Sonography in Cardiac Arrest

Real-time Assessment and Evaluation with Sonography - Outcomes Network (REASON)

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on behalf of Dr. Romolo Gaspari and the REASON Study Group
Thank you to the REASON network and clinicians at each site who have contributed.

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Marsia Vermeulen

No Financial Disclosures

I have no conflict of interests
“Ultrasound…the new stethoscope…”

# Feasibility

## Table 1  
Technical aspects of echo in life support

<table>
<thead>
<tr>
<th>View</th>
<th>Number (% of total)</th>
<th>Adequate view %</th>
<th>Adequate view %</th>
<th>Number within single 10 s window</th>
<th>Success rate (adequate view within 10 s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcostal</td>
<td>40 (80%)</td>
<td>36</td>
<td>25%</td>
<td>26</td>
<td>42%</td>
</tr>
<tr>
<td>Parasternal</td>
<td>70 (40%)</td>
<td>18</td>
<td>55%</td>
<td>11</td>
<td>85%</td>
</tr>
<tr>
<td>Apical</td>
<td>4 (1%)</td>
<td>3</td>
<td>75%</td>
<td>7</td>
<td>52%</td>
</tr>
<tr>
<td>Posterior</td>
<td>59 (41%)</td>
<td>47</td>
<td>54%</td>
<td>45</td>
<td>95%</td>
</tr>
</tbody>
</table>
no cardiac activity = stop
Duration of resuscitation efforts and subsequent survival after in-hospital cardiac arrest

Figure 1.
Shown is the cumulative percentage of patients achieving ROSC. Overall, 48·5% of the total population achieved ROSC. By 30 minutes, 42·5% achieved ROSC.

Goldberger et al. Lancet. 2012;
(n = a few)
Bedside Focused Echocardiography as Predictor of Survival in Cardiac Arrest Patients: A Systematic Review

Lacey Blyth, Paul Atkinson MB, BCh, BAO, BSc(Hons), MA(Cantab), MRCP, FCEM, Kathleen Gadd, MLIS, and Eddy Lang, MD, CCFP(EM)
<table>
<thead>
<tr>
<th>Study</th>
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<th>FP</th>
<th>TN</th>
<th>FN</th>
<th>n</th>
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<tr>
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<td>0</td>
<td>27</td>
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<tr>
<td>Selén (2005)</td>
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<td>3</td>
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<td>11</td>
<td>30</td>
<td>59</td>
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<td>102</td>
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<tr>
<td>Blaivas (2001)</td>
<td>20</td>
<td>13</td>
<td>136</td>
<td>0</td>
<td>169</td>
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<td>Pooled</td>
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<td></td>
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<td>568</td>
</tr>
</tbody>
</table>

FN = false-negative; FP = false-positive; n = number of subjects.

Blyth et al. AEM 2012
Methods

• Multicenter Prospective Observational Trial

• Adults with atraumatic PEA or Asystole (in the ED) undergoing resuscitation

• PoCUS at start & end of resuscitation

• Primary Outcome - ROSC

• REDCap Database
Power Calculation

80% power, 1 sided alpha 0.05 : \(761\) patients

Assuming: US will identify patients without ROSC

1% misclassification rate

20% ROSC

25% exclusion rate

Sasson et al. JAMA. 2008
Group Comparisons

—initial activity

- Lilliefors Test - Normality
- Mann-Whitney U test, Fisher Exact
May 2011 - November 2014, 18 Sites

Saint John

Ottawa

Kingston
Excluded

Vfib/Vtach Arrest
Missing Data
No US performed

Initial Database

1087

815

Included

Included

272
Patient Characteristics

Age - 63yo

Male - 62%

OOCHA - 84%

Length of resus - 18 min
Patient Characteristics

Initial activity on US - 32.7%

ROSC - 26.3%

Hospital Admission - 15.2%

Survival to Hospital DC - 1.5%
## Cardiac Rhythm

<table>
<thead>
<tr>
<th></th>
<th>Initial Rhythm</th>
<th>Start of Resuscitation</th>
<th>Final Rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEA</td>
<td>40%</td>
<td>49%</td>
<td>52%</td>
</tr>
<tr>
<td>Asystole</td>
<td>35%</td>
<td>47%</td>
<td>28%</td>
</tr>
<tr>
<td>VF/VT</td>
<td>14%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Other (SR/Paced)</td>
<td>4%</td>
<td>4%</td>
<td>20%</td>
</tr>
</tbody>
</table>
Timing During Resuscitation

