THE RACE-CARS TRIAL
Manual of Operations



RAndomized **C**luster **E**valuation
of **C**ardiac **AR**rest **S**ystems

Visit the study website for additional resources and tools that will continue to be added as the trial concludes.

https://racecarstrial.org/

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OVERVIEW

The team at Duke Clinical Research Institute (DCRI) is leading a pragmatic cluster-randomized trial that will test the implementation of community interventions to improve survival for people with cardiac arrest, one of the main causes of death in North Carolina (NC) and in the United States (US). In addition to addressing a major public health issue, the trial is one of the most innovative trials to be done in the US. The trial builds on a rich history of DCRI studies to implement guideline-based treatments in acute cardiovascular care. These programs have led to major improvements in systematic regional approaches to emergency cardiovascular care in the US and around the world.

Disclaimer: The Manual of Operations is a collection of information from multiple sources on cardiac arrest care including the American Heart Association and Emergency guidelines, scientific publications, HeartRescue materials, NC RACE-CARS materials, and others. The manual will serve as "Living Textbook" and will be updated when evidence or expert opinion changes or best practices are identified.

INTRODUCTION

Building on this history, the RACE-CARS trial is testing a systematic approach to implementing what is known to improve survival by partnering with communities to optimize care. If successful, the trial could lead to changes around the country to improve the current dismal survival of patients with cardiac arrest, while also demonstrating how randomized trials can be more efficiently integrated with routine patient care.

In 2019, in NC approximately 9,000 people suffered a non-traumatic out-of-hospital cardiac arrest (OHCA). Approximately 12.9% survived to hospital discharge. While NC rates of survival to hospital discharge are above the national average of 10.5%, county-level survival rates range from 0% to 21.5%. As a result, there are important opportunities for improvement.



In 2019, in NC approximately **9,000** *people suffered a non-traumatic out-of-hospital cardiac arrest (OHCA).*

In NC, 36.9 % of patients receive bystander cardiopulmonary resuscitation (CPR) which is below the national rate of 41.6%. Only 13.6% of arrests in public places have an automated external defibrillator (AED) applied prior to first responder or emergency medical services (EMS) arrival. Median time from 911 call to first CPR is approximately 6 minutes and time to first defibrillation is approximately 12 minutes. Furthermore, 71.1% of OHCA patients do not survive to hospital admission. The unique circumstances of OHCA (often occur at home and only minutes separate complete recovery from irreversible brain damage) make this an extraordinarily challenging public health problem. Like many public health problems, we believe that the critical barrier preventing progress is not the lack of knowledge about what to do but the effective systematic implementation of what is known to work. Thus, we believe the greatest opportunity for moving the needle on cardiac arrest outcomes, and the core intervention proposed in this clinical trial, is an intensified strategic focus on improved use of bystander CPR and bystander or first responder defibrillation.

The recent Institute of Medicine (IOM) report, "Strategies to Improve Cardiac Arrest Survival: A Time to Act," identified poor outcomes after OHCA as a major unsolved public health problem because of a lack of implementation of interventions known to be effective. The report calls for adoption of a number of

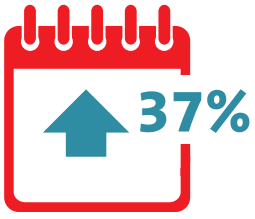
interventions likely to maintain blood flow to the cardiac arrest patient's brain and to increase their functional survival. Such interventions include rapid initiation of effective CPR by those who are at the patient's side: first bystanders, then dispatched first responders (police officers, firefighters, rescue squads, or life-saving crew members trained to perform basic life support until the paramedics arrive), then EMS, and lastly advanced multidisciplinary critical care at hospital admission. This requires a highly coordinated approach to cardiac resuscitation from all those involved in providing care. Moreover, the IOM report prioritizes the need for implementation research aimed at identifying, evaluating, and adopting best practices as well as new treatment implementation strategies. To provide the highest level of evidence the IOM has called for a randomized clinical trial testing best implementation strategies. Our NC emergency care infrastructure was cited by the IOM as a national model other states could follow to develop and maintain a statewide system to evaluate and improve cardiac arrest treatment and outcomes.



Median time from 911 call to first CPR is approximately **6 minutes** *and time to first defibrillation is approximately* **12 minutes**.

The NC EMS system includes 100 counties and the Cherokee Tribal Nation, over 305 EMS agencies with over 8,550 paramedics, and 125 hospitals including 23 with the capability to perform coronary artery interventions and critical care interventions. Building on this NC emergency care infrastructure, RACE-CARS randomized 57 NC EMS agencies (62 counties, some counties share EMS agency resources) in a 1:1 fashion to intervention or usual care. Based upon most recent statistics for the state, we estimate that over the 4 years of the intervention phase we will enroll about 20,000 adult patients with cardiac arrest. The structured intervention program will consist of 4 elements: (1) optimized medical 911 dispatch performance focused on enhanced recognition of possible cardiac arrest, (2) enhanced bystander initiation of CPR by 911- telephone coaches, (3) comprehensive community training of lay people in CPR and AED use, and (4) improved first responder performance including expanded engagement to achieve earlier use of AEDs. While all these approacheshave been used in prior research on OHCA outcomes, RACE-CARS is unique in combining these efforts into a strategic focused intervention that can be adjusted to the needs and abilities of individual counties and thus should be generalizable to counties across the US that vary according to population density, demographic and socioeconomic status and other potentially important factors. In a previous nonrandomized study of community and EMS interventions in 11 NC counties, we observed improved rates of bystander CPR and first responder defibrillation, associated with an observed 37% increase in survival with good neurologic outcome over a 4-year period. The present proposed trial extends this work to a larger more diverse group of counties and adds the experimental rigor of a cluster randomized design.

...improved rates of bystander CPR and first responder defibrillation, associated with an observed 37% increase in survival...



