

Introduction to Health Informatics

Centre for Health Informatics

Prof John Chelsom

Runs: 3 hours
Tutor: Prof John Chelsom
Mode of attendance: Classroom

Learning Objectives

- This session provides an introduction to Health Informatics, and how it relates to the structure, organisation and function of the healthcare system.
- Specific learning objectives are to:
 - 1 Understand the structure and function of healthcare systems
 - 2 Define Health Informatics and understand its scope
 - 3 See how Health Informatics contributes to healthcare delivery
 - 4 Identify sources of further information

Introduction to Health Informatics

- Structure, organisation and function of healthcare
- Health Informatics Defined
- Clinical Records
- Clinical Information Systems
- References and Further Reading

Information Sources

- Sources are listed in the references at the end of these slides



Some definitions have been taken from <http://thefreedictionary.com>.

Retrieved September 2010.

Where consensus on definitions or descriptions is required, these have been taken from Wikipedia.

Retrieved September 2010.

Structure, organisation and function of healthcare

Medicine and Healthcare

Medicine noun

- a. The science of diagnosing, treating, or preventing disease and other damage to the body or mind.
- b. The branch of this science encompassing treatment by drugs, diet, exercise, and other nonsurgical means.

<http://www.thefreedictionary.com/medicine>

The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000 by Houghton Mifflin Company. Updated in 2009. Published by Houghton Mifflin Company.

Contemporary medicine applies health science, biomedical research, and medical technology to diagnose and treat injury and disease, typically through medication, surgery, or some other form of therapy. The word medicine is derived from the Latin *ars medicina*, meaning the art of healing.

<http://en.wikipedia.org/wiki/Medicine>

health care noun

The prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by the medical and allied health professions.

<http://www.thefreedictionary.com/health+care>

The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000 by Houghton Mifflin Company. Updated in 2009. Published by Houghton Mifflin Company.

Healthcare Professions

Health care or healthcare is the treatment and prevention of illness.

Health care is delivered by professionals in medicine, dentistry, nursing, pharmacy and allied health.

http://en.wikipedia.org/wiki/Health_care

- Health care professions

- Medicine
- Nursing
- Dentistry
- Pharmacy

- Allied health professions include

- Athletic trainer
- Audiologist
- Dietician
- Occupational therapist
- Optometrist
- Paramedic
- Physiotherapist
- Radiographer

Medical Specialties

A specialty in medicine is a branch of medical science.

http://en.wikipedia.org/wiki/Medical_specialty

Surgical

focus on manually operative and instrumental techniques to treat disease

Anaesthesiology
Cardiovascular surgery
General surgery
Maxillofacial surgery
Neurosurgery
Obstetrics and gynaecology
Ophthalmology
Orthopaedic surgery
Paediatric surgery
Plastic surgery
Surgical oncology
Thoracic surgery
Transplant surgery
Trauma surgery
Urology
Vascular surgery

Medical

focus on the diagnosis and non-surgical treatment of disease

Cardiology
Dermatology
Emergency medicine
Endocrinology
Gastroenterology
Haematology
Hepatology
Intensive care medicine
Nephrology
Neurology
Oncology
Paediatrics
Psychiatry
Pulmonology
Rheumatology

Diagnostic

focus more purely on diagnosis of disorders

Clinical laboratory sciences
Clinical Neurophysiology
Pathology
Radiology

Public Health

Public health is "the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of society, organizations, public and private, communities and individuals." ¹

Public health is typically divided into epidemiology, biostatistics and health services. Environmental, social, behavioural, and occupational health are other important subfields.

http://en.wikipedia.org/wiki/Public_health

- Epidemiology – study of patterns of health and disease, at the population level
- Biostatistics – the application of statistics to topics in biology
- Health services – delivery of healthcare by medical and allied professionals

General Organisation of Healthcare

Primary Care

The health services that play a central role in the local community.

It refers to the work of health care professionals who act as a first point of consultation for all patients. Such a professional would usually be a general practitioner or family physician.

http://en.wikipedia.org/wiki/Primary_care

Secondary Care

The service provided by medical specialists who generally do not have first contact with patients, for example, cardiologists, urologists and dermatologists.

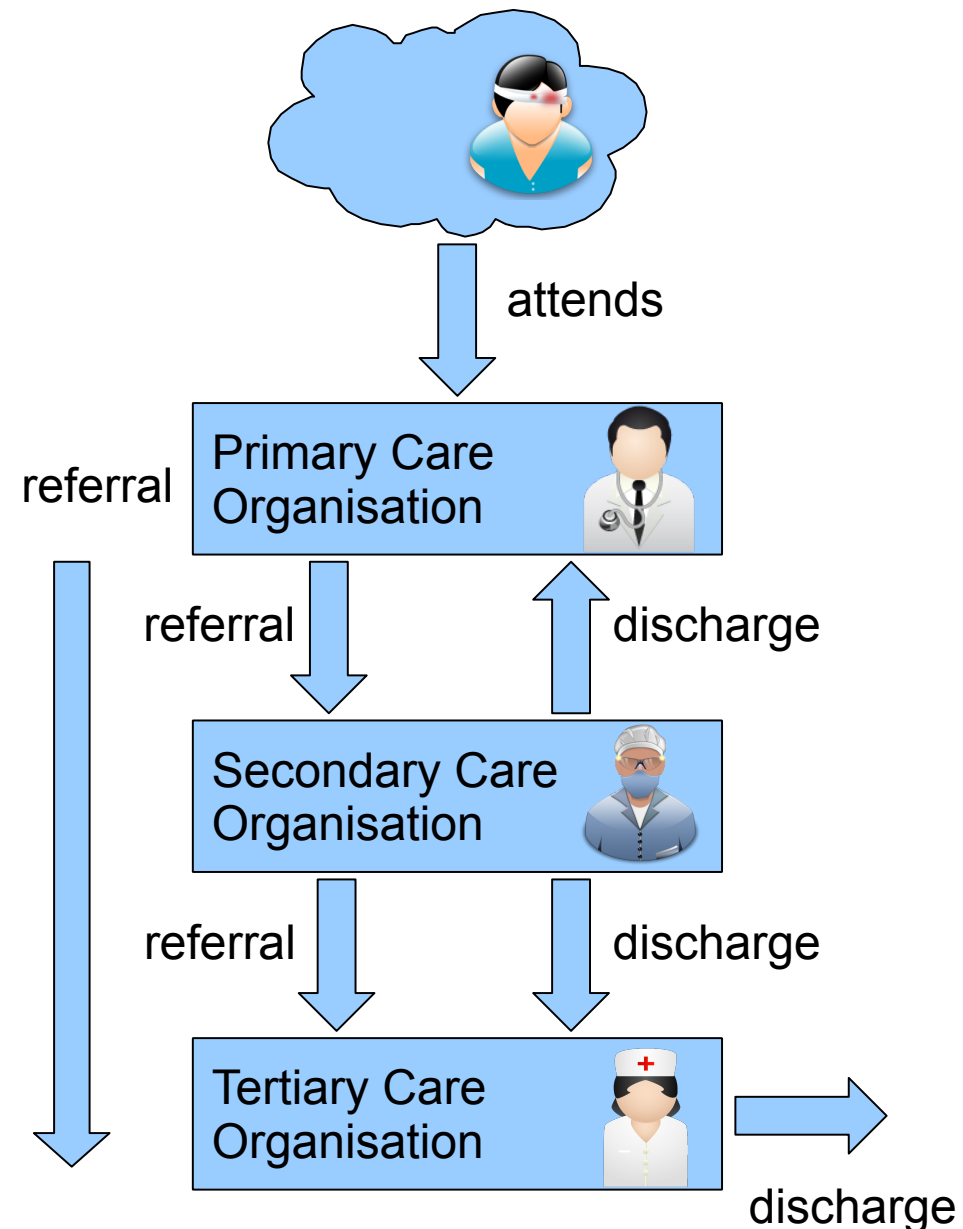
[In the UK] the term "secondary care" is used synonymously with "hospital care".

