Purpose of the graphs

These graphs are either event-based or patient based graphs and illustrate information about your patient population each quarter, comparing your results with both NRCPR goals and hospital comparison group medians. The goals, based on Guidelines 2005 *(2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2005;112:IV-1-IV-211*) and the NRCPR Gold Standards (*http://www.ircpr.org/*, were defined by expert opinion with consensus of the NRCPR Scientific Advisory Board and concurrence of the American Heart Association Emergency Cardiac Care Committee. The four graphs are:

- The percent of events when ventricular fibrillation/pulseless ventricular tachycardia was the initial rhythm for which time to defibrillation was within 3 minutes (≤3 minutes).
- The difference in discharge survival rates of patients who arrested during weekday days and evenings versus patients who arrested during weekday nights and on weekends.
- The percentage of cardiac arrests that were monitored (continuous ECG, pulse oximetry, or apnea bradycardia monitors) and/or witnessed.
- The percentage of patients with pulseless cardiac arrest who survived to hospital discharge.

How these reports can benefit your facility

Comparing your results with other facilities and with NRPCR goals can assist in identifying areas for process improvement in your facility. Each graph is presented with Adult, Pediatric and Neonate data allowing you to compare your results with the applicable patient population. This comparison will help your facility improve resuscitation practice and increase survival from cardiac arrest.

Graph: Percent of Events with Time to Defibrillation within 3 minutes (≤ 3 minutes)

The NRCPR Gold Standard for delivery of the first defibrillation shock is within three minutes (3 minutes) of recognition of the cardiac arrest when ventricular fibrillation/pulseless ventricular tachycardia is the initial rhythm. A recent publication by NRCPR investigators confirmed that for patients who arrest in the hospital with an initial rhythm of ventricular fibrillation/pulseless ventricular tachycardia, survival to hospital discharge is significantly better if the first defibrillation shock is delivered within three minutes compared to greater than three minutes. *(Chan PS, Krumholtz HM, Nichol G, Nallamothu BK Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med 2008; 358: 9-17.*)

- This graph is event-based and includes all events in which the first identified rhythm was ventricular fibrillation or pulseless ventricular tachycardia.
- The time to defibrillation is calculated as the interval from the reported time of initial recognition of the cardiac arrest to the reported time of the first attempted defibrillation.
- For each quarter, the graph displays the percentage of events occurring in the most recent 12 months for which time to defibrillation ≤ 3 minutes (Gold Standard).
- In addition to displaying quarterly percentages and NRCPR group median and goal, the graph also displays a center line and statistical control limits. The center line is an average of your facility's quarterly percentages. The lower and upper control limits represent the range of normal variation of these percentages for your facility.
- When used consistently, the graphs can help identify significant changes in your facility's ability to meet the NRCPR Gold Standard for this metric. Three flags that you can apply are: 1) quarterly percentages that fall outside the control limits; 2) six or more consecutively increasing or decreasing percentages; and 3) nine or more percentages on one side of the center line.

Graph: Variance in discharge survival rates of patients who arrested during weekday days and evenings versus patients who arrested during weekday nights and on weekends.

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Peberdy and NRCPR investigators reported the survival of patients sustaining in-hospital cardiac arrests during different hospital shifts. They studied 58,593 patients who sustained a cardiac arrest during the day/evening (7 AM-11 PM) shifts, and 28,155 patients who arrested during night (11 PM-7 AM) shifts. They included only the index (first) event. They found that survival to discharge was significantly better during the day/evening shifts (19.8%) compared to the night shifts (14.3%). Survival during day/evening shifts (20.6%) on weekdays was higher than on weekends (17.4%), but no different during night shifts. (*Peberdy MA, Ornato JP, Larkin GL, et al; Survival from in-hospital cardiac arrest during nights and weekends. JAMA 2008; 299: 785-792.*)

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event). Patients are stratified into two types of arrest categories: those who arrested during a weekday day or evening (7 AM-11 PM), and those who arrested during a weekday night (11 PM-7 AM) or on the weekend. Positive weekday day/evening better; negative night/weekend better.
- For each quarter, the graph displays the difference between survival to hospital discharge for the weekday day/evening group and survival to hospital discharge for the weekday night/weekend group of patients. Arrests occurring in the most recent 12 months are included in the calculations.
- In addition to displaying quarterly differences between day/evening and night/weekend survival rates and NRCPR group median and goal, the graph also displays a center line and statistical control limits. The center line is an average of your facility's quarterly values. The lower and upper control limits represent the range of normal variation of these values for your facility.
- When used consistently, the graphs can help identify significant changes in your facility's time of arrest survival differential. Three flags that you can apply are: 1) quarterly values that fall outside the control limits; 2) six or more consecutively increasing or decreasing values; and 3) nine or more values on one side of the center line.

