Location-Specific Cost Effectiveness of Public Access Defibrillation

SAEM, San Francisco 2006
Ontario Prehospital Advanced Life Support Study
Public Access Defibrillation (PAD)

• The effectiveness of rapid defibrillation for cardiac arrest is undisputed

• Rationale for PAD: ↑ availability of AEDs → faster defib times → ↑ survival

• Little research guiding optimal placement of AEDs
**PAD Considerations**

- 3-minute response time interval
- Multiple AEDs may be necessary per site
- Patient, system and clinical factors affect likelihood of an individual cardiac arrest being amenable to defibrillatory shock
- Widespread PAD potentially expensive, divert attention and resources from other programs
What is the cost-effectiveness of PAD when added to existing EMS?
In which specific locations would it be cost-effective to install AEDs?
Objective

To compare the incremental cost-effectiveness of the addition of a PAD program to the standard EMS response for a number of public location categories.
OPALS Study

- Prospective before-after clinical trial
- 10 years, 20 Ontario study communities
- Studied impact of early defib/ALS on cardiac arrest survival, neuro outcomes, quality of life
- Phase II: EMS and firefighter rapid AED
- Phase III: Full ALS
- Utstein style
Patients

All adults suffering a prehospital cardiac arrest of presumed **cardiac etiology** prior to EMS arrival

**Exclusions:**

- < 16 years
- *Obvious deaths* as per Ambulance Act
- Trauma victims
- Other non-cardiac etiology
Design

- Economic Evaluation
- Compare the total costs and life expectancy of treating cardiac arrest patients with and without an on-site automated electronic defibrillator (AED)
Data Collection

OPALS
1995-2000

Municipal Property Assessment Corporation

Provincial Dispatch Database
Data Collection

- *A priori*, property type codes grouped into 18 location categories
- Roll provided total number of sites, per location type, within the study boundary
Primary Outcome

- Incremental Cost Effectiveness Ratio

- The relative mean dollar cost of PAD in each location category per additional quality-adjusted life year (QALY).

\[ ICER = \frac{\text{Cost}_i - \text{Cost}_c}{\text{QALY}_i - \text{QALY}_c} \]

- i.e., the additional cost per life year gained
Decision Analysis Model

- Estimated life expectancy and treatment costs of patients by survival status, gender, age at cardiac arrest.
- Adapted data within Weinstein model for survival estimates and disease progression.
- Future life expectancy and costs discounted at a rate of 5%.
- Monte Carlo simulation estimated the uncertainty surrounding the ICERs.
Design of Decision Model

CONTINUES AS PER ARREST WITH MI WITH UNIQUE SET OF PROBABILITIES

Cardiac Arrest

Survived to Hospital

Survived to 30 Days

Arrest only

DIED within 30 Days

Arrest plus MI

No New Event

DIED

New Event

Update disease history

MI

DIED

Arrest

Arrest plus MI

MI only

DIED

Arrest only

No New Event

FIRST 30 DAYS AFTER CARDIAC ARREST

FOLLOWING 11 MONTHS AND SUBSEQUENT YEARS
Input Data

• Average \( n \) of cardiac arrests/yr (OPALS)

• Proportion of patients who die at scene, in hospital and survive to discharge without an on-site AED by gender, age (OPALS)

• Survival benefit from access to on-site AED in \( \leq 3 \) min (OR = 3.0, 95%CI = 2.3-4.0)

• Annual cost of AED materials, training (5-yr amortization = $1319.01/yr)

• Resource utilization costs were based on a representative Canadian sample with incident coronary heart disease
### Patient Characteristics

(\(N=7707\))

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>69</td>
</tr>
<tr>
<td>Male</td>
<td>67%</td>
</tr>
<tr>
<td>Bystander Witnessed</td>
<td>49%</td>
</tr>
</tbody>
</table>

**Initial Rhythm:**

- VF or VT: 37%
- PEA: 21%
- Asystole: 42%
- Survival: 4.0%
**EMS Characteristics**  
*(N=7707)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bystander CPR</td>
<td>16%</td>
</tr>
<tr>
<td>Fire/police CPR</td>
<td>39%</td>
</tr>
<tr>
<td>PAD response</td>
<td>0.2%</td>
</tr>
<tr>
<td>Fire first</td>
<td>49%</td>
</tr>
<tr>
<td>Defibrillation</td>
<td>43%</td>
</tr>
</tbody>
</table>

**Defibrillation response interval:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (min)</td>
<td>5.4</td>
</tr>
<tr>
<td>Response ≤ 8 min</td>
<td>91%</td>
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</table>
OPALS Cardiac Arrest Locations (N=7707)

- Small residential: 56%
- Large residential: 29%
- Outdoors: 3%
- Large public: 7%
- Small public: 5%
Average Years Between PAD Use (per Site)

