SEMMELWEIS UNIVERSITY
Institute of Health Informatics

Health Informatics: eHEALTH and TELEMEDICINE

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Agenda

→**Basic terms of health informatics**

- eHealth
- Telehealth
- Telemedicine
- mHealth

- Examples of eHealth solutions

Health informatics

- **Health informatics** (also called **health care informatics**, **healthcare informatics**, **medical informatics**, **nursing informatics**, or **biomedical informatics**) is a discipline at the intersection of information science, computer science, and health care.
- It deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.
- Health informatics tools include not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems. It is applied to the areas of nursing, clinical care, dentistry, pharmacy, public health, occupational therapy, and (bio)medical research.

eHealth

- eHealth (also written **e-health**) is a relatively recent term for healthcare practice supported by electronic processes and communication
  - Dating back to at least 50'years (from the first computers).
  - Usage of the term varies: some would argue it is interchangeable with health informatics with a broad definition covering electronic/digital processes in health
  - Others use it in the narrower sense of healthcare practice using the Internet.

Forms of e-health

The term eHealth is often, particularly in the U.K. and Europe, used as an umbrella term that includes telehealth, electronic medical records, and other components of health IT.

The term can encompass a range of services or systems that are at the edge of medicine/healthcare and information technology (IT)

Telemedicine

- **Telemedicine** is a rapidly developing application of clinical medicine where medical information is transferred through interactive audiovisual media for the purpose of consulting, and sometimes remote medical procedures or examinations.
  - Telemedicine may be as simple as two health professionals discussing a case over the telephone, or as complex as using satellite technology and videoconferencing equipment to conduct a real-time consultation between medical specialists in two different countries.
  - Telemedicine generally refers to the use of communications and information technologies for the delivery of clinical care (ICT).
  - Care at a distance (also called *in absentia* care), an old practice which was often conducted via post. There has been a long and successful history of in absentia health care which, thanks to modern communication technology, has evolved into what we know as modern telemedicine.

Telehealth or telemedicine?

- The terms eHealth and telehealth are at times incorrectly interchanged with telemedicine. Like the terms "medicine" and "health care", telemedicine often refers only to the provision of clinical services while the term telehealth can refer to clinical and non-clinical services such as medical education, administration, and research.

mHealth or m-Health

- Includes the use of mobile devices in collecting aggregate and patient level health data, providing healthcare information to practitioners, researchers, and patients, real-time monitoring of patient vitals, and direct provision of care (via mobile telemedicine).

Consumer health informatics (CHI)

- Use of electronic resources on medical topics by healthy individuals or patients.
- **Consumer Health Informatics** helps bridge the gap between patients and health resources. The Kaiser model is an example of allowing patients to remotely communicate with their physicians or other healthcare professionals.
- Consumer Health Informatics include technologies focused on patients as the primary users to health information.
- Consumer Health Informatics includes: Information Resources, Communications, Remote Monitoring, Videoconferencing, and Telepresence.
- Consumer health informatics is the branch of medical informatics that analyses consumers' needs for information; studies and implements methods of making information accessible to consumers; and models and integrates consumers' preferences into medical information systems.

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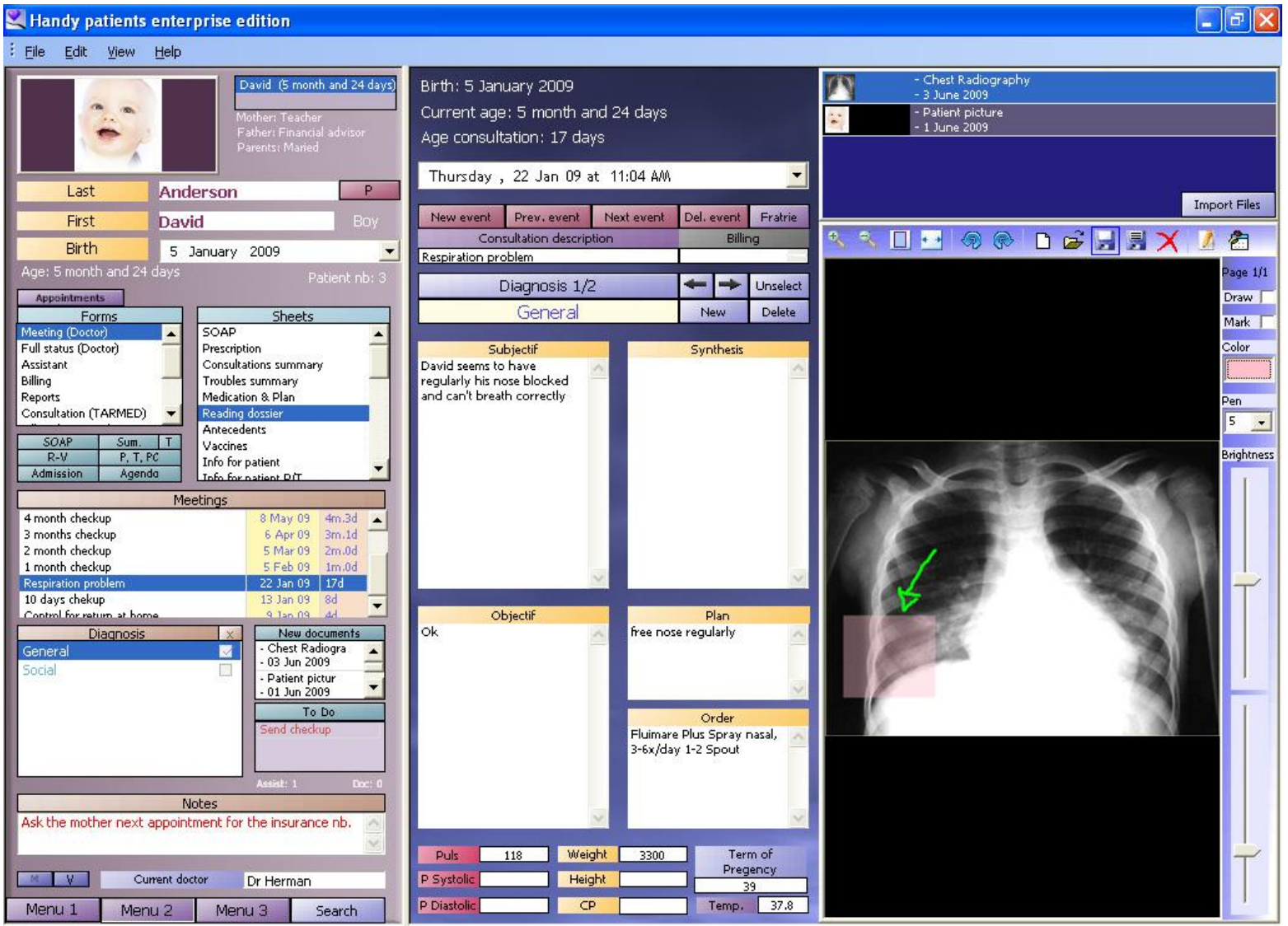
Healthcare Information Systems

