Out-of-Hospital Cardiac Arrest In North Carolina

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Director, Duke CCU
Disclosure

- Research contracts: AstraZeneca, Novartis, GSK, Sanofi-Aventis, BMS, The Medicines Company, Astellas, and Boehringer Ingelheim

- Consulting/Honoraria: AstraZeneca, GSK, BMS, Lilly, Novartis, Roche, Boehringer Ingelheim, The Medicines Company, Fibrex, and Sanofi-Aventis

- For full listing see www.dcri.duke.edu/research/coi.jsp
STEMI Systems Coverage

As of 6/21/2012 (630 Systems; 62.7% Population Coverage)
STEMI Accelerator

Individual hospital

Hub and spoke model

Regional system

Journal of Invasive Cardiology 2011; 23 A:8-12
STEMI Accelerator Sites
Improving SCA Survival by 50% in 5 years in North Carolina

1: Bystander Response
- Recognize SCA
- Early 911
- Effective bystander CPR
- Public access to AED

2: Pre-hospital Response
- Enhanced dispatch
- Enhanced CPR
- Appropriate defibrillation therapy
- Early Advanced Care

3: Hospital Response
- Patient triage to Resus. Center of Excellence
- Hypothermia
- 24/7 Cath Lab
- ICD
- Post-survival patient education & support
STEMI & CARDIAC RESUSCITATION

IDEAL SYSTEM

Cardiac Arrest
- Unresponsive
- Not breathing normally

Community
- Hands Only CPR | Bystander CPR
- Early activation of 911
- Apply AED before EMS arrival

EMS ON-SCENE
- Minimize interruptions of CPR
- Encourage 12-lead ECG after ROSC
- Consider Destination Protocol

Receiving Hospital (PCI-capable)
- Initiate hypothermia <6 hrs from onset of arrest
- Consider early PCI
- Defer Prognosis assessment for 3 days
- Consider need for ICD before discharge

Interhospital transfer

Referral Hospital (non PCI-capable)
- Initiate hypothermia <6 hrs from onset of arrest
- Consider transfer to resuscitation receiving center if unconscious and hemodynamically stable

EMS Triage Plan
50 yo man felt ill on Aug 5 2012

He was hugging wife, who felt him become heavy and then collapse in her arms

She worked in home health and had learned CPR at work one month earlier

Started CPR, called 9-1-1

Paramedics applied 6 shocks for VFib

ECG obtained
- Taken immediately to cath lab, where 95% RCA found to have slow distal flow
- BMS placed; CK-MB 75; LV EF .35
- Prognosis declared grim since no corneal reflex on arrival to CCU
- Therapeutic hypothermia X 24 hours
Woke up on his 51st birthday (3 days after arrest)
We know what to do!

- Recognize arrest
- 9-1-1 with good dispatch
- Bystander CPR (high quality)
- Rapid EMS response (high quality CPR)
- Going to right hospital
- Primary PCI (for ST elevation)
- Therapeutic hypothermia
- Goal-directed intensive care
- Rehab and ICD
“Humanity’s greatest advances are not in its discoveries – but in how those discoveries are applied ...”

Bill Gates, June 7, 2007
Harvard Commencement Address
"Many more people could survive cardiac arrest if regional systems of care were implemented"
Multifaceted Post-Cardiac Arrest Interventions (Including PPCI, hypothermia, intensive care)

% Survival with Cognitive Recovery*

<table>
<thead>
<tr>
<th>Author</th>
<th>Standard care</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oddo</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>Sunde</td>
<td>26</td>
<td>56</td>
</tr>
<tr>
<td>Knafelj</td>
<td>19</td>
<td>53</td>
</tr>
<tr>
<td>Wolfrum</td>
<td>47</td>
<td>69</td>
</tr>
<tr>
<td>Galeski</td>
<td>22</td>
<td>40</td>
</tr>
</tbody>
</table>

*Nichols Circulation 2010;121;709-729

* CPC 1 or 2
US Emergency Healthcare is Fragmented
21 primary PCI centers

5,240 paramedics

118 emergency departments

18,000 EMTs

540 EMS systems
Reforming health care
This is going to hurt
Cardiovascular emergencies for which treatment benefit is time dependent

