Push Hard, Drive Fast? Prehospital Termination of Resuscitation

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Medical Director
Georgetown EMS
EMS Call
EMS Call
EMS Call
EMS Call
Is this really the best strategy?
Goals and Objectives

• Understand **risks** associated with transporting patients in cardiac arrest
• Familiarize evidence-based termination of resuscitation **protocols** for **medical** cardiac arrests
• Discuss high quality resuscitation in the **field**
Background

450,000 out-of-hospital cardiac arrests / year
Background: CARES
Background: CARES

FIGURE 4. Cumulative overall survival rates, by participating emergency medical services agency — Cardiac Arrest Registry to Enhance Survival (CARES), United States, October 1, 2005–December 31, 2010*

Background: CARES

Background: CARES

Background

21.6% field termination
Background

24.6% ED termination
Risks of transporting
Risks of transporting: Patient
Perfusion During Cardiac Arrest with Chest Compressions

A

Perfusion Pressure

Compressions Initiate

Compressions Halt

Compressions Resume

Time

B

Perfusion Pressure

Compressions Initiate

Compressions Continue without Interruption

Compressions Halt

Time

Chest Compression Fraction Determines Survival in Patients With Out-of-Hospital Ventricular Fibrillation

Jim Christenson, MD; Douglas Andrusiek, MSc; Siobhan Everson-Stewart, MS; Peter Kudenchuk, MD;

Push hard, push fast…

“High-quality CPR should be recognized as the foundation on which all other resuscitative efforts are built”

Effect of Transporting

Effect of Transporting

Can Correct Closed-Chest Compressions Be Performed During Prehospital Transport?

Figure 1—Mean percentage of correct chest compressions with mannequin in stable environment

Stone, Thomas. PDM 1995;10:121-123.
Effect of Transporting

Can Correct Closed-Chest Compressions Be Performed During Prehospital Transport?

Figure 1—Mean percentage of correct chest compressions with mannequin in stable environment
Correct 77.6%
Incorrect 22.4%

Figure 2—Mean percentage of correct chest compressions in a moving ambulance
Correct 45.6%
Incorrect 54.4%

Stone, Thomas. PDM 1995;10:121-123.
Effect of Transporting

Odegaard et al. Resuscitation 2009;80:843-848
Effect of Transporting

How about **mechanical chest compression devices?**
Benefit of transporting

Poor chest compression quality with mechanical compressions in simulated cardiopulmonary resuscitation: A randomized, cross-over manikin study

Hans Blomberg\textsuperscript{a,b,*}, Rolf Gedeborg\textsuperscript{a,c}, Lars Berglund\textsuperscript{c}, Rolf Karlsten\textsuperscript{a}, Jakob Johansson\textsuperscript{a,b}

- Adequate chest compressions:
  - LUCAS CPR 58%
  - Manual CPR 88%

Benefit of transporting

• **Insufficient** evidence to support widespread use of mechanical CPR devices

Risks of transporting: Patient
Worse chest compressions
Push hard, push fast...

Performing effective chest compressions is a fundamental aspect of cardiac arrest survival

Push hard, push fast...

High quality chest compressions:
- Augments **cardiocerebral** circulation
- Interruptions decreases chance of **favorable outcomes**

Push hard, push fast…

High quality chest compressions concept not new
Push hard, push fast...

Minimally Interrupted Cardiac Resuscitation by Emergency Medical Services for Out-of-Hospital Cardiac Arrest

Bentley J. Bobrow, MD
Lani L. Clark, BS
Gordon A. Ewy, MD

Context Out-of-hospital cardiac arrest is a major public health problem.
Objective To investigate whether the survival of patients with out-of-hospital cardiac arrest would improve with minimally interrupted cardiac resuscitation (MICR), an

- Delayed intubation
- Uninterrupted chest compressions

Push hard, push fast...

