Impact of Information and Communication Technologies (ICT) on Health Care

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Department of Medical Informatics and Telemedicine
Medical University of Warsaw, Poland
Outline

1. ICT and health.
   WHO Global Observatory of eHealth - 2006

2. History. Major achievements in ICT for health care

3. Aspects:
   • Accessibility
   • Economy
   • Quality
   • Education

4. Conclusions
eHealth - the use of Information and Communication Technologies (ICT) for health
Connecting for Health
Global Vision, Local Insight
## Advancing ICT in health

<table>
<thead>
<tr>
<th>Core components</th>
<th>Requirements</th>
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</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>Affordable, reliable, durable and high-speed connections</td>
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<td></td>
<td>Intersectoral investment in ‘last-mile’ solutions</td>
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<tr>
<td>Technology and tools</td>
<td>Designed, developed and deployed for health</td>
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<td></td>
<td>Affordable, durable, user-friendly access devices and people who can install</td>
</tr>
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<td></td>
<td>and support them</td>
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<tr>
<td>Education and training</td>
<td>Skills to access, manage and use information</td>
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<td></td>
<td>Build capacity in eHealth policy and planning</td>
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<tr>
<td>Policies and standards</td>
<td>Coordinate systems and services</td>
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<td></td>
<td>Affordable rates, tariffs and services</td>
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<td>Development of global ethical and scientific norms, standards and commitments</td>
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<td></td>
<td>for transfer of information and protection of citizens</td>
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<tr>
<td>Evaluation</td>
<td>Evidence and experience to guide development and investment</td>
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<td></td>
<td>Evidence and information for policy and advocacy</td>
</tr>
<tr>
<td>Leadership and commitment</td>
<td>Long-term cross-sectoral outlook for public health policy, linked to ICT</td>
</tr>
<tr>
<td></td>
<td>policy, with participation of civil society</td>
</tr>
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<td></td>
<td>Working together across disciplines to improve opportunities for mutual gain</td>
</tr>
<tr>
<td></td>
<td>Design of macro-level policies to support micro-level initiatives</td>
</tr>
</tbody>
</table>

Source: Connecting for Health
Global Vision, Local Insight. WHO Report, 2005
Life expectancy at birth, 2003

### Examples of ICT in health

<table>
<thead>
<tr>
<th>ICT in public health practice</th>
<th>ICT in clinical care and laboratory practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify disease and risk factor trends</td>
<td>Track and provide patient information</td>
</tr>
<tr>
<td>Model diseases in populations</td>
<td>Enable communication between patients and professionals</td>
</tr>
<tr>
<td>Analyse demographic and social data</td>
<td>Deliver services despite distance and time barriers via ‘telemedicine’</td>
</tr>
<tr>
<td>Access research, publications and databases</td>
<td>Standardize ordering and delivery of drugs and supplies</td>
</tr>
<tr>
<td>Monitor and communicate potential threats to health</td>
<td>Monitor quality and safety in patient care settings</td>
</tr>
</tbody>
</table>

Source: Connecting for Health
Global Vision, Local Insight. WHO Report, 2005
### Towards new eHealth paradigms

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Impact of ICT</th>
</tr>
</thead>
</table>
| Citizens                | Allows personalized, citizen-centred care  
Health at home, in the workplace, or school – not just the hospital  
Focus on prevention, education and self-management  
Reaching out to peers for advice and support |
| Professionals           | Readily available high-quality distance-based learning for continuing professional education  
Remote consultations with patients, second opinions and professional networks  
Access to current, specialized, accredited knowledge for clinical care, research and public health |
| Hospitals and academia  | Hospitals as a virtual network of providers, connecting all levels of the system  
Quality and safety: improving care processes and reducing the possibility of medical errors.  
Facilitating mobility of citizens and their medical records  
New opportunities in basic and applied research: from health knowledge to action  
Collaboration and shared computing power (e.g., grid computing) |
| Health-related businesses| Providing health content as a commodity to the public and health professionals  
Research and development of new products and services: electronic health records, information systems, clinical registries  
Broad and cost-effective marketing for health products and services |
| Governments             | Health increasingly central to economy, security, foreign affairs and international relationships  
Limiting factor is no longer technology, but enabling environments  
New roles for stakeholders: health professionals and authorities, citizens |
| International agencies  | Need for rapid, coordinated response to global threats: natural disasters, infectious diseases and bioterrorism  
Growing awareness of importance of ICT in sustainable health systems |

Source: Connecting for Health  
Global Vision, Local Insight. WHO Report, 2005
Inequity between burden of disease and spending

