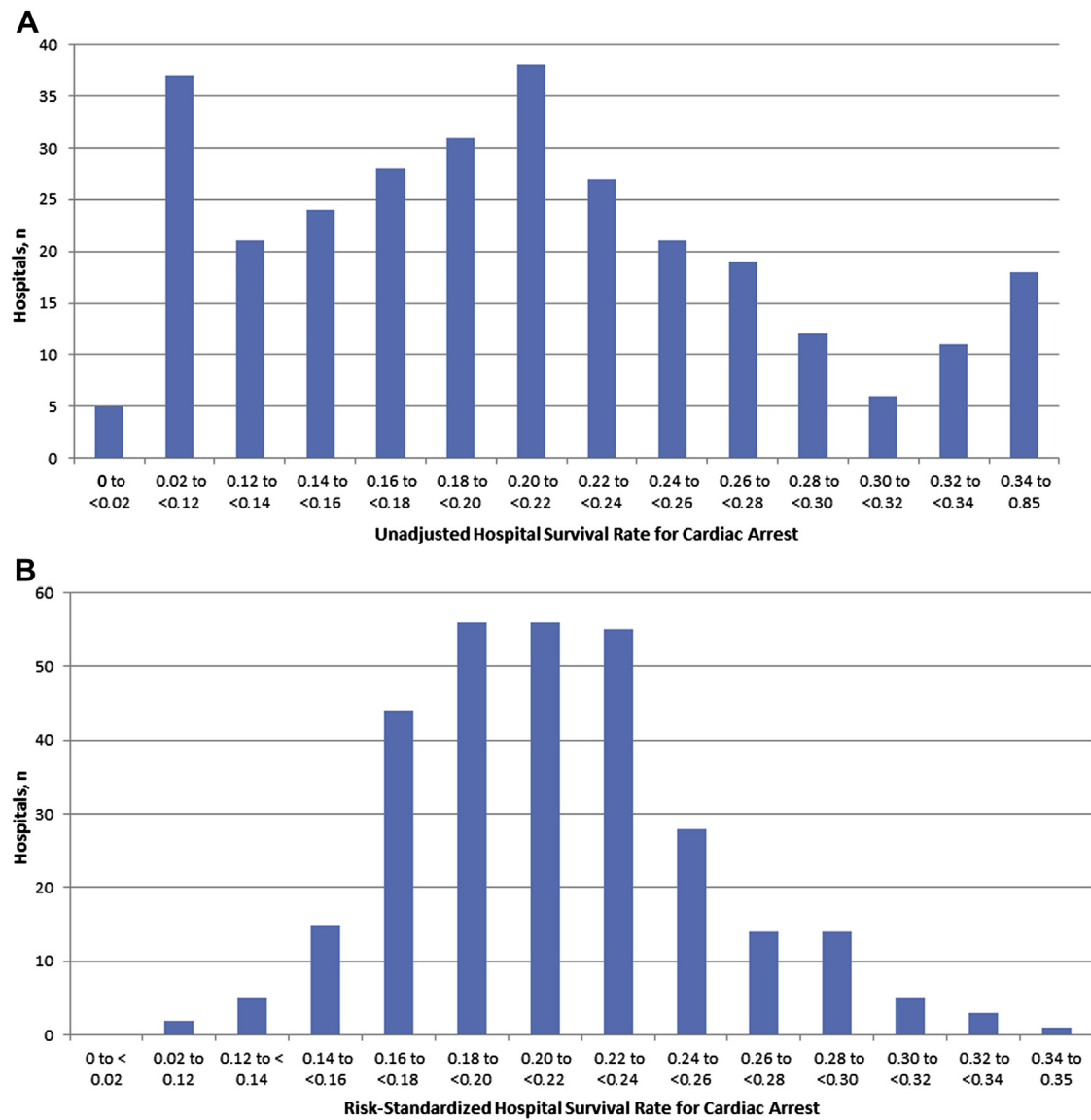


Figure 1 Distribution of Unadjusted and Risk-Standardized Hospital Survival Rates for In-Hospital Cardiac Arrest

(A) Observed hospital rates: the number of hospitals for each range of survival rates is displayed. A total of 276 hospitals with ≥ 10 in-hospital cardiac arrest cases were evaluated. (B) Risk-standardized hospital rates: the number of hospitals for each range of survival rates is displayed. A total of 276 hospitals with ≥ 10 in-hospital cardiac arrest cases was evaluated.

models and basing our risk standardization on the ratio of predicted to expected outcomes (15), thereby allowing us to generate risk-standardized rates for hospitals in the study. Without risk standardization, differences in hospital survival rates for in-hospital cardiac arrest may be due to differences 1) patient case-mix; and 2) quality of care between hospitals. From a quality perspective, only the last difference is of interest. With our risk-standardization approach, which controlled for differences in patient case-mix across hospitals, the range of hospital survival rates narrowed enormously, with the interquartile range decreasing from 12% to 4%. Even

more importantly, we found that more than half of hospitals changed in percentile rank by at least 10%, and nearly a quarter of hospitals changed in percentile rank by 20% or greater, suggesting a significant impact of risk standardization (to account for differences in case-mix) in assessing a hospital's survival outcomes for in-hospital cardiac arrest. Both of these findings suggest that simple comparisons of unadjusted hospital survival rates would be problematic and likely to lead to incorrect inferences. Importantly, despite the reduction in variability with our risk-adjustment methodology, there remained notable

