Participatory User Centered Design Techniques for a Large Scale Ad-Hoc Health Information System

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HealthNet
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Response to Mass Casualties Today

Problems
- Aging technologies
- Limited communication infrastructure
- Labor intensive
- Overwhelmed staff

Results
- Mis-triage
- Critical minutes are lost
- Prone to human error

What if radical changes in technology could revolutionize patient care?
Future Possibilities

First Responder → Treatment Officer → Incident Commander

- paper tag
- pen & clipboard
- radio
- E-Tag
- PDA
- Automated monitoring
E-Tags are revolutionary because

- More than just a telemetry monitor
  - EKG, Pulseox (SpO₂, HR), Temperature, NIBP, Triage status, Display
  - IEEE 802.15.4 low-power wireless
  - Ad-hoc Mesh Networking
  - Smart Software Alarms
  - Remote monitoring & control
  - Comparatively low cost – telemetry to the developing world.

More data, better features, all for a lower price.
Smart monitoring software

- Automated VS Monitoring
  - Triage validation
  - Adjustable thresholds
  - Smart alarms: process HRV, use additional EMR data
- Transmit data to EMR
  - Efficient patient transition
- Plug-n-play IEEE 802.15.4

Match the system with current practices

Smarter features, easier to use.
Handheld device for medics

One hand operated
Patient histograms

Patient Details
- Real-time vital signs & alerts
- Photos
- Triage Category
- Age
- Name
- Chief Complaint
- Contamination

<table>
<thead>
<tr>
<th>Photo</th>
<th>Patient ID</th>
<th>Triage</th>
<th>Name</th>
<th>Age</th>
<th>Chief Complaint</th>
<th>Contamination</th>
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</thead>
<tbody>
<tr>
<td><img src="image1" alt="Photo" /></td>
<td>22</td>
<td><img src="image2" alt="Triage" /></td>
<td>Karl Jennerjohn</td>
<td>60</td>
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<td><img src="image4" alt="Triage" /></td>
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<td></td>
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<td><img src="image6" alt="Triage" /></td>
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<td></td>
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<td></td>
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<tr>
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<td>24</td>
<td><img src="image8" alt="Triage" /></td>
<td>Ellis Gardner</td>
<td>18</td>
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<tr>
<td><img src="image9" alt="Photo" /></td>
<td>25</td>
<td><img src="image10" alt="Triage" /></td>
<td>June Gravitt</td>
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<td></td>
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<td><img src="image12" alt="Triage" /></td>
<td>Lee Wszewski</td>
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</table>
**Patient Transport Status (11 patients)**

<table>
<thead>
<tr>
<th>Triage</th>
<th>Patient ID</th>
<th>Age</th>
<th>Gender</th>
<th>Chief Complaint</th>
<th>Exposure</th>
<th>Location (Type; Name)</th>
<th>Departed Incident At</th>
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<tbody>
<tr>
<td>I</td>
<td>22</td>
<td>60</td>
<td>M</td>
<td>Laceration</td>
<td></td>
<td>Facility; Suburban</td>
<td>10:43 AM</td>
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<tr>
<td>II</td>
<td>29</td>
<td>17</td>
<td>F</td>
<td>Laceration</td>
<td></td>
<td>Scene; 51 university Boulevard East</td>
<td>10:43 AM</td>
</tr>
<tr>
<td>III</td>
<td>27</td>
<td>12</td>
<td>M</td>
<td>Laceration</td>
<td></td>
<td>Facility; Blair</td>
<td>10:44 AM</td>
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<tr>
<td>IV</td>
<td>30</td>
<td>9</td>
<td>F</td>
<td>Laceration</td>
<td></td>
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<tr>
<td>V</td>
<td>36</td>
<td></td>
<td>Unknown</td>
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<td>VI</td>
<td>31</td>
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<td></td>
<td>Scene; 51 university Boulevard East</td>
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<td>VII</td>
<td>23</td>
<td></td>
<td>Unknown</td>
<td>Penetrating Injury, Respiratory</td>
<td></td>
<td>Facility; Blair</td>
<td>10:43 AM</td>
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<tr>
<td>VIII</td>
<td>21</td>
<td>22</td>
<td>M</td>
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<td>Facility; Blair</td>
<td>10:43 AM</td>
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<tr>
<td>IX</td>
<td>24</td>
<td>19</td>
<td>F</td>
<td>Penetrating Injury, Respiratory</td>
<td></td>
<td>Facility; Blair</td>
<td>10:43 AM</td>
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<tr>
<td>X</td>
<td>26</td>
<td>18</td>
<td>F</td>
<td>Penetrating Injury, Respiratory</td>
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<td>Facility; Blair</td>
<td>10:43 AM</td>
</tr>
<tr>
<td>XI</td>
<td>25</td>
<td>65</td>
<td>F</td>
<td>Penetrating Injury, Respiratory</td>
<td></td>
<td>Facility; Suburban</td>
<td>10:38 AM</td>
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</tbody>
</table>

