What is Triaxial Field Induction (TFI) and Why You Should Care

Mike McEvoy, PhD, RN, CCRN, NRP
Chair – Resuscitation Committee, Albany Medical Center
Sr. Staff RN – Cardiac Surgical ICUs – Albany Med Ctr
EMS Coordinator – Saratoga County, New York
EMS Editor – Fire Engineering Magazine
Outline

• CPR 2010: that was then, this is now…
• Show me the money: is there proof?
• What matters?
• Why measure?
• How to assess CPR quality
• Unique hospital issues
• Solutions
CPR Sequence

Change

- A-B-C to C-A-B
- Initiate chest compressions before ventilations

Why?

- Reduce delay to compressions
- Can be started immediately
- Emphasizes importance of chest compressions
So, What Matters in CPR?

And how should we assess effectiveness?
Let’s Get One Thing Straight:

Where do most cardiac arrests occur?

- ~ 175,000 per year out of hospital
  - ROC data (Nichol et al, JAMA 2008)
- ~ 200,000 per year in hospital

Attention American Heart Association:
You need to focus more effort on IHCA
Chest Compressions

2010
- ≥ 50 mm (≥ 2”)
- At least 100 per minute

2005
- 38 – 51 mm (1.5 – 2”)
- 100 per minute

Most Common Errors:
1. Too slow (when averaged)
2. Not deep enough
3. Prolonged interruptions
4. Leaning
Chest Compressions

• ROC: survival associated with ↑ depth
• Abella et al: 100-120/min = ↑ survival
• Recommendations are LOE 4 & 5 (just do it, because we like it)
• In truth:
  – Ideal actual depth of CPR unknown
    • Probably lies near 50 mm
  – Best rate for CPR unknown
    • Is likely about 100/min
CPR Rate vs. ROSC

- 96-139
- 87-95
- 72-87
- 40-72

ROSC: 40-72
No ROSC: 40-72

p < 0.0083

Probability of ROSC

One Day Survival

Survival to Discharge

Effective CPR?

• How do you measure the effectiveness of CPR?
  – End tidal carbon dioxide
  – Feedback devices

• Measurement of CPR effectiveness has been proposed as a TJC standard
Waveform Capnography
Attaches to ET tube, measures CO$_2$
Measuring Exhaled CO$_2$

Colorimetric

Capnometry

Capnography
Measuring Exhaled CO$_2$

- Colorimetric
- Capnometry
- Capnography
Measuring Exhaled CO₂

- Colorimetric
- Capnometry
- Capnography
Carbon Dioxide (CO$_2$) Production
What If...
But, with High-Quality CPR...
So What’s the Goal During CPR?

- Try to maintain a minimum EtCO$_2$ of 10
- Push
  - HARD ($\geq 2”$)
  - FAST (at least 100)
- Change rescuer
  - Every 2 minutes
Capnography = Results, not process
CPR is Complicated!

© Paul Combs
Hospital Issues:

1. Bed Height
   - Optimal = bed at knee level of person administering chest compressions

2. Air Mattresses
   - No need to deflate mattress for CPR
     Perkins et al, Inten Care Med. 2003;29:2330-2335

3. Backboards
   - No evidence of benefit with backboard
     Perkins et al, Inten Care Med. 2003;29:2330-2335
Pre, Intra, Post arrest recommendations:

1. Real time feedback at the point of care
2. Shock early, don’t interrupt CPR, avoid hyperventilation, optimize depth
3. BENCHMARK
Process recommendations:
1. CPR performance metric monitoring
2. Continual monitoring and feedback
3. Complex cases: team logistics
4. CQI
What About Quality?

