New ACLS/Post Arrest Guidelines: For Everyone?

Laurie Morrison, Li Ka Shing, Knowledge Institute, St Michael's Hospital, University of Toronto
COI Declaration

Industry and ROC

ALS Taskforce ILCOR


St. Michael's
Inspired Care. Inspiring Science.

Medicine
UNIVERSITY OF TORONTO

rescu

American Heart Association
Learn and Live

CIHR
Canadian Institutes of Health Research

Institut de recherche en santé du Canada

IRSC
Institute of Circulatory and Respiratory Health

Institut de la santé circulatoire et respiratoire

The Laerdal Foundation
for Acute Medicine

National Institutes of Health
The Nation's Medical Research Agency
Scope of Work

The Chain of Survival

Early access
To get help

Early CPR
To buy time

Early Defibrillation
To restart heart

Early ACLS
To stabilize

Early Post-Resuscitation Care
To facilitate recovery

OHCA and IHCA
Critical CPR Concepts

CPR saves lives
Everyone should do it
Focus on continuous high quality
Minimize interruptions
Careful with ventilation
New Defib Toys
2010 Guidelines

Shout for Help/Activate Emergency Response

Start CPR
- Give oxygen
- Attach monitor/defibrillator

2 minutes

Check Rhythm

Return of Spontaneous Circulation (ROSC)

Drug Therapy
- IV/IO access
- Epinephrine every 3-5 minutes
- Amiodarone for refractory VF/VT

Consider Advanced Airway
- Quantitative waveform capnography

Treat Reversible Causes

Monitor CPR Quality

CPR Quality
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio
- Quantitative waveform capnography
  - If PETCO₂ <10 mm Hg, attempt to improve CPR quality
  - Intra-arterial pressure
    - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abrupt sustained increase in PETCO₂ (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Shock Energy
- Biphasic: Manufacturer recommendation (120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- Monophasic: 360 J

Drug Therapy
- Epinephrine IV/IO Dose: 1 mg every 3-5 minutes
- Vasopressin IV/IO Dose: 40 units can replace first or second dose of epinephrine
- Amiodarone IV/IO Dose: First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway
- Supraglottic advanced airway or endotracheal intubation
- Waveform capnography to confirm and monitor ET tube placement
- 8-10 breaths per minute with continuous chest compressions

Reversible Causes
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosisis)
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary
Defibrillator dashboard with CPR process measures

Perfusion pressure indicator

ALS Responder
Use of ET $\text{CO}_2$ During CPR

Confirming Intubation

Physiological Monitoring Quality of CPR
Rapid increase in ETCO2 predicts ROSC
Rapid decline in ETCO2 during ROSC predicts re-arrest
PSP of 20 seconds or longer associated with mortality
OR of 0.47 (0.27–0.82)
Anatomy of the Pre-Shock Pause

Optimize Hands On time

Manual vs Auto

Capacitor auto charges

No Pulse Check

No Analysis

One shock Only

Post Shock Pause

Human delay

Chest compressions

time

Analysis

Charge

Human delay
### Automatic Mode

<table>
<thead>
<tr>
<th>Device</th>
<th>Minimum Interruption, secs (Mean ± SD)</th>
<th>Maximum Interruption, secs (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.2 ± 0.1</td>
<td>8.1 ± 0.1</td>
</tr>
<tr>
<td>B</td>
<td>12.3 ± 0.2</td>
<td>15.7 ± 0.3</td>
</tr>
<tr>
<td>C</td>
<td>15.6 ± 0.1</td>
<td>16.9 ± 0.1</td>
</tr>
<tr>
<td>D</td>
<td>16.9 ± 0.1</td>
<td>18.1 ± 0.2</td>
</tr>
<tr>
<td>E</td>
<td>17.1 ± 0.2</td>
<td>18.3 ± 0.1</td>
</tr>
<tr>
<td>F</td>
<td>19.7 ± 0.1</td>
<td>22.1 ± 0.3</td>
</tr>
<tr>
<td>G</td>
<td>26.3 ± 0.1</td>
<td>28.4 ± 0.1</td>
</tr>
</tbody>
</table>

