Evidence-Based Performance Measures

Brent Myers, MD MPH
Director
Wake County Dept of EMS
Raleigh, NC
It is time to stop
Doing things TO patients
And start doing things
FOR patients.

- Benedict Arnold, oops, I mean Paul Hinchey
The History

We all got a collective bee in our bonnet several years ago because we were measured only on speed of ALS response and cardiac arrest survival.

The unintended consequence is that time trumped treatment.
<table>
<thead>
<tr>
<th>Clinical Area</th>
<th>Elements</th>
<th>NNT</th>
<th>Harm Avoided</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-Segment Elevation Myocardial Infarction (STEMI)</td>
<td>Aspirin 12-lead electrocardiograph (ECG), direct transport to percutaneous cardiac intervention (PCI) interval from ECG to balloon &lt; 90 minutes</td>
<td>15</td>
<td>Either a stroke, 2nd myocardial infarction, or a death</td>
</tr>
<tr>
<td>Seizure</td>
<td>Administration of benzodiazepine for status epilepticus</td>
<td>4</td>
<td>Persistent seizure activity</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>Noninvasive positive pressure ventilation (NIPPV)</td>
<td>6</td>
<td>Need for an endotracheal intubation</td>
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<tr>
<td>Trauma</td>
<td>Patients with an Injury Severity Score (ISS) &gt; 15 to trauma center</td>
<td>11</td>
<td>1 death</td>
</tr>
<tr>
<td>Trauma</td>
<td>Patients over 65 years of age with ISS &gt; 21 to trauma center</td>
<td>3</td>
<td>1 death</td>
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<tr>
<td>Cardiac arrest</td>
<td>Defibrillator to the scene &lt; 5 minutes rather than &lt; 8 minutes</td>
<td>8</td>
<td>1 death</td>
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</table>
A Recent Local Experience

- A suburban town council believed they may be receiving poor EMS treatment.

- This had clinical, operational, and budgetary implications.

- Used part of the EBM to address the issue.
# Cardiac Arrest

<table>
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<th>Clinical Measure</th>
<th>National Average</th>
<th>Wake EMS System</th>
<th>Holly Springs</th>
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<tr>
<td>All rhythms survival</td>
<td>7%</td>
<td>13%</td>
<td>25%</td>
</tr>
<tr>
<td>Shockable</td>
<td>15%</td>
<td>37%</td>
<td>40%</td>
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**NOTE:** Due to the small number of events in Holly Springs, this a trend comparison but does not reach statistical significance.
# Heart Attack

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<th>Goal</th>
<th>EMS System</th>
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<tr>
<td>Treatment Bundle</td>
<td>&gt; 90% compliance</td>
<td>87%</td>
<td>100%</td>
</tr>
<tr>
<td>9-1-1 to hospital</td>
<td>&lt; 60 minutes, 90%</td>
<td>50 minutes</td>
<td>53 minutes</td>
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## Major Trauma

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<tr>
<td>Scene Time</td>
<td>&lt;10 mins on average</td>
<td>11 mins</td>
<td>7 mins</td>
</tr>
<tr>
<td>Golden Hour</td>
<td>9-1-1 to trauma center, 90%</td>
<td>50 mins</td>
<td>48 mins</td>
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## Response Time Performance

**July 1, 2009 to October 30, 2009**

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<td>Non-Emergency</td>
<td>&lt;19:59 at 90th percentile</td>
<td>15:22</td>
<td>12:32</td>
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<tr>
<td>Emergency</td>
<td>&lt;11:59 at 90th percentile</td>
<td>12:19</td>
<td>12:05</td>
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Response time = 9-1-1 center processing + out-the-door + drive time
The Result

+ Town council was pleased that an analysis of more than response time was performed

+ They were (appropriately) satisfied that they were receiving good EMS service
Potential New Items

- Stroke Care
- Post-resuscitation Care
- Participation in the Continuum of Care
Going Forward -- Stroke

 Proposed measures:

- Utilization of a validated pre-hospital screen
- Screen for blood glucose
- If possible (? < 30 minutes drive), transport to primary stroke center that is capable of thrombolysis as well as percutaneous intervention if symptoms <5 hours
- If not and less than <3 hours, transport to hospital capable of thrombolysis
Stroke Destination Guide

- Symptoms of Acute Stroke
  - Positive Stroke Screen <3hrs onset
    - Yes
      - Fibrinolitic Checklist
        - No Contraindications
          - EARLY NOTIFICATION ACTIVATION and TRANSPORT
            - Any HOSPITAL in Wake County
    - No
      - Symptoms between 3-5 hrs onset?
        - Yes
          - EARLY NOTIFICATION ACTIVATION and transport
            - Duke Health Raleigh
            - WakeMed Raleigh
        - No
          - Symptoms > 5hr onset?
            - Yes
              - Any Emergency Department in Wake County
            - No
              - LEGEND
                | B | EMT-Basic | B |
                | I | EMT-Intermediate | I |
                | P | Paramedic | P |
                | A | APP | A |
                | M | Medical Control | M |
Post Resuscitation Care

* Paper on Resuscitation Centers is out now on PEC

* As you heard yesterday, this concept is gaining acceptance

* NNT to produce neurologically intact survivor from VF/VT is 4 to 6
Return of pulses?

