Application of Telemedicine in Acute-Onset Disaster Situations

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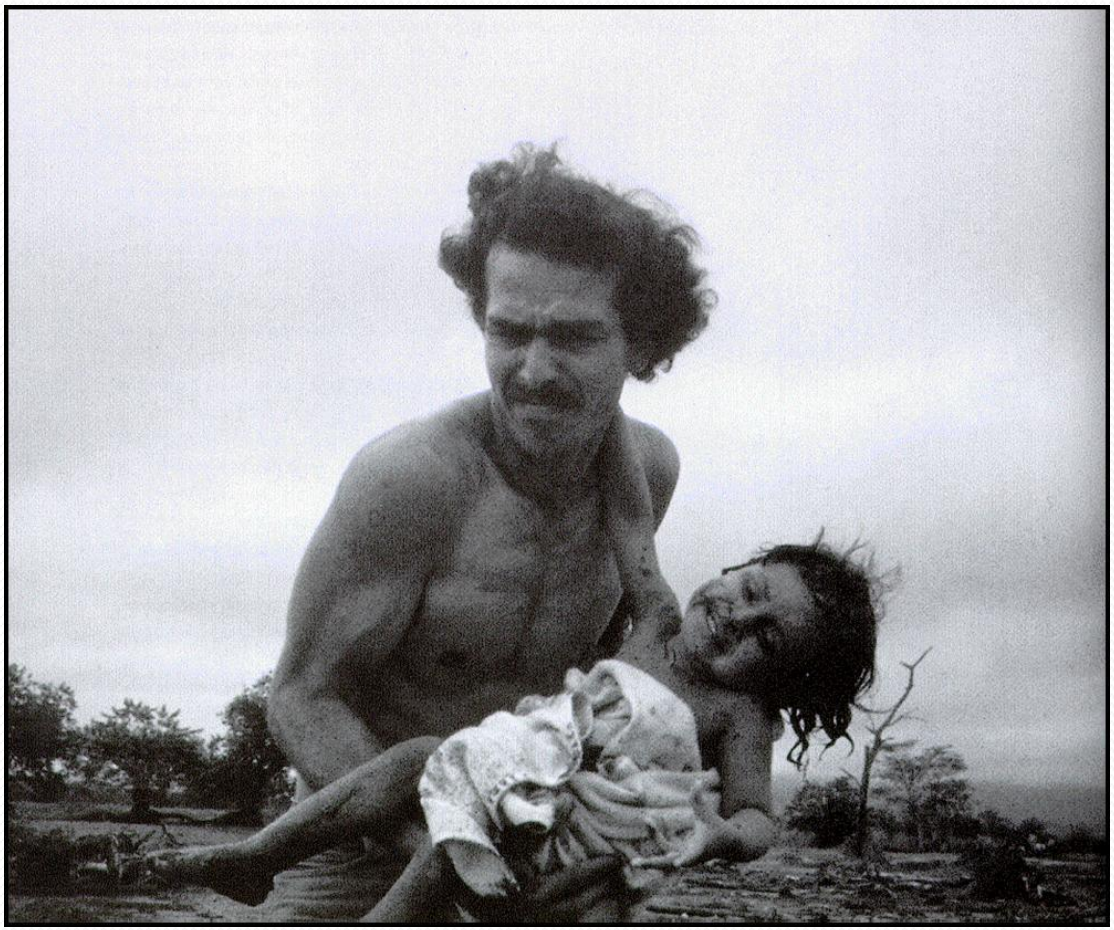
Disasters

Disaster

Vulnerability + Hazard = Disaster



Environmental Disasters

Biological Disasters

Anthropogenic Disasters

Telemedicine

"The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities".

- WHO (2008)