http://en.wikipedia.org/wiki/Secondary_care

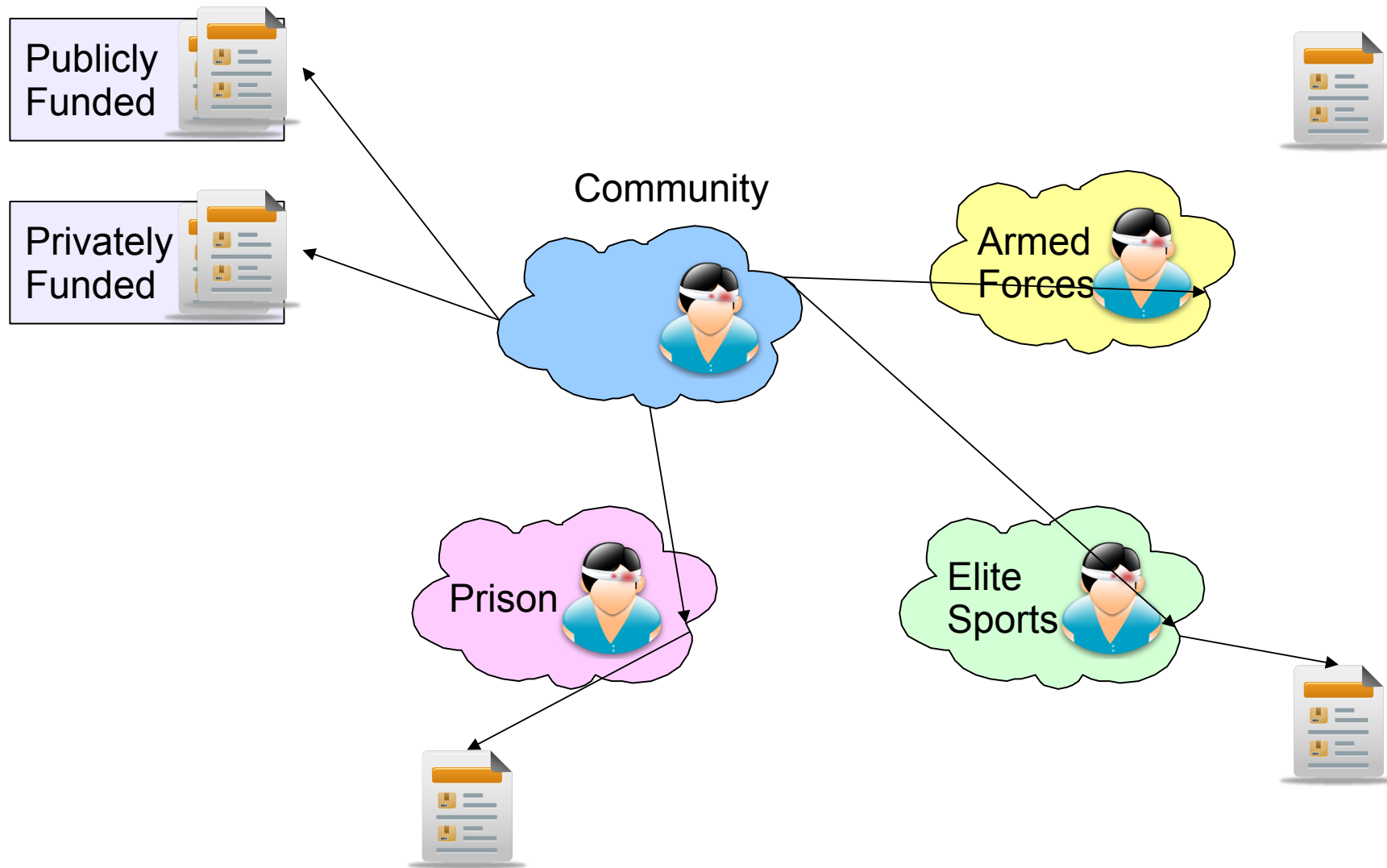
Tertiary Care

Specialized consultative care, usually on referral from primary or secondary medical care personnel, by specialists working in a centre that has personnel and facilities for special investigation and treatment.

http://en.wikipedia.org/wiki/Tertiary_care



Patient Centred Health



Clinical Trials

Clinical Trials are conducted to allow safety and efficacy data to be collected for health interventions (e.g., drugs, diagnostics, devices, therapy protocols).

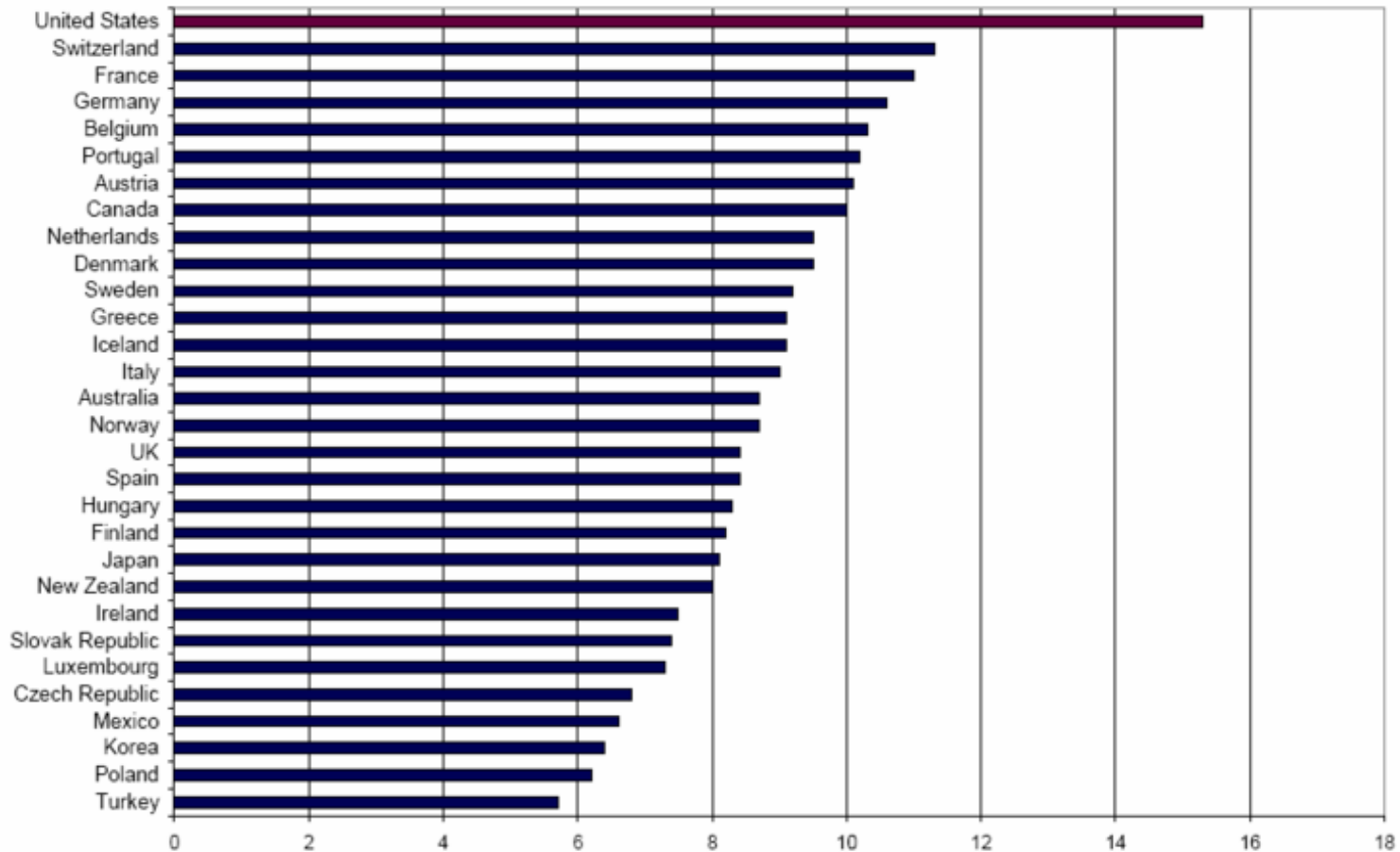
These trials can take place only after satisfactory information has been gathered on the quality of the non-clinical safety, and Health Authority/Ethics Committee approval is granted in the country where the trial is taking place.

http://en.wikipedia.org/wiki/Clinical_trial

- Clinical trials involve large scale data management for
 - Management of the trial itself
 - Gathering of the trial data (patient data)
 - Documentation of results