## WHO’s mortality strata

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Child mortality</th>
<th>Adult mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Very low</td>
<td>Very low</td>
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<tr>
<td>B</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>C</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>D</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>E</td>
<td>High</td>
<td>Very high</td>
</tr>
</tbody>
</table>

Source: Connecting for Health
Global Vision, Local Insight. WHO Report, 2005
### WHO Member States, by region and mortality stratum

<table>
<thead>
<tr>
<th>Region and mortality stratum</th>
<th>Description</th>
<th>Broad grouping</th>
<th>Member States</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Europe</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eur-A</td>
<td>Europe with very low child and very low adult</td>
<td>Developed</td>
<td>Andorra, Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland,</td>
</tr>
<tr>
<td></td>
<td>mortality</td>
<td></td>
<td>France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta,</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden,</td>
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<td></td>
<td></td>
<td></td>
<td>Switzerland, United Kingdom</td>
</tr>
<tr>
<td>Eur-B</td>
<td>Europe with low child and low adult mortality</td>
<td>Developed</td>
<td>Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia,</td>
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<tr>
<td></td>
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<td></td>
<td>Kyrgyzstan, Poland, Romania, Serbia and Montenegro, Slovakia, Tajikistan, The</td>
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<td></td>
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<td></td>
<td>former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan</td>
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<tr>
<td>Eur-C</td>
<td>Europe with low child and high adult mortality</td>
<td>Developed</td>
<td>Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova,</td>
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<td></td>
<td></td>
<td></td>
<td>Russian Federation, Ukraine</td>
</tr>
</tbody>
</table>

Source: Connecting for Health
Global Vision, Local Insight. WHO Report, 2005
Adult literacy by WHO Region, projections for 2005

## Index of ICT diffusion

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity</td>
<td>Physical infrastructure available to a country: per capita Internet hosts, PCs, telephone mainlines and mobile phones. Excludes electricity, broadband, and affordability measures.</td>
</tr>
<tr>
<td>Access</td>
<td>Number of Internet users, adult literacy rate, cost of a local call, and GDP per capita.</td>
</tr>
<tr>
<td>Policy</td>
<td>Comprises presence of Internet exchanges, competition in the local loop/domestic long distance and competition in the Internet service provider market.</td>
</tr>
</tbody>
</table>

Source: Connecting for Health
Global Vision, Local Insight. WHO Report, 2005
ICT diffusion = (Connectivity + Access + Policy) / 3

0 <= ICT diffusion <= 1
ICT diffusion, Africa

Democratic Republic of the Congo
Equatorial Guinea
Liberia
Mozambique
Sao Tome and Principe
Seychelles
Zimbabwe
Guinea-Bissau
Benin
Nigeria
Niger
Burkina Faso
Côte d’Ivoire
Mali
Congo
Chad
Uganda
Mauritania
Senegal
Comoros
Ethiopia
Central African Republic
Angola
Gambia
Burundi
Togo
United Republic of Tanzania
Malawi
Rwanda
Eritrea
Madagascar
Zambia
Cameroon
Lesotho
Ghana
Kenya
Algeria
Gabon
Guinea
Swaziland
Sierra Leone
Namibia
Cape Verde
Botswana
South Africa
Mauritius

Max 0.36 Mauritius

ICT diffusion, South-East Asia

Bhutan
Democratic People's Republic of Korea
Myanmar
Timor-Leste
Bangladesh
Nepal
India
Indonesia
Sri Lanka
Thailand
Maldives

Max 0.33 Maldives

ICT diffusion, Americas

Max 0.8 USA

<table>
<thead>
<tr>
<th>Country</th>
<th>Value</th>
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<tbody>
<tr>
<td>Andorra</td>
<td>Data not available</td>
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<td>Armenia</td>
<td>Data not available</td>
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<td>Serbia and Montenegro</td>
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<td>Monaco</td>
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<td>San Marino</td>
<td>Data not available</td>
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<td>Republic of Moldova</td>
<td>Data not available</td>
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<td>Kyrgyzstan</td>
<td>Max 0.76 Iceland</td>
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<td>Turkmenistan</td>
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<td>Albania</td>
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<td>Georgia</td>
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<td>Tajikistan</td>
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<td>Russian Federation</td>
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<td>Uzbekistan</td>
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<td>The former Yugoslav</td>
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<td>Republic of Macedonia</td>
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<td>Azerbaijan</td>
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<td>Luxembourg</td>
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<td>Sweden</td>
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<td>Iceland</td>
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ICT diffusion, Eastern Mediterranean

