Association Between Hospital Volume of Cardiopulmonary Resuscitation for In-Hospital Cardiac Arrest and Survival to Hospital Discharge

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Background

- In 2010, the AHA set an emergency cardiovascular care impact goal of doubling cardiac arrest survival by 2020.
- Progress among patients with in-hospital cardiac arrest (IHCA) has been slower compared to those with out-of-hospital cardiac arrest (OHCA) (65% vs 76% progress at FY 2016-17).
- Magnitude of IHCA survival vary widely across hospitals, but limited evidence exist on hospital characteristics associated with survival.
- Hospital case volume of cardiopulmonary resuscitation is not associated with survival in patients with OHCA.
- How case volume impact on survival for in-hospital cardiac arrest (IHCA) is largely unknown.
Methods

• We queried the National Inpatient Sample (NIS) of hospital discharges in the U.S. from 2005 to 2011 to identify adults ≥18 years who underwent cardiopulmonary resuscitation for IHCA

• Years > 2011 were excluded due to redesign of NIS that precludes case volume calculation

• Multivariable-adjusted restricted cubic spline was used to evaluate the association between hospital mean annual CPR volume and survival to hospital discharge

• Further analysis was conducted with CPR volume in quartiles
Results

Sample selection

Cases identified
(n=144,931)

Analysis restricted to adults
(n=137,466)

- 7465 non-adults (<18 years) excluded

7634 excluded to improve statistical inference
- Hospital reported <5 annual cases (n= 3000)
- missing values (n= 4634)

considered for sensitivity analysis
(n=129,832)

4750 transfers considered for sensitivity analysis only
- All transfer out (n= 4,333)
- Transfer in and death on day 1= (n=417)

Main analysis
(n=125,082)

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Main analysis
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Baseline characteristics across quartiles of CPR volume

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients (weighted)</td>
<td>144,422</td>
<td>146,368</td>
<td>148,592</td>
<td>146,698</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>68 (15)</td>
<td>67 (16)</td>
<td>67 (16)</td>
<td>66 (16)</td>
</tr>
<tr>
<td>Female, %</td>
<td>46</td>
<td>45</td>
<td>44</td>
<td>45</td>
</tr>
<tr>
<td>White, %</td>
<td>73</td>
<td>67</td>
<td>66</td>
<td>57</td>
</tr>
<tr>
<td>Elixhauser score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1</td>
<td>18</td>
<td>17</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>2-3</td>
<td>40</td>
<td>39</td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>≥4</td>
<td>42</td>
<td>44</td>
<td>46</td>
<td>51</td>
</tr>
<tr>
<td>Hospital bed size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>22</td>
<td>10</td>
<td>4.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Medium</td>
<td>36</td>
<td>28</td>
<td>23</td>
<td>8.4</td>
</tr>
<tr>
<td>Large</td>
<td>40</td>
<td>61</td>
<td>72</td>
<td>90</td>
</tr>
<tr>
<td>Hospital location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>19</td>
<td>7.1</td>
<td>1.6</td>
<td>1.8</td>
</tr>
<tr>
<td>Urban non-teaching</td>
<td>57</td>
<td>53</td>
<td>43</td>
<td>36</td>
</tr>
<tr>
<td>Urban teaching</td>
<td>24</td>
<td>41</td>
<td>55</td>
<td>62</td>
</tr>
</tbody>
</table>
Mean annual CPR volume is inversely associated with survival to hospital discharge. The values shown on the x-axis correspond to the 5th (reference), 25th, 50th, and 75th percentiles of mean annual CPR volume. P value for nonlinearity<0.001.
Risk-adjusted rate of survival to hospital discharge after cardiopulmonary resuscitation for IHCA, by quartile of CPR volume (p<0.001)
Other predictors of survival to hospital discharge after CPR for IHCA

References for grouped variables are Medicare ($); and small bed size hospital (β)
Days from CPR to hospital discharge among patients who survived to discharge (p<0.001)
Disposition of patients who survived to hospital discharge

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Routine</th>
<th>Transfer to extended care</th>
<th>Home with healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>35</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Q2</td>
<td>35</td>
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<td>10</td>
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<tr>
<td>Q3</td>
<td>35</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Q4</td>
<td>35</td>
<td>50</td>
<td>10</td>
</tr>
</tbody>
</table>
Hospice utilization among patient who survived to hospital discharge

Hospice facility | Home hospice

Q1 | Q2 | Q3 | Q4
Conclusion

• Unlike OHCA, hospital case volume of CPR is inversely associated with survival to hospital discharge in patients undergoing CPR for IHCA

• High case volume of CPR is an indicator of poor performing hospitals

• To improve survival in hospitalized patients, emphasis should be placed on early detection and intervention in patients whose conditions are deteriorating, with the goal of preventing IHCA
THANK YOU!