### Manual Mode – 5 seconds
Shortest PSP in Toronto

analysis

08:54:06

08:54:08
CPR Process – Personal Feedback

<table>
<thead>
<tr>
<th></th>
<th>AHA Guidelines</th>
<th>Mins of CPR that meet Guidelines (%)</th>
<th>Mean</th>
<th>SD</th>
<th>90(^{th}) % tile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mins of CPR</td>
<td></td>
<td>769</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp Rate</td>
<td>100-120</td>
<td>72%</td>
<td>105</td>
<td>10.33</td>
<td>118</td>
</tr>
<tr>
<td>Comp Fraction</td>
<td>≥ 0.6</td>
<td>89%</td>
<td>0.82</td>
<td>0.11</td>
<td>0.93</td>
</tr>
<tr>
<td>Comp Depth</td>
<td>≥ 5.0</td>
<td>39%</td>
<td>5.01</td>
<td>1.38</td>
<td>6.52</td>
</tr>
</tbody>
</table>
Summary of Changes

• Improve CPR quality
• Monitor CPR quality
• Feedback
  – Audio Visual Feedback
  – Audit and Feedback
• Reduce Peri-Shock Pause
### Survival Rates

Out-of-Hospital VF Cardiac Arrest in Epistry at Rescu
(Urban and rural regions of Southern Ontario)

<table>
<thead>
<tr>
<th>Year</th>
<th>Treated (N=)</th>
<th>Alive to discharge (N=)</th>
<th>Alive to discharge (%)</th>
<th>95% Confidence Limit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>234</td>
<td>40</td>
<td>17.1</td>
<td>12.3-21.9</td>
</tr>
<tr>
<td>2007</td>
<td>329</td>
<td>79</td>
<td>24.0</td>
<td>19.4-28.6</td>
</tr>
<tr>
<td>2008</td>
<td>404</td>
<td>86</td>
<td>21.3</td>
<td>17.3-25.3</td>
</tr>
<tr>
<td>2009</td>
<td>372</td>
<td>76</td>
<td>20.4</td>
<td>16.3-24.5</td>
</tr>
<tr>
<td>2010</td>
<td>353</td>
<td>99</td>
<td>28.0</td>
<td>23.4-32.7</td>
</tr>
<tr>
<td>2011</td>
<td>370</td>
<td>111</td>
<td>30.0</td>
<td>25.3-34.7</td>
</tr>
<tr>
<td>2012</td>
<td>359</td>
<td>104</td>
<td>29.0</td>
<td>24.3-33.7</td>
</tr>
<tr>
<td>2013</td>
<td>376</td>
<td>124</td>
<td>33.0</td>
<td>28.2-37.7</td>
</tr>
<tr>
<td>2014</td>
<td>394</td>
<td>137</td>
<td>30.2</td>
<td>25.8-34.6</td>
</tr>
</tbody>
</table>
2010 Guidelines

Part 4: CPR Overview: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality

American Heart Association Guidelines Update Cardiopulmonary Resuscitation and Emergency Cardiovascular Care
391 potential PICO questions prioritized for 2015 review

- 391 PICO questions completed in 2010
- 391 potential
- New topics added based on task force or public comment
- New ILCOR First Aid Task Force developed 55 PICO questions
- 165 systematic reviews completed
- 165 completed in 2015
- Combined or merged with other questions
- Retired as not relevant to current practice
- Considered low priority because of few developments in field
Top 5 Changes to CPR

1. **Compression rate: 100-120**
   A higher upper rate limit was added as CPR as quality decreases with >120 compressions per minute.

2. **Maximize compression time**
   Increased emphasis has been placed on minimizing the time without compressions to maximize coronary perfusion.

3. **Deep, but not too deep**
   An upper limit on the depth of chest compressions has been added. They should be between 5cm (2") and 6cm (2.5"). Deeper can be harmful.

4. **Directive dispatchers**
   Callers can receive increased guidance from emergency dispatchers regarding when to begin CPR. Dispatchers can also utilize social media applications to direct nearby assistance.