Refer to software solutions for appointment scheduling, patient data management, work schedule management and other administrative tasks surrounding health

Electronic health records

- An **electronic health record (EHR)** (also **electronic patient record** (EPR) or **computerised patient record**) is an evolving concept defined as a systematic collection of electronic health information about individual patients or populations.
- Enabling the communication of patient data between different healthcare professionals (specialists *etc.*).

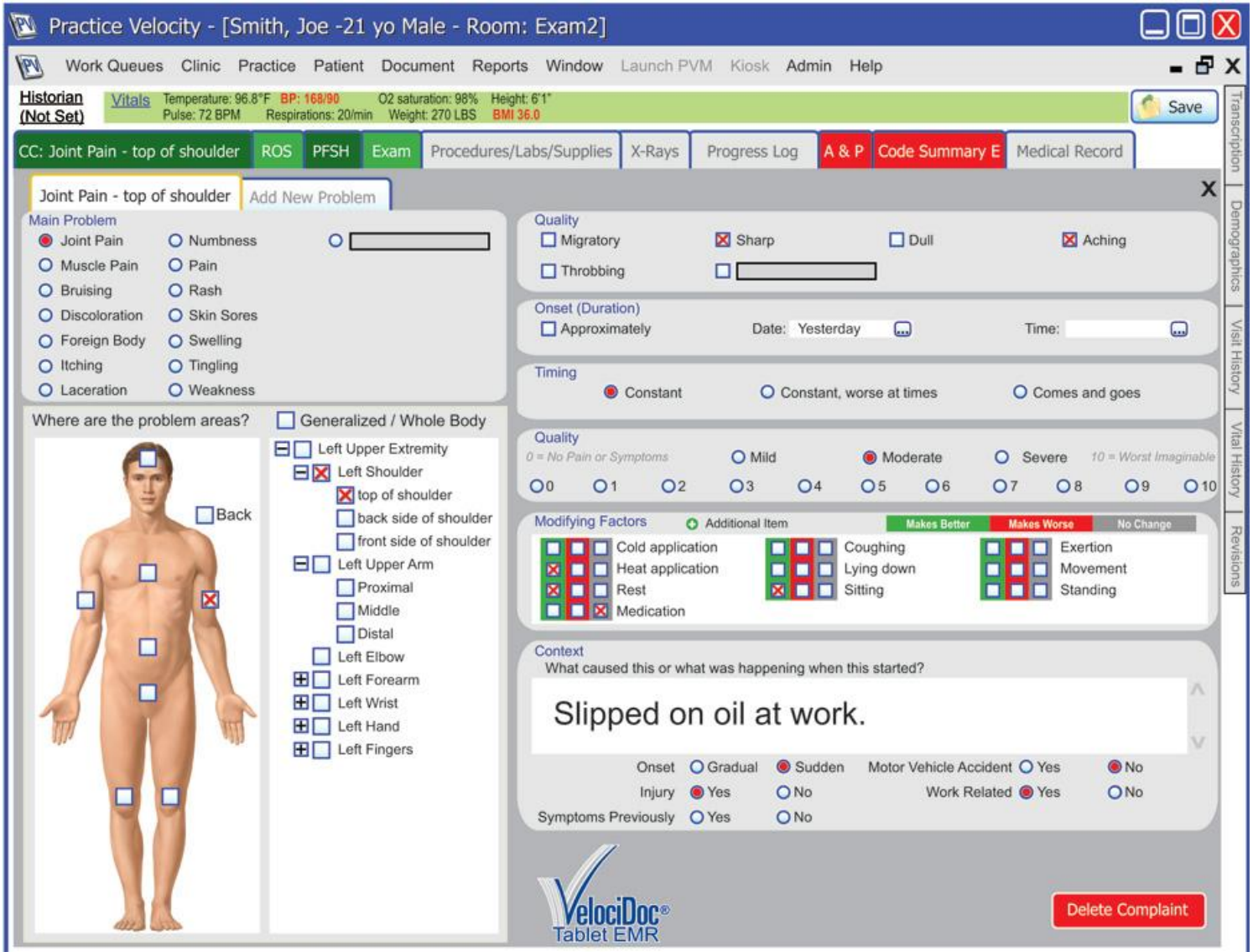
Electronic health records



Electronic health records

- It is a record in digital format that is capable of being shared across different health care settings, by being embedded in network-connected enterprise-wide information systems.
- Such records: may include a whole range of data in comprehensive or summary form, including demographics, **medical history, medication and allergies, immunization status, laboratory test results, radiology images, vital signs, personal stats like age and weight, and billing** information.
- Its purpose: can be understood as a complete record of patient encounters that allows the automation and streamlining of the workflow in health care settings and increases safety through evidence-based decision support, quality management, and outcomes reporting.

Electronic health records



Technical issues

- **Standard for communication of health data**
  - ANSI X12 (EDI) - transaction protocols used for transmitting patient data. Popular in the United States for transmission of billing data.
  - CEN's TC/251 provides EHR standards in Europe including:
    - EN 13606, communication standards for EHR information
    - CONTSYS (EN 13940), supports continuity of care record standardization.
    - HISA (EN 12967), a services standard for inter-system communication in a clinical information environment.
  - Continuity of Care Record - ASTM International Continuity of Care Record standard
  - DICOM - an international communications protocol standard for representing and transmitting radiology (and other) image-based data, sponsored by NEMA (National Electrical Manufacturers Association)
  - HL7 - a standardized messaging and text communications protocol between hospital and physician record systems, and between practice management systems
  - ISO - ISO TC 215 provides international technical specifications for EHRs. ISO 18308 describes EHR architectures

Meaningful Use

The meaningful use of EHRs intended by the US government incentives is categorized as follows:

- Improve care coordination
- Reduce healthcare disparities
- Engage patients and their families
- Improve population and public health
- Ensure adequate privacy and security.