STUDY OVERVIEW

STUDY DESIGN

RACE-CARS is a pragmatic cluster-randomized trial designed to compare a multifaceted intervention to usual care. The structured intervention program will consist of 4 elements: (a) use of rapid cardiac arrest recognition protocols triggering immediate EMS/ first responder dispatch by 911 telecommunicators, (b) systematic bystander resuscitation instruction by 911 telecommunicators, (c) comprehensive community training of lay people in CPR and AED use, and (d) improved first responder performance including earlier deployment to cardiac arrests and earlier use of AEDs.

STUDY OBJECTIVES

Primary Objectives:

1. Improve survival to hospital discharge with good neurologic function by 33%.

Secondary Objectives:

1. Increase bystander rates of CPR in intervention counties by 33% compared with control counties.
2. Increase rates of bystander or first responder defibrillation prior to paramedic (emergency medical provider trained in advanced cardiac resuscitation) arrival in intervention counties by 50% compared to control counties.

Tertiary Objectives:

1. Compare rates of recognition of cardiac arrest and telephone CPR instruction by dispatch centers.
2. Compare rates of overall hospital survival.
3. Compare functional status at 3 and 12 months.
4. Compare quality of life at 3 and 12 months.
5. Assess intermediate measures of implementation in the intervention counties.
   a. RE-AIM framework (reach, effectiveness, adoption, implementation, maintenance metrics under development).

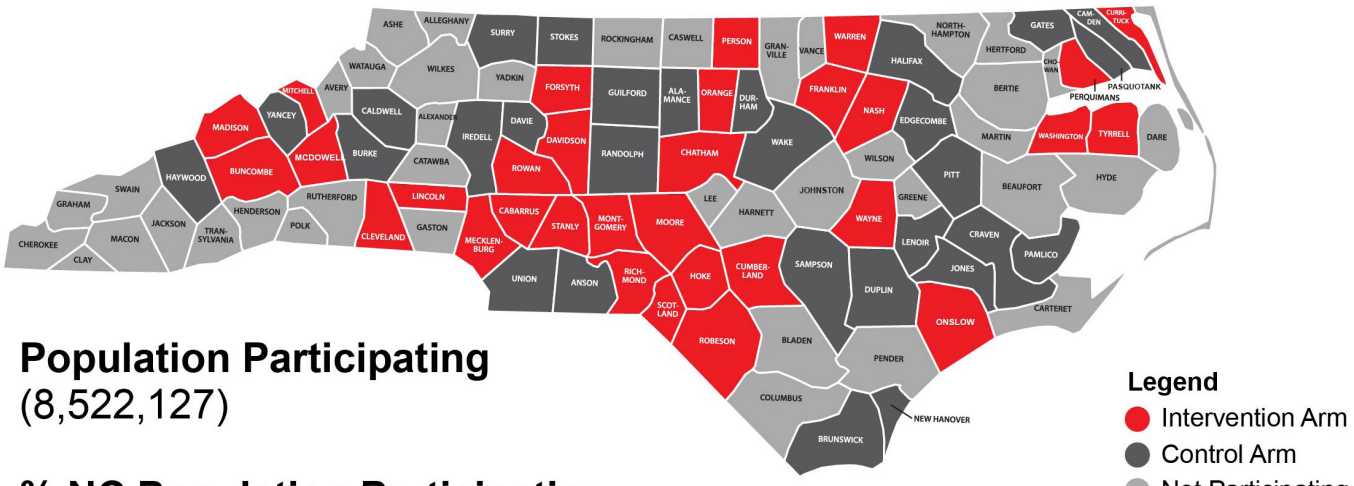
RECRUITMENT

RACE-CARS randomized 57 county clusters (62 counties) in NC with an estimated 20,000 patients with cardiac arrest. We randomized the 57 county clusters in a 1:1 fashion to intervention versus usual care. In order to minimize variation between counties, we used a covariate-constrained randomization between clusters in the two arms (Table 1). Within most counties, consecutive data are already being collected on all cardiac arrests through the Cardiac Arrest Registry to Enhance Survival (CARES). Figure 2 below lists the final randomization arm of each county. Final trial enrollment/participation was 55 county clusters (60 counties).

Table 1. Randomization

County Characteristics	Summary Statistic	Intervention N=29	Control N=28	% Standardized Difference
Population size 2010 census	Mean (SD)	132967 (1741970)	135888 (178945)	1.65%
Cardiac arrest, survival rate	Mean (SD)	8.7 (3.9)	8.6 (3.7)	3.05%
Location: Rural vs. Urban	Count/Total (Percentage)	15/29 (51.7%)	15/28 (53.6%)	3.70%
African American, percentage	Mean (SD)	21.8 (14.0)	21.6 (16.1)	1.02%
Hispanic ethnicity, percentage	Mean (SD)	6.7 (3.3)	6.9 (4.5)	3.95%
Average Income, Dollars	Mean (SD)	55780 (10237)	55837 (10927)	0.53%
CPR prior ro EMS arrival, percentage	Mean (SD)	40.1 (7.6)	39.6 (10.5)	5.17%
Defibrillation prior to EMS arrival, percentage	Mean (SD)	9.8 (6.6)	9.7 (4.8)	1.41%

