Resuscitation Research

Intraosseous Delivery of Fluids & Drugs During Cardiac Arrest

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How effective is IO bolus drug delivery during CPR?

Controlled animal trial of drug delivery during CPR:
  Tibial IO
  Sternal IO
  Central IV
Protocol

Cardiac arrest
KCl

No treatment    8 min

CPR    2 min

Inject

Sternum

Bolus
Evans Blue/epinephrine
0.2 mg/ml

Bolus
ICG/epinephrine
0.2 mg/ml

Tibia Series-1
IV Series-2

Normalized Arterial Concentration
Calculation of Appearance Time

0%
20%
40%
60%
80%
100%

-30 0 30 60 90 120 180 210 240 270 300 330 360 390 420 450 480 510

seconds of CPR

ICG tibia
Evans's Blue sternum

Black lines denote 50%
Red lines 100%

Concentrations normalized to max concentration
to highlight the appearance time differences.
Arterial Delivery of Dose Injecte

Tracer concentrations (µg/ml) divided by total dose infused (mg)

AUC over 6 minutes
Ratio Tibial vs. Sternal Delivery = 0.60

Appearance Time of Tracers in seconds
Sternum vs. Tibia

<table>
<thead>
<tr>
<th>Max Conc.</th>
<th>50% Conc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sternum</td>
<td>Tibia</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>80</td>
<td>300</td>
</tr>
<tr>
<td>60</td>
<td>180</td>
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<tr>
<td>30</td>
<td>100</td>
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<td>20</td>
<td>40</td>
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<td>20</td>
<td>50</td>
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<td>60</td>
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</tbody>
</table>

Mean (SD) 49 (30) 123 (87) 21 (6) 52 (19)
Range 20-100 40-300 10-30 25-80
Appearance Time of Tracers in seconds
Sternum vs. Central Vein

<table>
<thead>
<tr>
<th></th>
<th>Max Conc.</th>
<th>50% Max</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sternum</td>
<td>IV</td>
<td>Sternum</td>
<td>IV</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>100</td>
<td>36</td>
<td>57</td>
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<td>50</td>
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<td>24</td>
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<td>70</td>
<td>50</td>
<td>34</td>
<td>23</td>
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<td>50</td>
<td>50</td>
<td>29</td>
<td>28</td>
<td></td>
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<tr>
<td>110</td>
<td>110</td>
<td>52</td>
<td>48</td>
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<td>70</td>
<td>70</td>
<td>28</td>
<td>27</td>
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<tr>
<td>130</td>
<td>110</td>
<td>29</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

Mean (SD)  80 (33)  78 (30)  33 (10)  29 (10)
Range   50-130  50-110  24-52  23-48

Summary Appearance Times
seconds to max concentration and to % 50% max

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>50%</th>
<th>Max</th>
<th>50%</th>
<th>Max</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sternum n=15</td>
<td>62</td>
<td>25</td>
<td>122</td>
<td>51</td>
<td>77</td>
<td>33</td>
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<tr>
<td>Tibia n=8</td>
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<td>9</td>
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<td></td>
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<tr>
<td>IV n=7</td>
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<td>10</td>
<td>86</td>
<td>19</td>
<td>29</td>
<td>9</td>
</tr>
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Results

• Tibial drug delivery was 2-3 times longer/slower than Sternal delivery (20 vs. 50 seconds)

• The total dose delivered to arterial blood averaged over 6 min for tibia was 75% of sternal delivery for both the T and S site.

• Sternal IO appearance time delivered is similar to jugular vein.

Conclusion

• Both the IO tibial and IO sternal routes are effective for drug delivery during CPR

• The sternal route has some advantage of both time and efficiency

• The sternum IO drug delivery may be fully equivalent to IV delivery