5. **Audiovisual feedback**
   Feedback to lay-providers may improve CPR. When available, audiovisual devices may be used to optimize CPR quality.

- 100-120 compressions/min
- Minimize interruptions
  - Compression fraction >0.6
  - Preferably >0.8
  - Rhythm check 5 seconds
  - Pulse check – organized rhythm
- Deep to 5-6 cm
- Audio Visual Feedback

• Just use epinephrine
• Vasopressin offers no advantage

• ETCO\(_2\) waveform capnography is the gold standard
• US in the hands of experts may be....

• Epi within 1-3 mins in non shockable rhythms – ROSC adv with IHCA

• Titrate to O\(_2\) sat with sustained ROSC

• May be considered.....lots of caveats
Effect of 1 mg Epi Bolus During CPR

Effect of 1mg epinephrine IV during CPR (10 doses epi given to 4 pigs)

Aortic Pressures

Carotid Blood Flow

% of pre epi level

Epi

100%

10 second intervals after epi administration

Courtesy of Paul Dorian’s Lab 2014
Clinical paper

Effect of adrenaline on survival in out-of-hospital cardiac arrest: A randomised double-blind placebo-controlled trial

Ian G. Jacobs\textsuperscript{a,c,*}, Judith C. Finn\textsuperscript{a,c}, George A. Jelinek\textsuperscript{b}, Harry F. Oxer\textsuperscript{c}, Peter L. Thompson\textsuperscript{d,e}

The use of adrenaline in cardiac arrest significantly improves the proportion of patients achieving ROSC prehospital, but failed to demonstrate a better survival to hospital discharge, possibly due to inadequate sample size.
Placebo versus EPI

Cumulative Proportion Survival

Event | ROSC | ED/admission | 24hrs | 72hrs | Discharge

Placebo
- Event: 8%
- ROSC: 13%
- ED/admission: 4%
- 24hrs: 2%
- 72hrs: 25%
- Discharge: 4%

Epinephrine
- Event: 24%
- ROSC: 13%
- ED/admission: 2%
- 24hrs: 25%
- 72hrs: 13%
- Discharge: 4%
<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>Date</th>
<th>N</th>
<th>One-Month Survival</th>
<th>CPC 1-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hagihara 2012</td>
<td>OHCA</td>
<td>2012</td>
<td>417,188</td>
<td>VF: 15.4% vs. 21.3%</td>
<td>Propensity Matched: 5.1% vs. 7.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NonVF: 3.8% vs. 3.4%</td>
<td>Propensity Matched: 1.3% vs. 3.1%</td>
</tr>
<tr>
<td>Nakahara 2012</td>
<td>OHCA</td>
<td>2007-2008</td>
<td>49,165</td>
<td>VF: 28.2% vs. 17.7%</td>
<td>Propensity Matched: 6.1% vs. 13.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NonVF: 4.7% vs. 2.8%</td>
<td>Propensity Matched: 0.6% vs. 0.7%</td>
</tr>
<tr>
<td>Nakahara 2013</td>
<td>OHCA</td>
<td>2007-2010</td>
<td>96,079</td>
<td>VF: 16.5% vs. 28.8%</td>
<td>Propensity Matched: 17.0% vs. 13.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NonVF: 3.9% vs. 4.2%</td>
<td>Propensity Matched: 4.0% vs. 2.4%</td>
</tr>
<tr>
<td>Hayashi 2012</td>
<td>OHCA</td>
<td>2007-2009</td>
<td>3,161</td>
<td>VF: 13.5% vs. 12.0%</td>
<td>Propensity Matched: 4.1% vs. 6.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NonVF: 13.5% vs. 12.0%</td>
<td>Propensity Matched: 3.5% vs. 12.0%</td>
</tr>
<tr>
<td>Goto 2013</td>
<td>OHCA</td>
<td>2009-2010</td>
<td>209,577</td>
<td>VF: 15.4% vs. 27.0%</td>
<td>Propensity Matched: 7.0% vs. 18.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NonVF: 3.0% vs. 18.7%</td>
<td>Propensity Matched: 0.59 vs. 0.62%</td>
</tr>
</tbody>
</table>