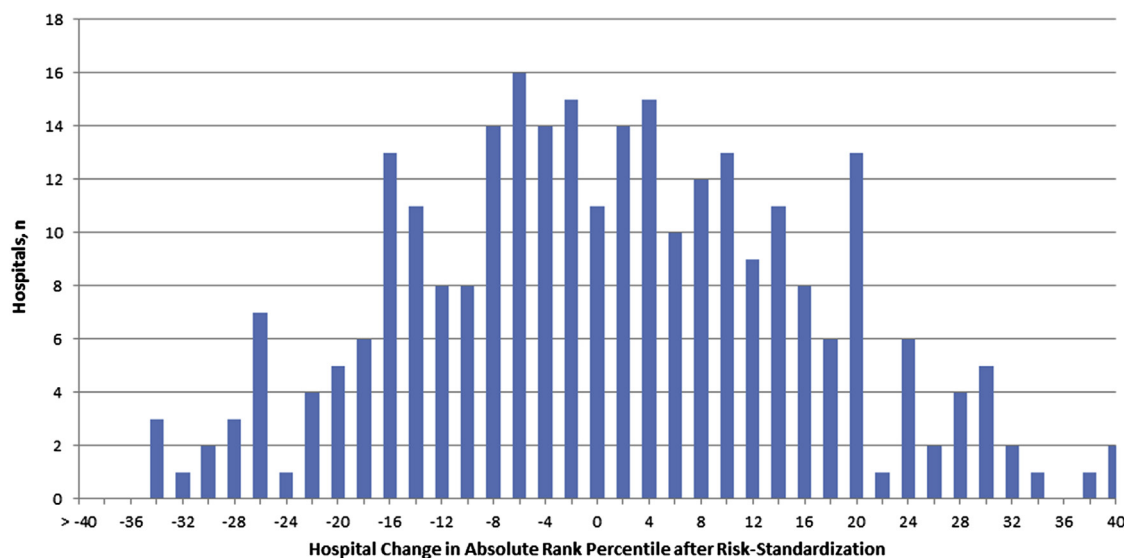


Figure 2 Hospital Change in Absolute Rank Percentile After Risk Standardization

The change in a hospital's percentile rank in survival rates for in-hospital cardiac arrest after accounting for patient case-mix is depicted. Of 272 hospitals, 143 (52.6%) had at least a 10% positive or negative absolute change in percentile rank after risk standardization, and 50 hospitals (23.2%) had a substantial $\geq 20\%$ absolute change in percentile rank.

differences in risk-standardized rates of survival. That suggests that some hospitals were able to achieve higher survival rates than others. For instance, some (9 of 272 [3.3%]) hospitals had risk-standardized survival rates of $\geq 30\%$, or $\sim 50\%$ higher than the average hospital. Which hospital factors or quality improvement initiatives are associated with the higher survival outcomes in these hospitals remain unknown. Therefore, identifying best practices at these top-performing hospitals should be a priority (22), as their dissemination to all hospitals has the potential to significantly improve survival for all patients with in-hospital cardiac arrest.

Study limitations. Our study should be interpreted in the context of the following limitations. First, although our risk model was able to account for a number of clinical variables, unmeasured confounding may exist. Specifically, our model did not have information on some prognostic factors, such as creatinine or the severity level for each comorbid condition. In addition, thorough documentation of patients' case-mix (e.g., comorbidities) and access to telemetry and intensive care unit monitoring may differ across sites, which could account for some of the hospital variation in risk-standardized survival rates. Second, our model did not adjust for intra-arrest variables (such as quality of cardiopulmonary resuscitation and time to defibrillation) which are known to influence survival outcomes. However, because these latter variables are attributes specific to a hospital's performance, their inclusion in a model developed to profile hospitals for resuscitation performance would be improper (3). Third, we did not have information on DNR status for

all admitted patients or the proportion of deaths with attempted resuscitation at each hospital, and this rate is likely to vary across hospitals. Such variation is likely to affect a hospital's crude rank performance for cardiac arrest survival. However, in our sensitivity analyses, we found that a hospital's risk-standardized rank performance was relatively unaffected by variation in DNR rates across sites, thus underscoring the importance of risk standardization for meaningful comparisons of in-hospital cardiac arrest survival across hospitals.

Fourth, our study population was limited to hospitals participating within the AHA's GWTG-Resuscitation program. Therefore, our findings may not apply to non-participating hospitals. Fifth, our model was developed in patients with in-hospital cardiac arrest. Because the reasons for cardiac arrest and comorbidity burden differ for patients with out-of-hospital cardiac arrest, our findings do not apply to cardiac arrests occurring outside hospitals. Finally, we have not developed a model for survival with good neurological outcome. Although this is an important consideration for patients with in-hospital cardiac arrest and should be the focus of a future study, our goal was to develop a risk-standardization model for in-hospital survival, as this is the outcome proposed by national organizations for a performance measure.

Conclusions

Given poor survival outcomes for in-hospital cardiac arrest, there is growing national interest in developing performance metrics to benchmark hospital survival for this condition.

In this study, we have developed and validated a model to risk-standardize hospital rates of survival for in-hospital cardiac arrest. We believe that use of this model to adjust for patient case-mix represents an advance in ongoing efforts to profile hospitals in resuscitation outcomes, with the hope that clinicians and administrators will be stimulated to develop novel and effective quality improvement strategies to improve their hospital's performance.

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Key Words: cardiac arrest ■ risk adjustment ■ variation in care.

APPENDIX

For a list of the AHA GWTG-Resuscitation (formerly, the National Registry of Cardiopulmonary Resuscitation) investigators and supplementary tables, please see the online version of this article.