The Obama Administration's Health IT program intends to use federal investments to stimulate the market of electronic health records:

- Incentives: to providers who use IT
- Strict and open standards: To ensure users and sellers of EHRs work towards the same goal
- Certification of software: To provide assurance that the EHRs meet basic quality, safety, and efficiency standards.

Telemedicine - History

- African villagers used smoke signals to warn people to stay away from the village in case of serious disease.
- In the early 1900s, people living in remote areas in Australia used two-way radios, powered by a dynamo driven by a set of bicycle pedals, to communicate with the Royal Flying Doctor Service of Australia.
- This service is still running!

Store-and-forward telemedicine

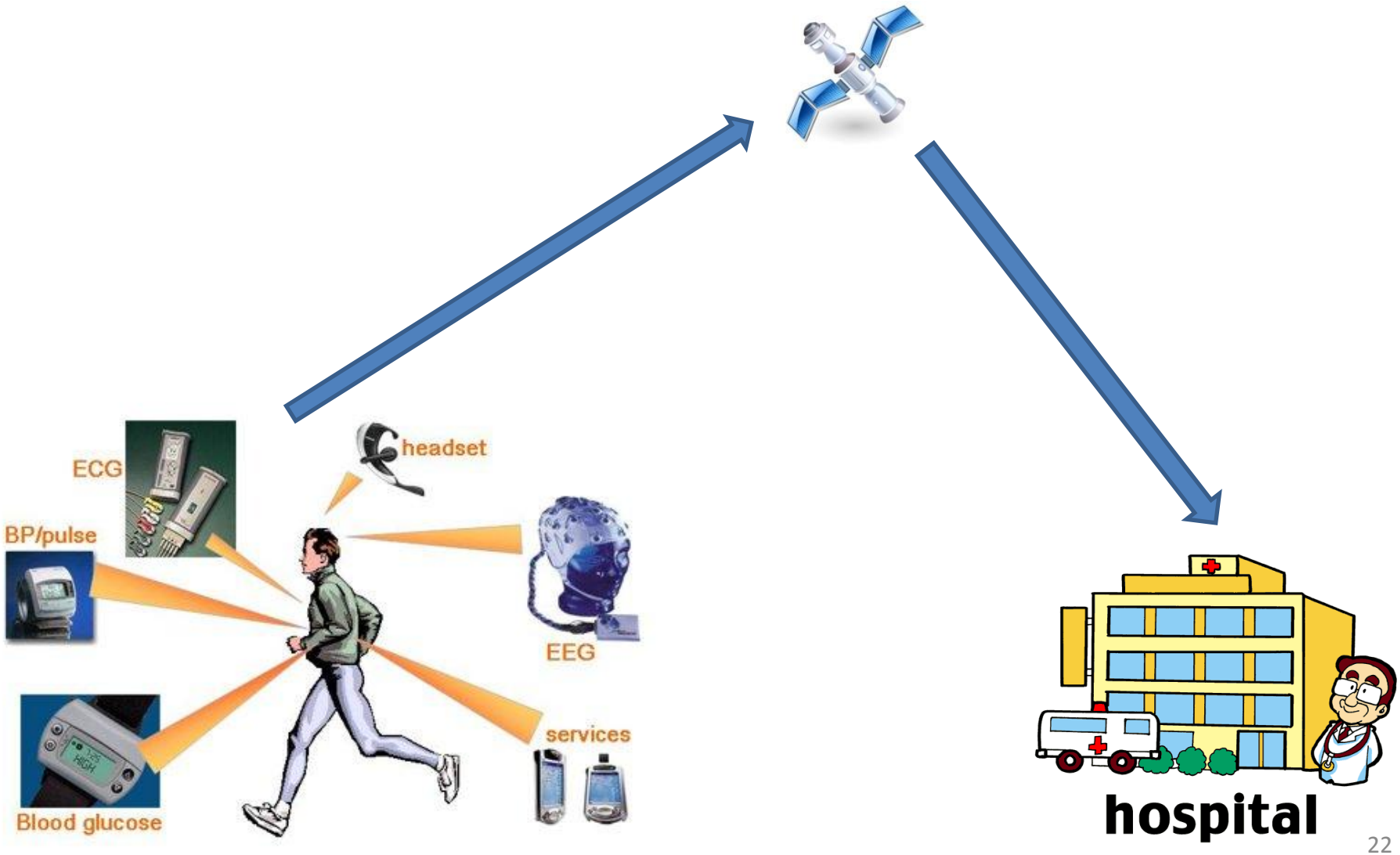
- It involves acquiring medical data (like medical images, biosignals etc.) and then transmitting this data to a doctor or medical specialist at a convenient time for assessment offline.
- It does not require the presence of both parties at the same time.
- Dermatology (cf: teledermatology), radiology, and pathology are common specialties that are conducive to asynchronous telemedicine.
- A properly structured Medical Record preferably in electronic form should be a component of this transfer.
- A key difference between traditional in-person patient meetings and telemedicine encounters is the omission of an actual physical examination and history. The store-and-forward process requires the clinician to rely on a history report and audio/video information in lieu of a physical examination.

Remote monitoring

- Enables medical professionals to monitor a patient remotely using various technological devices.
- Primarily used for managing chronic diseases or specific conditions, such as heart disease, diabetes mellitus, or asthma.
- These services can provide comparable health outcomes to traditional in-person patient encounters, supply greater satisfaction to patients, and may be cost-effective.

Monitoring of vital signs

Remote monitoring of vital signs



Interactive telemedicine

- Provides real-time interactions between patient and provider
- Include phone conversations, online communication and home visits.
- Many activities such as history review, physical examination, psychiatric evaluations and ophthalmology assessments can be conducted comparably to those done in traditional face-to-face visits.
- “Clinician-interactive” telemedicine services may be less costly than in-person clinical visits.