Graph: Percent of arrests monitored or witnessed

For an unmonitored or unwitnessed arrest the event onset time and down time (the time between the event onset and event recognition) are unknown which may impact response to resuscitation efforts and have a negative influence on outcome. Two studies by NRCPR investigators have demonstrated a beneficial effect on outcome if the event is monitored or witnessed. Peberdy, et al reported improved survival of monitored and witnessed arrests, both during day/evening and nighttime shifts (*Peberdy MA, Ornato JP, Larkin GL, et al; Survival from in-hospital cardiac arrest during nights and weekends. JAMA 2008; 299: 785-792*). Chan, et al reported improved survival of monitored patients with an initial rhythm of ventricular fibrillation/pulseless ventricular tachycardia (*Chan PS, Krumholtz HM, Nichol G, Nallamothu BK: Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med 2008; 358: 9-17*).

- This graph is event-based and includes all cardiac arrests.
- This graph displays the percentage of arrests that were monitored or witnessed.
- Monitored status includes continuous ECG, apnea monitor, apnea-bradycardia monitor and pulse oximetry.
- Witnessed status is the direct observation of onset of the cardiopulmonary arrest by someone (family, lay bystander, employee or health care professional) .
- For each quarter, the graph displays the percentage of arrests occurring in the most recent 12 months that were monitored or witnessed.
- In addition to displaying quarterly percentages and NRCPR group median and goal, the graph also displays a center line and statistical control limits. The center line is an average of your facility's quarterly percentages. The lower and upper control limits represent the range of normal variation of these percentages for your facility.
- When used consistently, the graphs can help identify significant changes in your facility's percentage of monitored or witnessed events. Three flags that you can apply are: 1) quarterly percentages that fall outside the control limits; 2) six or more consecutively increasing or decreasing percentages; and 3) nine or more percentages on one side of the center line.

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Graph: Percent of patients with pulseless cardiac arrest who survived to hospital discharge.

NRCPR investigators have published several studies addressing survival to discharge following cardiac arrest. Peberdy, at al demonstrated that overall 17% of 14,720 adults with in-hospital pulseless cardiac arrest survived to hospital discharge. (*Peberdy MA, Kaye W, Ornato JP, et al: Cardiopulmonary resuscitation of adults in the hospital: A report of 14 720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. Resuscitation 2003; 58: 297-308.*) Nadkarni, et al reported that the rate of survival to hospital discharge following pulseless cardiac arrest was higher in children age < 18 years old than adults age 18 years old (27% [236/880] vs 18% [6485/36 902]. (*Nadkarni VN, Larkin GL, Peberdy MA, et al: First Documented Rhythm and Clinical Outcome From In-Hospital Cardiac Arrest Among Children and Adults. JAMA 2006; 295: 50-57.*) Meaney, et al studied 464 pediatric ICU pulseless cardiac arrests (excluding neonatal ICU arrests); 62 newborns (age <1 month), 105 infants (age 1 month to <1 year), and 297 children (age 1-18 years). Survival to discharge was significantly better for newborns (27.4%) and infants (36.2%) compared to children (17%). (*Meaney PA, Nadkarni VM, Cook EF: Higher Survival Rates Among Younger Patients After Pediatric Intensive Care Unit Cardiac Arrests. Pediatrics 2006; 118: 2424-2433.*)

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event).
- For each quarter, the graph displays the percentage of patients with an index pulseless cardiac arrest occurring in the most recent 12 months who survived to hospital discharge.
- In addition to displaying quarterly percentages and NRCPR group median and goal, the graph also displays a center line and statistical control limits. The center line is an average of your facility's quarterly percentages. The lower and upper control limits represent the range of normal variation of these percentages for your facility.
- When used consistently, the graphs can help identify significant changes in your facility's survival to discharge rates. Three flags that you can apply are: 1) quarterly percentages that fall outside the control limits; 2) six or more consecutively increasing or decreasing percentages; and 3) nine or more percentages on one side of the center line.