Spending on Healthcare

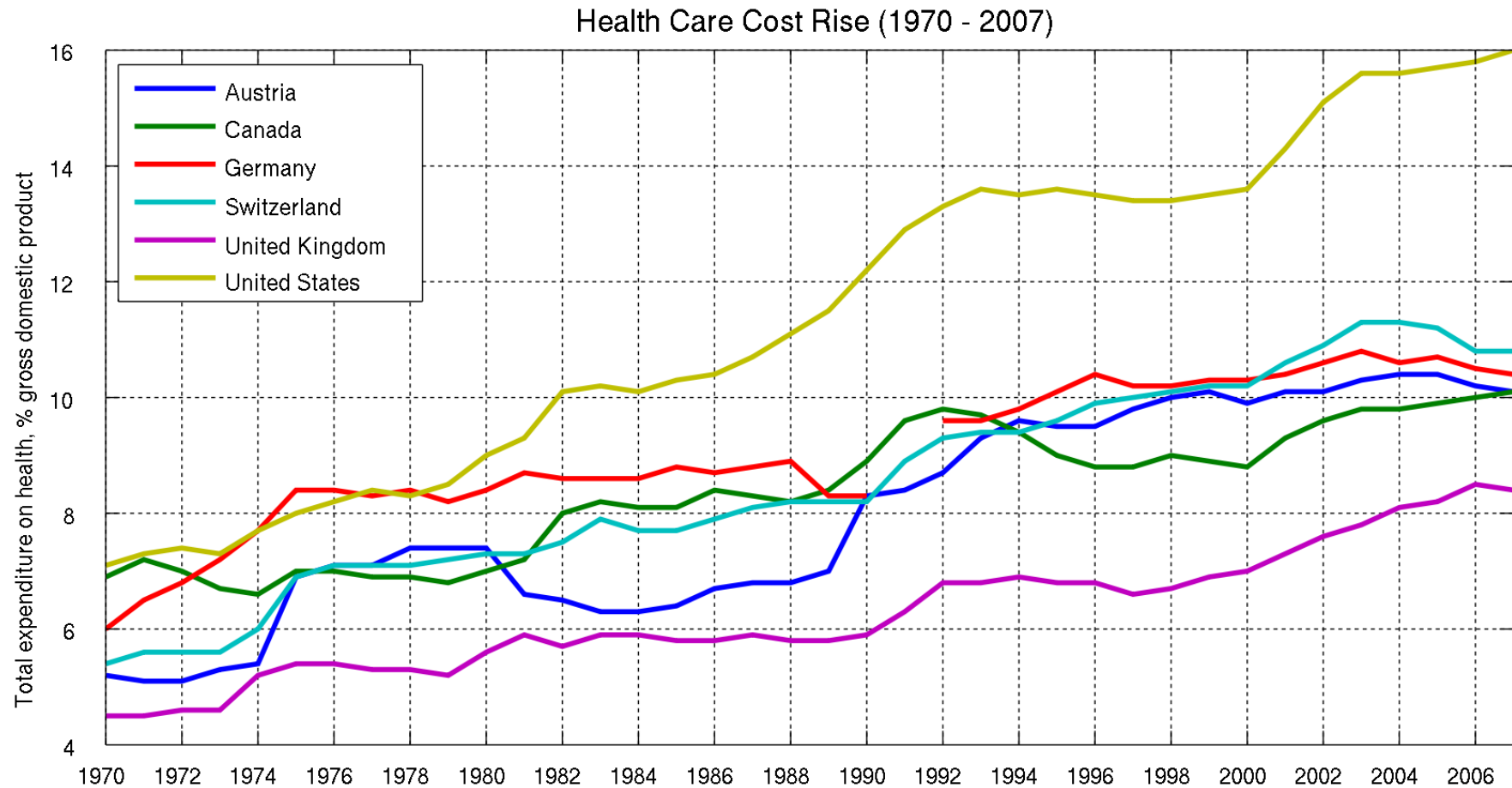
Healthcare Spending as % GDP



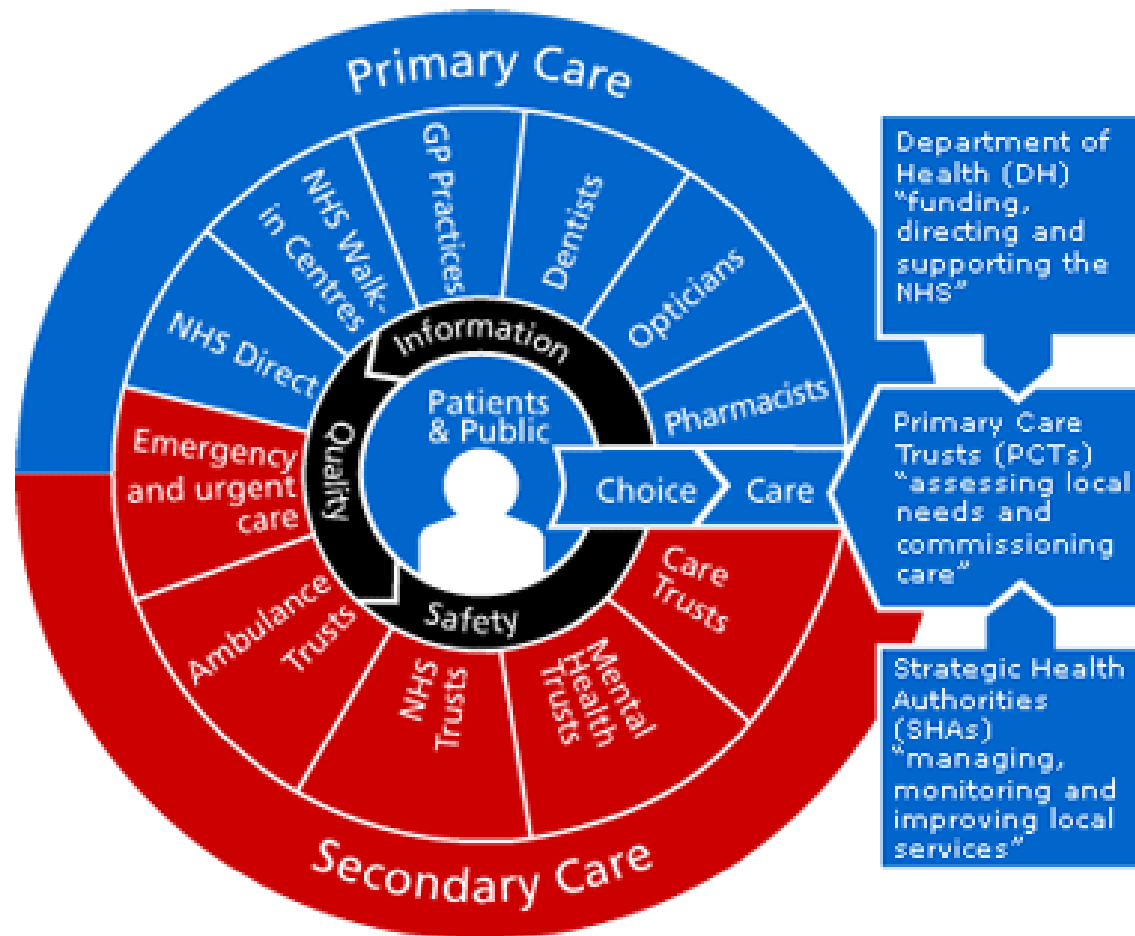
Source: Organization for Economic Cooperation and Development, OECD Health Data, 2008 (Paris: OECD, 2008).

Note: For countries not reporting 2006 data, data from previous years is substituted.

Rise in Healthcare Costs



Organisation in England (2002-13)



- Health services are commissioned by PCTs
- As of September 2010, PCTs and SHAs are due to be abolished
- Thereafter, GP-led groups will be responsible for most commissioning

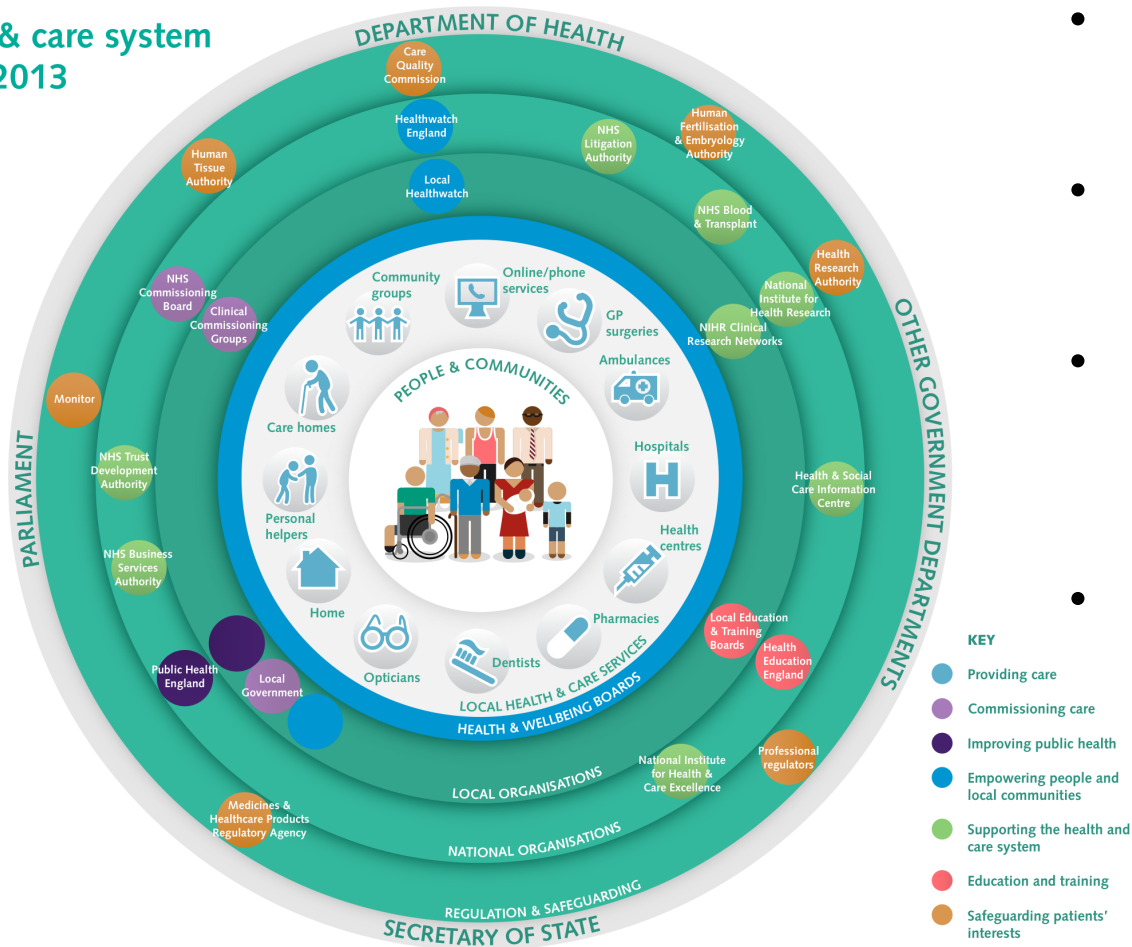
Source:

<http://www.nhs.uk/NHSEngland/thenhs/about/Pages/nhsstructure.aspx>

Retrieved in 2010

Organisation in England (2013)

The health & care system
from April 2013



- Health services are commissioned by CCGs
- Greater involvement of GPs in commissioning
- More use of private healthcare providers (controversial)
- All acute trusts are due to become Foundation Trusts i.e. greater independence as defined in Health and Social Care (Community Health and Standards) Act 2003

Source:

<http://www.nhs.uk/NHSEngland/thenhs/about/Pages/nhsstructure.aspx>

Retrieved in 2013

Organisation in the US

- Healthcare in the US is funded through insurance
 - 28% of population have state-funded insurance
 - Medicare – elderly and disabled
 - Medicaid – people on welfare or low income
 - Veterans Health Administration - ex-servicemen
 - 59% are insured through their employer
 - 13% are uninsured
- Managed Care
 - Health Maintenance Organization Act of 1973
 - Used to reduce the cost of healthcare

Managed Care Techniques

One of the most characteristic forms of managed care is the use of a panel or network of health care providers to provide care to enrollees.