Benefits and uses

- Telemedicine can be extremely beneficial for people living in isolated communities and remote regions and is currently being applied in virtually all medical domains. Patients who live in such areas can be seen by a doctor or specialist, who can provide an accurate and complete examination, while the patient may not have to travel or wait the normal distances or times like those from conventional hospital.
- Specialties that use telemedicine often use a 'tele-' prefix; for example, telemedicine as applied by radiologists is called 'teleradiology'. Similarly telemedicine as applied by cardiologists is termed as 'telecardiology', etc...

Benefits and uses

- Telemedicine is also useful as a communication tool between a general practitioner and a specialist available at a remote location.
- Telemedicine can be used as a teaching tool, by which experienced medical staff can observe, show and instruct medical staff in another location, more effective or faster examination techniques.
- It improved access to healthcare for patients in remote locations.
- "Telemedicine has been shown to reduce the cost of healthcare and increase efficiency through better management of chronic diseases, shared health professional staffing, reduced travel times, and fewer or shorter hospital stays."
- Several studies have documented increase patient satisfaction of telemedicine over past fifteen years.

Benefits and uses

- The first interactive telemedicine system, operating over standard telephone lines, for remotely diagnosing and treating patients requiring cardiac resuscitation (defibrillation) was developed and marketed by MedPhone Corporation in. A year later the company introduced a mobile cellular version, the MDphone. Twelve hospitals in the U.S. served as receiving and treatment centers.
- Monitoring a patient at home using known devices like blood pressure monitors and transferring the information to a caregiver is a fast growing emerging service. These remote monitoring solutions have a focus on current high morbidity chronic diseases and are mainly deployed for the First World.
- In developing countries a new way of practicing telemedicine is emerging better known as Primary Remote Diagnostic Visits, whereby a doctor uses devices to remotely examine and treat a patient.
- This new technology and principle of practicing medicine holds significant promise of improving on major health care delivery problems, in for instance, Southern Africa, because Primary Remote Diagnostic Consultations not only monitors an already diagnosed chronic disease, but has the promise to diagnose and manage the diseases a patient will typically visit a general practitioner for.

Telecardiology

- ECG or electrocardiograph can be transmitted using telephone and wireless. Einthoven, the inventor of the ECG, actually did tests with transmission of ECG through telephone lines. This was because the hospital did not allow him to move patients outside the hospital to his laboratory for testing of his new device. In 1906 Einthoven came up with a way to transmit the data from the hospital directly to his lab.
- **Teletransmission of ECG using indigenous methods.** One of the oldest known telecardiology system (teletransmission of ECG) was established in Gwalior, India in 1975 at GR Medical college by Dr. Ajai Shanker, Dr. S. Makhija, P.K. Mantri using indegenous technique for the first time in India.

Teleradiology

- Teleradiology is the ability to send radiographic images (x-rays, CT, MR, PET/CT, SPECT/CT…) from one location to another
- The most typical implementation are two computers connected via Internet. The computer at the receiving end will need to have a high-quality display screen that has been tested and cleared for clinical purposes. Sometimes the receiving computer will have a printer so that images can be printed for convenience.
- Today's Internet bandwidth enables the use of new technologies for teleradiology : the image reviewer can now have access to distant servers in order to view an exam. Therefore, they do not need particular workstations to view the images ; a standard PC and DSL connection is enough to reach keosys central server. No particular software is necessary on the PC and the images can be reached from wherever in the world.
- Teleradiology is the most popular use for telemedicine and accounts for at least 50% of all telemedicine usage.

Teleradiology

MRI (Magnetic Resonance Imaging)

Telepsychiatry

- Telepsychiatry, another aspect of telemedicine, also utilizes videoconferencing for patients residing in underserved areas to access psychiatric services. It offers wide range of services to the patients and providers, such as consultation between the psychiatrists, educational clinical program, diagnosis and assessment, medication therapy management, etc.

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Teledentistry

- is the use of information technology and telecommunications for dental care, consultation, education, and public awareness in the same manner as telehealth and telemedicine.

Robotic surgery

- *Computer-assisted surgery, and robot-assisted surgery are terms for various technological developments that currently are developed to support a range of surgical procedures.*
- Robot-assisted surgery was developed to overcome limitations of minimally invasive surgery. Instead of directly moving the instruments the surgeon uses a computer console to manipulate the instruments attached to multiple robot arms.
- The computer translates the surgeon's movements, which are then carried out on the patient by the robot. Other features of the robotic system include, for example, an integrated tremor filter and the ability for scaling of movements (changing of the ratio between the extent of movements at the master console to the internal movements of the instruments attached to the robot).
- The console is located in the same operating room as the patient, but is physically separated from the operative workspace. Since the surgeon does not need to be in the immediate location of the patient while the operation is being performed, it can be possible for specialists to perform remote surgery on patients. Robots can perform surgery without a human surgeon.