<table>
<thead>
<tr>
<th>Country</th>
<th>Value</th>
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<tbody>
<tr>
<td>Afghanistan</td>
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<td>Iraq</td>
<td>Data not available</td>
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<tr>
<td>Libyan Arab Jamahiriya</td>
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<td>Somalia</td>
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<tr>
<td>Djibouti</td>
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<td>Morocco</td>
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<td>Yemen</td>
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<td>Sudan</td>
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<td>Pakistan</td>
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<td>Egypt</td>
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<tr>
<td>Syrian Arab Republic</td>
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<tr>
<td>Tunisia</td>
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<tr>
<td>Iran (Islamic Republic of)</td>
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<tr>
<td>Jordan</td>
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<td>Lebanon</td>
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<td>Oman</td>
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<td>Saudi Arabia</td>
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<td>Kuwait</td>
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<td>Bahrain</td>
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<tr>
<td>Qatar</td>
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<tr>
<td>United Arab Emirates</td>
<td></td>
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</tbody>
</table>

Max 0.58 United Arab Emirates

ICT diffusion, Western Pacific

Max 0.68 Singapore

## ICT diffusion - summary

<table>
<thead>
<tr>
<th>Region</th>
<th>Max ICT diffusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>0,36 Mauritius</td>
</tr>
<tr>
<td>South East Asia</td>
<td>0,33 Maldives</td>
</tr>
<tr>
<td>Americas</td>
<td>0,80 USA</td>
</tr>
<tr>
<td>Europe</td>
<td>0,76 Iceland</td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>0,58 United Arab Emirates</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>0,68 Singapore</td>
</tr>
</tbody>
</table>
Sample country fact sheet on health and ICT diffusion

**Benin**

*Causes of death, African Region*

- Noncommunicable conditions: 45%
- Communicable diseases (including maternal causes): 40%
- HIV, TB, malaria: 25%


**Country statistics**

- **WHO region:** Africa
- **Total population:** 67,360,000
- **GDP per capita (in Int S, 2003):** 990
- **Life expectancy at birth (inf):** 52.0/54.0
- **Healthy life expectancy at birth (years):** 2002: 43.4/44.5
- **Child mortality rate (per 1000):** 159/156
- **Adult mortality rate (per 1000):** 393/392
- **Total health expenditure per capita (Int S, 2002):** 44
- **Total health expenditure as % of GDP (2002):** 4.7

*Figures are for 2003 unless indicated.*


**Mortality stratum**

- D: high child, high adult

*Countries in regional mortality stratum*

- Algeria
- Angola
- Burkina Faso
- Cameroon
- Cape Verde
- Chad
- Comoros
- Equatorial Guinea
- Gabon
- Gambia
- Ghana
- Guinea
- Guinea-Bissau
- Liberia
- Madagascar
- Malawi
- Mauritania
- Mauritius
- Niger
- Nigeria
- Sao Tome and Principe
- Senegal
- Seychelles
- Sierra Leone
- Togo

**Selected demographic indicators**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Urban</th>
<th>Rural</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>120</td>
<td>80</td>
<td>200</td>
</tr>
<tr>
<td>Access to improved water</td>
<td>60</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Access to sanitation</td>
<td>40</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Adult literacy</td>
<td>40</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Population living on $1 a day</td>
<td>30</td>
<td>20</td>
<td>50</td>
</tr>
</tbody>
</table>


**Country ICT trends**

- **Mobile phones:**
- **Telephone mainlines:**
- **Telephone mainlines in largest city:**
- **Telephone mainlines, rural areas:**
- **Personal computers:**
- **Internet hosts:**


**Country ICT access indicators**

- **Internet users per 1000 inhabitants:** 2002: 7
- **Adult literacy rate 2005:** 89
- **Cost of a 5-minute fixed line phone call:** 2002: 0.665
- **GDP per capita:** 2002: 1,074


*See explanatory notes for sources and methods.*

*Note:* Data not available.
WHO Global Observatory of eHealth - 2006

• At 58th Session in May 2005, the World Health Assembly (WHA) adopted a resolution WHA58.25 establishing an eHealth Strategy for the World Health Organization (WHO). The Global Observatory of eHealth (GOe) was created which undertook a world-wide survey on eHealth.