Such integrated delivery systems typically include one or more of the following:

- A set of selected providers that furnish a comprehensive array of health care services to enrollees;
- Explicit standards for selecting providers;
- Formal utilization review and quality improvement programs;
- An emphasis on preventive care; and
- Financial incentives to encourage enrollees to use care efficiently.

http://en.wikipedia.org/wiki/Managed_care

Health Management Organisation (HMO)

- An HMO is a type of Managed Care Organisation
- Care is provided by a network of physicians, hospitals and other care organisations which hold a contract with the HMO
- HMO requires that each patient appoints a Primary Care Physician to act the first point of contact
- The PCP can then refer patients to Secondary or Tertiary care within the HMO network

Kaiser Permanente

Founded in 1945 by industrialist Henry Kaiser and physician Sidney Garfield.

As of 2006, Kaiser Permanente operates in nine states and the District of Columbia, and is the largest managed care organization in the United States.

Kaiser Permanente has

- 8.6 million health plan members
- 167,300 employees
- 14,600 physicians
- 35 medical centres
- 431 medical offices.

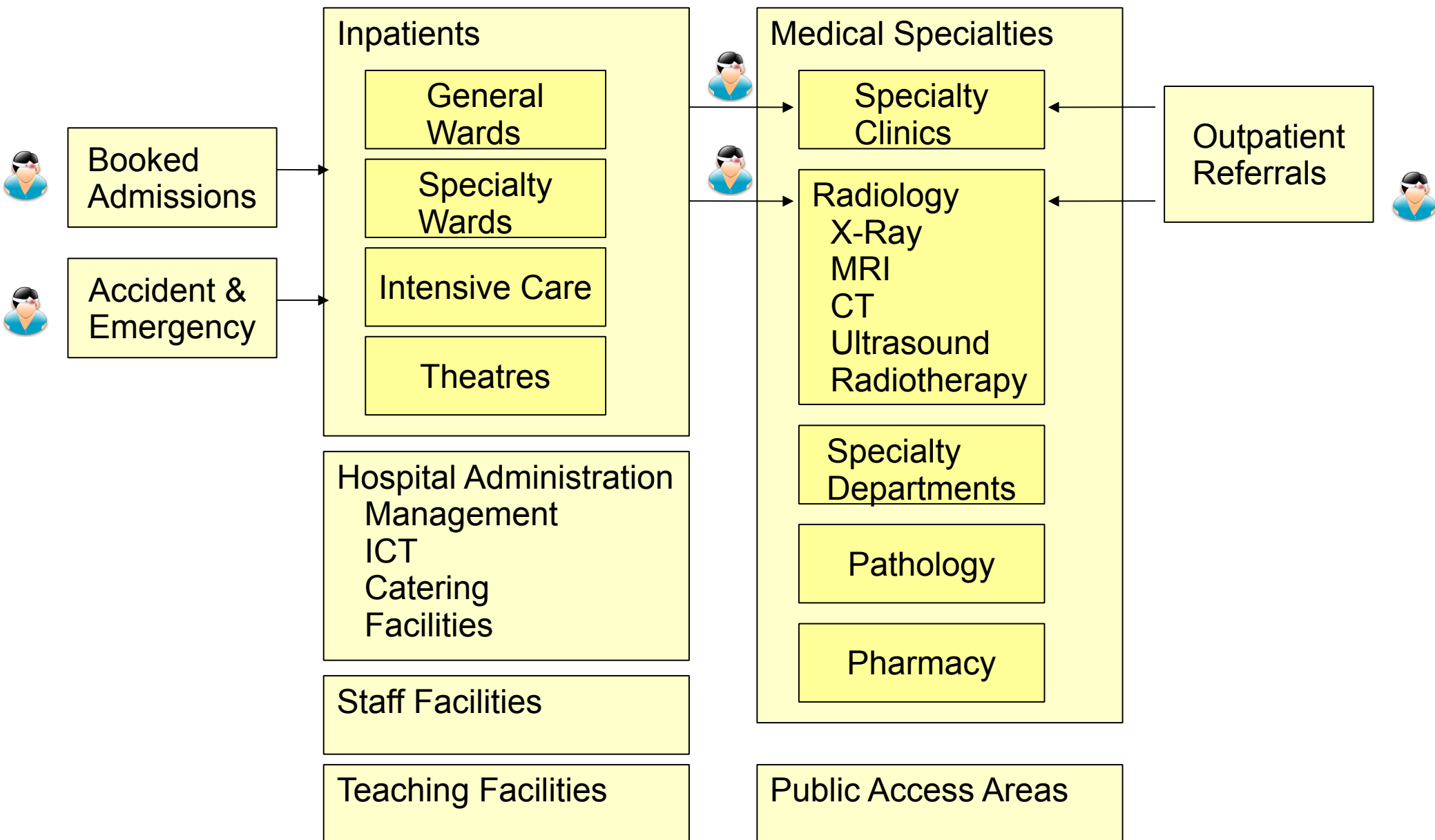
In its most recently reported year, the non-profit Kaiser Foundation Health Plan and Kaiser Foundation Hospitals entities reported a combined \$1.3 billion in net income on \$34.4 billion in operating revenues.

http://en.wikipedia.org/wiki/Kaiser_Permanente

Hospitals in the US

- There are almost 8,000 hospitals in the US
- Not-for-profit hospitals provide about 70% of overall capacity
 - Many operated by charities
- Private, for profit hospitals make up 15%
- Public, state run hospitals make up 15%
 - mainly owned by county and city governments
- Hospitals tend to focus on inpatient care, but some run outpatient clinics and emergency rooms