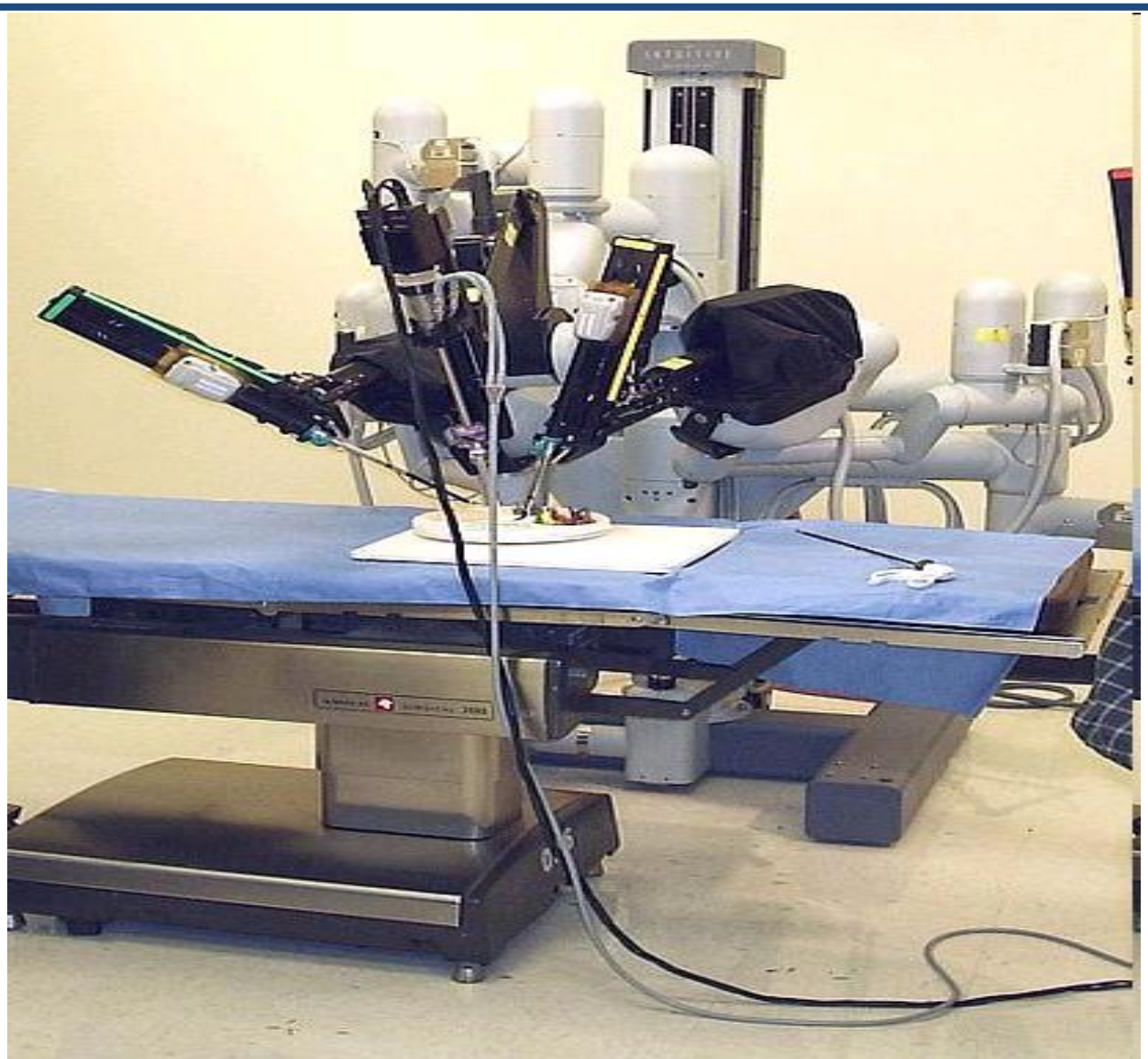
History

- The world's first surgical robot was the "Arthrobot", which was developed and used for the first time in Vancouver, BC, Canada in 1983. The robot was developed by a team led by Dr. James McEwen and Geof Auchinlek, in collaboration with orthopaedic surgeon, Dr. Brian Day. National Geographic produced a movie on robotics which featured the Arthrobot.
- In related projects at that time, other medical robots were developed, including a robotic arm that performed eye surgery and another that acted as an operating assistant, and handed the surgeon instruments in response to voice commands.
- 1985 a robot, the PUMA 560, was used to place a needle for a brain biopsy using CT guidance.
- In 1988, the PROBOT, developed at Imperial College London, was used to perform prostatic surgery.
- The ROBODOC from Integrated Surgical Systems was introduced in 1992 to mill out precise fittings in the femur for hip replacement.
- Further development of robotic systems was carried out by Intuitive Surgical with the introduction of the da Vinci Surgical System and Computer Motion with the *AESOP* and the ZEUS robotic surgical system. (Intuitive Surgical bought Computer Motion in 2003; ZEUS is no longer being actively marketed.)

Advantages and disadvantages

- Major advances aided by surgical robots have been remote surgery, minimally invasive surgery and unmanned surgery.
- Some major advantages of robotic surgery are precision, miniaturization, smaller incisions, decreased blood loss, less pain, and quicker healing time.
- Further advantages are articulation beyond normal manipulation and three-dimensional magnification, resulting in improved ergonomics.
- Robotic techniques are also associated with reduced duration of hospital stays, blood loss, transfusions, and use of pain medication.
- With a the cost of the robot at $1,200,000 dollars and disposable supply costs of $1,500 per procedure, the cost of the procedure is higher.
- Additional surgical training is needed to operate the system
- Higher expectations may explain higher rates of dissatisfaction and regret.