Cardiac Arrest: 5 (0-12) min
EMS: 25 (18-35) min
ED Arrival: 0 (0-1) min
ACLS Started: 4 (2-7) min
US#1: 14 (9-21) min
ACLS Completed

(median time in min (IQR))
Timing by Initial US results

Cardiac Arrest
CPR/EMS
ED Arrival
ACLS Started
US#1
ACLS Completed

(median time in minutes)
Survival

- Initial ROSC: 47.4%
- Hospital Admission: 27.6%
- Hospital Discharge: 8.2%

8 pts US +, 4 pts US -
ROSC:
47.4\%

vs.

14.5\%
p<0.001
Survive to admission: 27.6% vs. 8.2% p<0.001
<table>
<thead>
<tr>
<th>US +</th>
<th>ROSC +</th>
<th>ROSC -</th>
</tr>
</thead>
<tbody>
<tr>
<td>129</td>
<td>456</td>
<td>130</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>456</td>
</tr>
</tbody>
</table>

Sensitivity 63.2% (56% to 70%)

Specificity 77.8% (74% to 81%)

LR + 2.85 (2.37 to 3.43)

LR - 0.47 (0.39 to 0.57)
Sensitivity 63.9%  
(54% to 72%)

Specificity 72.9%  
(69% to 76%)

LR + 2.36  
(1.97 to 2.83)

LR - 0.49  
(0.39 to 0.63)

<table>
<thead>
<tr>
<th></th>
<th>survival to admission</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>US +</td>
<td>78</td>
<td>181</td>
</tr>
<tr>
<td>US -</td>
<td>44</td>
<td>487</td>
</tr>
</tbody>
</table>
Survival to Discharge

- For Hospital Discharge (total 12 survivors)
- Similar test characteristics
  - Sensitivity 66.7% (35% to 90%)
  - Specificity 67.7% (64% to 71%)
  - LR+ 2.07 LR- 0.49
<table>
<thead>
<tr>
<th></th>
<th>Asystole</th>
<th>PEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>In ED</td>
<td>380</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td><strong>US+</strong> 39</td>
<td><strong>US+</strong> 220</td>
</tr>
<tr>
<td></td>
<td><strong>US-</strong> 341</td>
<td><strong>US-</strong> 190</td>
</tr>
<tr>
<td>ROSC</td>
<td>7 18%</td>
<td>122 55%</td>
</tr>
<tr>
<td></td>
<td>34 10%</td>
<td>41 21%</td>
</tr>
<tr>
<td>Hospital Admission</td>
<td>4 10%</td>
<td>72 33%</td>
</tr>
<tr>
<td></td>
<td>20 6%</td>
<td>22 11%</td>
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</tbody>
</table>

\[p=0.0001\]
## Influence on Outcomes

<table>
<thead>
<tr>
<th></th>
<th>ROSC</th>
<th>Survival to admission</th>
<th>Survival to discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Presenting Rhythm (PEA)</strong></td>
<td>2.12</td>
<td>1.62</td>
<td>0.715</td>
</tr>
<tr>
<td></td>
<td>(1.53-2.94)</td>
<td>(1.08-2.43)</td>
<td>(0.18-2.63)</td>
</tr>
<tr>
<td><strong>ED Rhythm (PEA)</strong></td>
<td>4.24</td>
<td>3.90</td>
<td>4.91</td>
</tr>
<tr>
<td></td>
<td>(2.95 - 6.13)</td>
<td>(2.44-6.26)</td>
<td>(1.01-32.66)</td>
</tr>
<tr>
<td><strong>Downtime (&lt;5min)</strong></td>
<td>1.82</td>
<td>2.03</td>
<td>3.03</td>
</tr>
<tr>
<td></td>
<td>(1.31-2.53)</td>
<td>(1.35-3.04)</td>
<td>(0.82-12.04)</td>
</tr>
<tr>
<td><strong>Ultrasound (+activity)</strong></td>
<td>6.12</td>
<td>4.54</td>
<td>4.06</td>
</tr>
<tr>
<td></td>
<td>(4.3-8.7)</td>
<td>(3.00-6.95)</td>
<td>(1.10-16.17)</td>
</tr>
<tr>
<td><strong>Age (&lt;50)</strong></td>
<td>0.90</td>
<td>1.05</td>
<td>2.05</td>
</tr>
<tr>
<td></td>
<td>(0.59-1.36)</td>
<td>(0.63-1.74)</td>
<td>(0.51-7.63)</td>
</tr>
<tr>
<td><strong>Location of arrest (in ED)</strong></td>
<td>3.08</td>
<td>1.45</td>
<td>3.41</td>
</tr>
<tr>
<td></td>
<td>(1.98-4.79)</td>
<td>(0.91-2.32)</td>
<td>(0.85-12.75)</td>
</tr>
</tbody>
</table>