**Triage Status**

<table>
<thead>
<tr>
<th>Location</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>On Scene</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Departed</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>7</td>
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<tr>
<td>Total</td>
<td>1</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>11</td>
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</table>

**Bed Availability**

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<tr>
<th>Facility</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>JHMI</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Blair</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

**Vehicle Status (3 vehicles)**

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Type</th>
<th>Status</th>
<th>Destination</th>
<th>Arrival Time</th>
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<tbody>
<tr>
<td>2149</td>
<td>ALS Ambulance</td>
<td>Unknown</td>
<td>Suburban</td>
<td>10:57 AM</td>
</tr>
<tr>
<td>2149</td>
<td>ALS Ambulance</td>
<td>Unknown</td>
<td>Suburban</td>
<td>10:57 AM</td>
</tr>
<tr>
<td>2531</td>
<td>ALS Ambulance</td>
<td>Enroute to Facility</td>
<td>Suburban</td>
<td>Estimated: 10:59 AM</td>
</tr>
</tbody>
</table>

Last Updated: 9/5/2006 12:43:25 PM
What are the important Features

Surveyed conducted:
- at Arlington County Virginia EMS
- basic paramedics to chiefs and officers
- 5 to 22 years of experience
Mass Casualty Disaster

- 20 patients
  - Red Cross volunteers
- 16 responders
  - Homeland Security
- 2 receiving facilities
  - 1 hospital
  - 1 Auxiliary Care Center
- 2 teams with identical structure
  - 1 commander
  - 3 officers
  - 3 medics

Paper Tags: green shirts

E-Tags: yellow shirts
Roles and Tools

Medic in Paper Team
- pen & clipboard

Medic in Electronic Team
- PDA

Incident Commander Paper Team
- radio

Incident Commander Electronic Team
- aerial video
- sensor data
Pre-Drill Training

- Electronic Team Group Training
  - 10 minutes
  - Medics played with devices
- Paper Team pre-trained by standard EMS procedures
Disaster Drill Process

- Patients triaged and held on scene for 30 minutes
  - EMS Protocol: Patients *should* be reassessed every 3 - 15 min
- Highest priority patients transported to Hospital
- Remaining patients transported to Auxiliary Care Center
Drill Results

Post Drill Debrief

- “This was a more efficient way to keep track of triage counts”
  - (mean=4.86, s =0.38)

- “With more training, I would be more likely to endorse this equipment”
  - (mean= 4.25, s =0.5)

- “Electronic triage tags helped me work more efficiently”
  - First responders
    - (mean= 2.3, s =1.1)
  - Officers
    - (mean= 4.6, s =0.55)

<table>
<thead>
<tr>
<th></th>
<th>Paper Team</th>
<th>Electronic Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to initially triage 10 patients</td>
<td>9 min</td>
<td>8 min 40 sec</td>
</tr>
<tr>
<td>Total Triage performed</td>
<td>29</td>
<td>72</td>
</tr>
<tr>
<td># calls by Transport Officer</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td># calls by Incident Command</td>
<td>42</td>
<td>20</td>
</tr>
</tbody>
</table>
## Concluding Remarks

<table>
<thead>
<tr>
<th>Principle</th>
<th>Application to emergency medical response applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accessibility and Customizability</strong></td>
<td>One hand operation of PDAs</td>
</tr>
<tr>
<td></td>
<td>Provide multiple types of alarms indicators</td>
</tr>
<tr>
<td></td>
<td>Allow manual override of automation</td>
</tr>
<tr>
<td><strong>Minimize Hazards and Errors</strong></td>
<td>Prevent user mistakes</td>
</tr>
<tr>
<td></td>
<td>Minimize false alarms</td>
</tr>
<tr>
<td></td>
<td>Eliminate, protect against, or warn of hazards</td>
</tr>
<tr>
<td><strong>Plan for failures</strong></td>
<td>Device failure</td>
</tr>
<tr>
<td></td>
<td>Unreliable network</td>
</tr>
<tr>
<td></td>
<td>Provide backups</td>
</tr>
<tr>
<td><strong>Wearability</strong></td>
<td>Consider weight, size, battery-life, sensor types</td>
</tr>
<tr>
<td></td>
<td>Devices must be water-resistant to decontamination procedures</td>
</tr>
</tbody>
</table>
Future Challenges

- Lots of user roles, many unpredictable factors
- Ease of Use
  - Limited training time, backup capabilities
- Discovery of Human Error
- Lack of trust in technology
- Need for workflow changes
  - New technologies warrant new methodologies for emergency response
Acknowledgements

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Medical Community

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