**BIG Observational Studies >775,000 patients**

**Propensity matched**

Duration of OHCA prior to ROSC

Indication bias confounding

No Post Arrest Care Protocol

Ø TTM
Ø Access to PCI
Ø Vasopressor Support
Ø Neuroprognostication
Focus on the Rescuer

Making the RIGHT thing the EASIEST thing to do

One size DOES NOT fit all in Resuscitation

Focus on the Patient
The optimal dose of epinephrine during CPR in human beings is unknown. We studied ten prehospital cardiac arrest patients (six men and four women; mean age, 54 ± 5 years) to determine the vasopressor response and change in the end-tidal carbon dioxide concentration ($P_{\text{ET}}CO_2$) after incremental (1-, 3-, and 5-mg) doses of IV epinephrine given five minutes apart during closed-chest CPR. All patients were in ventricular fibrillation on arrival of the paramedics and did not respond to standard advanced cardiac life support. CPR was performed with a con. Thumper®; all patients were intubated and ventilated at 12 tim.
Clinical paper

Effect of adrenaline on survival in out-of-hospital cardiac arrest: A randomised double-blind placebo-controlled trial☆

Ian G. Jacobsa,c,*, Judith C. Finna,c, George A. Jelinekb, Harry F. Oxerc, Peter L. Thompsond,e

The use of adrenaline in cardiac arrest significantly improves the proportion of patients achieving ROSC prehospital, but failed to demonstrate a better survival to hospital discharge, possibly due to inadequate sample size. Further studies on the role of adrenaline in cardiac arrest are required to determine optimal dose and timing for drug administration.
Cardiac arrests with asystole or pulseless electrical activity (n=119,978)

Arrests in emergency department, intensive care unit, surgical unit, other specialty unit (n=83,490)

Arrests of general inpatient floor or ward (n=36,488)

Survival to discharge

Patients received vasopressin before epinephrine (n=85)

Final study population (n=25,095)
Quality of CPR Monitoring

2014 OHCA

<table>
<thead>
<tr>
<th>N (Minutes of CPR)</th>
<th>Compression Rate (comps/min)</th>
<th>Compression Fraction</th>
<th>Compression Depth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1269</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Epinephrine given**: 1203 (94.8%)
- **Amiodarone given**: 83 (0.7%)
- **Advanced airway deployed**: 928 (73.1%)

<table>
<thead>
<tr>
<th>Intervals</th>
<th>Survival to discharge (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>11.2</td>
</tr>
<tr>
<td>4-6</td>
<td>8.0</td>
</tr>
<tr>
<td>7-9</td>
<td>5.3</td>
</tr>
<tr>
<td>&gt;9</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time of administration of epinephrine (minutes)</th>
<th>Survival to discharge (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>11.2</td>
</tr>
<tr>
<td>4-6</td>
<td>8.0</td>
</tr>
<tr>
<td>7-9</td>
<td>5.3</td>
</tr>
<tr>
<td>&gt;9</td>
<td>3.5</td>
</tr>
</tbody>
</table>

| ALS arrival to first drug given                  | 18.54                     |
| ALS pt contact to first drug given               | 8.68                      |
| CPR start to any drug given                      | 11.18                     |

<table>
<thead>
<tr>
<th>Minutes of CPR Meeting Standard(%) Mean 7434</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHA Guidelines-ROC</td>
</tr>
<tr>
<td>105.20</td>
</tr>
<tr>
<td>0.78</td>
</tr>
<tr>
<td>4.87</td>
</tr>
</tbody>
</table>

| ALS arrival to first drug given                  | 9.08                      |
| ALS pt contact to first drug given               | 7.68                      |
| CPR start to any drug given                      | 6.83                      |

| ALS arrival to first drug given                  | 11.09                     |
| ALS pt contact to first drug given               | 5.98                      |
| CPR start to any drug given                      | 4.97                      |
Fatal Flaws

• To slow to recognize CA
• To slow to start compressions
• To slow to apply defib
• To slow to shock
• Training - infrequent, remote from ward
• Feedback - none Point of Care, infrequent audit and feedback
• Mock codes - NASCAR analogy
One size DOES NOT fit all in Post Resuscitation

1. Target 32-36°C for 24 hours
   Targeted temperature management in patients with ROSC who are coma-tose BUT prehospital cooling isn’t so hot, in the field is not beneficial and may be harmful.

