COMP2322:
Introduction to Health Informatics

Health Informatics:

Introduction

Time: **Tues+ Thur: 13:00-13:50**

Location: **Masri406**

Section: **1**

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Dr Adel Taweel

Birzeit University

Health Informatics

"Healthcare supported by electronic processes"

Other terms in use:
– Medical Informatics
– Healthcare informatics
– Health Information Technology (HIT)
– Medical Information Systems (MIS)
– Biomedical informatics (also includes Bioinformatics: gene sequencing etc.)

Paper medical records?

Are they good enough?

[...] Paper medical records?

- illegible handwriting
- Ambiguous
- incomplete data
- data fragmentation
  - each lab report is a separate piece of paper which does not allow a physician to visualize the progress of a patient's conditions.
- poor availability
  - studies have shown that as much as 40% of the time the paper record can not be found.
- Paper files can easily get lost!

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[...] Paper medical records?

- Insecure- often unguarded shelving in a clinic
- Paper records become bulky with time ->leads to lack of overview.
- Moving records around or to share with other clinicians - papers have to be photocopied, then mailed – is expensive and inefficient.
- Can take large space in large organisations

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Illegible Handwriting causing death!

Doctors' sloppy **handwriting** kills more than 7,000 people annually. It's a shocking statistic, and, according to a July 2006 report from the National Academies of Science's Institute of Medicine (IOM), preventable medication mistakes also injure more than 1.5 million Americans annually.   15 Jan 2007
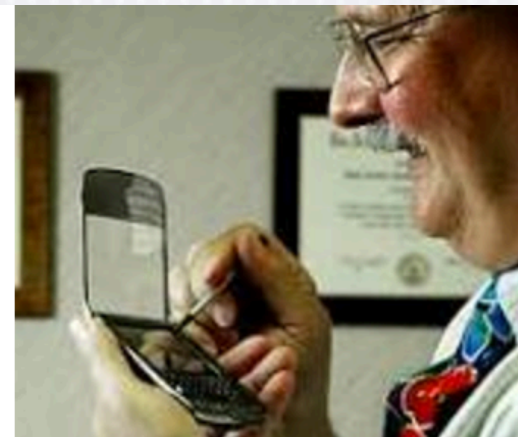
Cause of Death: Sloppy Doctors - TIME
content.time.com/time/health/article/0.8599.1578074.00.html

Dr. Nomal Chandra Borah
Chairman & Managing Director, Guwahati Neurological Research Centre

Doctor's illegible handwriting creating confusion, causing death

Apr 20, 2015, 05.17 PM IST

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Teaching method

- Lectures **(~ 2hrs per week)**
  Sec1: Monday + Wednesday   10:00- 10:50 (Bamieh206)

- Independent Student Reading
- Practical work: Lab (+ **a group project**)

- Tutorials/Case study discussion (**in lectures**)

---------------------- **Course Assessment** ----------------------

- Mid-term exam   **25%**
- Project /Assignments   **30%**
- Lab work   **15%**
- Final exam   **30%**

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Recommended Course Textbooks

- Paraded Sinha, Gaur Sunder, Prashant Bendale, Manisha Mantri, Atreya Dande*. Electronic Health Record Standards, Coding Systems, Frameworks, and Infrastructures*, John Wiley & Sons, Inc., 2013, ISBN: 978-1-118-28134-5

- Richard Gartee. Essentials of Electronic Health Records, 1st Edition, 2010, ISBN-10: 0-13-708525-7 / 0137085257

- Alfred Winter, Reinhold Haux, Elske Ammenwerth, Birgit Brigl, Nils Hellrung, Franziska Jahn, Health Information Systems: Architectures and Strategies ISBN: 978-1-84996-440-1 (Print) 978-1-84996-441-8 (Online)

- Bonnie F Fremgen and Suzanne S. Frucht, Medical Terminology A Living Language, Sixth edition, Pearson, 2016 , ISBN-10: 0134070259/ ISBN-13: 978-0134070254

- Ramona Nelson and Nancy Staggers, Health Informatics. Elsevier, 2014, ISBN: 9780323100953