da Vinci Surgical System
with robotic arm operating table



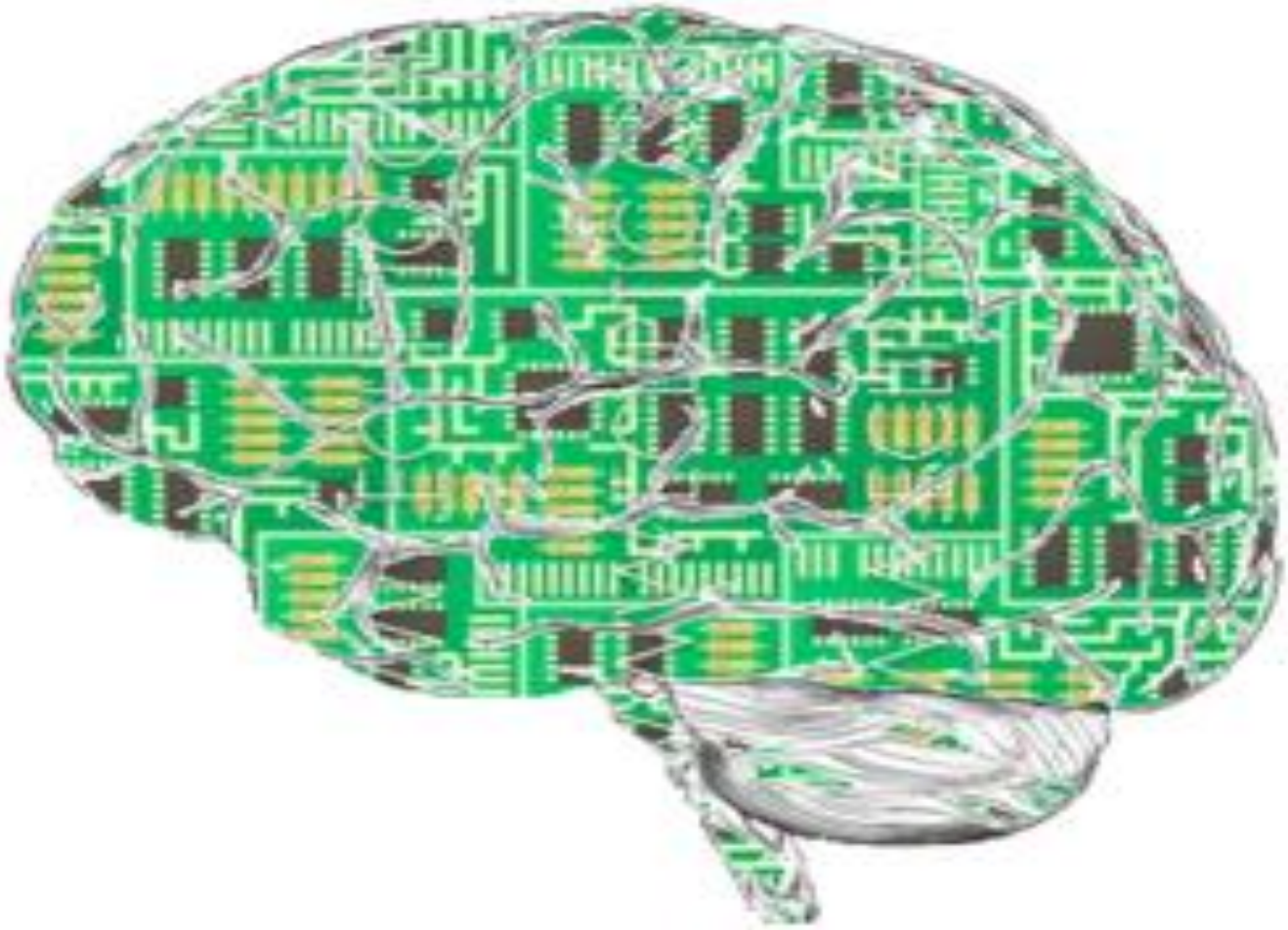
A surgical team at Hackensack University Medical Center uses the Da Vinci robot. (NYTIMES, February 12, 2008)

http://www.youtube.com/watch?v=nhusxZE7dJ4

Applications

- General surgery
- Cardiology and electrophysiology
- Gastrointestinal
- Gynecology
- Urology etc.

Artificial **I**ntelligence



Definition

- **Artificial intelligence** (**AI**) is the intelligence of machines and the branch of computer science that aims to create it.
- AI textbooks define the field as „the study and design of intelligent agents” where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success

AI in medicine

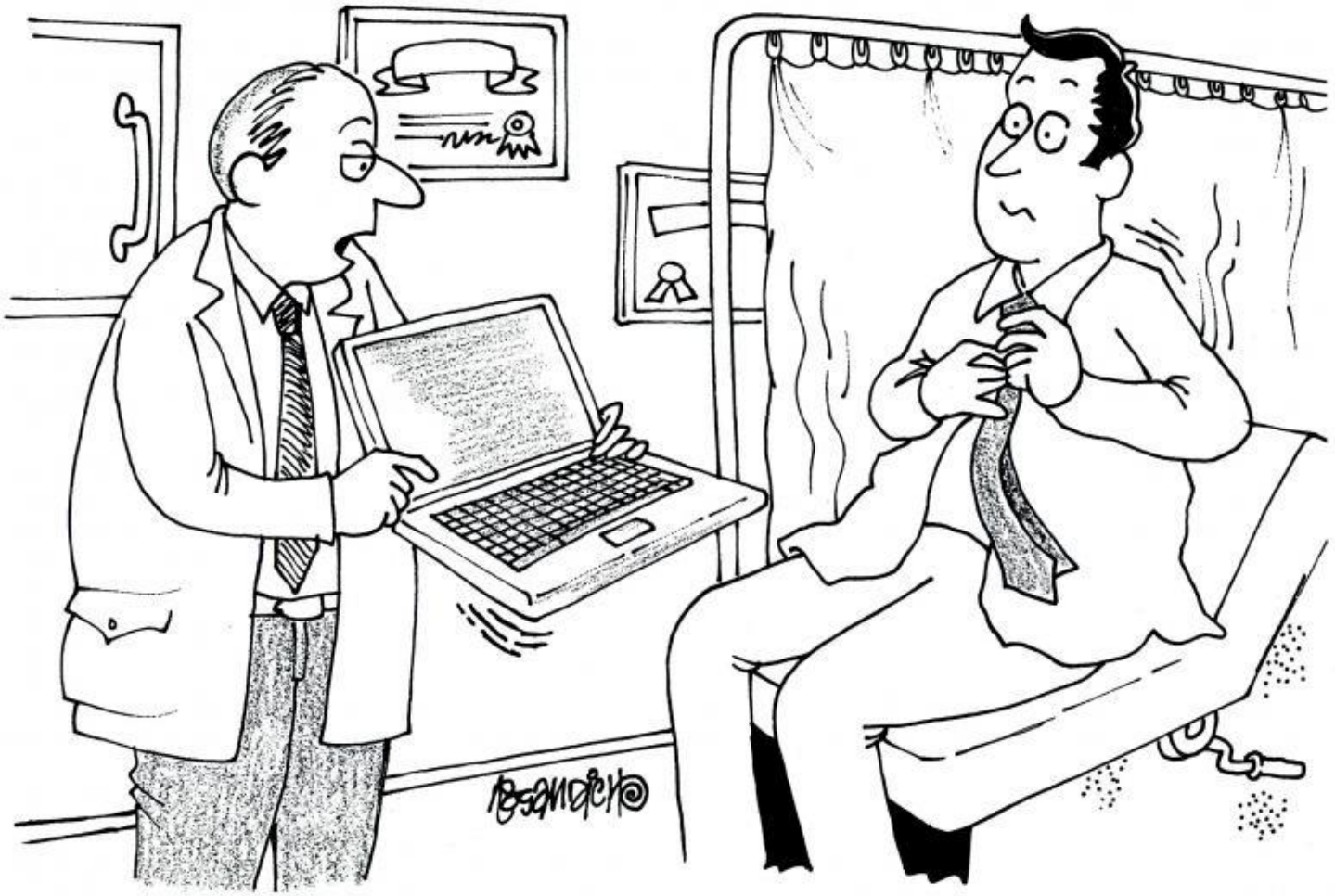
- 'Medical artificial intelligence is primarily concerned with the construction of AI programs that **perform diagnosis and make therapy recommendations**. Unlike medical applications based on other programming methods, such as purely statistical and probabilistic methods, medical AI programs are based on symbolic **models of disease** entities and their relationship to patient factors and clinical manifestations.‘

Clancey and Shortliffe, 1984

Examples

- Expert systems contain medical knowledge, and are able to reason with data from individual patients to come up with reasoned conclusions.
  - *Generating alerts and reminders*
  - *Diagnostic assistance*
  - *Therapy critiquing and planning*
  - *Agents for information retrieval*
  - *Image recognition and interpretation*

The future?