2. Assess core for potential VE
   Al

3. Wait before you prognosticate
   Wait 72 hours after arrest or 72 hours after cooling ends before prognostication.

One size DOES NOT fit all in Post Resuscitation

- Donation after circulatory death
- WLST < 72 hours is fatal

Donation after circulatory death

One size DOES NOT fit all in Post Resuscitation

- Consider for non STEMI
Pittsburgh Cardiac Arrest Categories

<table>
<thead>
<tr>
<th>Category 1</th>
<th>Awake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 2</td>
<td>Coma without severe shock</td>
</tr>
<tr>
<td>Category 3</td>
<td>Coma with severe shock or pulmonary dysfunction</td>
</tr>
<tr>
<td>Category 4</td>
<td>Coma with loss of brainstem reflexes</td>
</tr>
</tbody>
</table>

*Rittenberger 2011; Resuscitation 82: 1399-1404*
Customize care based on expectations

Post-Arrest STEMI

- Category 1
- Category 2
- Category 3

Category 4 → CT head → Discuss with Family → Limitation of Care → Straight to Cath Lab
STEMI + who else goes to cath?

STEMI

Category 1 → Straight to Cath Lab
Category 2
Category 3
Category 4 → CT head → Discuss with Family

Limitation of Care
STEMI + who else goes to cath?

STEMI

Primary VF

Suggestive History

Cardiogenic Shock

Category 1
Category 2
Category 3
Category 4
CT head
Discuss with Family
Limitation of Care

Straight to Cath Lab
STEMI + who else goes to cath?

STEMI

Primary VF

Suggestive History

Cardiogenic Shock

Echo with Focal Wall Motion Abnormalities

Rising Troponin

Category 1 → Straight to Cath Lab

Category 2

Category 3

Category 4 → CT head → Discuss with Family

Limitation of Care
33ºC or 36ºC?

- In undifferentiated patients, neither has been shown to be superior
  - In patients with <50% expected survival, consider using the more aggressive regimen
Clinical paper

Association between a quantitative CT scan measure of brain edema and outcome after cardiac arrest

Robert B. Metter, Jon C. Rittenberger, Francis X. Guyette, Clifton W. Callaway

GWR: Gray Matter to White Matter Ratio
Progression of Cerebral Edema after Rewarming
33ºC or 36ºC?

• In undifferentiated patients, neither has been shown to be superior
  – In patients with <50% expected survival, consider using more aggressive regimen
  – Use temperature to affect specific pathophysiology: cerebral edema, brain tissue hypoxia, seizures

CT with intermediate edema

Consider 33 > 36
33ºC or 36ºC?

- In undifferentiated patients, neither has been shown to be superior
  - In patients with <50% expected survival, consider using more aggressive regimen
  - Use temperature to affect specific pathophysiology: cerebral edema, brain tissue hypoxia, seizures

```
Consider 33 > 36
```

```
Consider 33 > 36
```

```
Consider 33 > 36
```

```
Consider 33 > 36
```
Impact of Guidelines

The Utstein Formula of Survival

Medical Science × Educational Efficiency × Local Implementation = Survival

Resus 2014
Knowledge Translation or Implementation Science

Right provider
Right patient
Right treatment
Right time interval
→
Right outcome
Implement, Implement, Implement
Audit and Feedback = Survival
HIGHLIGHTS AT A GLANCE

1. ADULT BASIC LIFE SUPPORT
2. ADULT ADVANCED CARDIOVASCULAR LIFE SUPPORT
3. PEDIATRIC BASIC LIFE SUPPORT
4. PEDIATRIC ADVANCED LIFE SUPPORT
5. NEONATAL RESUSCITATION
6. EDUCATION
7. FIRST AID

www.heartandstroke.ca/guidelines2015