Minimally Interrupted Cardiac Resuscitation by Emergency Medical Services for Out-of-Hospital Cardiac Arrest

Bentley J. Bobrow, MD
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Context  Out-of-hospital cardiac arrest is a major public health problem.
Objective  To investigate whether the survival of patients with out-of-hospital cardiac arrest would improve with minimally interrupted cardiac resuscitation (MICR), an

• **Improved** survival (9.1% vs 3.8%)

Risks of transporting: Providers / Public
Lights and Sirens…

Majority of EMS provider deaths due to ambulance crashes

Lights and Sirens...

Characteristics of Fatal Ambulance Crashes in the United States: An 11-Year Retrospective Analysis
Christopher A. Kahn, BS, BA, Ronald G. Pirrallo, MD, MHSA, Evelyn M. Kuhn, PhD

60% of ambulance crashes occur during emergency use

Kahn et al. PEC 2001;5:261-269.
Lights and Sirens…

CHARACTERISTICS OF FATAL AMBULANCE CRASHES IN THE UNITED STATES: AN 11-YEAR RETROSPECTIVE ANALYSIS

Christopher A. Kahn, BS, BA, Ronald G. Pirrallo, MD, MHSA, Evelyn M. Kuhn, PhD

78% of fatal crashes involve death outside ambulance

Kahn et al. PEC 2001;5:261-269.
Lights and Sirens...

Ambulance Collisions in an Urban Environment

Non-Emergency Transport: 27.0 crashes per 100,000 patients

Lights and Sirens…

Ambulance Collisions in an Urban Environment

Non-Emergency Transport:
27.0 crashes per 100,000 patients

Emergency Mode:
45.9 crashes per 100,000 patients

Lights and Sirens...
Risks of transporting: Providers / Public

Increased risk of crashes
Push hard, push fast…

“High-quality CPR should be recognized as the foundation on which all other resuscitative efforts are built”

Transporting

**Cardiac Arrest Survival is Rare Without Prehospital Return of Spontaneous Circulation**

David A. Wampler, PhD, LP, Lindsey Collett, EMT-P, Craig A. Manifold, DO, Christopher Velasquez, EMT-P, Jason T. McMullan, MD

2 year study San Antonio / Cincinnati

Transporting

**CARDIAC ARREST SURVIVAL IS RARE WITHOUT PREHOSPITAL RETURN OF SPONTANEOUS CIRCULATION**

David A. Wampler, PhD, LP, Lindsey Collett, EMT-P, Craig A. Manifold, DO, Christopher Velasquez, EMT-P, Jason T. McMullan, MD

**Zero survivors from asystole**

Transporting

CARDIAC ARREST SURVIVAL IS RARE WITHOUT PREHOSPITAL RETURN OF SPONTANEOUS CIRCULATION

David A. Wampler, PhD, LP, Lindsey Collett, EMT-P, Craig A. Manifold, DO, Christopher Velasquez, EMT-P, Jason T. McMullan, MD

“Survival to hospital discharge after OHCA is exceedingly rare without achieving ROSC prior to hospital arrival…”

Transporting

CARDIAC ARREST SURVIVAL IS RARE WITHOUT PREHOSPITAL RETURN OF SPONTANEOUS CIRCULATION

David A. Wampler, PhD, LP, Lindsey Collett, EMT-P, Craig A. Manifold, DO, Christopher Velasquez, EMT-P, Jason T. McMullan, MD

“Resuscitation efforts should focus on achieving field ROSC.”

Transporting

**CARDIAC ARRREST SURVIVAL IS RARE WITHOUT PREHOSPITAL RETURN OF SPONTANEOUS CIRCULATION**

David A. Wampler, PhD, LP, Lindsey Collett, EMT-P, Craig A. Manifold, DO, Christopher Velasquez, EMT-P, Jason T. McMullan, MD

“Transport should be reserved for patients with field ROSC and/or a shockable rhythm, as there appears to be no benefit to transporting patients who are asystolic on presentation.”