Acute Hospital Organisation

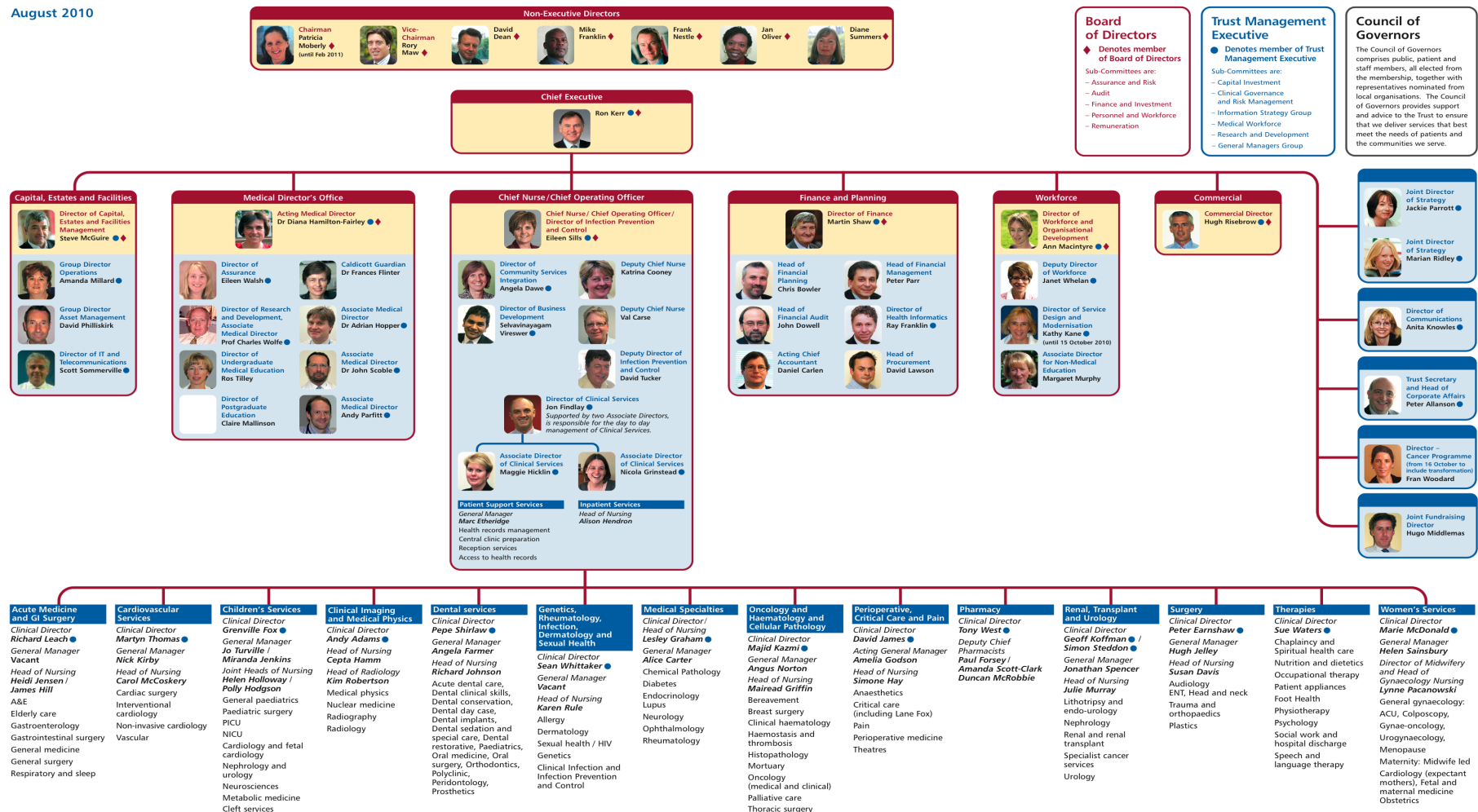


Acute Hospital Organisation

Your guide to the Guy's and St Thomas' organisational structure

showing
we **care**

August 2010



Our Values: Put patients **first** • Take **pride** in what we do • **Respect** others • Strive to be the **best** • Act with **integrity**

http://www.guysandstthomas.nhs.uk/resources/about_us/org_structure/Org_chart_current.pdf

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Health Informatics Defined

Definition and Scope of Health Informatics

Health Informatics

Informatics is the science* of information, the practice of information processing, and the engineering of information systems.

[http://en.wikipedia.org/wiki/Informatics_\(academic_field\)](http://en.wikipedia.org/wiki/Informatics_(academic_field))

- Health Informatics is the application of Informatics in healthcare

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 and (bio)medical research.

http://en.wikipedia.org/wiki/Health_informatics

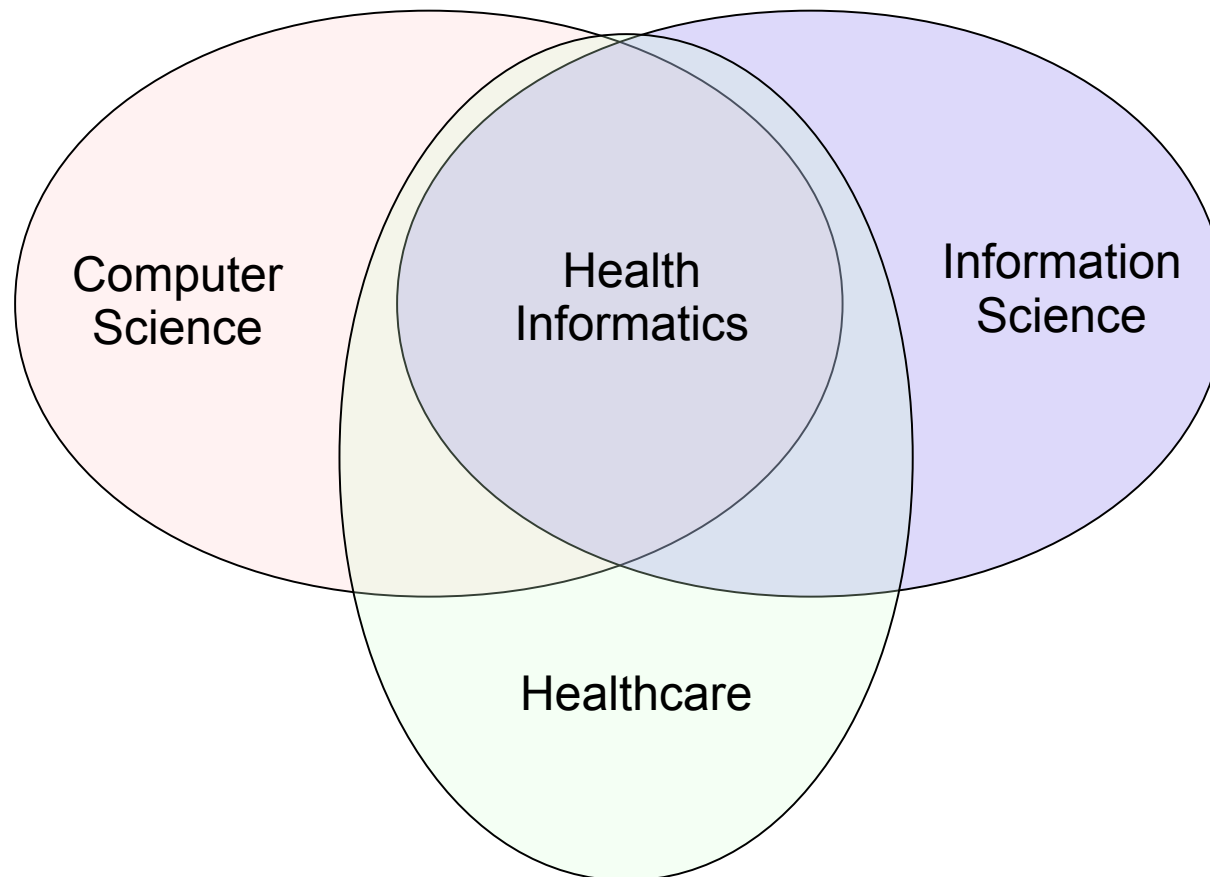
- * Science (from Latin scientia, meaning "knowledge") is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe.

<http://en.wikipedia.org/wiki/Science>

As an Academic Discipline

Health informatics (also called health care informatics, healthcare informatics, medical informatics or biomedical informatics) is a discipline at the intersection of information science, computer science, and health care.

http://en.wikipedia.org/wiki/Health_informatics



Scope of Health Informatics

architectures for electronic medical records and other health information systems used for billing, scheduling, and research

decision support systems in healthcare, including clinical decision support systems

standards (e.g. DICOM, HL7) and integration profiles (e.g. Integrating the Healthcare Enterprise) to facilitate the exchange of information between healthcare information systems

controlled medical vocabularies (CMVs) such as the Systematized Nomenclature of Medicine, Clinical Terms (SNOMED CT), MEDCIN, Logical Observation Identifiers Names and Codes (LOINC), OpenGALEN Common Reference Model or the highly complex UMLS - used to allow a standard, accurate exchange of data content between systems and providers

use of hand-held or portable devices to assist providers with data entry/retrieval or medical decision-making, sometimes called mHealth.

http://en.wikipedia.org/wiki/Health_informatics

Open Health Informatics

Open Health Informatics combines four key elements which have the potential to bring a fresh approach to the way clinical information systems are delivered

- open source software
- open standards
- open systems interfaces
- open development processes

Pioneered at City University

See www.openhealthinformatics.org

Open Standards

- Open standards facilitate the representation and interchange of clinical records and can help reduce the timescale and cost of implementation
 - Core information standards
 - Web standards, XML, SAML, OWL
 - Health records representation
 - HL7, HL7 CDA, CCR, CCD
 - Clinical coding and classification
 - Snomed CT, LOINC, ICD-10, UMLS
 - Profiles for information exchange
 - IHE, Continua Alliance

Open Source Software

- Using open source software places the emphasis on the overall solution, not the implementation of a single product
 - Well known open source EHR
 - OpenEHR, openEMR, openVista, Tolven
 - Can also build clinical systems using best of breed
 - Mirth, Orbeon Forms, eXist, JFreeChart
- Barriers exist to using open source software
 - Licensing models
 - Support and maintenance
 - Product lock-in (just like proprietary products)

Open Interfaces

- Use open interfaces to ensure the easy interchange of health information
 - Expose (web) service interfaces
 - Service Oriented Architecture (SOA)
- Also ensures that open source software can be used without 'vendor' lock-in
 - Use best of breed components
 - Swap components in and out when something better becomes available

Open Processes

The Agile Manifesto is a statement of the principles that underpin agile software development. It was drafted [in] February 2001, [when] representatives of various new methodologies [...] met to discuss the need for lighter alternatives to the traditional heavyweight methodologies.

http://en.wikipedia.org/wiki/Agile_manifesto

We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value

- *Individuals and interactions* over processes and tools
- *Working software* over comprehensive documentation
- *Customer collaboration* over contract negotiation
- *Responding to change* over following a plan

That is, while there is value in the items on the right, we value the items on the left more.⁶

Clinical Records

Definition of Clinical Records

Introducing Clinical Information
Systems

Clinical Encounters & Record Keeping

The doctor-patient relationship typically begins an interaction with an examination of the patient's medical history and medical record, followed a medical interview² and a physical examination.

After examination for signs and interviewing for symptoms, the doctor may order medical tests (e.g. blood tests), take a biopsy, or prescribe pharmaceutical drugs or other therapies.

Differential diagnosis methods help to rule out conditions based on the information provided.

During the encounter, properly informing the patient of all relevant facts is an important part of the relationship and the development of trust.