Telemedicine

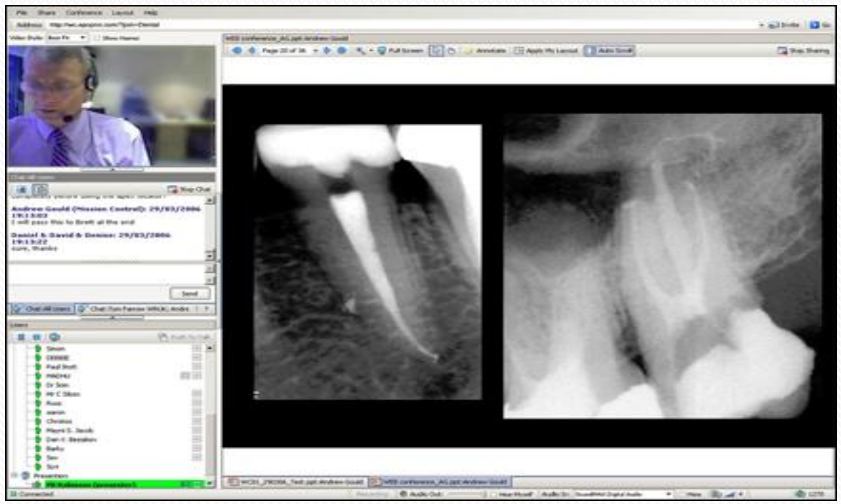
- Telemedicine is practiced on the basis of two concepts:
  - Real time (synchronous)
    - Requires the presence of both parties at the same time and a communications link between them
  - Store-and-forward (asynchronous)
    - Acquiring medical data (like medical images, biosignals, etc) and then transmitting this data to a doctor or medical specialist at a convenient time for assessment offline

Telemedicine

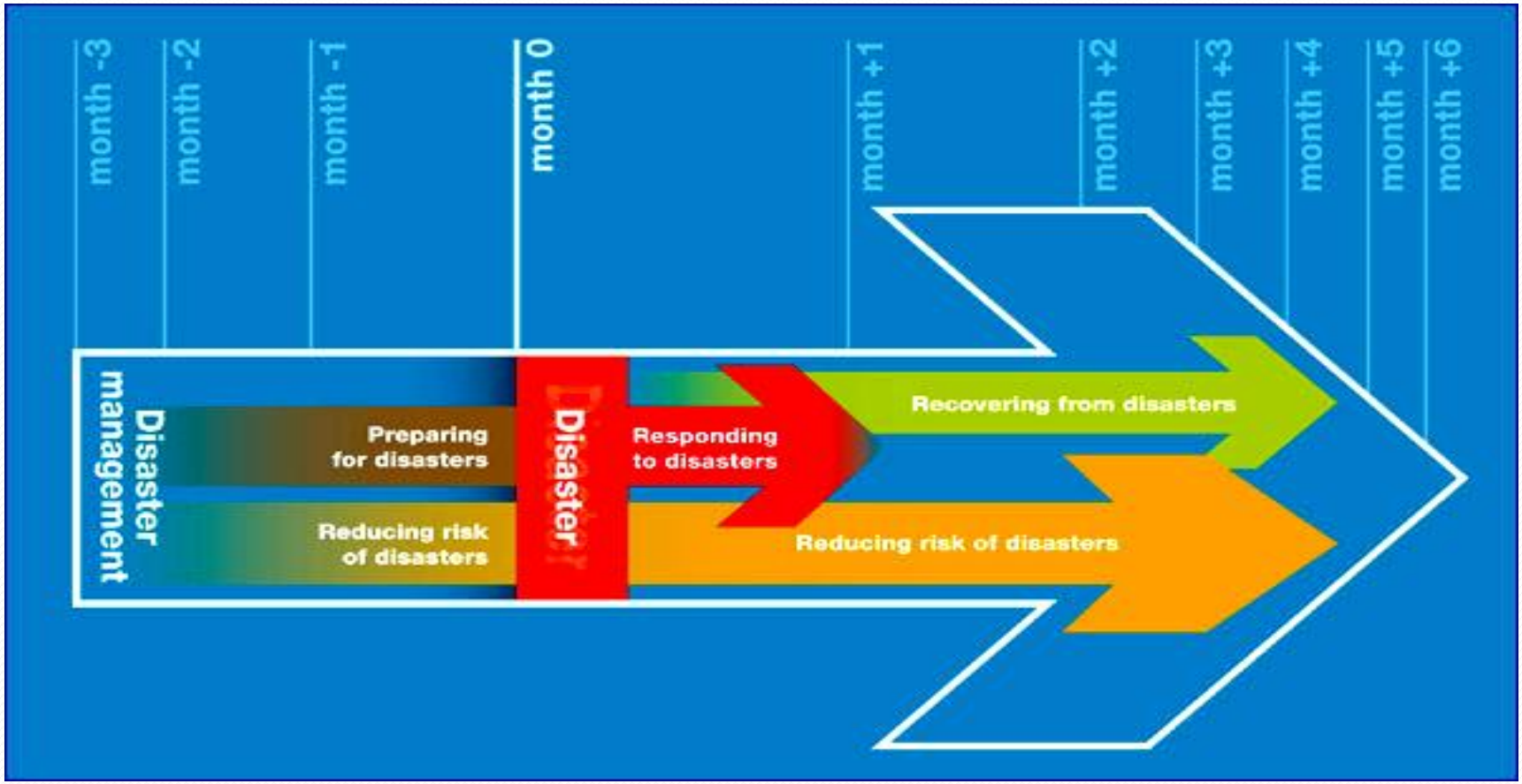
- Video conferencing is the most common form
- Monitoring a patient at home using known devices like blood pressure monitors and transferring the information to a caregiver
- Peripheral devices can be attached to computers or the video-conferencing equipment which can aid in an interactive examination (tele-otoscope, tele-stethoscope, etc)