- STEMI
- Stroke
- Cardiac Arrest

N = 43,801 NCDR STEMI Patients
2005-2006


Regional Approach to Cardiovascular Emergencies
## Cardiac arrest

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Class&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Level&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>All medical and paramedical personnel caring for a patient with suspected myocardial infarction must have access to defibrillation equipment and be trained in cardiac life support.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>It is recommended to initiate ECG monitoring at the point of FMC in all patients with suspected myocardial infarction.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Therapeutic hypothermia is indicated early after resuscitation of cardiac arrest patients who are comatose or in deep sedation.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Immediate angiography with a view to primary PCI is recommended in patients with resuscitated cardiac arrest whose ECG shows STEMI.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Immediate angiography with a view to primary PCI should be considered in survivors of cardiac arrest without diagnostic ECG ST-segment elevation but with a high suspicion of ongoing infarction.</td>
<td>IIa</td>
<td>B</td>
</tr>
</tbody>
</table>

ECG = electrocardiogram; FMC = first medical contact; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.
If you don’t measure it, you can’t improve it
Variation in Survival for Cardiac Arrest Resuscitations Outcomes Consortium
Survival to Discharge for VF Arrest

- Vancouver: 25.0
- Toronto: 15.7
- Seattle: 39.9
- Portland: 22.5
- Pittsburgh: 21.5
- Ottawa: 14.8
- Milwaukee: 26.0
- Iowa: 22.7
- Dallas: 9.5
- Alabama: 7.7

Nichol JAMA. 2008;300(12):1423-1431
**Cardiac Arrest Registry**

**Part A: Non-HealthEMS Users start here, otherwise skip to part B**

1. **Street Address (Where Arrest Occurred)**
   - City
   - State
   - Zip Code

2. **First Name**
3. **Last Name**

4. **Age**
5. **Date of Birth**
6. **Gender**
7. **Race/Ethnicity**
   - American-Indian/Alaska Native
   - Asian
   - Black/African-American
   - Hispanic/Latino
   - Other

**Part B: To be completed by all Users**

7. **EMS Agency ID**
8. **Date of Arrest**
9. **Call #**
10. **Booklet ID (HealthEMS Users Only)**

**First Responding Agency**

- **Hospital Destination**

**Dispatch Times**

- **EMS Notified**
- **EMS Arrived at Scene**

**Arrest Information**

- **Location Type**
  - Home/Residence
  - Public Building
  - Street/Hwy
  - Nursing Home
  - Residence/Institution
  - Physician Office/Clinic
  - Educational Inst.
  - Hospital

- **Witnessed Arrest**
  - Yes
  - No

- **Unwitnessed Arrest**

17. **Presumed Cardiac Arrest Etiology**
   - Trauma
   - Respiratory
   - Drowning
   - Electrocution
   - Other

**Resuscitation Information**

- **Time of 1st CPR**
- **RCSC Time**
- **CPR Stopped/Termination Time**
- **Time of 1st Defibrillation**

18. **Resuscitation Attempted by EMS**
   - Yes
   - No

21. **Was an AED Used During Resuscitation**
   - Yes
   - No
   - AED Present but not Used
   - AED Malfunctioned

20. **Who Initiated CPR**
   - Bystander
   - Bystander Family Member
   - First Responder/Police
   - EMS Personnel
   - Medical Provider
   - Other

22. **Who First Applied Monitor/Defibrillator, AED**
   - Not Applicable
   - Bystander
   - Bystander Family Member
   - First Responder/Police AED
   - EMS AED or Monitor/Defibrillator
   - ALS First Responder Monitor/Defibrillator

**First Cardiac Arrest Rhythm of Patient and ROSC Information**

23. **First Arrest Rhythm of Patient**
   - Ventricular Fibrillation
   - Ventricular Tachycardia
   - Asystole
   - Idioventricular/PEA
   - Unknown Shockable Rhythm
   - Unknown Unshockable Rhythm