The medical encounter is then documented in the medical record, which is a legal document in many jurisdictions.³

<http://en.wikipedia.org/wiki/Medicine>

Clinical Record Keeping

Henry Stanley Plummer, M.D. (March 3, 1874 – December 31, 1936) was a prominent internist and endocrinologist who, along with Drs. William Mayo, Charles Mayo, Stinchfield, E. Starr Judd, Christopher Graham, and Donald Balfour founded Mayo Clinic.

Perhaps one of his greatest contributions was the development of a simple, easily retrievable medical record system that became the model for record keeping worldwide.

http://en.wikipedia.org/wiki/Henry_St Stanley_Plummer



In 1968 the Mayo Clinic demonstrated computerized health records using light pens to record patient responses to questionnaires.

The first electronic record were introduced in 1994 and paper records were eliminated in 2005.

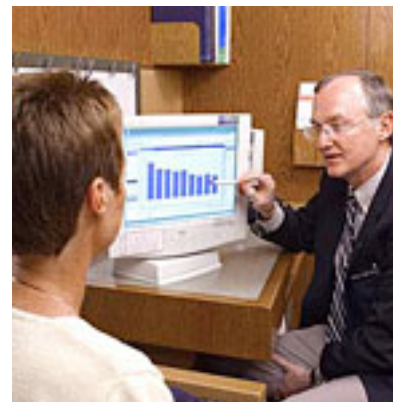
Nearly 100 years ago, Dr. Henry Plummer developed the concept of the "unit record," in which all of a patient's records reside in a single file that travels with the patient and is stored in a central repository. This simple system quickly became the standard for medical record keeping around the world.

<http://www.mayoclinic.org/emr>

Which of the following phrases best describe the speed of your heartbeat?

- ☐ I am not usually aware of the speed of my heartbeat.
- ☐ My heartbeat is sometimes very fast.
- ☐ My heart seems to beat very fast all of the time.
- ☐ My heartbeat is sometimes very slow.
- ☐ I occasionally have attacks of very rapid heartbeat, which usually start suddenly and stop suddenly.
- ☐ None of the above describe it.

☐ ←Go back ☐ Erase ☐ Continue→



Clinical Records Defined

A medical record, health record, or medical chart is a systematic documentation of a patient's individual medical history and care.

The term 'Medical record' is used both for the physical folder for each individual patient and for the body of information which comprises the total of each patient's health history.

http://en.wikipedia.org/wiki/Medical_record

- In the UK, we tend to use the term 'health record' whereas in the US 'medical record' is more prevalent
- In the UK, a person's NHS health record is owned by the Department of Health, with the individual having various rights to access it, usually under supervision from a healthcare professional. <http://www.nhsmedicalrecords.org.uk/medicalrecords.php>
- In the US, a person owns the data in their record and the organisation that produced it owns the media.

Contents of a Clinical Record

Medical History

Surgical history
Obstetric history
Allergies
Medications
Family history
Social history
Habits
Immunisation history
Growth chart and development history

Demographics

Patient identifiers
Name
Address
Sex
Ethnicity
Religion
Occupation
Next of kin
Primary care physician

Clinical Correspondence

Referral letters
Discharge summaries
Clinic letters

Orders and Prescriptions

Lab (Pathology) tests
Radiology (images)
Drug prescriptions
Ancillary services

Test Results

Lab test results
Diagnostic images
(Radiology reports)

Medical Encounters

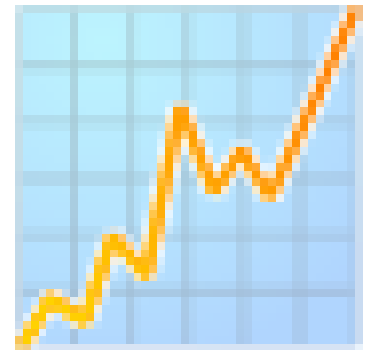
Complaint
History of current illness
Physical examination
Assessment and plan

Progress Notes

Daily updates on patient condition
during a period of hospitalisation

Transient Clinical Data

- Some patient information is recorded and stored only for a short time in a clinical record
 - Vital Signs: Body Temperature, Pulse Rate(Heart Rate), Blood Pressure and Respiratory Rate.
 - Intake: Medication, Fluid, Nutrition, Water and Blood, etc.
 - Output: Blood, Urine, Excrement, Vomitus and Sweat, etc.
 - Observation on Pupil size.
 - Capability of four limbs of body



Source: http://en.wikipedia.org/wiki/Medical_record

EPR and EHR

- The Electronic Patient Record (EPR) is the clinical record for a patient, held electronically, for a single care setting
 - Primary care (the GP Record)
 - Secondary care (the Hospital Record)
- The Electronic Health Record (EHR) is a complete cradle-to-grave record, held electronically
 - Accessed in any care organisation/setting (cf EPR)
 - By any legitimate member of the care team
 - And by the patient themselves
 - Gathering data from many different sources
 - With functionality for adding new data to the record

Clinical Information Systems

Definition and Scope

General Architecture

Clinical and Hospital Information Systems

- A hospital Information System encompasses all general informatics requirements in the acute hospital setting.

A hospital information system (HIS), also called clinical information system (CIS) is a comprehensive, integrated information system designed to manage the administrative, financial and clinical aspects of a hospital.

Specifically, Clinical Information Systems (as opposed to HIS) concentrate on patient-related and clinical-state-related data (electronic patient record).

Types of Clinical Information System

Electronic Patient Record

Electronic Health Record

Patient Administration System (PAS)

Primary Care System

Out-of-hours System

Ambulatory Care System

Community Health System

Mental Health System

Child Health System

Health Screening System

Picture Archiving and Communications System (PACS), Radiology Information System (RIS)

Emergency Care System (A&E)

Maternity System

Laboratory Information Management System (LIMS)

Physiotherapy, audiology, theatres, cardiology, rheumatology, etc

Order Communications (CPOE)

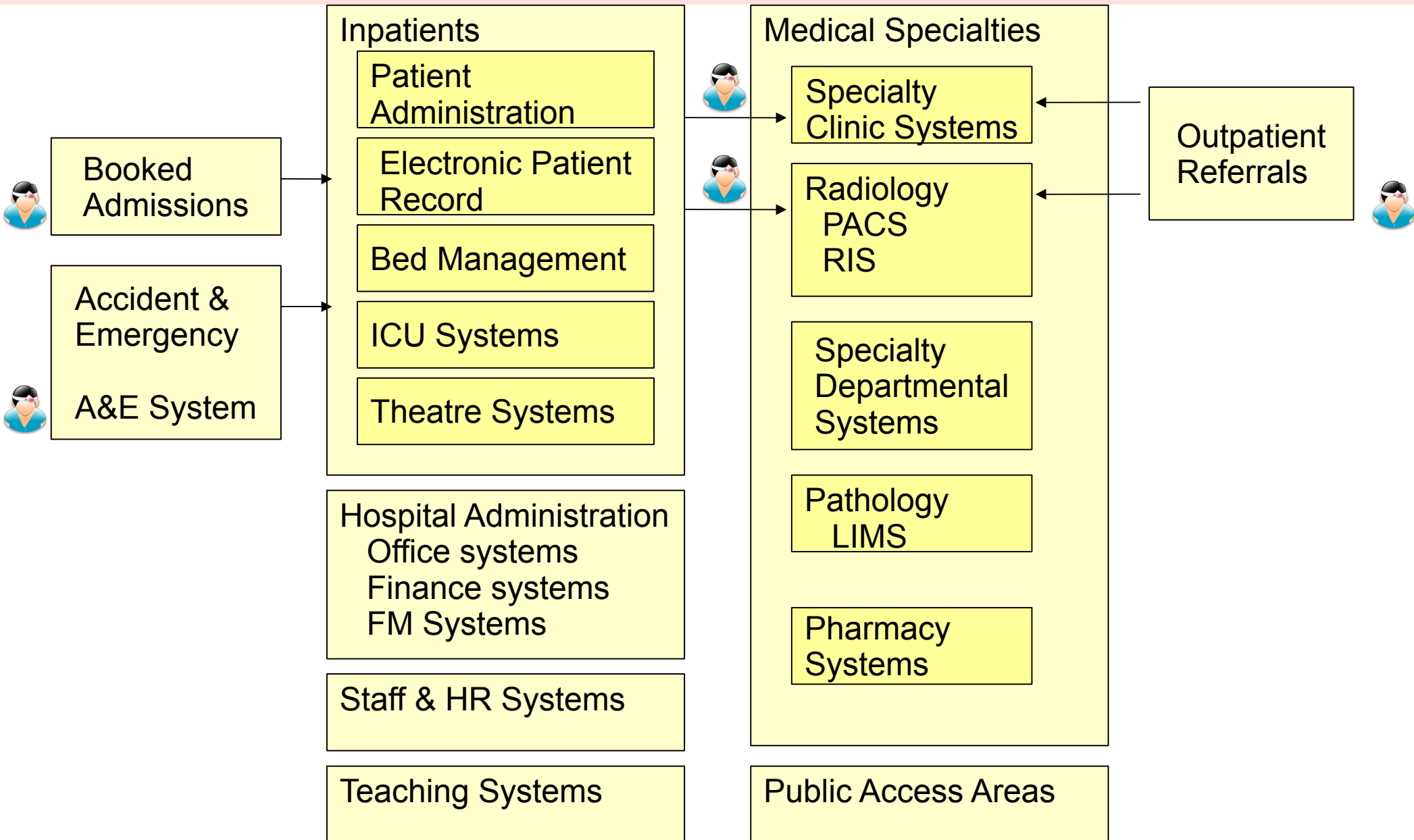
Electronic Prescribing & Medications Management