Telemedicine

Telemedicine



Disaster management



1. Planning and preparedness
2. Early detection and surveillance
3. Crisis response
4. Treatment
5. Recovery and mitigation

Telemedicine in disaster situations

- Acute response:
  - Assistance with triage, transportation, and medical logistics coordination
  - Remotely monitoring special needs patients, such as the ventilator-dependent (e–intensive care unit systems)
- Subacute response:
  - Ambulatory/primary care and specialty consultation services
  - Identification of outbreaks
- Chronic response (recovery):
  - addressing disaster-unique healthcare needs, such as mental health, infectious disease, and environmental or bioterrorism agent exposure

Telemedicine & Pre-hospital Care

Telemedicine & Pre-hospital Care

"...the restructuring of the pre-hospital healthcare system was crucial for optimal management of the healthcare needs of Tsunami victims and for the reduction of the patient loads on secondary medical facilities."

- Schwartz et al. (2006)

Telemedicine & Pre-hospital Care

1. Avoid unnecessary emergency transports
   - Fewer ambulance transports
   - Fewer aeromedical evacuations

Telemedicine & Pre-hospital Care

2. Reduce time to treatment
   - Redirection to more appropriate centres of care
   - Early formulation of treatment plans

Telemedicine & Pre-hospital Care

3. Improve capabilities of field medical personnel
   - Decision support
   - Augmented skills

Telemedicine Technology

Telemedicine technology

- Portable Medical Devices
  - Ultrasound
  - Medical Imaging Resources, Inc.
- Mobile Computing/PDAs/Smartphone
  - Intel and AMD
  - UMPC
  - Windows Mobile/BlackBerries

Telemedicine technology

- Wireless Communication
  - Bluetooth
  - WLAN
    - IEEE standards
    - Wi-Fi very common
    - Needs pre-existing internet connection
  - Zigabee
    - IEEE 802.15.4 layer
    - Allows quick connectivity
  - WiBro
    - Cellular technology
    - CDMA vs. GSM
  - WiMAX
    - Uses cellular technology but connects to modem
    - Same problems as WiBro, just cheaper
  - Satellites
    - Broadband global area network (BGAN)
    - Latency and bandwidth

Gap Analysis - Technologic

Gap analysis - technologic

Framework:

- A **rapidly deployable**, portable, yet rugged system, that can reach into hazard zones and buildings;
- A **self-repairing** system that heals itself automatically in the event of loss of portions of infrastructure;
- A system that supports wireless communications for **off-the-shelf systems** and devices;
- A system that supports both **high bandwidth** (digital video) communications for a small number of devices and low bandwidth communications for many (hundreds to thousands) of devices;
- A system that provides robust (but not necessarily high data rate) I**nternet communications** to access critical off site data;
- A system that maintains **quality of service** for transmission of critical information; and
- A system that provides adequate **data security**.

Gap analysis - technologic

GAP	Problems
Communication	Network range → Constant disconnects Bandwidth dedication
Self Heal Technologies	Network parameter change Minimal human intervention COTS Non-moving parts

Fig. 1. Experimental configuration.