• The Observatory’s mission is to improve health by providing Member States with strategic information and guidance on effective practices, policies and standards in eHealth.
It is recommended that WHO in collaboration with appropriate partners should:

1. Facilitate the development of those generic eHealth tools most sought after by its Member States.
2. Raise awareness of existing eHealth tools and services through the creation of electronic directories and that there should be a special focus on open source eHealth solutions.
3. Develop an international knowledge exchange network to share practical experiences on the application and impact of eHealth initiatives.
4. Create an eHealth information resource to support the needs of Member States in key areas such as eHealth policy, strategy, security and legal issues.
5. Promote the use of eLearning programmes for professional and ongoing education in the health sciences. Further, WHO should advocate for the inclusion of eHealth courses within university curricula.
History. Major achievements in ICT for health care

Nobel prizes in Medical Imaging:
• 1979 – Cormack, Hounsfield – Computer Tomography (CT),
• 2003 – Lauterbur, Mansfield – Magnetic Resonance Imaging (MRI)
Beginning of Medical Imaging

- Roentgen – 1905
Computer Tomography - CT

- Hounsfield – 1975
Results
Results cont.
Frequently used definitions

**Telemedicine** - use of medical information exchanged from one site to another via electronic communications to improve patients' health status. (ATA)

**Telehealth** – use of information and communication and technologies to deliver health services and transmit health information over both long and short distances. It’s about transmitting voice, data, images, and information rather than moving patients or healthcare practitioners and educators. (CST)

**Telenursing** - is the practice of nursing over distance using telecommunication technology (NCSBN)
Accessibility

- Access to medical services becomes possible from rural areas and small towns
Alaska largest US Telemedicine Program
Hubs & Spokes are the heart and hand of each program

Source: D. Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8th of January, 2007
Ontario, Canada physicians schedule Telemedicine Encounters with patients

Source: D. Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
South Africa – Polkowane -Northeast Region

Medical Residents learning Telemedicine Software & Video Applications for Spirometry

Obstacles: Remote South African village with limited technology

Source: D.Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Developing Countries request help from a distance for pediatric illnesses or injuries

Source: D. Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Economy - cost containment

European health expenditures per country

- Currently some costs are paid by
  - National Health Organizations
  - Private Insurance
  - Individual payment

Source: F.Lievens, M.Jordanova. eHealth International Initiatives, Structures and Trends. 11th ISfTeH Int. Conf., 27-29 November 2006, Capetown, South Africa
Economy

In developed countries 60% of health care costs are generated by ageing population.
How eHealth can cope with that problem?
By home monitoring and telecare.

It can be applied in diseases such as cardiac failure, hypertension, diabetes, chronic obstructive pulmonary disease (COPD).
Telehealth Monitoring Applications

Source: D. Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Telemedicine/Telehealth Clinical Applications

Patient Suite Integration Model

Video Colposcope

Source: D.Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Telemedicine/Telehealth Clinical Applications

Camera and Illumination Source

Source: D.Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Telemedicine/Telehealth Clinical Applications

Electronic Stethoscopes

SmartSteth

Simulscope

Ausculette II

Source: D. Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Telemedicine/Telehealth Clinical Applications

Medical Devices

Vital Sign Monitor

Digital 12-Lead ECG for PC or Palm Pilot

Digital Spirometry

Source: D.Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Telemedicine/Telehealth Clinical Applications

General Exam Camera

Source: D.Castelli. AMD Global Telemedicine. Presentation for the Medical University of Warsaw, 8.01. 2007
Quality

• In many cases ICT can improve the quality of medical care.

• Telecardiology applied in Acute Coronary Syndromes (ACT) is a good example. The use of eHealth can diminish the time from the onset of symptoms (pain in the chest) to intervention (angioplasty and stent implantation). The rule of „Golden Hour” can be fulfilled.
Acute Coronary Syndromes (ACS)

- Thrombus
- Unstable coronary heart disease or myocardial infarction
- Myocardial infarction
- Vascular lumen
- Arteriosclerotic lamina

Unstable coronary heart disease or myocardial infarction

Myocardial infarction

[Citation]

Hospital with interventional cardiology unit

Retransmission to:
- fax
- palmtop
- laptop
- PC
Structure of the telecardiological system
Mazovia District in Poland

Population: 5 120 tys.
Area: 35 tys. km²

- Cathlab with LifeNet
- Cathlab without LifeNet

"Ambulances with "Lifepak12"

Emergency room with "Lifepak12"
Current developments in telecardiology(1)

- **Home-monitoring** of patients with arrhythmias and after myocardial infarction
- **Event-monitoring** in patients with implanted cardioverter-defibrillator
Current developments in telecardiology(2)

HOME MONITORING - Report

![Graph showing mode switching and duration of mode switching over time. The graph highlights an event labeled AF, indicating atrial fibrillation.](image)
Current developments in telecardiology(3)

- Medical images, movies and sounds transmission (coronarographies, ECHO, stethoscope, etc.) for consultation
Current developments in telecardiology

- **Home-monitoring** of patients with end-stage heart failure – approved by Polcard National Program
- System for cardiological **rehabilitation** in patients after CABG – approved by Polcard National Program
Education

1. Blended model of learning seems to be most appropriate in medical sciences.

2. The most challenging factor in e-learning is lack or limitation of interpersonal contact, which is crucial in training future physicians.