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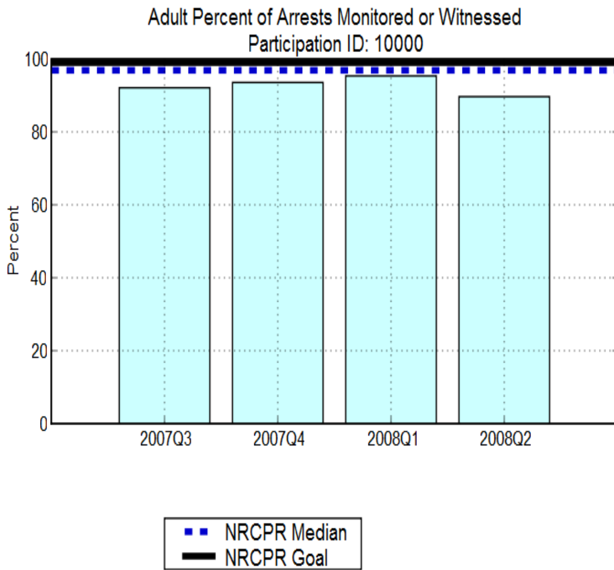
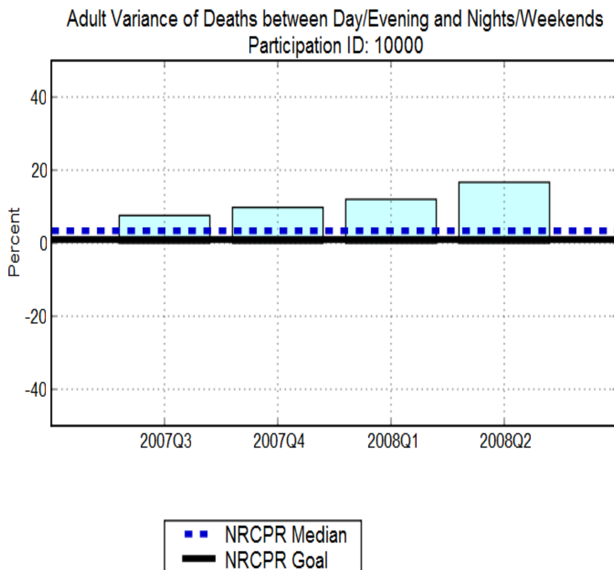
Adult Cardiopulmonary Arrest [Participant 10000]



Percent of arrests monitored or witnessed

- This graph is event-based and includes all cardiac arrests.
- This graph displays the percentage of arrests that were monitored or witnessed.
- Monitored status includes continuous ECG, apnea monitor, apnea-bradycardia monitor and pulse oximetry .
- Witnessed status is the direct observation of onset of the cardiopulmonary arrest by someone (family, lay bystander, employee or health care professional).
- For each quarter, the graph displays the percentage of arrests occurring in the most recent 12 months that were monitored or witnessed.



Variance in discharge survival rates of patients who arrested during weekday days and evenings versus patients who arrested during weekday nights and on weekends

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event). Patients are stratified into two types of arrest categories: those who arrested during a weekday day or evening (7 AM-11 PM), and those who arrested during a weekday night (11 PM-7 AM) or on the weekend.
- For each quarter, the graph displays the variance between survival to hospital discharge for the weekday day/evening group and survival to hospital discharge for the weekday night/weekend group of patients. Positive = weekday day/evening better, negative = night/weekend better.

