Telemedicine and its impact on catastrophic events

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Scope of presentation

- Stellenbosch University - BERG
- Background
- Motivation
- Disaster Response System
- Current Projects
- Disaster specific projects
- Conclusion
Where are we?
Where are we?

Stellenbosch
Where are we?

Stellenbosch
Background

• H-M-W seminar – sponsored by DAAD

• Management of Natural Disasters

• Flood
• Tornado
• Hurricane
• Volcanic eruption
• Landslide
• Earthquake

<table>
<thead>
<tr>
<th>Severity</th>
<th>Richter Scale</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great earthquake</td>
<td>8.0-8.9</td>
<td>0-2 per year</td>
</tr>
<tr>
<td>Major earthquake</td>
<td>7.0-7.9</td>
<td>18 per year</td>
</tr>
<tr>
<td>Destructive</td>
<td>6.0-6.9</td>
<td>120 per year</td>
</tr>
<tr>
<td>Damaging</td>
<td>5.0-5.9</td>
<td>800 per year</td>
</tr>
</tbody>
</table>

*American Medical Association 2010
Background

Disaster effects:

- Significant infrastructure destruction:
  - Hospitals/clinics
  - Homes
  - Businesses
  - Roads/transportation
  - Loss of essential services (power, water, etc.)
Background

Morbidity and Mortality
Direct Injuries and Deaths

• Direct Immediate (0-2 days)
  • Crush/trauma/asphyxia
  • Drowning or burns

• Direct Acute (2-14 days)
  • Dehydration
  • Environmetal Exposure
  • Renal failure
  • Infections
Background

Crush Syndrome: Typical Treatment

- Fluid resuscitation (1 liter normal saline bolus, 1.5 liters/hr infusion) initiated before extrication
- Cardiac Monitor if possible
- Brisk diuresis (urine flow of 300–500 cc/hr)
- Diagnose and treat other metabolic derangements:
  - Hyperkalemia
  - Hypocalcemia
- Treat tissue damage
- Pain control
Background

- Disasters follow no rules

- All disasters, regardless of etiology, have similar medical and public health consequences.

- The key principle of disaster medical care is to do the greatest good for the greatest number of patients
Motivation

• Reduce mortality numbers

• Quick and efficient medical care response

• Quick and effective diagnosis

• Provide specialized care

Mobile Disaster Response System
Mobile disaster response system

- Diagnose
- Categorize
- Monitor
- Treat
Mobile disaster response system

Lifeline Services: Minimum Requirements

Water
- 20L/person/day

Food
- 8000 kJ/person/day

Shelter
- 3.5 m² / person

Sanitation
- 20 people / toilet

Health services
- less than 50 patients per 8 hours

* American Medical Association 2010
International Trauma and Disaster Institute
Mobile disaster response system

Categorization of Patient Injury Severity

Field Medical Triage

Conducted on different levels

- On-site Triage
- Medical Triage
- Evacuation Triage

On-site Categorization

- Rapid Categorization required on-site
- Personnel are typical ‘first-responders’
- Patients are Color Coded

* American Medical Association 2010
International Trauma and Disaster Institute
# Categorization of Patient Injury Severity

<table>
<thead>
<tr>
<th>Color</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RED</strong></td>
<td><strong>URGENT</strong></td>
<td>Casualties who require immediate life-saving interventions (airway, breathing, circulation)</td>
</tr>
<tr>
<td><strong>YELLOW</strong></td>
<td><strong>DELAYED</strong> or <strong>EXPECTANT</strong></td>
<td>Casualties who do not require immediate life-saving interventions and for whom treatment can be delayed or Casualties who are not expected to survive due to the severity of injuries complicated by the conditions and lack of resources</td>
</tr>
<tr>
<td><strong>GREEN</strong></td>
<td><strong>MINOR</strong></td>
<td>Individuals who require minimal or no medical care</td>
</tr>
<tr>
<td><strong>BLACK</strong></td>
<td><strong>DECEASED</strong></td>
<td></td>
</tr>
</tbody>
</table>

* American Medical Association 2010
International Trauma and Disaster Institute
Current projects

Research at BERG

Overview of completed and current projects involving aspects of E-medicine
Telemedicine Devices currently under development

- Reflex sensing and diagnosis system
- Tactile sensing system for detection of cancer
- Auscultation jacket
- Precordial electro-phonocardiogram (PCG)
- Minimally invasive surgical manipulator
- Motion capture for rehabilitation of stroke patients
- Autonomous analysis of adventitious lung sounds
- Mobile phone-based ophthalmoscope
- Asynchronous telemedicine with ultrasound
- Many others....
Current projects

Lung Sounds
Current projects

Heart Sounds

Aorta  Pulmonal  Right Arm  Left Arm
Tricuspid  Mitral  Right Leg  Left Leg

Sound  ECG  ICG

normalised amplitude

normalised amplitude

$S_1$  $S_2$

$S_1$  $S_2$  $S_3$
Current projects
Heart Sounds
Current projects

Heart Sounds

From both projects:

- Different types of abnormal heart sounds diagnosed automatically using artificial intelligence (neural networks) with 90% accuracy.

- Data can be sent to medical specialists in other locations via telemedicine link.
Current projects

Pediatric auscultation

- Screening for innocent heart murmurs in infants using artificial intelligence and electronic stethoscope.
- Can be used via telemedicine as well.
- Device already commercialized with a spin-off company.
Current projects

Reflex sensing system

Activate, record and diagnose a reflex semi-automatically.

Neural networks for data classification.

Same accuracy in assigning reflex when compared to medical practitioner.
Current projects

Portable Ultra Sound with E-medicine platform

Used for obstetric ultrasound evaluations over telemedicine.
Current projects

Patient monitor

Monitor following vital signs:

- Blood oxygen saturation
- Heart rate / ECG
- Fever
- Motion
- Respiration
- (Blood pressure)
Current projects

Patient monitor
Current projects

Ophthalmoscope*
There clinical burden of hypertension. Other diagnoses are also possible including possible detection of Cranial bleeding.

Early detection is possible with ophthalmoscopy (images of the eye).

Nurses are not trained in this skill.

Possible via telemedicine to have a specialist examine images.

* GET Project
Current projects

Ophthalmoscope
Low-cost system using hand-help scope, digital camera, cell phone and web platform.
Current projects

Surgical Manipulator
Current projects

Surgical Manipulator
The aim is to develop a minimally invasive surgical manipulator.

Laparoscopic surgery.

Can be operated remotely using telecommunication link.

Low-cost (compared to others).
Conclusions

- Through innovative R&D, we can make a widespread impact on healthcare delivery, via telemedicine.
- We have tested most of our prototypes in real clinical settings to evaluate their usefulness.
- Collaboration with medical practitioners is of utmost importance.
- Overall future outlook for our projects are very positive.
Thank you....!