24. **ROSC**
   - Yes
   - No

25. **Sustained ROSC**
   - Yes
   - No

26. **Out of Hospital Disposition**
   - Resuscitation not initiated at scene due to obvious signs of death, CNE, resuscitation is not required
   - Resuscitation terminated at scene due to medical control order, protocol/policy requirements completed
   - Transported to hospital with/without ROSC

27. **End of the Event**
   - Dead in Field
   - Pronounced Dead in ED
   - Ongoing Resuscitation in ED

**First Cardiac Arrest Rhythm Strip (Apply with Scotch Tape on Top and Sides)**
Bystander Intervention (924)

AED %: 1.3% (12)
CPR %: 23.5% (217)

Cardiac Etiology Survival Rates

Overall: 11.8% (1096)
Bystander Wit'd: 18.7% (396)
Utstein: 31.7% (164)
Utstein Bystander: 28.7% (80)
EMS Witnessed: 19.8% (172)
Unwitnessed: 4.0% (528)
Shockable/Bystander: 41.4% (396)
myCares.NET
powered by Sansio

- Reporting Systems
- Reporting – only select agencies
- Sites in progress
- Future Sites

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>% Population</th>
<th>Cumulative Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMS Systems in NC</td>
<td>100</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>EMS Systems reporting into CARES</strong></td>
<td>31</td>
<td>55.28%</td>
<td>55.28%</td>
</tr>
<tr>
<td>EMS Systems in Progress</td>
<td>14</td>
<td>12.94%</td>
<td>68.22%</td>
</tr>
<tr>
<td>Future EMS Systems</td>
<td>57</td>
<td>31.78%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Therapeutic Hypothermia
Hypothermia After Cardiac Arrest Study Group

- 275 patients VT/VF
- 5-15 minutes to initiation of resuscitation
- <60 minutes to restoration
- 24 hour temp 32-34 degrees
- 8 hours to achieve target temp

Cooling blankets, ice packs

### Hypothermia After Cardiac Arrest Study Group

**Survival and Neurologic Outcome at Discharge**

<table>
<thead>
<tr>
<th></th>
<th>Hypothermia</th>
<th>Normothermia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survival</strong></td>
<td>64%</td>
<td>50%</td>
</tr>
<tr>
<td>p=0.02</td>
<td>87/137</td>
<td>69/138</td>
</tr>
<tr>
<td><strong>Favorable neurologic outcome</strong></td>
<td>47%</td>
<td>31%</td>
</tr>
<tr>
<td>p=0.009</td>
<td>64/134</td>
<td>42/135</td>
</tr>
</tbody>
</table>

Hypothermia

- Hypothermia saves lives

- Candidates
  - Persistent coma (not following commands) following Return of Spontaneous Circulation (ROSC)
  - VT/VF or “shockable rhythm”
  - Possibly asystole / pulseless electrical activity
Hypothermia

- Questions remain
  - Who, how, when to start, for how long
  - Role and value of prehospital hypothermia
  - When to assess neurological recovery
Therapeutic Hypothermia After Out-of-Hospital Cardiac Arrest
Evaluation of a Regional System to Increase Access to Cooling

20% increase risk of death for each hour of delay to initiation of cooling

<table>
<thead>
<tr>
<th>Time ROSC to cooling</th>
<th>Good neuro. outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 39 min</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>26/43</td>
</tr>
<tr>
<td>40 – 102 min</td>
<td>49%</td>
</tr>
<tr>
<td></td>
<td>21/43</td>
</tr>
<tr>
<td>&gt;102 min</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td>19/42</td>
</tr>
</tbody>
</table>

1. Induction

- Initiate CMC Therapeutic Hypothermia Post Cardiac Arrest
- Verify Allergies:

Admit to ICU under Dr.: ___________________________ List: __________

Condition: Critical
Diagnosis: Cardiac Arrest
Notify Paging Operator at 355-2443 to activate Code Cool
Consults
- Pulmonary and Critical Care Consultants (PCCC): page #3767 immediately, unless previously notified
- Sanger Cardiology
- Physical Medicine and Rehabilitation - List 66287
- Activate Group Page #760 for family support referral