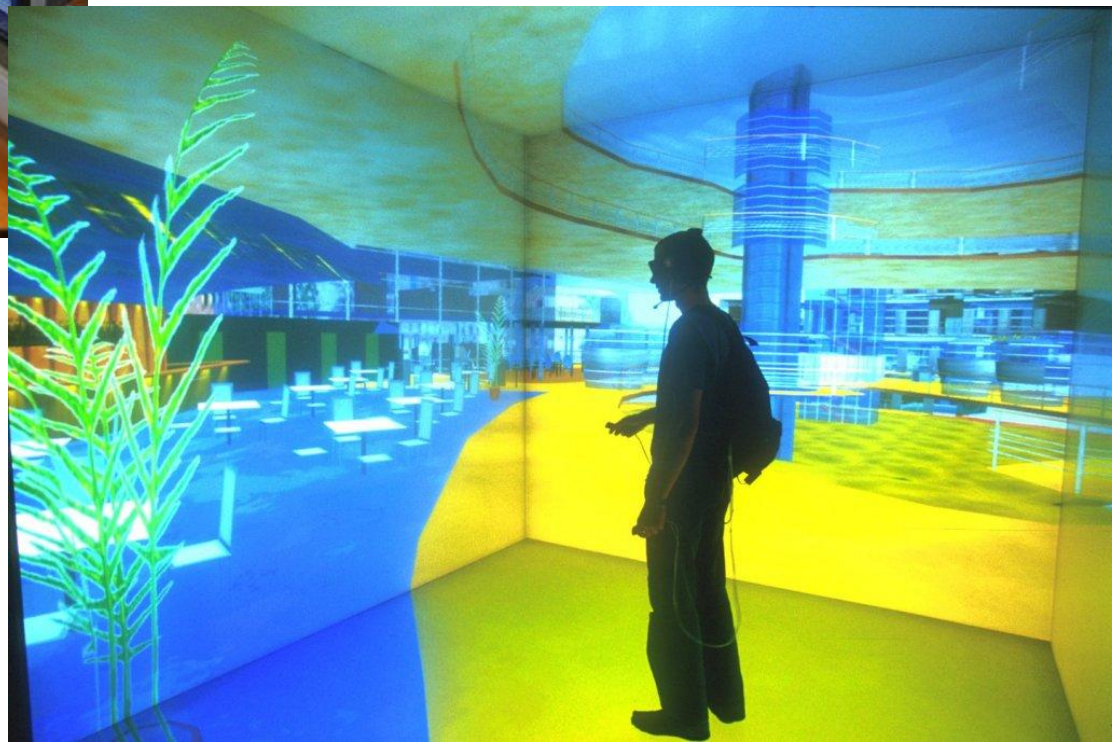


"If you want a second opinion, I'll ask my computer."

Virtual reality

- **Virtual reality** (**VR**) is a term that applies to computer-simulated environments that can simulate places in the real world, as well as in imaginary worlds.
- Users can interact with the computer-generated environment

VR System



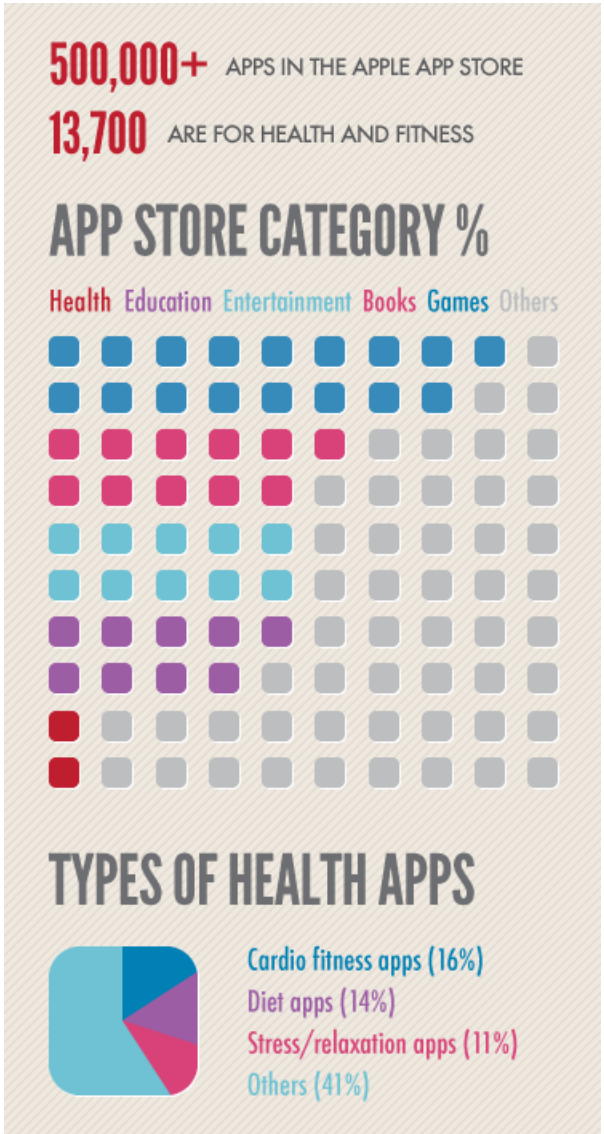
U.S. Navy personnel using a VR parachute trainer