Casino 0.36
Non-acute hospital 5
Nursing home 5
Penal institution 18
Indoor shopping mall 26
Hotel 46
Golf course 87
Recreation/Assembly/Community 97
Airport/Heliport/Rail/Bus station 104
Restaurant/Bar 147
Water/Boat/Marina 240
School/College/University 246
Medical office/Clinic 293
Single store/Strip mall 324
Office building 379
Multi-residential dwelling 457
Single residential dwelling 1009
Sports field/Park 1121
Stadium/Fairground 1190
Factory/Industrial/Railway/Dockyard 1541

Potential PAD Use per Site (yrs)
<table>
<thead>
<tr>
<th>Location</th>
<th>Arrests</th>
<th>Sites</th>
<th>Arrest/Site/Yr</th>
<th>ICER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casino</td>
<td>28</td>
<td>2</td>
<td>2.800</td>
<td>$542</td>
</tr>
<tr>
<td>Non-acute hospital</td>
<td>42</td>
<td>42</td>
<td>0.200</td>
<td>$30750</td>
</tr>
<tr>
<td>Nursing home</td>
<td>457</td>
<td>460</td>
<td>0.199</td>
<td>$45926</td>
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<tr>
<td>Indoor shopping mall</td>
<td>77</td>
<td>394</td>
<td>0.039</td>
<td>$67690</td>
</tr>
<tr>
<td>Penal institution</td>
<td>6</td>
<td>21</td>
<td>0.057</td>
<td>$128783</td>
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<tr>
<td>Hotel</td>
<td>65</td>
<td>604</td>
<td>0.022</td>
<td>$143530</td>
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<tr>
<td>Golf course</td>
<td>9</td>
<td>156</td>
<td>0.012</td>
<td>$205990</td>
</tr>
<tr>
<td>Recreation/Assembly/Community</td>
<td>165</td>
<td>3206</td>
<td>0.010</td>
<td>$205407</td>
</tr>
<tr>
<td>Restaurant/Bar</td>
<td>48</td>
<td>1410</td>
<td>0.007</td>
<td>$347954</td>
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<tr>
<td>Airport/Heliport/Rail/Bus station</td>
<td>4</td>
<td>83</td>
<td>0.010</td>
<td>$368608</td>
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<tr>
<td>Water/Boat/Marina</td>
<td>5</td>
<td>240</td>
<td>0.004</td>
<td>$478647</td>
</tr>
<tr>
<td>School/College/University</td>
<td>36</td>
<td>1770</td>
<td>0.004</td>
<td>$598210</td>
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<tr>
<td>Single store/Strip mall</td>
<td>231</td>
<td>14956</td>
<td>0.003</td>
<td>$925784</td>
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<tr>
<td>Medical office/Clinic</td>
<td>41</td>
<td>2399</td>
<td>0.003</td>
<td>$955614</td>
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<td>Office building</td>
<td>96</td>
<td>7276</td>
<td>0.003</td>
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<tr>
<td>Stadium/Fairground</td>
<td>1</td>
<td>238</td>
<td>0.001</td>
<td>$1910193</td>
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<tr>
<td>Sports field/Park</td>
<td>14</td>
<td>3139</td>
<td>0.001</td>
<td>$4104539</td>
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<tr>
<td>Factory/Industrial/Railway/Docks</td>
<td>56</td>
<td>17261</td>
<td>0.001</td>
<td>$4323180</td>
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<tr>
<td>Location</td>
<td>Probability Cost Effective</td>
<td># AEDs Cost Effective</td>
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<tr>
<td>---------------------------------------------</td>
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<tr>
<td>Casino</td>
<td>100%</td>
<td>54.8</td>
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<tr>
<td>Non-acute hospital</td>
<td>99%</td>
<td>1.7</td>
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<tr>
<td>Nursing home</td>
<td>67%</td>
<td>1.1</td>
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<tr>
<td>Indoor shopping mall</td>
<td>2%</td>
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<tr>
<td>Penal institution</td>
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<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td>0%</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golf course</td>
<td>0%</td>
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Cost Effectiveness Acceptability Curves

- Value of an Additional Year of Life
- Probability PAD Program is Cost Effective

Casinos | Non-acute Hospitals | Nursing Homes
Limitations

- No large metropolitan centers (>1 million) in our population
- Few large sporting venues in this Canadian study region
- Canadian costs
- Assumptions of economic analysis
- Some would argue for willingness to pay threshold greater than $50,000/life year gained
Conclusions

• Only 3 locations where PAD considered cost-effective based on willingness to pay $50K/life year gained

• Does not appear cost-effective to install AEDs in any of the other 16 locations

• No convincing evidence to support widespread implementation of PAD
EMS and public health directors should consider methods for improving survival for ALL cardiac arrest patients (e.g., improving citizen CPR, optimizing the traditional EMS response, targeted responder programs).