Yes → Traumatic Arrest?

Yes → Transport to Trauma Center
- Duke Hospital Durham
- UNC
- WakeMed Raleigh

No → No → Age < 18?

Yes → Transport to Pediatric Specialty facility
- WakeMed Raleigh

No → Transport to closest hypothermia capable hospital
- Duke Hospital Durham
- Rex Hospital
- WakeMed Raleigh
Time of Care Continuum

- Hard to see benefit from EMS response time except for arrival of AED (Dr. Richmond’s talk, Dr. Blackwell’s paper)
- Time critical emergencies, however, where we participate in the continuum of care is important:
  - Time to reperfusion for STEMI
  - Time to reperfusion for stroke
  - Major trauma
Elements of Continuum of Care

Response Time
Scene Time
Drive Time
D2B

Elements

0 20 40 60 80 100
Suggested Language

“EMS response times should be developed at the community level in conjunction with receiving facilities to ensure 90% compliance with treatment guidelines for time critical emergencies such as STEMI, Stroke, and Major Trauma”
Summary

- NNT concept can be used to quantify benefit of EMS activities
- Proposed additions:
  - Stroke
  - Post-resuscitation
  - Continuum of care time considerations
Tourniquets and Goody Powders

Brent Myers, MD MPH
Director
Wake County Dept of EMS
Raleigh, NC
Life is really simple
But we insist
On making it Complicated.

-Confucius
Causes of Renal Failure in North Carolina

- Untreated hypertension
- Uncontrolled diabetes
- Goody Powders

SOURCE: My favorite nephrologist
Wake County Experience

- Placed tourniquets on all units in February 2005
- Have been used on 31 patients
  - One train amputation of a lower leg
  - Gunshots and stabbings
  - 10 patients with indwelling catheters/fistulae/shunts for dialysis (one patient had 2 applications in a week)
The Evidence

- Review of experience from the military experience in Iraq (165 patients)

- Evaluated the impact of tourniquets upon clinical status on arrival, blood products, and ultimate outcome

- Beekley AC J of Trauma 2008;68:S28-37
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Outcomes

- No significant difference between groups regarding need for blood transfusion
- There was no difference in mortality between the two groups
- Limited due to observational nature
Recent Review

- The prehospital utilization of tourniquets is reviewed and encouraged.
- Good reading for EMS providers, EM, and Trauma Surgery.
- Doyle G. PEC 2008;12:241-56
Myths?

+ Ischemia will be a problem
+ Reperfusion will be a problem
+ Neurologic damage will be a problem
Routine EMS Tourniquet Use Algorithm

Significant Extremity Bleeding with need for other interventions?

Yes: Apply tourniquet to bleeding limb(s) on proximal segment

No:

Transport 30 min expected?

Yes: Reassess for removal

No: Leave on and transport
The Ten Bleeding Shunts

- Mean lowest SBP = 117
- Mean highest pulse = 86
- Mean estimated blood loss = 970
- Mean number of “soaked” towels = 2.5
- Mean number of hyperbolic terms in the narrative = 2.5
Quotes from Charts

“Gently placed the tourniquet”

“Did not completely cut off blood flow but tightened only to control bleeding”

“Tried to release the shunt and the bleeding started again”
58 year old female with PMH significant for ESRD with HD

- Femoral AV fistula was in place
- ~30 minutes prior to calling EMS, bleed from fistula began
- Blood was “on the gown, on the kitchen floor, in the bed room”
Patient #9 Case Report

- Blood was “squirting 2 feet in the air” from the right upper thigh
- Initial assessment:
  - Respirations – agonal at 4 breaths/min
  - Pulse = 48 and weak at carotid
- Two minutes and 15 seconds after arrival, the tourniquet was in place
Patient #9 Case Report

- Scene time <10 minutes
- After tourniquet placement:
  - Pulse increased from 48 to 84
  - Blood pressure increased to 78/58
  - Respirations increased from 4 to 18
  - SaO2 = 88%
- Patient alert and interactive after 8 minute transport to ED
Summary

- Tourniquet use is inexpensive
- It can be lifesaving, and when it is not, it will help calm the EMS providers and the patient
- No demonstrable harm in the first 30 minutes
What To Do with Refractory Ventricular Fibrillation?