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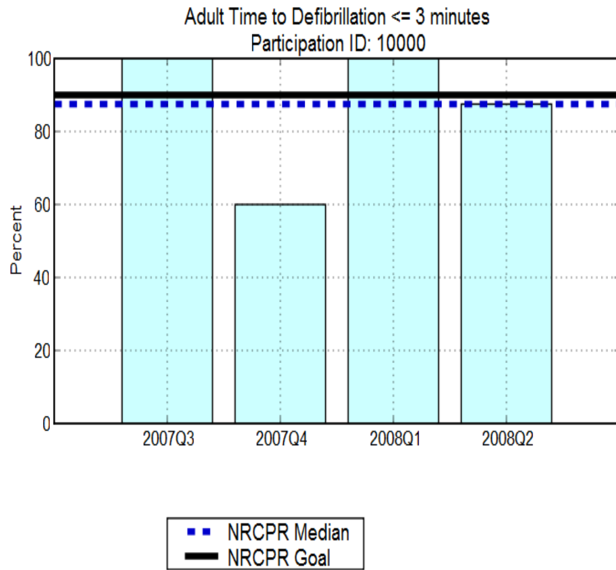
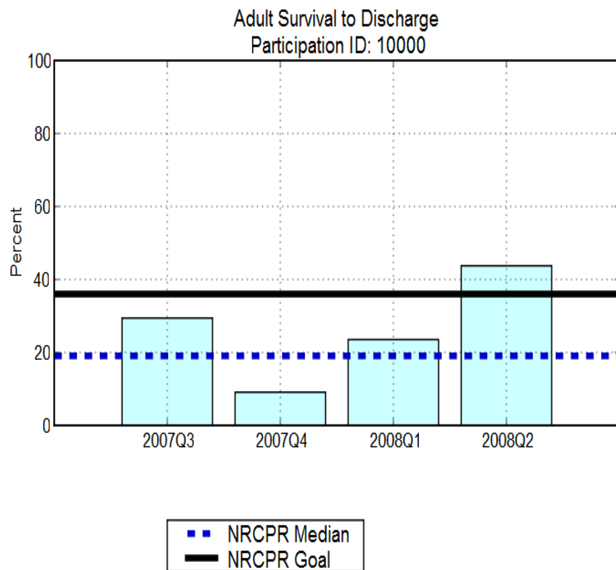


Percent of Events with Time to Defibrillation within 3 minutes (≤ 3 minutes)

- This graph is event-based and includes all events in which the first identified rhythm was ventricular fibrillation or pulseless ventricular tachycardia.
- The time to defibrillation is calculated as the interval from the reported time of initial recognition of the cardiac arrest to the reported time of the first attempted defibrillation.
- For each quarter, the graph displays the percentage of events occurring in the most recent 12 months for which time to defibrillation ≤ 3 minutes (Gold Standard).



Percent of patients with pulseless cardiac arrest who survived to hospital discharge

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event).
- For each quarter, the graph displays the percentage of patients with an index pulseless cardiac arrest occurring in the most recent 12 months who survived to hospital discharge.

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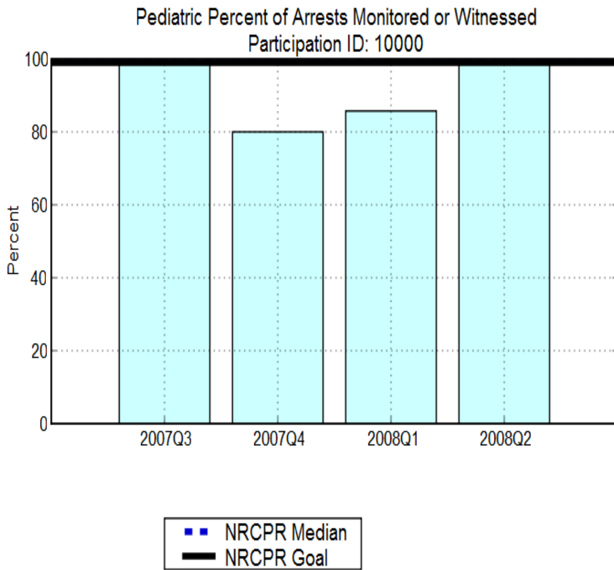
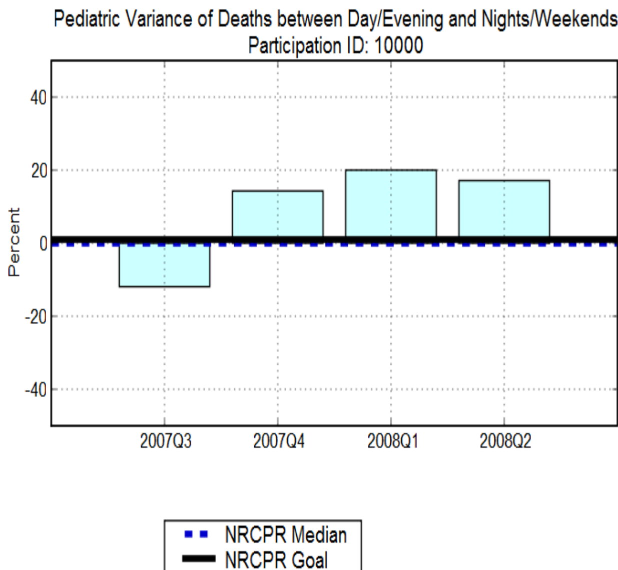
Pediatric Cardiopulmonary Arrest [Participant 10000]