Figure 2. Participation Map

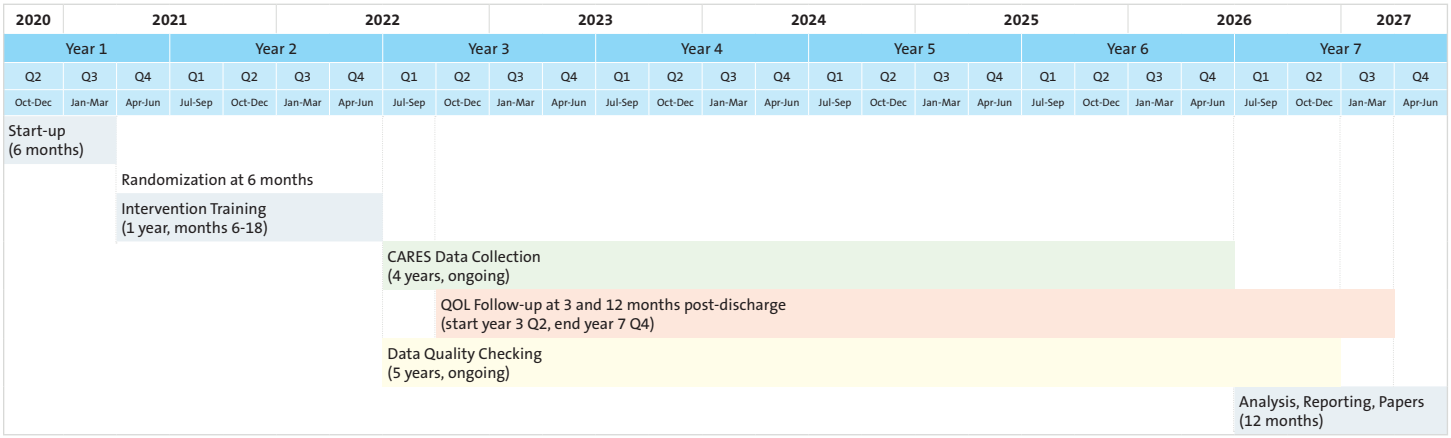


TIMELINE

RACE-CARS is an NIH/NHLBI sponsored trial with a duration of 7 years and consists of:
(See figure 3 for timeline)

- Start-up period.
- Randomization and recruitment period.
- Intervention training period.
- 4-year intervention period.
- Data collection including the 12-month follow-up for quality of life period.
- Close-out and data analysis period.

Figure 3. Timeline



CARDIAC ARREST REGISTRY TO ENHANCE SURVIVAL (CARES) AND LONG TERM FOLLOW UP STUDY DATA

CARES data collection has been ongoing in NC since 2012. The registry collects comprehensive cardiac arrest information including 911 call center information (performance metrics), bystander and first responder treatments, EMS care, hospital care, and prehospital and hospital outcomes. The CARES database is critical to our trial because all information entered will be used to monitor trial process and to examine the impact of the intervention.

All intervention counties have implemented a new CARES data collection module for 911 dispatch data (module previously optional). This dispatch module collects details on the recognition and on delivery of telephone CPR instructions for cardiac arrest. Our tertiary outcomes metrics will be obtained from this dispatch module and include 911-call to the recognition of cardiac arrest, time from call to CPR instruction, and time from call to first chest compression.

There is a long-term follow-up component to the RACE-CARS trial where we will assess functional status and health related quality of life. These data will be combined with the CARES data for each cardiac arrest survivor. These long-term outcomes will be collected at 3 and 12 months.

To measure the impact of the intervention, we are working with sites to generate and discuss cardiac arrest performance. We have conducted individual site meetings yearly where we work to identify incremental opportunities to improve intervention, treatment and outcomes. There are routinely schedule calls with community partners, 911 and EMS to discuss ongoing trial work, best practices, and barriers to implementing the 4 trial interventions. There are 2 state meetings, one in the east and one in the west, to review overall trial progress and presentations of best practices. Yearly, we also have regional meetings to bring intervention counties together to share ideas and resources.

ELIGIBILITY CRITERIA: INCLUSION

1. Patients age >=18 years who experience a non-traumatic, out-of-hospital cardiac arrest.
2. Patients who are pulseless on arrival of 911 Responder; OR
3. Patients who become pulseless in the presence of 911 Responder; OR
4. Patients who have a pulse on arrival of 911 Responder, where a successful attempt at defibrillation was undertaken by a bystander prior to arrival of 911 responder.

ELIGIBILITY CRITERIA: EXCLUSION

1. Age <18 years old age.
2. Unworked/untreated cardiac arrests, to include codes that are terminated immediately upon arrival of EMS because the patient is not a viable candidate for resuscitation due to:
   a. Injuries incompatible with life.
   b. The presence of rigor mortis or lividity.
   c. Signs of decomposition.
   d. Presence of a valid DNR.
3. Private EMS transport that did not involve 911 dispatch (example: inter-facility transport between nursing home and hospital).
4. Cardiac arrest of clear and obvious traumatic etiology.
5. Bystander suspected cardiac arrest, where ROSC was achieved without the need for defibrillation or 911 Responder CPR.