What does this have to do with termination of resuscitation?
Termination of resuscitation: **Empowers** prehospital providers to focus high quality resuscitations in the **field**
TOR Protocols

Retrospective Canadian urban study
Multivariate analysis to propose TOR guideline
700 arrests over 22 months

TOR Protocols

- Consider termination when no ROSC and
- Arrest not witnessed by EMS
- No shocks given

TOR Protocols

Derivation and evaluation of a termination of resuscitation clinical prediction rule for advanced life support providers

Laurie J. Morrison\textsuperscript{a,b,d,*}, P. Richard Verbeek\textsuperscript{b,c}, Marian J. Vermeulen\textsuperscript{d,e}, Alex Kiss\textsuperscript{e}, Katherine S. Allan\textsuperscript{a}, Lisa Nesbitt\textsuperscript{f}, Ian Stiell\textsuperscript{f,g}

- Retrospective Canadian urban study
- Multivariate analysis to propose TOR guideline
- 4,673 arrests

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System response interval &lt;8 min</td>
<td>1.7 (0.7, 3.9)</td>
</tr>
<tr>
<td>Patient response interval &lt;8 min</td>
<td>1.7 (1.2, 2.4)</td>
</tr>
<tr>
<td>Bystander witnessed</td>
<td>1.9 (1.4, 2.4)</td>
</tr>
<tr>
<td>EMS witnessed</td>
<td>4.8 (3.6, 6.5)</td>
</tr>
<tr>
<td>Initial rhythm ventricular fibrillation or ventricular tachycardia</td>
<td>10.7 (7.6, 15.0)</td>
</tr>
<tr>
<td>CPR started by bystander</td>
<td>2.8 (2.1, 3.8)</td>
</tr>
<tr>
<td>First shock by EMT-D</td>
<td>2.9 (2.0, 4.4)</td>
</tr>
<tr>
<td>First shock by fire</td>
<td>2.4 (1.8, 3.3)</td>
</tr>
<tr>
<td>First shock by paramedic</td>
<td>2.8 (2.2, 3.7)</td>
</tr>
<tr>
<td>First shock by Public Access Defibrillation Program (PAD)</td>
<td>11.5 (5.0, 26.6)</td>
</tr>
<tr>
<td>Shocked (by PAD or provider)</td>
<td>8.8 (6.2, 12.7)</td>
</tr>
<tr>
<td>Any return of spontaneous circulation</td>
<td>506.6 (161.7, &gt;999.9)</td>
</tr>
</tbody>
</table>

TOR Protocols

Derivation and evaluation of a termination of resuscitation clinical prediction rule for advanced life support providers

Laurie J. Morrison, P. Richard Verbeek, Marian J. Vermeulen, Alex Kiss, Katherine S. Allan, Lisa Nesbitt, Ian Stiell

- TOR may be considered when
  - No ROSC prior to transport
  - No shock delivered
  - No bystander CPR
  - Unwitnessed arrest

TOR Protocols

Validation of a universal prehospital termination of resuscitation clinical prediction rule for advanced and basic life support providers

Laurie J. Morrison a,b,d,*, P. Richard Verbeek b,c, Cathy Zhan a, Alex Kiss e, Katherine S. Allan a,f

• Retrospectively validate proposed TOR protocols

TOR Protocols

1. Arrest witnessed by emergency medical services personnel
2. A shock was delivered
3. There was a return of spontaneous circulation at any point during the resuscitation
4. Bystander cardiopulmonary resuscitation performed
5. Arrest witnessed by bystander

If ALL criteria are present
- Transport to local ED

If NONE of the criteria are present
- Terminate Resuscitation

TOR Protocols

1. There was a return of spontaneous circulation (prior to transport)
2. Arrest witnessed by emergency medical services personnel
3. A shock was delivered

If ALL criteria are present
Transport to local ED

If NONE of the criteria are present
Terminate Resuscitation

Table 2
Action according to advanced life support termination of resuscitation prediction rule* outcome.