Percent of arrests monitored or witnessed

- This graph is event-based and includes all cardiac arrests.
- This graph displays the percentage of arrests that were monitored or witnessed.
- Monitored status includes continuous ECG, apnea monitor, apnea-bradycardia monitor and pulse oximetry .
- Witnessed status is the direct observation of onset of the cardiopulmonary arrest by someone (family, lay bystander, employee or health care professional).
- For each quarter, the graph displays the percentage of arrests occurring in the most recent 12 months that were monitored or witnessed.



Variance in discharge survival rates of patients who arrested during weekday days and evenings versus patients who arrested during weekday nights and on weekends

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event). Patients are stratified into two types of arrest categories: those who arrested during a weekday day or evening (7 AM-11 PM), and those who arrested during a weekday night (11 PM-7 AM) or on the weekend.
- For each quarter, the graph displays the variance between survival to hospital discharge for the weekday day/evening group and survival to hospital discharge for the weekday night/weekend group of patients. Positive = weekday day/evening better, negative = night/weekend better.

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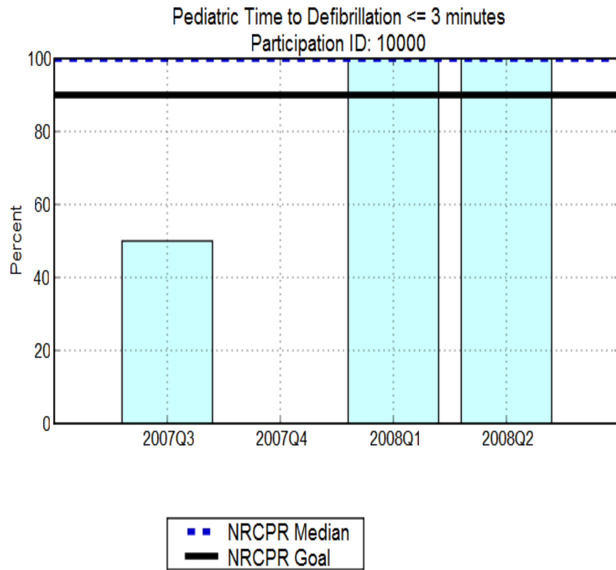
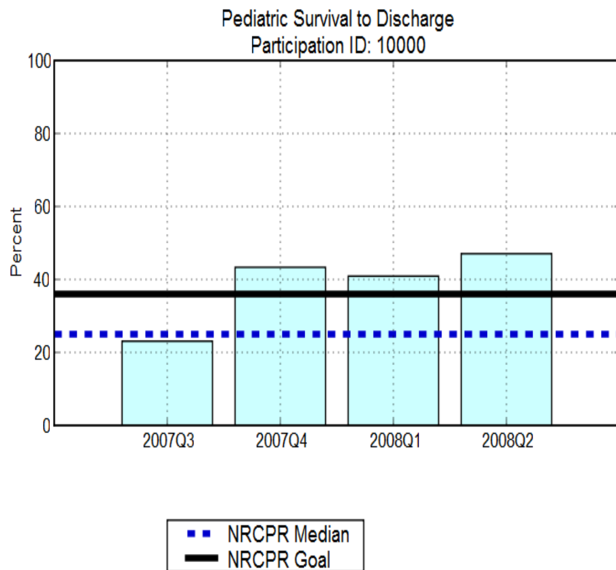


Percent of Events with Time to Defibrillation within 3 minutes (≤ 3 minutes)

- This graph is event-based and includes all events in which the first identified rhythm was ventricular fibrillation or pulseless ventricular tachycardia.
- The time to defibrillation is calculated as the interval from the reported time of initial recognition of the cardiac arrest to the reported time of the first attempted defibrillation.
- For each quarter, the graph displays the percentage of events occurring in the most recent 12 months for which time to defibrillation ≤ 3 minutes (Gold Standard).