Figure 4. CARES EMS and Hospital Module Data Elements

Run ID	Dispatcher CPR instructions provided	ITD used	Original Emergency Room outcome	Ambulance dispatched	Percent below poverty category
EMS agency	Was an AED applied prior to EMS arrival?	ITD used detail	Transfer to hospital ID	Ambulance en route	Total population
Date of arrest	Who first applied the AED?	ITD used other	Hospital (Trans) - Was hypothermia care initiated/continued?	FR on scene	White alone
Year of arrest	Did police first apply the AED?	Were drugs administered?	Hospital section status	Ambulance on scene	Black or African American alone
Age (Years)	Who first defibrillated the patient?	Drugs administered detail	Transferred hospital section status	EMS at patient side	American Indian and Alaska Native alone
Gender	Did police first defibrillate the patient?	Vascular access	Final diagnosis myocardialinfarction	Ambulance left scene	Asian alone
Race/ethnicity	Did 911 responder perform CPR?	12 Lead	Coronary angiography performed	Ambulance arrived at ED	Native Hawaiian and other Pacific Islander alone
Medical history	First monitored rhythm	STEMI	Coronary angiography date	Latitude	Some other race alone
Destination hospital ID	First rhythm type	STEMI location	Coronary angiography time	Longitude	Two or more races
Location type	Sustained ROSC	End of the event	Was a cardiac stent placed?	Tract ID	Population per square mile
Location type category	When did sustained ROSC first occur?	Emergency Room outcome	CABG performed	Median household income in the past 12 months (in 2018 inflation-adjusted dollars)	Rural urban continuum code
Arrest witnessed	Was hypothermia care provided in the field?	Survived to hospital admission?	ICD placed and/or scheduled	Median age	Total population-urban/rural
Arrest after arrival of 911 responder	When was hypothermia care initiated?	Hospital outcome	Date of discharge/ death	Median age: Male	Urban: Inside urbanized areas
Arrest witnessed status	Mechanical CPR device used	Patient made DNR outcome	Time of discharge/ death	Median age: Female	Urban: Inside urban clusters
Presumed cardiac arrest etiology	Mechanical CPR device used detail	Survived to hospital discharge?	Estimated time of arrest	Percent male	Rural
Resuscitation attempted	Mechanical CPR device other	Discharge from the hospital	Time of 1st CPR	Population 25 years and over	
Initiated CPR	Automated CPR feedback device used	Neurological outcome	Time of 1st defibrillation	High school diploma or higher	
Type of bystander CPR provided	Advanced airway successfully placed in the field	CPC Score	Call received at dispatch center	Average household size	
	Advanced airway detail	Hospital - Was hypothermia care initiated/continued?	FR dispatched	Unemployment Rate	
	Advanced airway other	Why was hypothermia care not initiated or continued in the hospital?	FR en route	Percent below poverty level	

Figure 5. CARE Dispatch Module Element

Preliminary	Patient	Time Measures
Cardiac Arrest Before Arrival of EMS	Age Classification: Infant, Child, Adult	Transfer Call
CPR Already in Progress	Conscious	Time Elapsed before Dispatcher first addressed caller
Did Dispatch recognize need for CPR	Breathing Normally	Dispatch Recognized Need for CPR
CPR Instructions Started	**Comments**	Dispatcher Began Instructions
Were Compressions Started	Coaching or Compliments for Dispatcher	Time to First Compressions
Barriers to CPR	Other Comments	

Reports specific to the interventions adopted by each EMS site will be provided on a quarterly basis. All data specifically identified by EMS site will be held confidential and shared only with the specific EMS and 911 agencies and trial staff. Trial staff may use blinded data or aggregated data to convey information to intervention sites as needed.

For every minute the chance of survival decreases by 10% if nothing is done.

INTERVENTION PLAN

Each intervention county will develop a written intervention action plan, which will evolve over the course of the trial. The plan needs to be customized to each county, given the specific needs and opportunities. All intervention counties should address the four interventions as outlined below.

INTERVENTIONS

Intervention 1: Rapid cardiac arrest recognition protocols that trigger immediate priority EMS/first responder dispatch by 911 telecommunicators.

Intervention 2: Systematic bystander resuscitation instruction by 911 telecommunicators.

The first two interventions involve quality improvement efforts to be implemented by 911 dispatch telecommunicators (TCs). During the implementation phase of the trial, each intervention county will review its status in relation to the EMS dispatch protocols and develop a detailed plan to optimize cardiac arrest recognition, dispatch performance, and 911 CPR and AED instruction to bystanders. The RACE-CARS Intervention team will assist each county with developing their customized plan based on customized reports and interventions. The CARES database dispatch module will be used to collect quality metrics such as rates of recognition by 911 rates of CPR started, median time from 911-call to recognition of cardiac arrest, time from call to CPR instruction, time from call to first chest compression, and barriers to starting CPR as recommended by current resuscitation guidelines.

Basic Recommendations

1. Data collection and timely entry into the CARES Dispatch Module.
   a. CARES data manger will schedule a time to train you.
   b. Data entry of cases as soon as possible but no more than 30 days after the event (contingent on EMS entry).
   c. Prompt action if contacted by the CARES manager to resolve any issues.
2. Review every cardiac arrest call that meets the CARES Dispatch Module criteria–EMS confirms it is a cardiac arrest and a resuscitation has been attempted.

3. Establish a line of communication with EMS and your Medical Director.
    a. EMS CARES cases generate the 911 case.
    b. Establish a contact at EMS to resolve any issues.
    c. Medical Director has oversight of the dispatch protocols and usually EMS protocols as well.
    d. Agreement from Fire and Law enforcement to respond to all cardiac arrest calls.
4. Train and provide continuing education in dispatch assisted cardiopulmonary resuscitation (DACPR) for all TCs.
    a. Training for 100% of TCs.
        i. Initial training will require an estimated 3-4 hours.
        ii. Follow the AHA recommendations for content.
    b. Require ongoing continuing education.
        i. This will require 2-3 hours annually.
        ii. Follow the AHA recommendations for content.
    c. Identify additional training based on your performance data (CARES Dispatch Module).
5. Create a recognition program for outstanding TC performance.
6. Establish communication between 911, Fire, Law, and EMS to share data.
7. Create Action Plan for improvement efforts.
    a. Goal is first compression in ≤ 180 seconds, the minimum acceptable standard.
    b. Implement steps to decrease the time.
        i. Education on early recognition of cardiac arrest and strategies to manage that call.
        ii. Implement the no, no, go strategy.
        iii. Unless the arrest happens in a public location, implementation strategies to quickly move through the AED question (examples may include-don't ask it if is an arrest at residence or if they ask what it is, move on to the next instruction).

Advanced Recommendations

1. Use social media to activate lay person responders.
2. Create and map a comprehensive AED list.
    a. Partner with Fire, EMS, and GIS staff.
    b. Merge the 911 list, NCOEMS list, and other lists that you may have.
3. Participate in community training events.