<table>
<thead>
<tr>
<th></th>
<th>Death</th>
<th>Survival*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminate (test positive)</td>
<td>743</td>
<td>0</td>
</tr>
<tr>
<td>Transport to Emergency Department (test negative)</td>
<td>1523</td>
<td>130</td>
</tr>
<tr>
<td>Total</td>
<td>2266</td>
<td>130</td>
</tr>
<tr>
<td>Sensitivity (95% CI)</td>
<td></td>
<td>32.8 (30.8–34.7)</td>
</tr>
<tr>
<td>Specificity (95% CI)</td>
<td></td>
<td>100 (99.8–100)</td>
</tr>
<tr>
<td>Positive predictive value (95% CI)</td>
<td></td>
<td>100 (99.8–100)</td>
</tr>
<tr>
<td>Negative predictive value (95% CI)</td>
<td></td>
<td>7.9 (6.8–9.0)</td>
</tr>
<tr>
<td>Transport rate (%)</td>
<td></td>
<td>69.0</td>
</tr>
</tbody>
</table>
### Table 3
Action according to basic life support termination of resuscitation prediction rule* outcome.

<table>
<thead>
<tr>
<th>Action</th>
<th>Death</th>
<th>Survival^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminate (test positive)</td>
<td>1302</td>
<td>0</td>
</tr>
<tr>
<td>Transport to Emergency Department (test negative)</td>
<td>964</td>
<td>130</td>
</tr>
<tr>
<td>Total</td>
<td>2266</td>
<td>130</td>
</tr>
<tr>
<td>Sensitivity (95% CI)</td>
<td></td>
<td>57.5 (55.4–59.4)</td>
</tr>
<tr>
<td>Specificity (95% CI)</td>
<td></td>
<td>100 (99.8–100)</td>
</tr>
<tr>
<td>Positive predictive value (95% CI)</td>
<td></td>
<td>100 (99.8–100)</td>
</tr>
<tr>
<td>Negative predictive value (95% CI)</td>
<td></td>
<td>11.9 (10.6–13.3)</td>
</tr>
<tr>
<td>Transport rate (%)</td>
<td></td>
<td>45.6</td>
</tr>
</tbody>
</table>

But...How long should resuscitations be attempted?
TOR Protocols

NAEMSP Proposed TOR Protocol

• **20-30 minutes** of ACLS
• **Airway** management
• **IV** access
NAEMSP Proposed TOR Protocol

Asystole / PEA after 20-30 minutes = Termination of Resuscitation
TOR Protocols

NAEMSP Proposed TOR Protocol

Retrospectively validated

ZERO Survivors to Discharge

Cone et al. PEC 2005;276-281.
Can we use capnography to predict survival?
TOR Protocols: Capnography

**End-Tidal CO$_2$ as a Predictor of Survival in Out-of-Hospital Cardiac Arrest**

Marc Eckstein, MD, MPH,$^{1,2}$ Lorien Hatch, MA,$^1$ Jennifer Malleck, MS,$^1$ Christian McClung, MD,$^1$ Sean O. Henderson, MD$^{1,3}$

- Retrospective study in LA
- > 3,000 arrests

PDM 2011;148-150.
TOR Protocols: Capnography

Factors significant associated with ROSC

- **Initial** EtCO2 > 10
- EtCO2 **dropping** < 25%

PDM 2011;148-150.
TOR Protocols: Capnography

End-Tidal CO$_2$ as a Predictor of Survival in Out-of-Hospital Cardiac Arrest

Marc Eckstein, MD, MPH, Lorien Harch, MA, Jennifer Malleck, MS, Christian McClung, MD, Sean O. Henderson, MD

- Male
- Unwitnessed arrest
- No bystander CPR
- Non v-fib
- Initial EtCO$_2$ < 10
- EtCO$_2$ dropping > 25%

PDM 2011;148-150.
“There are insufficient data to support or refute a specific cutoff of end tidal CO2 at different time intervals as a prognostic indicator of outcome during adult cardiac arrest.”