Percent of patients with pulseless cardiac arrest who survived to hospital discharge

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event).
- For each quarter, the graph displays the percentage of patients with an index pulseless cardiac arrest occurring in the most recent 12 months who survived to hospital discharge.

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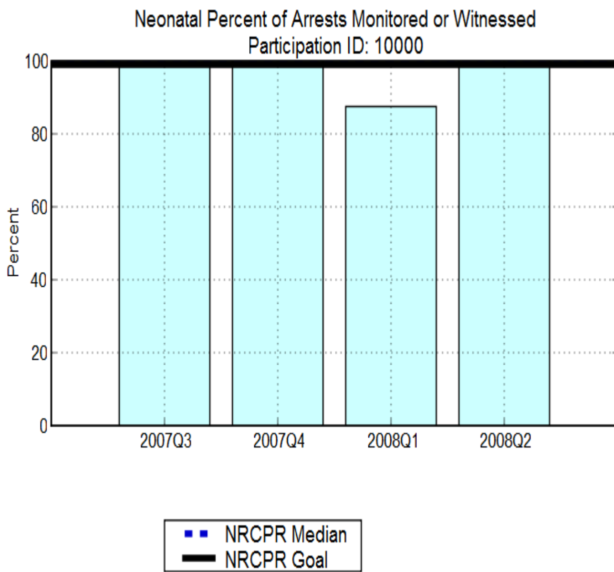
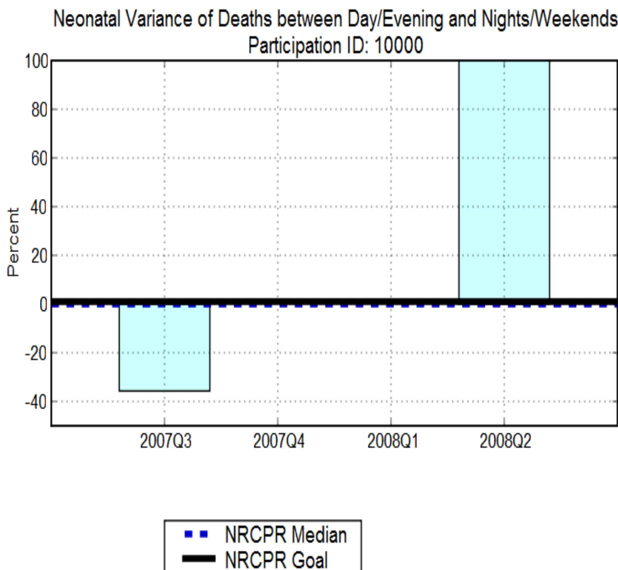
Neonatal Cardiopulmonary Arrest [Participant 10000]



Percent of arrests monitored or witnessed

- This graph is event-based and includes all cardiac arrests.
- This graph displays the percentage of arrests that were monitored or witnessed.
- Monitored status includes continuous ECG, apnea monitor, apnea-bradycardia monitor and pulse oximetry .
- Witnessed status is the direct observation of onset of the cardiopulmonary arrest by someone (family, lay bystander, employee or health care professional).
- For each quarter, the graph displays the percentage of arrests occurring in the most recent 12 months that were monitored or witnessed.



Variance in discharge survival rates of patients who arrested during weekday days and evenings versus patients who arrested during weekday nights and on weekends

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event). Patients are stratified into two types of arrest categories: those who arrested during a weekday day or evening (7 AM-11 PM), and those who arrested during a weekday night (11 PM-7 AM) or on the weekend.
- For each quarter, the graph displays the variance between survival to hospital discharge for the weekday day/evening group and survival to hospital discharge for the weekday night/weekend group of patients. Positive = weekday day/evening better, negative = night/weekend better.