BEST PRACTICES

Training & Education

- Telecommunicators trained and certified in CPR.
- Follow AHA-recommended T-CPR training standards; provide frequent refreshers for these low-frequency, high-acuity calls.
- Train staff to move rapidly through the cardiac arrest protocol with the goal of achieving hands-on-chest as quickly as possible.
- Train on effective caller coaching techniques.
- Provide video-based training on safely repositioning patients when necessary.
- Evaluate barriers to CPR and develop targeted training to address recurring issues.
- Use AI-assisted training and call review tools to enhance learning and performance improvement.

Call Processing & Cardiac Arrest Recognition

- Use a standardized cardiac arrest interrogation process.
- Assess responsiveness and breathing immediately.
- Treat agonal breathing as cardiac arrest until proven otherwise.
- Use Fast-Track processes for early dispatch when appropriate.
- Avoid delays from excessive patient movement; begin CPR instructions in place when feasible.
- Achieve rapid cardiac arrest recognition and minimize time to first chest compression.

DA-CPR Delivery & Caller Coaching

- Begin DA-CPR instructions immediately after arrest recognition.
- Use simple, direct, confident instructions.
- Evaluate telecommunicator coaching techniques and provide feedback.
- If a caller asks what an AED is, provide brief direction and continue moving through the protocol.
- Allow telecommunicators to review their own calls, identify strengths and opportunities for improvement, then incorporate QA feedback.
- When possible, have additional telecommunicators assist during active cardiac arrest calls.

AED Program & Community Preparedness

- Ask about AED availability when appropriate.
- If the arrest is not in a public location, consider omitting the AED question per local protocol/ APCO guidance.
- Work with GIS partners to evaluate AED placement and coverage gaps.
- Engage Fire Marshals and community partners to identify AED locations and improve AED signage, placement, and public awareness.
- Promote AED training and public readiness programs.

Technology & Innovation

- Implement video-to-911 capabilities to allow telecommunicators to visualize the scene and improve guidance.
- Use AI tools for training, call review, and performance feedback.
- Maintain systems that support rapid identification of AED locations.

Quality Improvement & Performance Monitoring

- Review cardiac arrest protocols regularly with telecommunicators and supervisors.
- Focus protocol reviews on reducing time to hands-on-chest.
- Provide monthly updates to staff on CPR benchmark performance.
- Track arrest recognition time and time to first chest compression.
- Conduct routine cardiac arrest case reviews.
- Share 911 call data with EMS/CARES abstractors to verify CPR initiation and performance metrics.
- Use QA findings to drive targeted training and protocol improvements.

Recognition & Culture

- Recognize staff who contribute to cardiac arrest saves.
- Highlight success stories and performance achievements.
- Foster a team approach to cardiac arrest call handling and continuous improvement.
- Provide your feedback.

Training & Interagency Collaboration

- Hire a training specialist to serve as a liaison between Fire, EMS, and Law Enforcement.
- Conduct regular joint Fire/EMS Team CPR training.
- Include Law Enforcement in cardiac arrest response training and exercises.
- Standardize roles and responsibilities for multi-agency cardiac arrest response.
- Use after-action reviews to identify opportunities for improvement.

AED Access & Deployment

- Equip Fire and Law Enforcement vehicles with AEDs.
- Place AEDs in personal vehicles of frequent volunteer responders when feasible.
- Move AEDs outside fire stations or other facilities to allow faster access during emergencies.
- Place AEDs outside public buildings to improve 24/7 accessibility.
- Evaluate AED placement and relocate devices based on response patterns and cardiac arrest hotspots.

Rural Response Strategies

- Develop non-traditional response models for rural communities.
- Dispatch the closest available responder directly to the scene to begin high-quality CPR as soon as possible.
- Allow responders to retrieve AEDs en route rather than requiring a stop at the station.
- Identify and address geographic barriers that delay CPR and defibrillation.

Community Responder Programs

- Implement an off-duty responder smartphone application to alert nearby trained responders.
- Recruit and engage volunteer responders in rural and underserved areas.
- Promote community CPR and AED training programs.
- Encourage participation from public safety personnel as community cardiac arrest champions.

AED Program Leadership

- Engage Fire Marshals in AED initiatives.
- Maintain an inventory of AED locations throughout the community.
- Assist businesses and organizations with AED placement recommendations.
- Promote best practices for AED signage, accessibility, maintenance, and reporting.
- Support public education regarding AED use and availability.

Recognition & Survivor Engagement

- Recognize responders for cardiac arrest saves.
- Recognize exceptional care even when the patient does not survive.
- Include Fire, EMS, Law Enforcement, dispatchers, and bystanders in survivor celebrations.
- Use county commissioner meetings and public events to recognize responders and survivors.
- Leverage recognition events to build support for cardiac arrest programs and AED funding.

Leadership & System Improvement

- Establish cardiac arrest response as a shared Fire, EMS, and Law Enforcement priority.
- Review response data to identify opportunities to reduce time to CPR and defibrillation.
- Track first-responder arrival times, CPR initiation, and AED application.
- Use success stories and outcome data to support funding requests for AEDs, training, and responder programs.

Intervention 3: Comprehensive community training of lay people in CPR and AED use.