Treatment Parameters
- Refer to CMC Therapeutic Hypothermia After Cardiac Arrest Guideline
- Goal Temperature 33°C
- Minimize FiO₂ to maintain So₂ greater than 95%
- Maintain Mean Arterial Pressure (MAP) greater than 65 mmHg
- Maintain PaCO₂ of 35 - 42 mmHg

Pharmacy/Treatments and Interventions
- Weight: __________ kg
- Hold all orders for Beta Blockers and Antihypertensive medications
- Maintenance IV Fluids: __________ at __________ ml per hour
- Norepinephrine (Levophed) 5 mcg/min; titrate to maintain MAP greater than 65 mmHg

Induction Phase (if not completed in the ED)
- Place Temperature monitoring Foley catheter
- Initiate refrigerated (4°C) IV NS 30 ml/kg bolus over 1 hour as tolerated
- Apply Cooling Device with goal temperature set to 33°C

Pantoprazole (Protonix) 40 mg IV Q24H; first dose upon admission to ICU

Shivering Protocol
- Initiate sedation per CMC Sedation and Analgesia for the Mechanically Ventilated Non-Paralyzed Patient (MD to initiate)
- For refractory shivering: Vecuronium (Norcuron) 0.1 mg/kg IV Push Q1H PRN shivering

Maintenance Phase
- Maintain temperature of 33°C for 24 hours via Cooling Device

Re-warming Phase
- Begin controlled re-warming at less than 0.5°C per hour to 37°C via Cooling Device
- Discontinue sedation once 36°C is achieved
- Cooling Device to remain operational with goal temperature of 37°C until order received to discontinue

Implement: SOC CMC Tight Glucose Control for the Adult Patient in MICU SICU TICU DHI CVICU or Neuro ICU (Eudotool®) if 2 consecutive blood glucose checks greater than 150 mg/dL

2. Maintenance

3. Rewarming
Induced Hypothermia

**History**
- Non-traumatic cardiac arrest (drowning and hanging are permissible in this protocol)

**Signs and Symptoms:**
- Return of pulse

**Differential:**
- Continue to address specific differentials associated with the original dysrhythmia

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**Postresuscitation Protocol**

- **Unsuccessful**
  - **Airway Management Protocols**
    - **NO**
  - **NO**

- **Successful**
  - **Perform Neuro Exam Per IH Job Aide**
  - **Expose Patient Apply Ice Packs to Axilla and Groin**
  - **Cold Saline Bolus 30 mL/kg to max 2 liters**
    - **I**
  - **Dopamine 10-20 mcg/kg/min target MAP 90-100**
    - **P**

---

**Discontinue Cooling Measures**

- **<33 C**
  - **Postresuscitation Protocol**
  - **Reassess Temperature**
    - **>33 C and Pt Shivering**
      - **Etomidate 20 mg IV/IO**
        - **A**
        - **A**
      - **Still Shivering**
        - **Consider Vecuronium 0.15 mg/kg to max 10 mg**
        - **A**

---

**Pearls:**
- Criteria for Induced Hypothermia
- ROSC not related to blunt/penetrating trauma or hemorrhage
- Age 12 or older with adult body habitus
- Temperature after ROSC greater than 34 C degrees
- Advanced airway in place with no purposeful response to pain
- If no advanced airway can be obtained, cooling may only be initiated on order from online medical control
- Take care to protect patient modestly. Undergarments may remain in place during cooling
- Do not delay transport to cool
- Frequently monitor airway, especially after each patient move
- Patients may develop metabolic alkalosis with cooling. Do not hyperventilate
Surface cooling pads
Complications of hypothermia

- Increased pneumonia / sepsis risk
- Hypovolemia
- Bradycardia
- Hyperglycemia
- Decreased drug clearance
- Increased bleeding
- Shivering
- Loss of K, Mg, Phos, Ca.
- Hyperkalemia in rewarming stage

Polderman KH, Crit Care Med 2009; 37:1101–1120
Bystander CPR
2.4 times survival to hospital discharge