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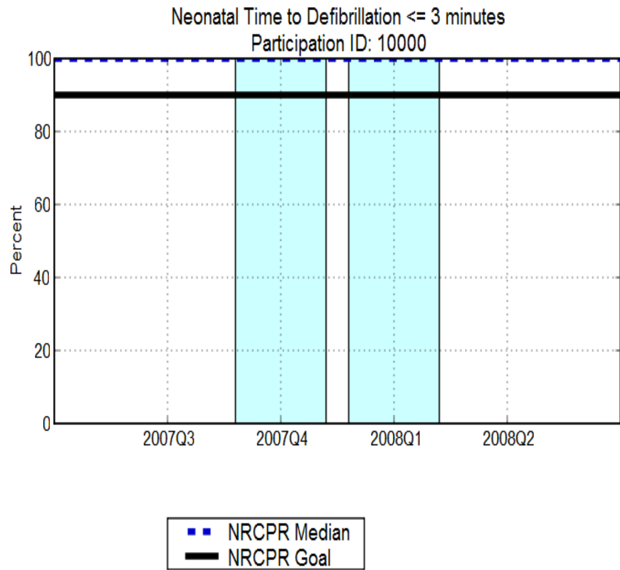
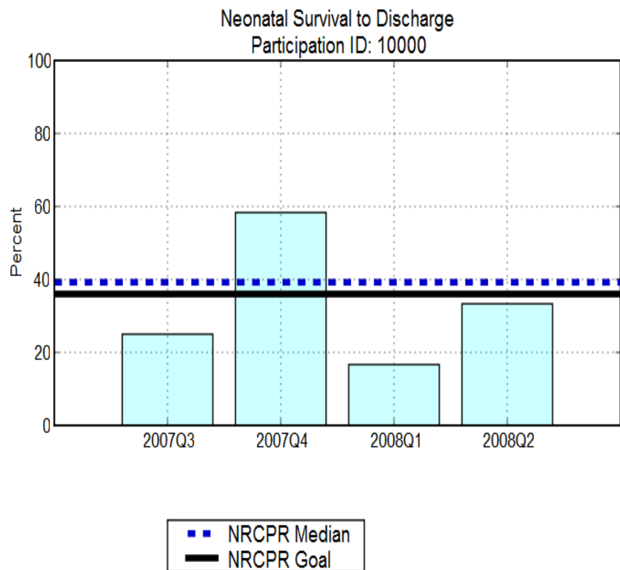


Percent of Events with Time to Defibrillation within 3 minutes (≤ 3 minutes)

- This graph is event-based and includes all events in which the first identified rhythm was ventricular fibrillation or pulseless ventricular tachycardia.
- The time to defibrillation is calculated as the interval from the reported time of initial recognition of the cardiac arrest to the reported time of the first attempted defibrillation.
- For each quarter, the graph displays the percentage of events occurring in the most recent 12 months for which time to defibrillation ≤ 3 minutes (Gold Standard).



Percent of patients with pulseless cardiac arrest who survived to hospital discharge

- This graph is patient-based and includes each patient's first recorded pulseless cardiac arrest during his/her hospital stay (index event).
- For each quarter, the graph displays the percentage of patients with an index pulseless cardiac arrest occurring in the most recent 12 months who survived to hospital discharge.

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Strategies for improvement

Goal: Improve Resuscitation Outcomes (survival to hospital discharge)

Are there Opportunities for Improvement in the Resuscitation Event?

For years hospitals have invested many hours and dollars in the preparation, training and equipment needed for the resuscitation event. Survival rate of patients who have had a cardiac or pulmonary arrest has traditionally been very low. Peberdy, at al demonstrated that overall 17% of 14,720 adults with in-hospital pulseless cardiac arrest survived to hospital discharge. (*Peberdy MA, Kaye W, Ornato JP, et al: Cardiopulmonary resuscitation of adults in the hospital: A report of 14 720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. Resuscitation 2003; 58: 297-308.*)
Key elements of resuscitation may provide great opportunities to improve survival post resuscitation.

- Survival to hospital discharge of patients who arrest in the hospital with an initial rhythm of ventricular fibrillation/pulseless ventricular tachycardia is significantly better if the first defibrillation shock is delivered within three minutes compared to greater than three minutes--Chan PS, Krumholtz HM, Nichol G, Nallamothu BK Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med 2008; 358: 9-17.
- Discharge survival rates of patients sustaining in-hospital cardiac arrests vary by shift and day of week--Peberdy MA,Ornato JP, Larkin GL, et al; Survival from in-hospital cardiac arrest during nights and weekends. JAMA 2008; 299: 785-792.
- Discharge survival is improved of monitored patients with an initial rhythm of ventricular fibrillation/pulseless ventricular tachycardia--Chan PS, Krumholtz HM, Nichol G, Nallamothu BK: Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med 2008; 358: 9-17..