3. Multimedia, virtual reality and simulations of different types are opportunities given by e-learning.
Blended Model of learning

E-learning

Traditional face to face training

Blend
The Virtual Patient
http://www.medics.man.ac.uk/work/virtpat/

dialogue with the simulated patient is carried out using natural language
Interactive Simulation of Patients
the ISP-project
http://isp.his.ki.se/

User types the question using free text and the system responds by playing a corresponding video sequence, in which the simulated patient (actor) gives the answer.
Virtual Hospital: Patient Simulations

http://www.vh.org/Providers/Simulations/PatientSimulations.html

Pediatric Virtual Patients

Case 8

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Virtual Reality
Simulation of endoscopic techniques
Microsurgery simulation

Manipulator stand

Image seen by the operator
Microsurgery simulation
International Virtual Medical School

**IVIMEDS** – established in 2002 as a not for profit organization. There are 26 participating universities from all over the world - Europe, North and Central America, Asia and Australia. Embraces the continuum of medical education including undergraduate, postgraduate and continuing medical education (CME).
IVIMEDS - The International Virtual Medical School

Welcome to The International Virtual Medical School

Listening, learning and sharing the best of world health

IVIMEDS is a worldwide partnership of 36 leading edge medical schools and institutions from 36 countries committed to:

- improving health and tackling human disease by providing a blend of high quality student-centred e-learning and face-to-face learning for medical students, trainers and practicing doctors;
- setting new standards in education by drawing on innovative and established curricula and assessment and practice of Partner Institutions and benefiting maximum benefit from new educational technologies;
- providing a global perspective on medical practice that takes account of the distinctive contributions by different members of the healthcare team;
- providing a programme that is responsive to changing societal requirements and tailored to meet the needs of individual students;
- embracing the continuum of medical education including undergraduate and postgraduate education and continuing professional development.

Ambeds News

The IVIMEDS programme offers significant advantages to students...
ivimeds is an international not-for-profit partnership of medical schools and institutions working to develop the full potential of e-learning in medical education. In partnership with its members, ivimeds aims to provide an effective means of developing and sharing a range of quality digital learning resources and value-added educational services across the continuum of education. Primary development efforts are focussed on the undergraduate medical curriculum, though strategic opportunities for developments at postgraduate and continuing professional development level are being explored.
Opportunities of e-learning

E-learning is being described as a revolutionary approach in presenting and transferring knowledge, which will be quickly developed in the upcoming future. There are several opportunities, which stand for this point of view:

1. Creation of interactive model of learning, which stimulates knowledge acquisition,
2. Flexibility in both time and location, while accessing content presented online,
3. Appropriate use of innovative IT technologies in learning process,
4. Possibility of cooperation between teachers and students from different schools.
Future developments of ICT in health care

- **Telenavigation** during operations: PTCA, ablation
- **Robots** (e.g. da Vinci)
Benefits of eHealth, an example

- U.S. Government Accounting Office studied benefits of e-Health in 11 public and private Health Care Delivery organizations of varying sizes and settings (rural/urban) that had invested significantly in e-Health (Oct., 2003).

  - 50%-80% reduction in medication error rates
  - >15% reduction in laboratory and diagnostic imaging tests due to online access to results
  - 30% increase in use of formulary and generic drugs
  - Significant reduction in time to refer patients using online scheduling and communication tools
  - 40% increase patient screening and preventative health care procedures
  - 40% increase in use of standard protocols by physicians

Source: Jalayer B. eHealth, Electronic Health Record and Technology Infrastructure. Presentation to WHO-EMRO, Sept. 2004, Teheran, Iran
Conclusions

• **Impact:** The advantages of eHealth implementation are numerous: better access to health care services, cost containment, better quality and safer care, possibility of e-learning for undergraduate and postgraduate medical education

• Health is increasingly seen as a driver for – as well as beneficiary of – ICT development

• Universities and health institutions can implement eHealth in research, education and clinical practice

• Combination of demographics, health statistics and ICT indices is vital for developing eHealth strategy for each country