Baseline survival

0 – 2.1

2.1 – 4.1

4.2 – 6.7

6.8 – 9.0

9.1 +

Overall

5.0

4.0

2.7

1

1.2

2.4

Circ Cardiovasc Qual Outcomes. 2010;3:63-81
## Chest-compression-only vs. standard CPR

Meta-analysis of randomized dispatch instruction

### Survival to hospital discharge in 3 trials

<table>
<thead>
<tr>
<th></th>
<th>Chest-compression-only CPR</th>
<th>Standard CPR</th>
<th>Risk ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hallstrom et al (2000)(^{14})</td>
<td>35/240 (15%)</td>
<td>29/278 (10%)</td>
<td>1.40 (0.88–2.22)</td>
</tr>
<tr>
<td>Rea et al (2010)(^{15})</td>
<td>122/978 (12%)</td>
<td>105/956 (11%)</td>
<td>1.14 (0.89–1.45)</td>
</tr>
<tr>
<td>Svensson et al (2010)(^{16})</td>
<td>54/282 (19%)</td>
<td>44/297 (15%)</td>
<td>1.29 (0.90–1.86)</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>211/1500 (14%)</td>
<td>178/1531 (12%)</td>
<td><strong>1.2 (1.01 – 1.46)</strong> (1.01–1.46)</td>
</tr>
</tbody>
</table>

Favors standard CPR  Favors compression only CPR

\(P = 0.04\)
Chest compression only CPR

- Bystanders more willing to initiate
- Arterial blood is adequately oxygenated at onset of primary cardiac arrest
- Less likely to cause regurgitation of stomach contents
- Rescue breathing interrupts critical chest compressions
- Easier to teach
- Observational evidence of improved survival

Simplifying to hands-only CPR

Experts now believe an adult who suddenly collapses due to cardiac arrest has enough air in his lungs and blood during CPR and doesn’t need mouth-to-mouth breathing.

If you see someone collapse …

... have someone call 911.

Position unresponsive adult.

Press about 2 inches

Begin hands-only CPR with straight arms and forceful compressions at about 100 a minute.

Lift hands slightly after each to allow chest to recoil.

Use an automated external defibrillator if available.

Keep CPR interruptions to a minimum.

Take turns with a bystander until emergency medical services arrive.

SOURCES: University of Arizona Sarver Heart Center; American Heart Association
Chest Compression-Only CPR by Lay Rescuers and Survival From Out-of-Hospital Cardiac Arrest

Bobrow et al. JAMA 2010;304:1447-1454
Bystander CPR for OHCA in Arizona (2005 to 2010)

Overall incidence of bystander CPR

2005  2006  2007  2008  2009

Bobrow, et al. JAMA 2010;304:1447-1454
Bystander CPR for OHCA in Arizona (2005 to 2010)

Percent of lay CPR providers who performed CO-CPR

- 2005: 20%
- 2006: 20%
- 2007: 40%
- 2008: 60%
- 2009: 76%

P < 0.0001

Bobrow, et al. JAMA 2010;304:1447-1454
Chest Compression-Only CPR by Lay Rescuers and Survival From Out-of-Hospital Cardiac Arrest

A. All OHCA

Survival to Hospital Discharge:

- Std-CPR: 7.8%
- CO-CPR: 13.3%

AOR 1.6 (95% CI, 1.08-2.35)

B. Witnessed/Shockable

Survival From Out-of-Hospital Cardiac Arrest:

- Std-CPR: 17.7%
- CO-CPR: 33.7%

P < 0.001

Bobrow, et al. JAMA 2010;304:1447-1454
CPR Quality
Coronary Perfusion pressure (Ao diastolic - RA diastolic)
Chest compression fraction and survival

- 506 patients with VF / VT and no defib. before EMS arrival.
- Electronically recorded cardiopulmonary resuscitation before the first shock.
- Age 64, 80% male
- 51% bystander CPR
- 6 minutes call to scene
- 11 minutes call to first shock.
- ROSC 72%
- Survived to discharge 23%