Brent Myers, MD MPH
Director
Wake EMS System, Raleigh, NC
“However beautiful the strategy, you should occasionally look at the results.”

-- Winston Churchill
The Plan

- Two Brief Case Reviews
- Review of the Evidence (and the Anecdote)
- A Modest Proposal
Case #1

* 82 year-old male
* Pseudo-witnessed cardiac arrest in his home
* No bystander CPR but FR arrival in <6 mins
Case #1

- Firefighters begin uninterrupted compressions
- AED advised shock and one is delivered prior to EMS arrival
Case #1  Initial Rhythm
Case #1

- EMS arrives just as first defibrillation is being provided
- BVM EtCO2 = 44 with good wave form
- IO is placed in tibia
- King Airway is placed
- Vasopressin and epinephrine are administered
Case #2 Third +10 mins
Case #2

- Bicarbonate, amiodarone, procainamide are administered

- Magnesium is also administered

- At ~ 25 minutes, EtCO2 = 35
Case 1 Shock 7 +23 mins
Insanity: Doing the same thing Over and over again and Expecting different results

-Albert Einstein
+36 mins First DSED
Case #1 DSED post-rhythm
Case #1 DSED #1 Monitor #2
End of the Story

- Patient arrives in emergency department with EtCO2 of 50 and good wave form

- After additional resuscitative efforts in the emergency department, work is terminated
Case #2 First Shock at + 103 seconds
9th shock at + 27 mins

09:48:58 Paddles

09:49:09 Paddles

Charge Complete
Vital Signs

09:49:19 Paddles Medtronic, Inc.
Vince’s 12th shock, +38 mins (5 mins before transfer)
Follow-Up

- Patient achieved ROSC shortly after arrival in the community ED
- Witnessed by ED staff and wife, patient had purposeful movement in an attempt to remove his ETT
- Prior to transfer for PCI, patient suffered repeat ventricular fibrillation arrest and could not be resuscitated
A Little Evidence

Observations:

- Refractory ventricular fibrillation is not new, particularly in the EP lab
- Current ACLS guidelines are superior to all previous ACLS guidelines
- The following discussion is “post-ACLS” and not “anti-ACLS”
There Are Five Things

- Electrical reversion at 200 wsec, 300 wsec, 360 wsec
- Intubation, hyperventilation, epinephrine
- Aggressive use of IV lidocaine with 360 wsec to follow
- Bretylium and magnesium IVP with 360 wsec to follow
- Repeat 360 wsec

Slovis and Wrenn, J Critical Illness, 1994
<table>
<thead>
<tr>
<th>P</th>
<th>IO Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Epinephrine 1 mg IV/IO repeat every 3-5 minutes</td>
</tr>
<tr>
<td>I</td>
<td>Vasopressin 40 U IV/IO</td>
</tr>
</tbody>
</table>

After 5 cycles of CPR check rhythm and pulse

Repeat Defibrillation
After defibrillation resume CPR without pulse check

| P | Amiodarone 1st dose is 300 mg and may be repeated once at 150 mg. |
| P | Sodium Bicarbonate |
| I | Establish a secondary circulatory access point |

After 5 cycles of CPR check rhythm and pulse

Repeat Defibrillation
After defibrillation resume CPR without pulse check

| P | Magnesium Sulfate |
| I | Consider Epinephrine drip |

Repeat Defibrillation
After defibrillation resume CPR without pulse check

| P | Sodium Bicarbonate |

Airway Protocol

Repeat Defibrillation
Pause 5 secs max to check rhythm/pulse, resume CPR
Recurrent – a Beta Blocker?

- The antiarrhythmic properties of beta blockade are often overlooked.
- Like lidocaine, giving beta-blockade to prevent dysrhythmia or “clean up” PVCs in the ischemic heart appears unwarranted.
- But what about “post-ACLS”?
Why Might This Work?

- Block the deleterious effects of beta stimulation from exogenous epinephrine and/or endogenous catecholamines
- “Membrane stabilization”
- Class II antidysrhythmic properties
Human Case Series

- 11 reports with 20 total observational patients in VF
- 17 patients with successful termination of VF (all 3 non-survivors in one series)
- 11 of 17 survived to discharge

Can We Reach a Conclusion?