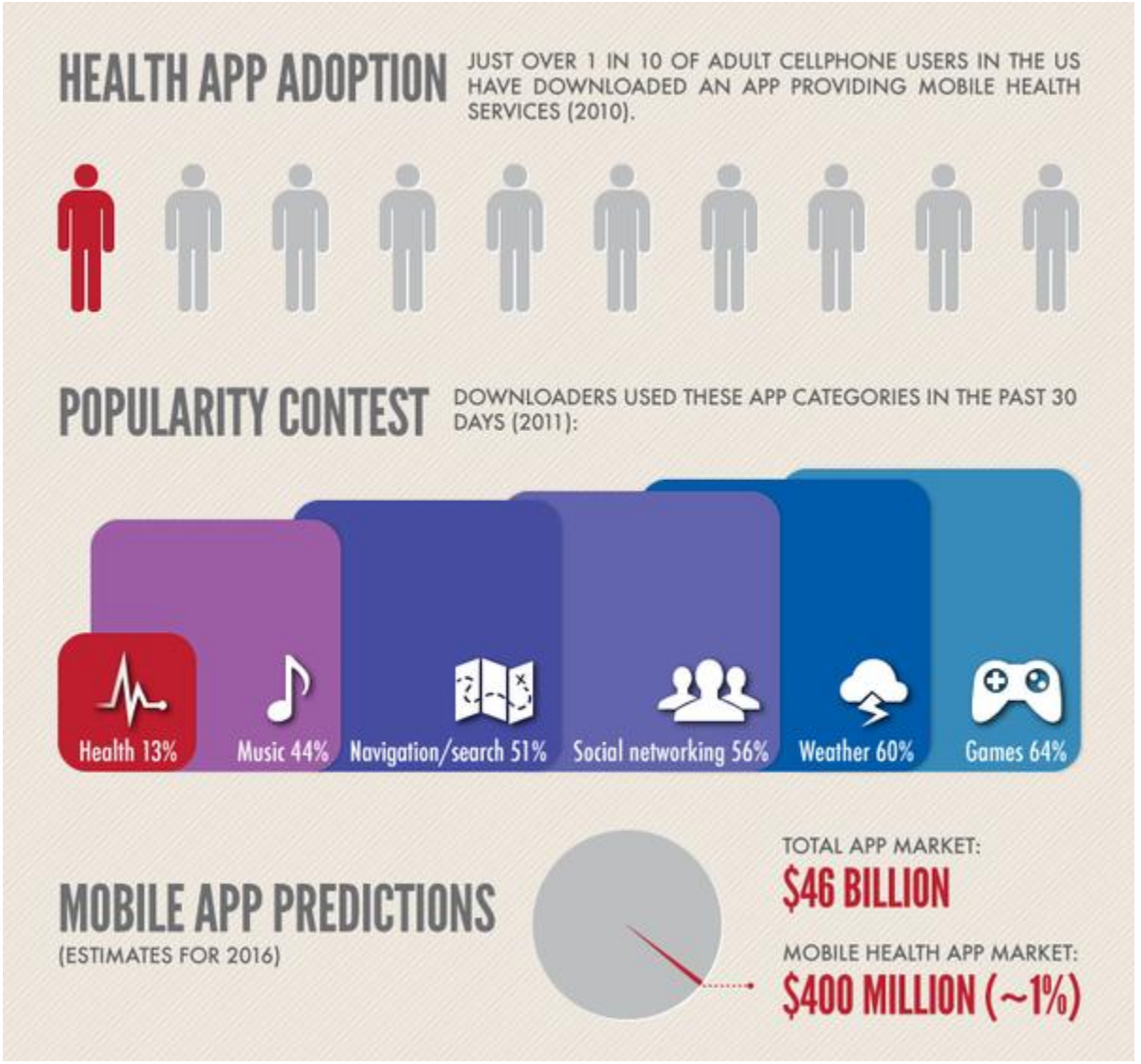
VR in medicine

- Surgical training and planning
- Medical education
- Radiation treatment planning and control
- Rehabilitation and sports therapy
- Disability solutions
- Neurological evaluation
- Psychiatric and behavioural health (e.g. treatment for various phobias)

Mobile health market

http://www.behance.net/gallery/Infographic-Mobile-Health-market-snapshot/4468557





Some mHealth apps

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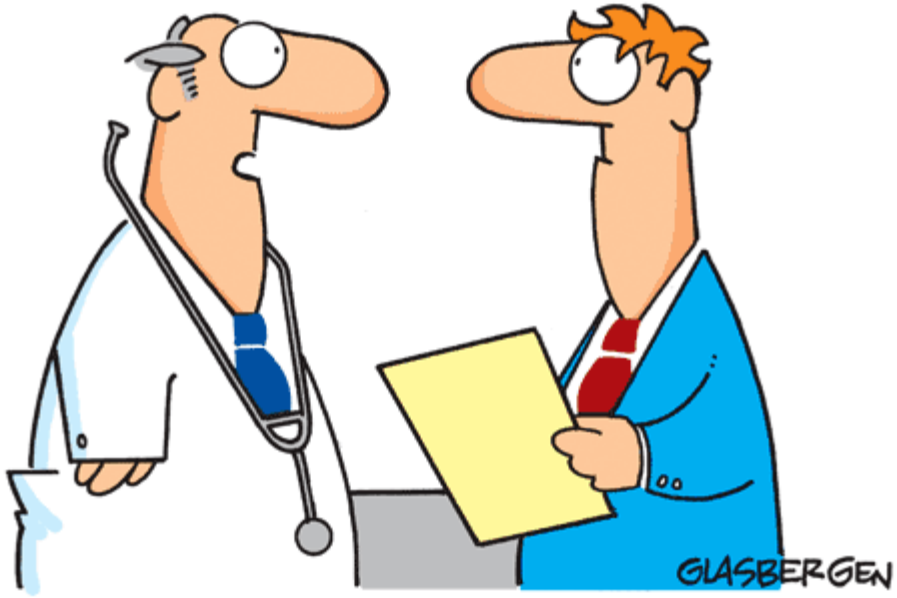
www.glasbergen.com



"More and more patients are going to the Internet for medical advice. To keep my practice going, I changed my name to Dr. Google."

THANK YOU FOR YOUR ATTENTION!