Survival to discharge

Percentage surviving

Chest compression fraction

Dispatcher Instruction
- Amsterdam dispatch
- 506 cardiac arrest emergency calls (3%)
- Unrecognized, dispatch 0.9 min later, on scene 1.4 minute later
- Main reason for not recognizing the cardiac arrest was not asking if the patient was breathing (42 of 82) / describe the type of breathing

3 month survival by dispatch recognition

## Odds ratio of survival by CPR status and BLS response time

**Witnessed cardiac arrest, King County 1983 – 2000, n = 7265**

<table>
<thead>
<tr>
<th>BLS response time</th>
<th>Overall</th>
<th>&lt; 3 min</th>
<th>4 min</th>
<th>&gt; 5 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispatcher instructed CPR</td>
<td>1.8</td>
<td>1.5</td>
<td>1.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>2.0</td>
<td>1.1</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>No CPR</td>
<td>1.5</td>
<td>1.1</td>
<td>1.5</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Can we improve bystander CPR rates from 18% to 40% in Durham?
**Medicine**

The Durham area has one of the highest per capita concentrations of hospital beds and physicians in the world. With over 2,300 physicians, there is an approximate average of 10.6 physicians per 1000 residents in Durham. Two excellent university teaching hospitals are located in the area -- Duke Medical Center in Durham and UNC Hospitals (state teaching hospital) in Chapel Hill.
Durham as case study in cardiac arrest

- Bystander CPR rate in 2010 was 18% (24% nationally, 40% in Seattle and Arizona)
- Duke is number one employer in Durham
- “Hands-only CPR” can be taught with 5 minute training module
- Program to train all Duke employees to perform CPR
Can we identify patterns of frequency of arrests, bystander CPR rates, time to response at neighborhood level to improve care?
Attempted resuscitations 2009-2010
Bystander CPR rates by Neighborhood

Wake County

Durham County

Mecklenburg County
Duke Football Game
September 1, 2012
>500 people trained in CPR
(8 people, 4 hours = 16 trained per man-hour)
To improve CPR rates in Durham and in NC, where should we start?
NC Health Systems

Number of Employees

Carolinas HealthCare System: 48,120
UNC Health Care: 44,200
Duke University: 33,705
VIDANT Health: 11,000
New Hanover Regional Medical Center: 9,000
Presbyterian Healthcare: 5,400
Dispatchers should instruct untrained lay rescuers to provide Hands-Only CPR for adults who are unresponsive with no breathing or no normal breathing.
How do we improve application of hypothermia?
Hypothermia for PEA arrest? Can we predict no chance for recovery within 5 days?

47-year-old woman with a history of atrial fibrillation, recently started on dofetilide, who suffered a witnessed ventricular fibrillation cardiac arrest while a passenger in a car on April 5th 2011 at about 10:30 a.m.

- PEA on ED arrival, 45 min of CPR
- Therapeutic hypothermia begun
- Shock, acute renal failure treated with dialysis, and severe anoxic brain injury.
April 11 (6 days after arrest). No response to commands. GCS 5. Multisystem organ failure.

My note:
“2. Cardiac arrest and anoxic encephalopathy. Her chance of recovery is becoming very small. We discussed her situation with her husband. “

April 13 (8 days after arrest). Still comatose. “We had a long discussion with her family, including review of her decreasing likelihood of good recovery, and what she would want us to do under that circumstance.

Decision to continue care. Trach/PEG April 15.
Discharged April 28, still on dialysis, moving around, but not following commands or speaking

Since has made complete recovery – returned to cardiology clinic January 11

Had long discussion with her and her husband at Costco last Sunday
Conclusions:

- Cardiac arrest is common and care and outcomes are heterogeneous.
- There are some regions including Rowan, Mecklenburg and Wake counties with higher survival rates.
- Simple interventions in the chain of survival improve survival, with focus on bystander CPR, EMS protocols, primary PCI, therapeutic hypothermia.
- 50% improvement in survival is a bold but realistic goal.
- Regional systems will play a key role in improving regional care of cardiovascular emergencies.