Clinical correspondance

Care Planning

Care Pathways

Acute Hospital Systems



Components of a HIS

- Study by Bagayoko et al⁵ lists HIS functionality in a large hospital in France (University Hospital "La Timone" of Marseilles)

Care Management

Registration
Appointments & Scheduling
Management of Movement (Transfers)
Care Plan Management
e-prescription (acts, medicine)
Nursing
Report and Mail Management
Logistics
Resource Management (stocks, human, materials)
Clinical Research, Epidemiology, Statistics and Education
Health Information Exchange

Orders and Requests

Laboratory management
Pharmacy management
Imaging
Exploratory Procedures
Emergency Department
Surgery Department

Other Features

Clinical Decision Support
Digital Work Space
Data Warehousing
Quality of Care Assessment

Facility Management

Access Management
Rights/Entitlements
Activity Management
Medical Economics Management
Accounting and Record
Human resources
Equipment Management
Purchasing/Inventory

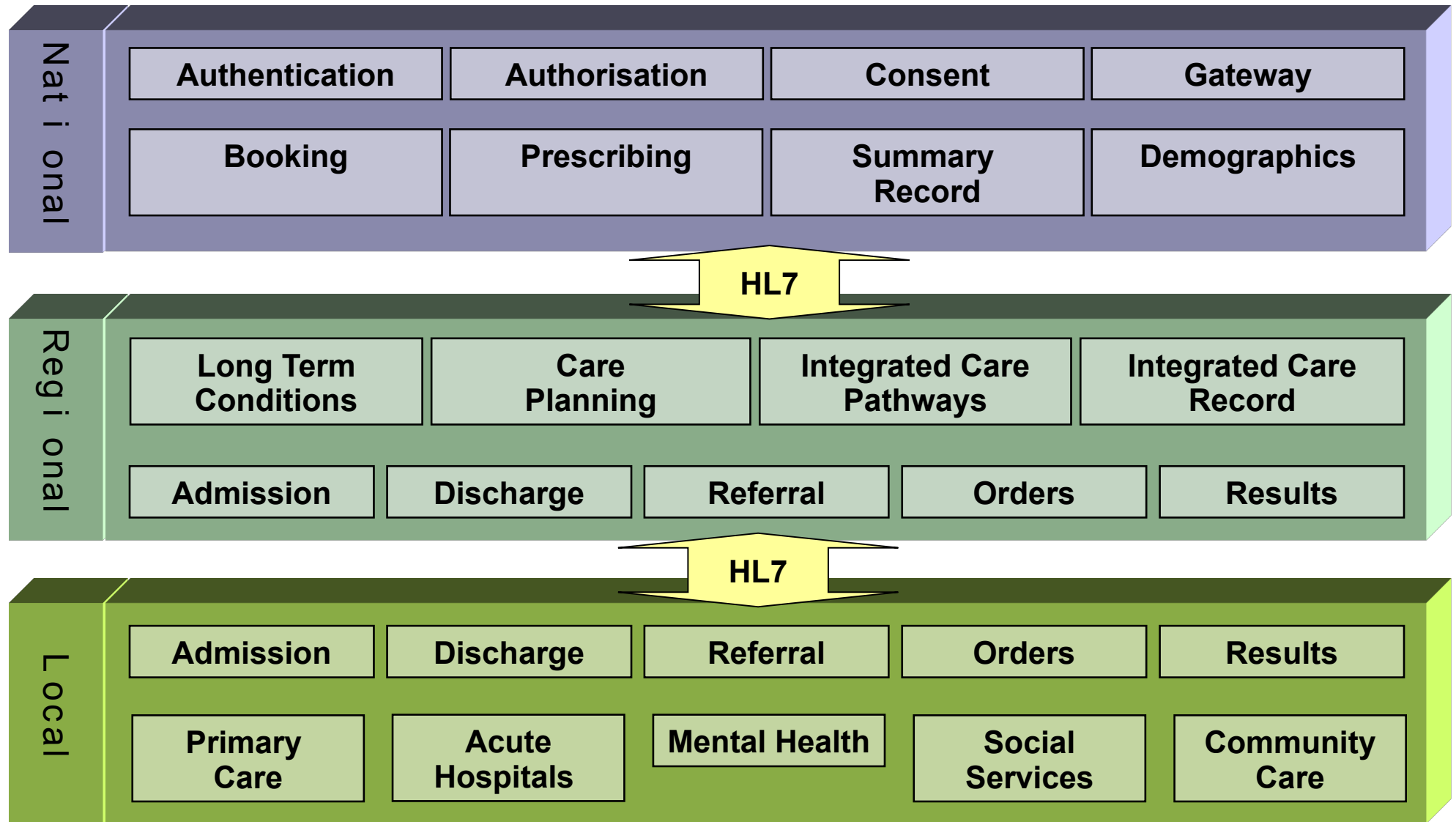
HIS Environment Management

HIS Infrastructures
Monitoring and Planning Tools
Communication Management
Repositories and Terminology Management

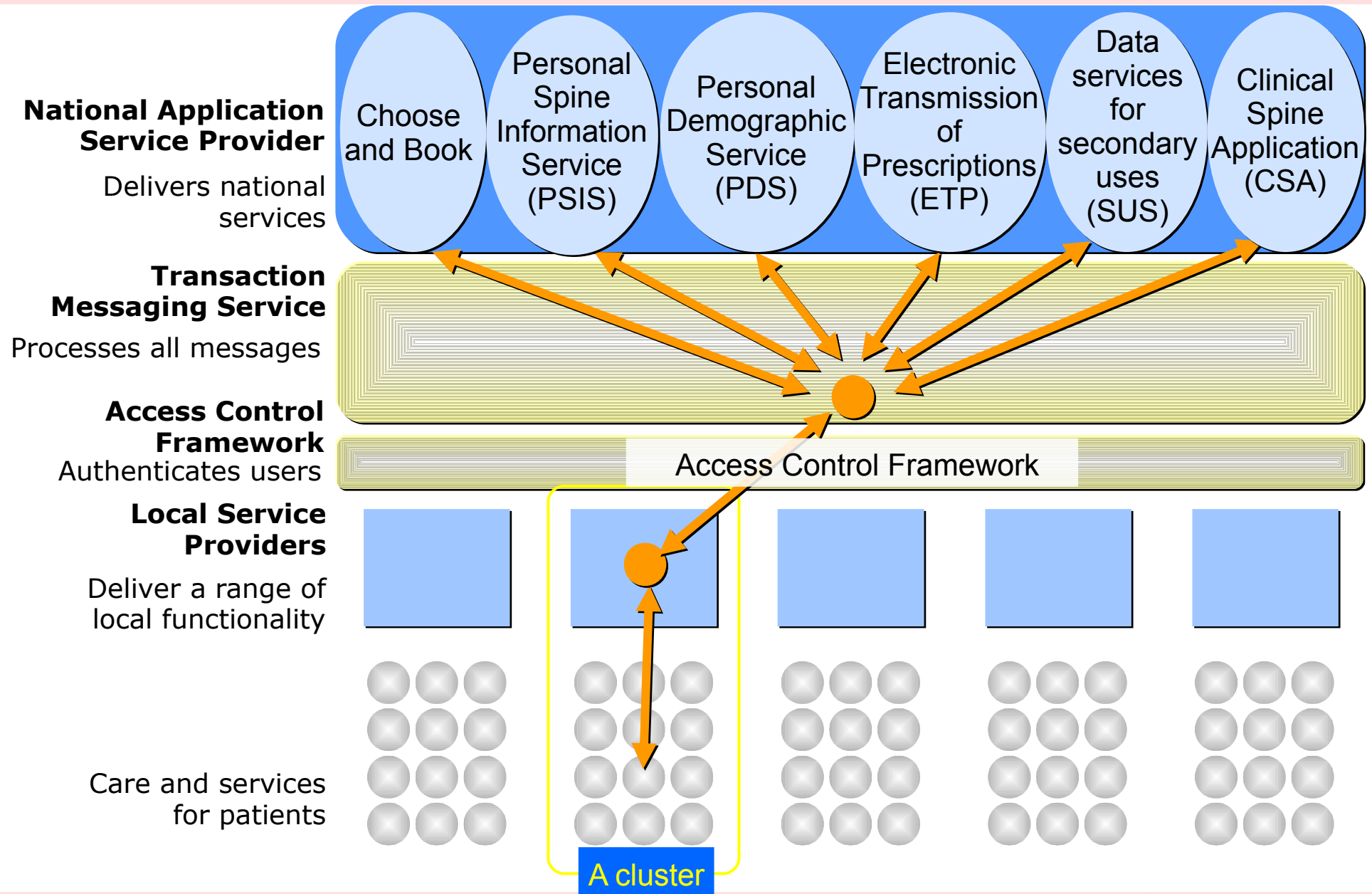
Admin Functions

Patient identity management
Outpatient Visits, Admissions, Stays
Bed Management
Billing