Basic Recommendations

1. **Community Partner Group**: Form a group with community partners to teach CPR and spread awareness about sudden cardiac arrest in your area.
   a. The EMS trial coordinator establishes and leads the group, coordinating partners and activities. Recruit partners from various sectors, such as local health systems, 911, fire, law enforcement, colleges, service clubs, non-profits, churches, and interested citizens.
   b. *Train-the-trainer*: Expand the community partner group's training reach through training volunteer partners to teach hands-only CPR.
   c. Meet routinely to stay connected and consider sharing event details through email lists or shared calendars.
   d. Collect training numbers from community partners, such as through QR codes linking to an online tracking form.
   e. Report all training numbers to the trial through the RACE-CARS community intervention survey, including any underserved or specialty populations separately.
2. **County Leadership Partnerships**: Partner with local leaders (e.g., county commissioners, hospital, school, and business leaders) toward community efforts. Successful partnerships involve leaders committing to any of the following:
   a. Assigning representatives to the community partner group.
   b. Participating or leading training events.
   c. Contributing to fundraising efforts.
   d. Supporting sudden cardiac arrest-related advocacy, legislation, or policy formation.
   e. Establishing policies to train everyone in their organization in hands-only CPR.
3. **Community CPR Training Events**: Organize events with the community partner group to teach hands-only CPR and AED use.
   a. Follow the 4 C's approach (*Check, Call, Compress, Connect*) and concentrate on:
      i. Recognizing cardiac arrest.
      ii. Calling 911.
      iii. Retrieving an available AED.
      iv. Performing hands-only CPR (self-initiated or with dispatch assistance).
      v. Reviewing the steps to use an AED.
   b. Prioritize busy venues and interested groups, such as events, festivals, and faith congregations. Encourage trainees to train their family at home (i.e., provide heart-shaped stress balls for home education).
   c. Use training events as an opportunity to encourage AED placement in visible, easily accessible areas, such as outside rather than inside the buildings.

Advanced Recommendations

4. **Organizational Training**: Work with large employers (health systems, county government, schools, businesses) to create a policy to train all staff in CPR and AED use during new employee orientation, refreshed yearly.
   a. Target major employers to sustainably reach a substantial portion of the county's population beyond what individual training events could reach.

   b. Where possible, use a train-the-trainer approach to establish a local trainer within the workplace. Implement the HeartSafe Workplace Initiative. Workplaces must train all employees in hands-only CPR. Workplaces must maintain a cardiac arrest emergency response plan.
5. **Underrepresented Population Outreach**: Strive to form inclusive partnerships to ensure fair access to cardiac arrest education and resources, especially for populations disproportionately affected by cardiac arrest.
   a. Identify disparities based on factors like race, location, ethnicity, and income.
   b. Create a plan targeting these gaps with specific strategies, like locating high-density housing or churches in high cardiac arrest areas.
   c. Host training events for specific populations, such as training bilingual staff for migrant workers, and track progress.
6. **Public-Facing Cardiac Arrest Promotion**: Increase public-facing activity in the community to raise awareness about cardiac arrest.
   a. Host a survivor celebration event annually, sharing stories to motivate and change behavior.
   b. Use local media like billboards, TV/radio, and social media to promote awareness and share success stories, including your community partner group's efforts and national stories like Damar Hamlin, the Buffalo Bills player who survived cardiac arrest.
   c. Recognize survivors and staff at county commissioner meetings to raise awareness and highlight the financial needs of providing best cardiac arrest care.

BEST PRACTICES

- Integrate CPR into Drivers Ed programs.
- Ensure local high school students are trained in CPR per House Bill 837 (Effective with the Class of 2015) and House Bill 914.
- Secure funding for training resources and community-placed AEDs. Consider forming a non-profit, partnering with local businesses, or applying for grants.
- Conduct training in waiting rooms for families of cardiology/internal medicine patients.
- Include training upon discharge for STEMI patients, cardiac arrest survivors, and their families.
- Repurpose simulation labs for community CPR training.
- Use staff downtime for community efforts, such as tracking AED locations from businesses.
- Identify "hot spot areas" of increased cardiac arrest to deploy training efforts using geocoding, such on densely populated housing.
- Work with colleges and universities to establish CPR training initiatives.
- Tailor training methods to be culturally competent and inclusive.

Intervention 4: Optimized first responder performance including earlier use of AEDs.

First responders are one the most important components to improve cardiac arrest survival. They represent the first trained rescuers to physically encounter the patient. While most first responders are fire-based, in NC there are examples of fire department-based, law enforcement-based, rescue squad-based and even industrial based first response services. First responder/public safety resources should be optimized to deliver cardiac arrest care based on minimizing the time to CPR and time to defibrillation while maximizing the quality of CPR. This would include Fire and Law enforcement agreeing to be dispatched to all cardiac arrest calls, working towards 24/7 coverage in all Fire stations, and provision of AEDs to all personnel that are responding. Efforts would look at opportunities to ensure that all public safety resources are trained in CPR and well versed with the local systems. Every emergency vehicle routinely dispatched on medical emergencies should have an AED and policies in place designed to optimize care to the cardiac arrest victim.

Basic Recommendations

1. Survey to understand current first responder response and resources.
2. Respond to all cardiac arrest calls.
3. Have all response vehicles equipped with an AED.
4. Identify strategies for volunteers to arrive with an AED without having to go by the station (ones who respond the most, relocate AED's that could be picked up on the way, send the closest to the scene to assure high quality CPR while the others get the AED, etc.).
5. Use high quality CPR-Team based approach .
   a. Assign personnel to monitor chest compressions including rate, depth, full recoil, and pauses.
   b. Limit pauses in chest compression to extent possible including minimal pause for defibrillation.
   c. Rotate every 2 minute.
6. Participate in community training events.
7. Establish communication between 911, Fire, Law, and EMS to share data.

Advanced Recommendations

1. Consider ways to include more existing public safety resources into cardiac arrest plan. Examples on non – traditional resources:
   - Traditional law enforcement (Municipal Police, Sheriff and Highway Patrol).
   - Campus police /security for academic facilities as well as major employment centers.
   - Industrial Fire Brigades and medical response teams.
   - Park rangers and game wardens.
   - Department of Transportation Vehicles Assistance Patrols.
2. Place an AED in a personal vehicle for the most frequent volunteer responder to cardiac arrest.
3. Consider moving AEDs to the exterior of buildings and/or move to a central location where the AED is visible and accessible.
4. Add signage to all areas that have AEDs.
5. Petition county government to fund 24/7 coverage at all Fire stations and AEDs in all responding vehicles.