- 2015 ACLS Guidelines
TOR Protocols: Maryland

Arrest **unwitnessed** by EMS.
No shockable rhythm.
TOR Protocols: Maryland

At least 15 minutes of high quality CPR.
TOR Protocols: Maryland

Exclusions: Pregnancy, pediatric, hypothermia.
What are the barriers to prehospital termination of resuscitation?
Barriers to Prehospital TOR

$$$$
Barriers to Prehospital TOR Laws
Barriers to Prehospital TOR

Community Expectation
Barriers to Prehospital TOR

Rescue Culture
Barriers to Prehospital TOR

Inadequate Family Comfort Training
What to do before termination of resuscitation?
Perfusion During Cardiac Arrest with Chest Compressions

A

Perfusion Pressure

Compressions Initiate

Compressions Halt

Compressions Resume

Compressions Resume

Time

B

Perfusion Pressure

Compressions Initiate

Compressions Continue without Interruption

Compressions Halt

Time

**Position 1 (Patient Left)**
1. Assesses responsiveness and checks pulses
2. Initiates chest compressions immediately
3. Alternates chest compressions with Position 2

**Position 2 (Patient Right)**
1. Removes clothing at chest
2. Attaches defibrillator pads
3. Attaches AED or ECG Monitor/defibrillator
4. Alternates chest compressions with Position 1
5. Applies Lucas 2 if available

**Position 3 (Patient Head)**
1. Opens and clears airway
2. Insert King Airway per protocol
3. BVM ventilations at appropriate rate and depth

**Position 4 (Paramedic)**
1. Makes all patient treatment decisions
2. Initiates IV/IO access (If IO, right humeral head is the preferred site)
3. Administers medications and provides additional treatment as needed

**Position 5 or more (Extra)**
1. Assist in different positions when needed
2. Document incident activity
3. Family Advocate
Coordinated team-based approach
High performance Resuscitation

Emphasizes minimizing interruptions to chest compressions.

Continuous compressions.
High performance Resuscitation

Appropriate depth, rate and full recoil during compressions
What to do after termination of resuscitation?
After TOR

Death Notification
After TOR

Death Notification is **challenging**

- Difficult **survivor** emotions
- Feelings of **failure**
- Fear of **blame**
After TOR

GRIEV_ING
GATHER

Gather the family; ensure everyone is present.
RESOURCES

Call for support resources available to assist the family with their grief.
IDENTIFY

Identify YOURSELF
Identify DECEASED by name
Identify KNOWLEDGE of relatives
Educate the family on the events that have occurred and the status of their loved one.
Verify that their family members has died.
Give the family personal time and space to absorb.
INQUIRE
Ask if there are any questions.
NUTS & BOLTS

Of the body… funeral home, morgue, etc.
GIVE

Give contact information for family assistance.
After TOR

Death Notification is challenging

• Structured, formalized method can be helpful
The decision to terminate resuscitation is based on the balance between the risks, benefits and burdens these interventions place on patients, family members and healthcare providers.
Putting it all together

There are circumstances where resuscitation is inappropriate and should not be provided.

- 2015 ACLS Guidelines
Survival from prehospital cardiac arrest requires high quality CPR.
Putting it all together

Transporting patient in cardiac arrest is not without **risks**.
Putting it all together

Transporting patient in cardiac arrest is not without risks.

Poorer compressions
Putting it all together

Transporting patient in cardiac arrest is not without risks.

Ambulance crashes
Putting it all together

It is **rare** to survive cardiac arrest unless resuscitated in the field.
Putting it all together

Termination of Resuscitation Protocols **empowers** EMS providers to concentrate on high quality prehospital resuscitation.
Questions?

JVNable@gmail.com