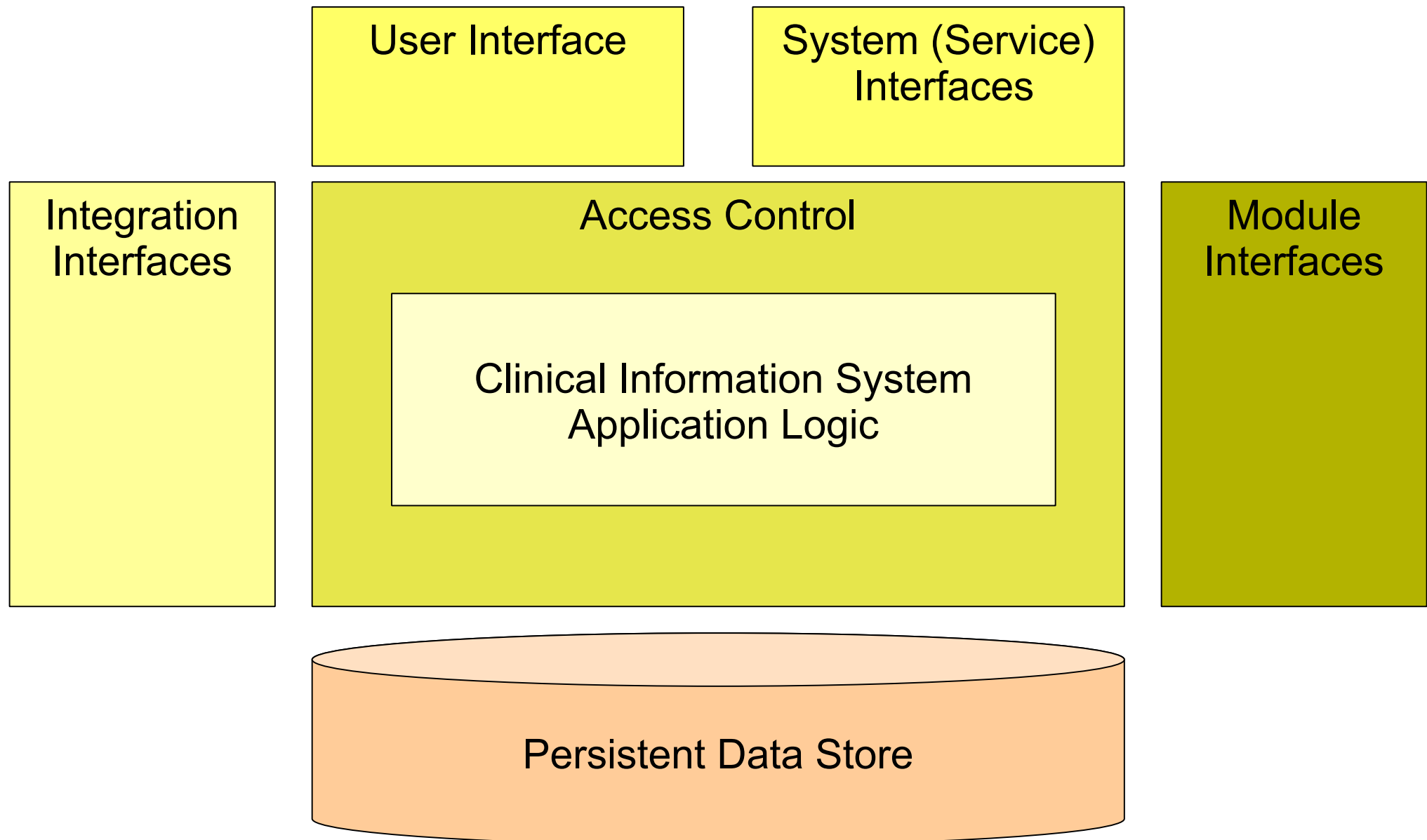
Local, Regional, National



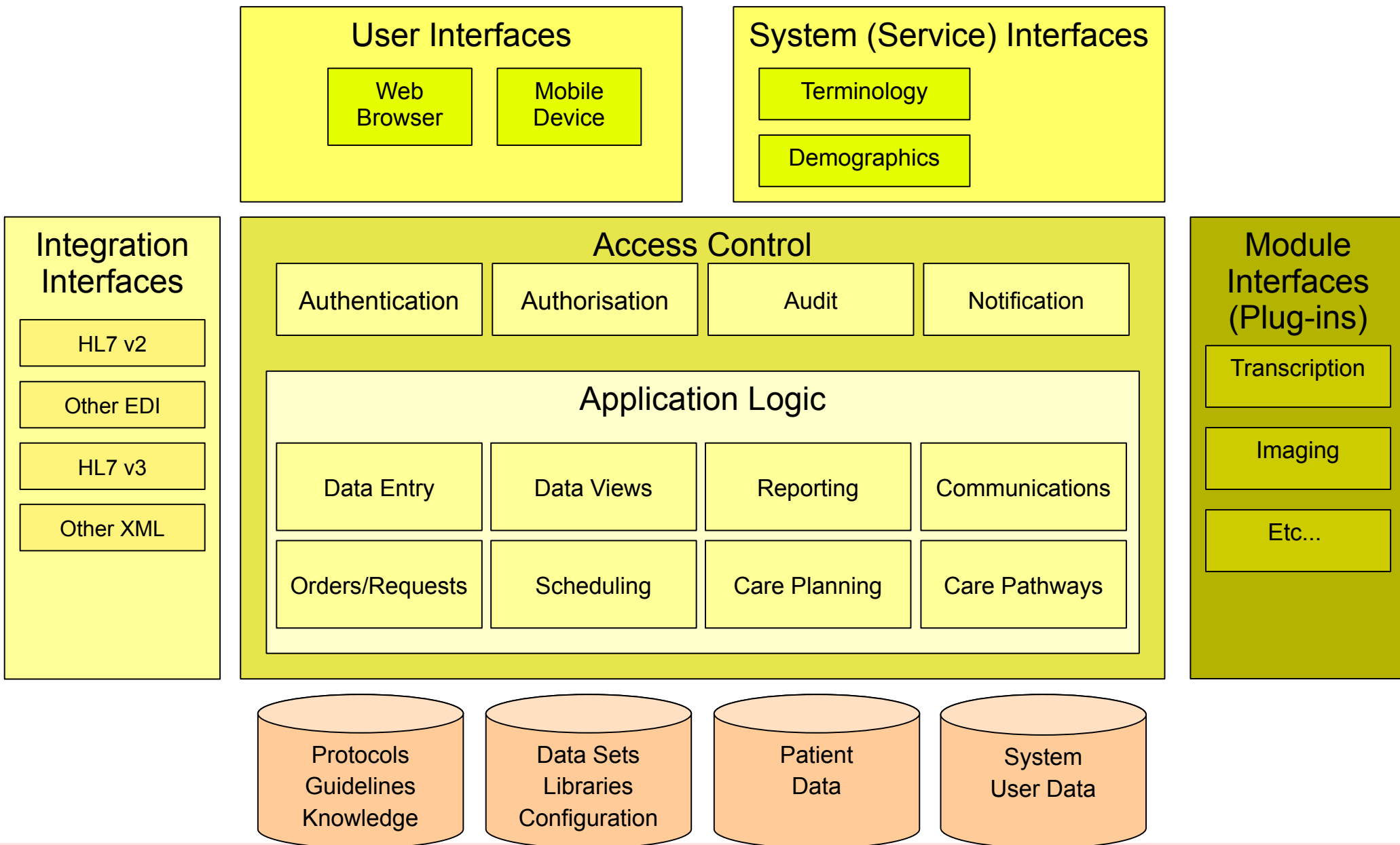
National Services in England



General Architecture of CIS



Detailed Architecture of CIS



References and Further Reading

Reading List available through Moodle

Compiled by Prof Abdul Roudsari

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4. Gerard F. Anderson, Bianca K. Frogner, Roger A. Johns and Uwe E. Reinhardt. *Health Care Spending And Use Of Information Technology In OECD Countries*. *Health Affairs*, 25, no. 3 (2006): 819-831. doi: 10.1377/hlthaff.25.3.819

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- Taylor P. From Patient Data to Medical Knowledge: Principles and Practice of Health Informatics. Blackwell Scientific 2006 [ISBN 0-7279-1775-7]
- Deutsch T, Cramp DG, Carson ER. Decisions, Computers and Medicines: the Informatics of Pharmacotherapy. Amsterdam: Elsevier, 2001 [ISBN 0-444-50004-9]

Journals (from Reading List)

Journal of Medical Internet Research

Journal of the American Medical Informatics Association
(JAMIA)

International Journal of Medical Informatics (IJMI- Elsevier)

Health Informatics Journal (Sheffield Academic Press - UK)

BMJ Medical Informatics Collection

Medical Informatics and the Internet in Medicine

Methods of Information in Medicine, the official journal of the
European Federation for Medical Informatics

Health Information and Libraries Journal

See http://en.wikipedia.org/wiki/List_of_medical_and_health_informatics_journals

Free Online Resources

BioMed Central <http://www.biomedcentral.com>

BioMed Central is an STM (Science, Technology and Medicine) publisher which has pioneered the open access publishing model.

PubMed Central <http://www.ncbi.nlm.nih.gov/pmc/>

PubMed Central (PMC) is the U.S. National Institutes of Health (NIH) free digital archive of biomedical and life sciences journal literature.