Gap analysis - technologic

GAP	Problems
Computing Hardware	Terrain built laptops
Computing Power	Medical imaging processing Self-contained units Non-COTS components “Economical Concept”

1. Data acquisition hardware
2. Image display
3. Image processing hardware

1. Data acquisition device (DAD)
2. Off-site processing facility
3. Smartphone for transmitting

Gap analysis - technologic

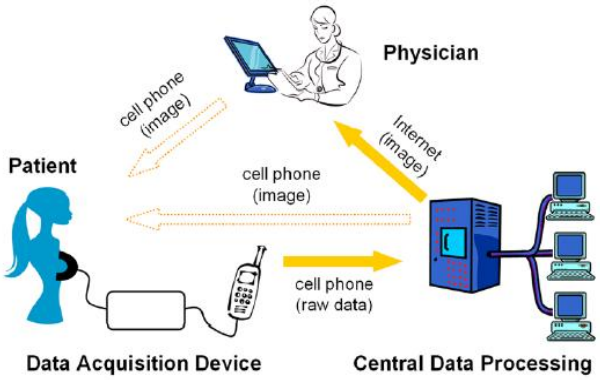


Figure 1. System configuration for the breast cancer tumors patient self-test screening. Outlined arrows indicate optional reporting of results to the patient.
doi:10.1371/journal.pone.0002075.g001

Fig. 1. Experimental configuration.

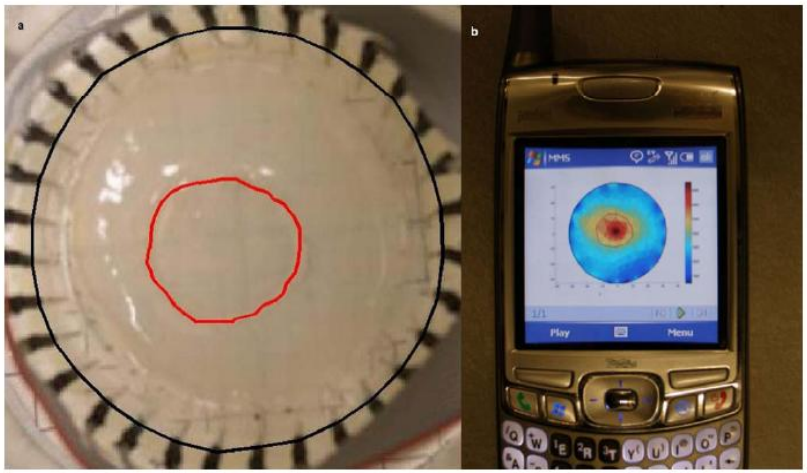


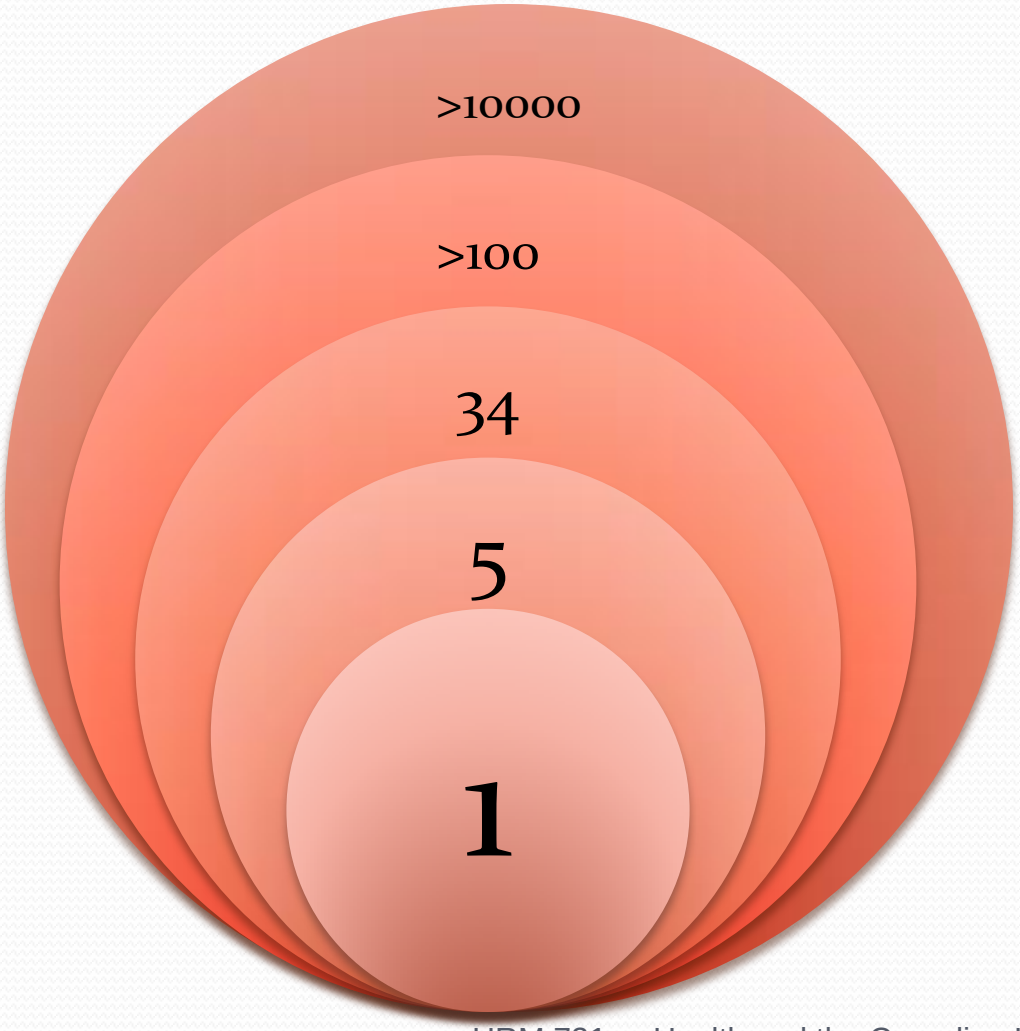
Figure 4. Minimally invasive surgery example. a) The DAD of the system with two types of gel representing an area treated with irreversible electroporation, marked in red, surrounded by normal tissue. b) Reconstructed result as it was displayed on the screen of a commercial cellular phone. Warm colors represent higher conductivity regions that denote an electroporated area.