Elements to Improving Resuscitation Outcomes

Time to Defibrillation:

Decreasing time to defibrillation is a key determinant of positive cardiac arrest patient outcome, survival to hospital discharge. Chan et al confirmed that with the shortest time to defibrillation the opportunity for survival is greatest.

What changes can be made that will result in decreased time to defibrillation?

Hospital teams have developed and tested process and system changes that allowed them to improve performance related to time to defibrillation. These measures should help to ensure access to appropriate equipment and improve consistency of process measures.

- Assure that stand-alone AEDs and/or AED mode in manual defibrillators are available throughout the facility.
- In the event of sudden cardiac arrest a defibrillator should be available within one to two minutes.
  - Identify locations of AEDs on a map of the facility. By visualizing the actual placement of AEDS on a drawing of the institution one may be alerted to possible oversights in placement. Examples include long distances between AEDs, possible geographic barriers to device access, too many AEDS in some areas and inadequate or no devices in others.
  - Early defibrillation should be available in geographically isolated parts of the hospital where code team response times are long.
  - Resist the desire to think of the placement of AEDS "by department". Take a walk and see how long it takes to get from any point in the building. Consider placing stand-alone AEDs in non-patient-care areas, such as cafeteria, waiting rooms and other public areas and admissions department.
- All BLS personnel must be trained to operate, be equipped with, and permitted to operate a defibrillator if in their professional duties they are expected to respond to people in cardiac arrest. Defibrillators include stand-alone AEDs and AED mode in manual defibrillators.

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- Allowing every staff person to practice defibrillating a mannequin during training may decrease the fear of using a defibrillator and administering the initial shock.

Day/Night/Weekend Variance

Peberdy and NRCPR investigators reported a significant difference in survival to hospital discharge of patients who arrested during the weekday daytime and evening shifts, as compared to the night and weekend shifts.

What changes can be made that will result in decreased day/night/weekend variance?

In order to address these issues you must first determine if there is a variance in discharge survival among the weekday and weekend shifts. If there is a difference in survival, processes must be reviewed. Several conditions that may affect the survival variance among shifts are:

- Unit staffing differences among shifts
- Experience level of staff
- Training of staff
- Availability of Providers
- Staffing of arrest team
- Response time of team
- Availability of basic supply items
- Support for non-clinical activities; if lacking may prevent staff from remaining at the patient bedside

Addressing one or several of these issues may provide more equitable staffing, training and/or experience across times of day and days of the week.

- For example, implementing or increasing the frequency of mock codes at night and on weekends may enhance the skill level of staff involved. Traditionally, more experienced management and education staffs are present during the day shift; to dramatically increase the frequency of education opportunities and mock codes for the night and weekend shifts will take administrative approval and support.
- Another improvement opportunity may be the response of team members and providers during the night and weekend shifts. For instance, review response time of team members and/or providers during different times of day to identify specific personnel or departments with a longer code response time.
- Consider a mechanism to provide additional resources for clinical personnel working the 'off shifts' and provide an acceptable way for these newer staff members to access valuable resources.
- Careful implementation of a rapid response system (MET/RRT) or specialty skilled buddy system to assist new/inexperienced staff with patient assessment and interventions for patients with deteriorating conditions may contribute to increased survival.

Percent of Arrests Monitored or Witnessed

When a patient arrests and the arrest is not witnessed or the patient is not monitored at the time, valuable seconds are lost and important interventions may be delayed affecting outcome. Survival to discharge is improved if the arrest is monitored or witnessed.

What changes can be made that will result in increased monitored/witnessed arrests?

If you identify frequent unmonitored/unwitnessed arrests at your facility, you may want to consider the following:

- Availability of monitored beds
- Appropriateness of patient placement within the medical center
- Addition of "flex" beds and/or staff to accommodate patients with short term increased acuity needs
- Flexible visiting - allowing families to stay with loved ones if desired
- Visibility of high acuity patients close to nursing stations.

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- Flexibility of electronic monitoring - allowing the monitor to go to the patient, rather than the patient moving to the monitor.
- Implementing a MET/RRT program in order to rapidly identify those patients at risk who should be placed on continuous electronic monitoring or moved to a monitored unit.

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