† NO

† Authors of literature review call for a randomized trial

† Meanwhile, we have individuals who are fibrillating “post-ACLS”
Recurrent Pathway

1. **Procainamide**
   - q 2 mins to max
   - After 5 cycles of CPR check rhythm and pulse
   - Repeat Defibrillation
   - After defibrillation resume CPR without pulse check
   - Max Dose Procainamide reached?

   - **Yes**
   - **Contact MC**

   - **No**
   - Metoprolol
   - q 2 mins to max
   - After 5 cycles of CPR check rhythm and pulse
   - Repeat Defibrillation
   - After defibrillation resume CPR without pulse check
   - Max Dose Metoprolol reached?

   - **Yes**
   - **Contact MC**

   - **No**
What About Persistent VF?

△ Working hypothesis is that this is an electrical/mechanical problem

△ Vectors, waveforms, and total energy each seem to play a role

△ Not smart enough to talk about biphasic, reticulinear, etc.
What Evidence Do We Have?

- Atrial fibrillation patients
  - Propofol and up to 2 “standard” single monitor/defibrillator cardioversions were provided from April 1998 and January 2003
  - 99 patients failed to cardiovert after these 2 standard cardioversions
  - They were enrolled in the study
What Evidence Do We Have?

- These 99 patients underwent Double Sequential External Cardioversion with each Defibrillator charged to 360J
- 66 were cardioverted on the first double attempt
- 14 were cardioverted on the second double attempt
- 81% of the 99 were successfully cardioverted
What Evidence Do We Have?

- 12 month period to remain in NSR is similar between the “standard” and the “high energy” group
- No incidence of CHF, no significant burns, no other known complications in this study associated with higher-energy shocks

Alaeddini J et al. PACE 2005;28:3-7
Atrial fibrillation patients who failed traditional cardioversion were enrolled in the study and treated with the “quadruple pad approach”

Measured success of cardioversion, post-treatment CK-MB and troponin

Marroughe NF  PACE 2001;24:1321-24
Patients with chronic atrial fibrillation

\[ \text{Transthoracic cardioversion with 200 J} \rightarrow \text{Sinus rhythm} \rightarrow \text{Follow} \]

\[ \text{Failure} \]

\[ \text{Transthoracic cardioversion with 360 J} \rightarrow \text{Sinus rhythm} \rightarrow \text{Follow} \]

\[ \text{Failure} \]

\[ \text{Quadruple paddle approach} \rightarrow \text{Sinus rhythm} \rightarrow \text{Follow} \]

\[ \text{Failure} \]

\[ \text{Internal cardioversion} \]

**Figure 2. Study protocol.**
Results

- 46 patients failed chemical cardioversion
- 27 of these were successfully cardioverted after 200J + 360J
- 19 then underwent DSEC
- 14 were successfully cardioverted
- 4 of the remaining 5 failed transvenous cardioversion
Results

![Bar graph showing results for 200J, 360J, and DSED, comparing Initial CK and Post CK.](Image)
Here It Is – The Big Study

- 1994 study by Hoch et al.
- 2,990 consecutive patients in 3 year EP lab experience with 5,450 total EP studies
- Treatment described was applied to 5 total patients
What Did We Say About 5 Things?

+ Pre-DSED attempts ranged from 7 to 20 attempts with single device
+ VF, VT, WPW, and AF were dysrhythmias encountered
+ EF ranged from 10 to 60%
+ Range between defibrillations was 0.5 to 4.5 seconds
So What Happened?

All five patients were successfully cardioverted on the first DSED.

“This finding, combined with its ease and limited morbidity, warrants further study of this approach.”

Persistent Pathway

1. Apply new defibrillator pads at a new site.
2. After 5 cycles of CPR, check rhythm and pulse.
3. Repeat Defibrillation.
   - Pause 5 seconds max to check rhythm/pulse, resume CPR.
4. Did V-fib Break at All?
   - No:
     - Double sequential external defibrillation.
     - Pause 5 seconds max to check rhythm/pulse, resume CPR.
5. Contact Medical Control (MC).
So What?

- Clearly, the greatest proportion of survivors are successfully defibrillated early (1 or 2 shocks) – 50% of our survivors never have an airway at all.

- Should we, as Dr. Henry recently suggested, write off the rest?
What We’re Gonna’ Do

- Continue with proven compression, minimal ventilation, and hypothermia strategy
- Add aggressive treatment for those patients who experience “post-ACLS” ventricular fibrillation
Everybody gets so much Information all day long That they lose their Common sense

-Gertrude Stein
Life is really simple
But we insist
On making it Complicated.

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Causes of Renal Failure in North Carolina

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