Gap analysis - clinical

Gap analysis – clinical

- Structured review of:
  - PubMed, The Cochrane Library, ISI Web of Knowledge, EMBASE, Inspect
    - *Telemedicine, telehealth, teleradiology, telepathology, teleconsultation, remote, mass casualty, disaster, disaster recovery, disaster response, disaster management*
  - Hand searches of identified papers' reference lists
  - Exclusion criteria: homecare, exclusively technology related, not in English or Persian

Gap analysis – clinical



Telemedicine

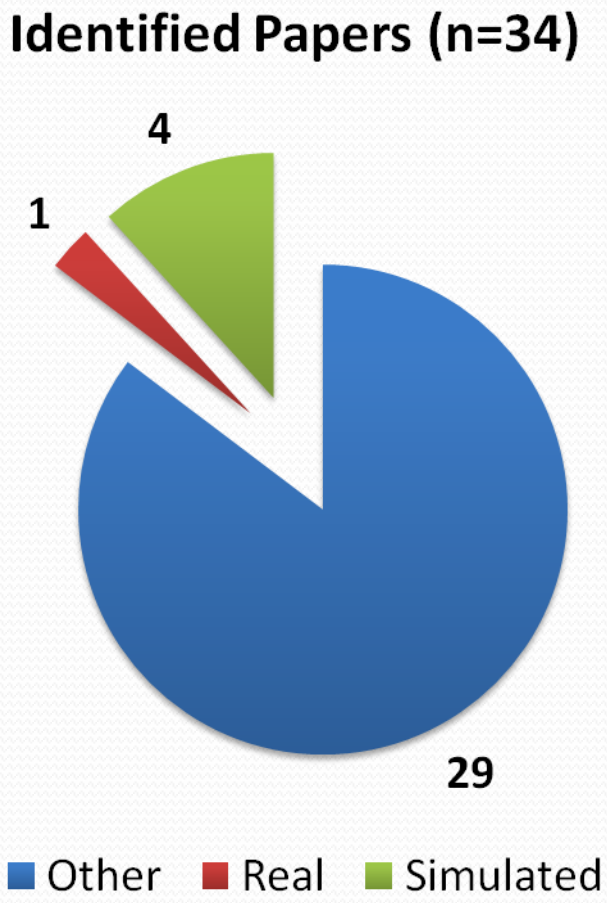
Telemedicine Applications

Telemedicine in Disasters

Disaster Case Studies

Real Disaster Case Study

Gap analysis – clinical



- No quantitative analysis
- Rarity, variability, and unpredictability pose barriers

- Future methodologies:
  - Retrospective chart analysis
  - Time-series design
  - Focus groups, interviews, surveys

Ethical issues

Ethical issues

- International telemedicine issues
  - Legal responsibilities
  - Consent
  - Licensure
- The protection of the rights of the patient who is unable to give fully informed consent to their participation in a tele-consultation in a disaster situation
- Clinical risks
  - Misdiagnosis and technical reliability
  - Treatment delay

Thank You