CPR quality improvement during in-hospital cardiac arrest using a real-time audiovisual feedback system

Benjamin S. Abella a,*, Dana P. Edelson b, Salem Kim a, Elizabeth Retzer c, Helge Myklebust d, Anne M. Barry c, Nicholas O’Hearn e, Terry L. Vanden Hoek c, Lance B. Becker a

In-Hospital Arrests, Dec 2004 – Dec 2005
Audiovisual CPR Feedback

- Incorporated into monitor/defibrillator
- Real time
- Accelerometer-based
Handheld Feedback Device

Cardiopulmonary resuscitation feedback improves the quality of chest compression provided by hospital health care professionals

Charles N. Pozner MD a,*, Adam Almozlino a, Jonathan Elmer a, Stephen Poole a, De'Ann McNamara RN a, David Barash MD b

a STRATUS Center for Medical Simulation, Brigham and Women's Hospital, Boston, MA 02115, USA
b Concord Health Care Strategies, LLC, Concord, MA, USA

Handheld accelerometer-based audiovisual device
Generation of Feedback
Post Code Reviews

Device Type: LIFEPACK 15
CPR Annotations Edited: Yes
Device Configuration: 06355ROK02000V
Duration: 00:50:22
Incident ID: 2010070813303100-MEDIC 23
Statistical Parameters: 1000-0300-3000-05

Compressions Ratio (total time)
- 10:22 / 10:55 = 95 %

Compression Rate
- 110/minute

Compressions/minute
- 104/minute

Initial Rhythm
- 1.025mm/sec
Introduced in January 2014

Laerdal
EMS Feedback = ROSC

- FDNY uses audio-visual feedback
- Deactivated audio feedback for 1 week
- ROSC ↓ 20%

NY State EMS Council Report Jan 2012
Improving Patient Outcomes

How effective are feedback systems?

- Significantly improved CPR performance (rate, depth, limiting ventilations)
- No improvement in ROSC

We have a problem:

Compression feedback devices over estimate chest compression depth when performed on a bed

Gavin D. Perkins¹,², Laura Kocierz¹, Samuel J. Benfield³, Robert A. McCulloch³, Robin P. Davies²
Accelerometer CPR Depth

Perkins et al. Resuscitation 2009;80:79-82
The Mattress Issue:

- Mattress compression = 35 – 40% of total compression depth
- Accelerometer feedback devices fail to account for mattress compression
- Use of a backboard fails to compensate for mattress compression

Perkins et al. Resuscitation 2009;80:79-82
The Solution:

Directly measure the true compression depth.
Triaxial Field Induction:

TrueCPR™
Back Pad Under Patient
Compress Chest Pad
Triaxial Field Induction (TFI)
Completeley Different than Accelerometers

- Base plate creates 3-dimensional magnetic fields
- Top piece senses field
- Calculates true Anterior/Posterior depth
- Does not require exact alignment
TrueCPR Coaching Device

- Metronome
- Depth dial
- Rate
- Event timer
TrueCPR Summary Report

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressions ratio</td>
</tr>
<tr>
<td>(total time)</td>
</tr>
<tr>
<td>03:13 / 13:41 = 24%</td>
</tr>
</tbody>
</table>

| Good compressions             |
| (total compressions)          |
| 119 / 362 = 33%               |

|                          |
| Longest pause:           |
| 133 sec                  |

|                          |
| # pauses > 10 sec:       |
| 5                        |

|                          |
| Longest interval w/o     |
| good compression:        |
| 440 sec                  |
TrueCPR Summary Report

Compression Depth

<table>
<thead>
<tr>
<th>Compression depth (cm (IQR))</th>
<th>% in target (5-6 cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.6 (4.2, 5.2)</td>
<td>119 / 362 = 33%</td>
</tr>
</tbody>
</table>

- Too shallow: 243 (67%)
- Too deep: 0 (0%)

Compression Rate

<table>
<thead>
<tr>
<th>Compression rate</th>
<th>% in target (100-120)</th>
</tr>
</thead>
<tbody>
<tr>
<td>111 /minute</td>
<td>360 / 362 = 99%</td>
</tr>
</tbody>
</table>

- Too slow: 2 (1%)
- Too fast: 0 (0%)
TrueCPR Summary Report

Serial Number: ALPHA2 0024

- **Green:** Target depth and rate zones
- **Yellow:** Pauses
FIGURE 4. Schematic of average chest compression depth achieved by participants using either TFI (Group 1) or ACC (Group 2).

Summary

- Compressions are key to outcomes
  - Most common errors: depth and speed
- We must assess CPR effectiveness
  - It improves survival
  - 2013 AHA Recommendation
- Current tools: EtCO₂, ACC, TFI
  - CO₂ delayed
  - ACC inaccurate
  - TFI - Very promising!

www.mikemcevoy.com