BEST PRACTICES

- Hire training specialist to act as liaison between fire and EMS.
- Fire and EMS train together for Team CPR.
- Place an AED in a personal vehicle for the most frequent volunteer responder to cardiac arrest.
- Place AEDs outside of buildings.
- Provide AED for fire and law enforcement.

- Use county commissioner meeting to recognize staff and survivors as recruiting strategy.
- Recognition for saves and/or for good care was provided but the patient did not survive.
- Use Fire Marshals in AED efforts, identification, reporting, and recommendation of AED best practices to owners.

EMS LEADERSHIP AS THE TRIAL COORDINATOR

Sudden cardiac arrest is one of the two conditions for which EMS systems were originally designed. In recent years, much new evidence has accumulated to inform and guide the care and treatment for SCA victims.

Successful resuscitation for patients in cardiac arrest requires a systems approach. Because of its extreme emergent onset and limited window for intervention, successful systems must develop an integrated, community-wide system of care, beginning with bystander care and continuing through coordinated care in the hospital.

The EMS role will be critical in coordinating the intervention work at the county level, working with a team of representatives from 911- dispatch centers, EMS education, community organizations, first responders and health systems, and they will interface with the implementation team. They will assure data capture and entry, report generation and review, and refinement of plans based on data measurement and feedback. This approach of establishing and working with regional teams, using a refined menu of specific interventions tailored to the local needs and barriers, coached by our experienced coordinating center staff, with measurement and feedback for refining the intervention, has been highly successful in our previous programs of emergency care quality improvement for acute myocardial infarction (MI) in NC.

Step 1: Engage with 911, Fire, hospitals, and community organizations

1. Send announcement and your role in the trial (RACE-CARS Trial Letter to Partners document).
2. Schedule calls to discuss the trial interventions.
3. Create working group to address the community efforts component.
4. Track metrics; bystander, AED defibrillation prior to EMS arrival, survival, and survival with good neurological outcomes.

Step 2: Organize community education and AED efforts

1. See community recommendations.
2. Track metrics; bystander, AED defibrillation prior to EMS arrival, survival, and survival with good neurological outcomes.
3. Track training metrics; number of events, number trained, location, and date.

Step 3: Goal–Develop quality improvement process for OHCA in concert with hospital, first responders (fire and law), and 911

1. Case review process for all OHCA events with formal feedback to team including CPR metrics where available.
2. Feedback of survival information to EMS staff, 911, and first responders.
3. CARES registry data collection.
4. Share project reports.
5. Regularly meet with team.

Step 4: Optimize Team Based CPR plan

1. Goal: First Responders and EMS using the same team plan.
   a. Interagency drill / training on CPR and AED scenario.
2. Goal: Optimize defibrillation / reduce time to defibrillation.
3. Goal: No interruption in quality of CPR as advanced care is introduced to patient.
   a. Allowable interruption for <10 seconds.
4. Goal: Chest compression fraction >60%.
   a. Use of CPR feedback devices to assure quality of CPR.
   b. Use of CPR monitoring by electronic devices to provide record of performance for post event evaluation.
   c. Consider team member assigned to track compression fraction manually if electronic means not available.
5. Goal: Utilize check sheets during cardiac arrest to provide maximum process reliability and minimize variation.
6. Education-EMS Experience and Exposure.
   a. EMS systems should monitor their clinical personnel's exposure to resuscitation and, where possible, implement strategies to address low exposure.
   b. Training with other responder agencies is essential to ensure that all providers are prepared to work together effectively.

Step 5: Organize Survivor Celebrations

1. Work with local hospitals as partners.
2. Find vendors to cover costs of food, venue, other.
3. Invite:
   a. Survivors.
   b. Families.
   c. Reps from the links in the chain of survival involved in events.
      i. 911 Center.
      ii. First Responders.
      iii. EMS.
      iv. Emergency Department and Hospital Staff.
   d. Bystanders who performed CPR.
   e. Local politicians.
   f. Media coverage.

Expectation of Requirement of participating EMS agencies and other emergency entities

1. Timely CARES Data Entry – Each EMS agency will have a primary responsibility for timely CARES data entry, including DACPR module and pursuing hospital data, for the RACE-CARS clinical trial.
2. Recruitment of Strategic Partners
   - Each EMS agency will be responsible for coordinating the participation of 911 dispatch center, first responder, and community leaders in the trial. In conjunction with the RACE-CARS team, EMS agencies will work with each community partner to implement and carry out consistent interventions. EMS agencies will help to ensure that implementation has occurred with each emergency agency.
3. Recruitment of Cardiac Arrest Survivors for Long-Term Follow-Up
   - We will collaborate with EMS agencies in each of the 60 participating counties to approach survivors and their caregivers and get permission for DCRI to conduct telephone-based structured interviews that will define more comprehensively their outcomes and extent of recovery/impairment.

- EMS agencies will establish a process to identify survivors from the CARES registry, obtain contact information, mail out the "Opt Out" letter, and provide contact information to the DCRI call center. This contact information will be used by the RACE-CARS study team to contact the patient by telephone at 3 and 12 months post-hospital discharge to ask a brief set of questions about the survivor's quality of life and functional ability. EMS will be responsible for troubleshooting any wrong addresses and/or phone numbers.

4. Intervention Conduct
   - Participating EMS agencies assigned to the intervention will work with dedicated RACE-CARS implementation staff to carry out details of the intervention throughout the trial conduct period.
5. Attendance on calls, site visits, regional visits, and state meetings.