OR (95%CI)
Do US findings affect resus efforts?
- Patients started on IV continuous drip pressors

- Initial US Activity (n=75)
  (+) n=51
  (-) n=24

- Repeat US
  (+) n=13
  (-) n=11

- Resuscitation (n=64)
  (+) n=37
  (-) n=5

- ROSC (n=42)
  (+) n=18
  (-) n=0

- Admitted (n=18)

- ROSC (n=3)

- Admitted (n=1)
Survival to hospital discharge rates are low.
Survival to hospital discharge rates are low.

1.5% overall, 0.5% if no cardiac activity on US
US activity is associated with ROSC in PEA, but not in asystole
US activity is associated with ROSC in PEA, but not in asystole.

PEA with cardiac activity had the highest likelihood of survival to hospital admission.
US is not a reliable independent test to predict cardiac arrest outcome in ED patients, overall, or even in PEA.
US is not a reliable independent test to predict cardiac arrest outcome in ED patients, overall, or even in PEA

LR+ve 1.64 - 2.85; LR-ve 0.42 - 0.49
Patients with cardiac activity on US had more use of IV pressor support. Survival in this group was higher.
Patients with cardiac activity on US had more use of IV pressor support.

Survival in this group was higher.

?association vs causation
References


7. Blaivas M, Fox JC. Outcome in cardiac arrest patients found to have cardiac standstill on the bedside emergency department echocardiogram. Acad Emerg Med. 2001; 8:616–21.


Questions?

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romolo.gaspari@umassmemorial.org

REASON Study Group
<table>
<thead>
<tr>
<th></th>
<th>survival to DC</th>
<th>death</th>
</tr>
</thead>
<tbody>
<tr>
<td>US +</td>
<td>8</td>
<td>251</td>
</tr>
<tr>
<td>US -</td>
<td>4</td>
<td>527</td>
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</tbody>
</table>

**Sensitivity 66.7%** (35% to 90%)

**Specificity 67.7%** 64% to 71%

**LR + 2.07** (1.37 to 3.12)

**LR - 0.49** (0.22 to 1.10)
PEA Survival - ROSC

Sensitivity 74.85%
(67.46% to 81.31%)

Specificity 60.32 %
(53.93% to 66.47%)

Positive Likelihood Ratio 1.89
(1.58 to 2.25)

Negative Likelihood Ratio 0.42
(0.31 to 0.55)

<table>
<thead>
<tr>
<th></th>
<th>ROSC +ve</th>
<th>ROSC -ve</th>
</tr>
</thead>
<tbody>
<tr>
<td>US +ve</td>
<td>122</td>
<td>98</td>
</tr>
<tr>
<td>US -ve</td>
<td>41</td>
<td>149</td>
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</table>
Sensitivity 76.6%  
(67% to 85%)

Specificity 53.2%  
(48% to 59%)

LR+ 1.64  
(1.39 to 1.92)

LR - 0.44  
(0.30 to 0.64)
<table>
<thead>
<tr>
<th></th>
<th>US+</th>
<th>US-</th>
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<tbody>
<tr>
<td></td>
<td>Downtime &lt;5 min</td>
<td>Downtime ≥5 min</td>
</tr>
<tr>
<td>In ED</td>
<td>142</td>
<td>129</td>
</tr>
<tr>
<td>ROSC</td>
<td>73</td>
<td>65</td>
</tr>
<tr>
<td>Hospital Admit</td>
<td>43</td>
<td>35</td>
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<tr>
<td>p=0.0001</td>
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**Table:**

<table>
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<tr>
<td></td>
<td>Downtime &lt;5 min</td>
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<tr>
<td>In ED</td>
<td>183</td>
<td>355</td>
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<td>41</td>
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<td>19</td>
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<td>p=0.0001</td>
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