Pervasive Triage: Towards Ubiquitous, Real-time Monitoring of Vital Signs for Pre-hospital Applications

http://www.aid-n.org

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Pervasive Vital Signs Monitoring

Goal: use noninvasive biomedical sensors to seamless collect data from incident to end destination.

- More information on the vital signs and location of the patients to be obtained during initial triage.
- Reduce the workload of the responders.
- Provide a more accurate count of the patients.
AID-N Motivation: Previous Discrete Triage System

What if radical changes in disaster response technologies **revolutionize** the quality of pre-hospital patient care?

- **Paper Triage Tags**
- **Pens & Forms**
- **Charts & White Boards**
- **Wireless Tag with Automated Sensors**
- **Field PDA**
- **Driver’s License Scanner**
- **Web Portals**
AID-N System Overview

Advanced Health and Disaster Aid Network
Usable Triage System: Noninvasive Biomedical Sensors

Hardware and Software in Biomedical Sensors

- **Hardware – small, low power**
  - TelosB
  - MicaZ

- **Software – mesh n/w**
  - TinyOS
  - CodeBlue

- **Auxillary boards**
  - Pulseox board
  - Triage tag board
  - Blood pressure cuff board
  - Ekg board
Seamless Information Transfer

Accident Scene → Triage → Vehicle
→ Hospital / Auxiliary Care Center

- Sensors – backwards compatible with sensors in current emergency medical service vehicles.

- Collected sensor data can allow researchers to better understand what exactly occurs during a mass casualty incident.

- Relieves workload of responder – continuously monitor patients remotely.
Patient Monitoring and Data Collection
Communicates: (802.15.4) to/from patient sensors

<table>
<thead>
<tr>
<th>Alert Category</th>
<th>Alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>No pulse</td>
</tr>
<tr>
<td></td>
<td>Bradycardia</td>
</tr>
<tr>
<td></td>
<td>Tachycardia</td>
</tr>
<tr>
<td></td>
<td>Onset of change</td>
</tr>
<tr>
<td></td>
<td>Stability</td>
</tr>
<tr>
<td>Oxygen Saturation</td>
<td>Low oxygen saturation</td>
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<tr>
<td></td>
<td>Onset of change</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Systolic pressure</td>
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<tr>
<td></td>
<td>Diastolic pressure</td>
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<tr>
<td></td>
<td>Widening pulse pressure</td>
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<td></td>
<td>Narrowing pulse pressure</td>
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<tr>
<td></td>
<td>Mean arterial pressure</td>
</tr>
<tr>
<td></td>
<td>Change</td>
</tr>
</tbody>
</table>
Mass Casualty Drill: Bus Accident

- Bus accident in Maryland.
- Initial assumptions.
  - Patients complaints.
    - Blunt trauma.
    - Pre-existing conditions.
  - Hospitals within 15 mi radius reached surge capacity.
Analyze Realistic Deployment

- 20 patients, 16 responders.
- 1 hospital, 1 auxiliary care center.
- 2 teams with identical structure: 1 commander, 3 officers, 3 medics.
  - Electronic team.
  - Paper team.

Paper Team Patients: green shirts

Electronic Team Patients: yellow shirts
Usable System: 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 (tagged) and held on scene for 30 minutes.
  - EMS Protocol: Patients *should* be reassessed every 3 - 15 minutes.
- Highest priority patients transported to hospital.
- Remaining patients transported to Auxiliary Care Center.
Disaster Drill Results

• Number of times the patients triaged in electronic system – increased by almost 3 fold.

• The communication among electronic triage team was greater and more information retrieved.

Transport Officer Paper Team

Transport Officer Electronic Team
Revolutionize Healthcare: Challenges

Vision – change how data in healthcare in collected and disseminated.

• Challenges
  • Need location tracking - easily deployable, work indoors & out.
  • Keep focus on patient and not technology.
  • Need sensor to collect the mental state of the patient.
  • Need delay tolerant infrastructure – patient wander out of range, communication goes down.
  • Need security – fast, lightweight, secure.
Demo

Improving Situational Awareness during Emergency Medical Response

• UbiComp--Tuesday, September 19, 2006 5:30-7:30pm
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Extra Slides
Demo

Improving Situational Awareness during Emergency Medical Response

• UbiComp--Tuesday, September 19, 2006 5:30-7:30pm
Context Aware GUI

GUI aware of location and displays necessary information

- Scene of accident – Displays patient vital info and map
- Transport Vehicles – Displays vital signs and map
- Auxillary Care – Displays patient vital signs and map
- Triage Commander – Displays transportation information on the patients
More Hardware & Software Details

- **Radio**
  - CC2420
  - 2.4 GHz radio
  - 70 – 200 ft range
  - Power ~41 mW

- **RAM** – 4KB / 10 KB

- **ROM** – 128KB, 48KB

- **Programming Lang** – Nesc, Java, C Sharp, ASP.net

- **Pulseox & EKG motes last** ~1-2 days

- **BP Cuff mote last** ~ 5 hrs

- **Cost** = $300 currently, but cheaper if mass produced