LONG TERM FOLLOW UP STUDY-QUALITY OF LIFE OVERVIEW

Our primary goal of increasing the number of survivors to hospital discharge with good neurological function is important, but its health policy implications are strongly dependent on how well those survivors do long term and how much producing these incremental health benefits will cost counties. We will conduct quality of life (QOL) follow-up interviews for cardiac arrest patients who survive cardiac arrest to hospital discharge. We will partner with EMS agencies in each of the 60 participating counties to approach survivors and their caregivers and get permission for DCRI to conduct telephone-based structured interviews that will define more comprehensively their outcomes and extent of recovery and impairment.

Throughout our 4-year data collection period, we expect to enroll approximately 750 survivors across intervention and control sites. The DCRI call center will conduct the surveys. Survivors will be identified under the direction of the EMS county coordinators and consent will be obtained for this follow-up by the DCRI call center.

Each consented survivor will be followed at approximately 3 and 12 months for quality of life (SF-36) and functional status outcomes (modified Rankin score, telephone version); and to assess intermediate measures of implementation in the intervention counties. Functional status and Quality of Life will be compared between the two intervals.

Quality Control: To ensure that we are contacting all available cardiac arrest survivors, the NC CARES Coordinator will generate a list of survivors from CARES and compare to the list of survivors who have been submitted by each agency. The clinical trial coordinator will follow-up with the counties on a regular basis to resolve any outstanding missing survivors and/or contact information. Vital status will also be collected at 12 months.

Survivor Data: EMS coordinators will collect demographic and contact information (name, gender, address, date of birth, phone numbers – mobile and landline, email address, CPC score, date of cardiac arrest, if they passed away after discharge, date of death, CARES patient identifier) and send the survivor an "Opt Out" letter. The contact information will be entered into the REDCap database. The project leader, clinical trial coordinator, and DCRI call center staff will have access to contact information to conduct the informed consent process and the long-term follow-up study. The EMS agency will need to troubleshoot all wrong addresses and/or phone numbers. All contact information will be stored behind a secure firewall in a password-protected database. Only the DCRI call center will have access to this contact information.

TOP 10 CHECK LIST

1. **Concentrate on 3 most important process measures:**
   Community – Bystander CPR Rate
   First responder – AED before Advanced Life Support (ALS) arrival
   Telecommunicator – less than 180 seconds to telecommunicator CPR (TCPR)
2. **Recruit county commissioner and CEO/head of health system to be directly involved** (and give them credit for help in saving lives!).
3. **Recognize a heart safe workplace** (if not already done).
4. **Host annual survivor celebration** (if not already doing).
5. **Review** (and provide feedback) **your dispatch data** (recognition, telecommunicator assisted CPR, time to hands on chest) **and have specific steps for improvement .**
6. **Establish program to train "large groups" of county employees hands-only CPR** (engage safety staff, train the trainer).
7. **Identify 2 or 3 "super responders" and get them AEDs for private vehicle** (EMS, fire, law enforcement who keep radio on at night and respond to emergencies "off duty").
8. **Get sheriff departments to respond to cardiac arrests with AEDs.**
9. **Train all members in hands only CPR/AED use:**
   1. Health systems
   2. Churches
   3. Schools
10. **Know that by doing these things, you will save lives in your community!**

ACRONYMS

1.	APCO	Association of Public-safety Communications Officials
2.	ACLS	advanced cardiac life support
3.	ACS	acute coronary syndrome
4.	AED	automated external defibrillator
5.	AHA	American Heart Association
6.	ALS	advanced life support
7.	AMI	acute myocardial infarction
8.	ARC	American Red Cross
9.	BLS	basic life support
10.	CAC	cardiac arrest center
11.	CARES	Cardiac Arrest Registry to Enhance Survival
12.	CCC	clinical coordinating center
13.	CO2	carbon dioxide
14.	CPC	cerebral performance category
15.	CPR	cardiopulmonary resuscitation
16.	CQI	continuous quality improvement
17.	DACPR	dispatch assisted cardiopulmonary resuscitation
18.	DCC	data coordinating center
19.	DCRI	Duke Clinical Research Institute
20.	DNR	do not resuscitate
21.	DSD	double sequence defibrillation

22.	DSMB	data safety monitoring board
23.	ECC	emergency cardiovascular care
24.	ECG	electrocardiogram
25.	ED	emergency department
26.	EMD	emergency medical dispatch
27.	EMS	emergency medical service
28.	EMT	emergency medical technician
29.	ERC	European Resuscitation Council
30.	HP CPR	high performance cardiopulmonary resuscitation
31.	I.O.	intraosseous
32.	I.V.	intravenous
33.	ICCA	incident command for cardiac arrest
34.	ILCOR	International Liaison Committee on Resuscitation
35.	IOM	Institute of Medicine
36.	MI	Myocardial Infarction
37.	NC	North Carolina
38.	NHLBI	National Heart, Lung and Blood Institute
39.	NIH	National Institute of Health
40.	OHCA	out of hospital cardiac arrest
41.	PAD	public access defibrillation
42.	PEA	pulseless electrical activity
43.	PPCI	primary percutaneous coronary intervention
44.	PSAP	public safety answering point
45.	QI	quality improvement
46.	QOL	quality of life
47.	RACE-CARS	RAndomized Cluster Evaluation of Cardiac ARrest Systems
48.	RCT	randomized clinical trial
49.	RE-AIM	reach, effectiveness, adoption, implementation, maintenance
50.	ROSC	return of spontaneous circulation
51.	SCA	sudden cardiac arrest
52.	SCD	sudden cardiac death
53.	SF-36	short form health survey
54.	SOC	system of care
55.	STEMI	ST-elevating myocardial infarction
56.	TCPR	telephone-assisted cardiopulmonary resuscitation
57.	TFCPR	team focused cardiopulmonary resuscitation
58.	TC	Tele-communicator
59.	VF	ventricular fibrillation
60.	VT	ventricular tachycardia
61.	YMCA	Young Men's Christian Association

NOTES