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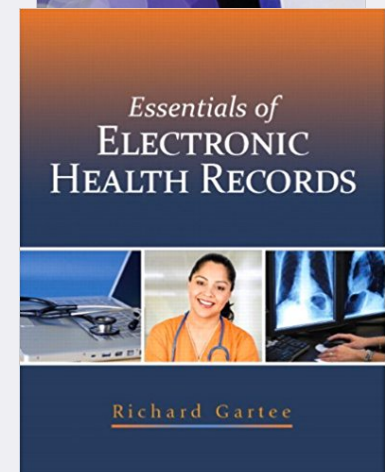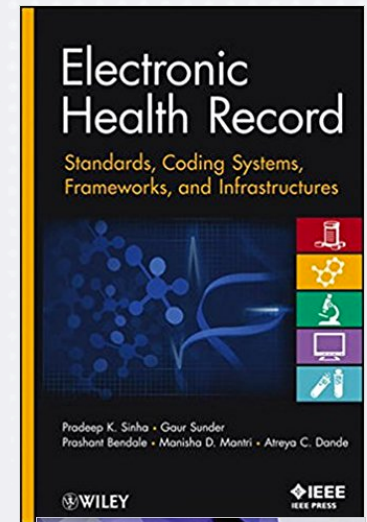
Health Informatics

Defined!

What does Health Informatics mean?

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[…] DEFINITION

"Medical information science is the science of using system-analytic tools . . . to develop procedures (algorithms) for management, process control, decision making and scientific analysis of medical knowledge."

[Shortliffe EH. The science of biomedical computing. Med Inform 1984; 9:185-93.]

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[...] DEFINITION

" ...the rapidly developing scientific field that deals with the storage, retrieval, and optimal use of biomedical information, data, and knowledge for problem solving and decision making."

[Shortliffe et al. Medical Informatics: Computer Applications in Healthcare. Addison Wesley, 1990.]

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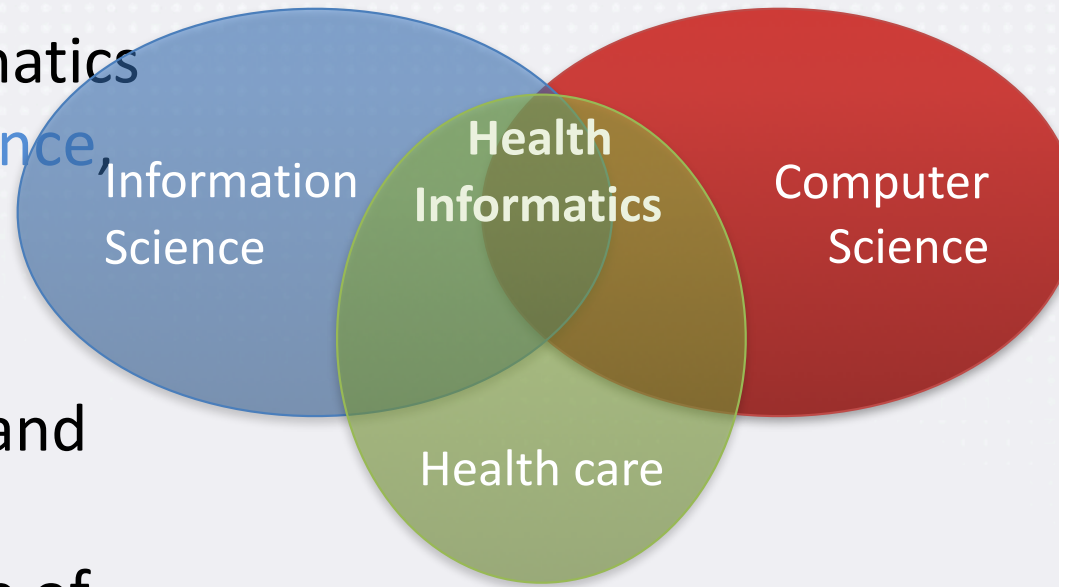
[...] DEFINITION

"Biomedical and health informatics (BMHI) is the <u>*science*</u> of using data and information, often aided by technology, to improve individual health, health care, public health, and biomedical research."

[Hersh, 2009]

[...] DEFINITION

"Health informatics or medical informatics is the intersection of information science, computer science, and health care.

 It deals with the resources, devices, and methods required to optimise 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
[Wikipedia]

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Health Informatics is the systematic application of Information Science, Computer Science, Healthcare and Technology to health practice, research, and learning

[applied science]

How its domains are related?

Contributing Domains:

Information Science

Computer Science

Technology

Health or Healthcare

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[...] DEFINITION

Health Informatics is the systematic application of **information science**, computer science, Healthcare and technology to health practice, research, and learning

[applied science]
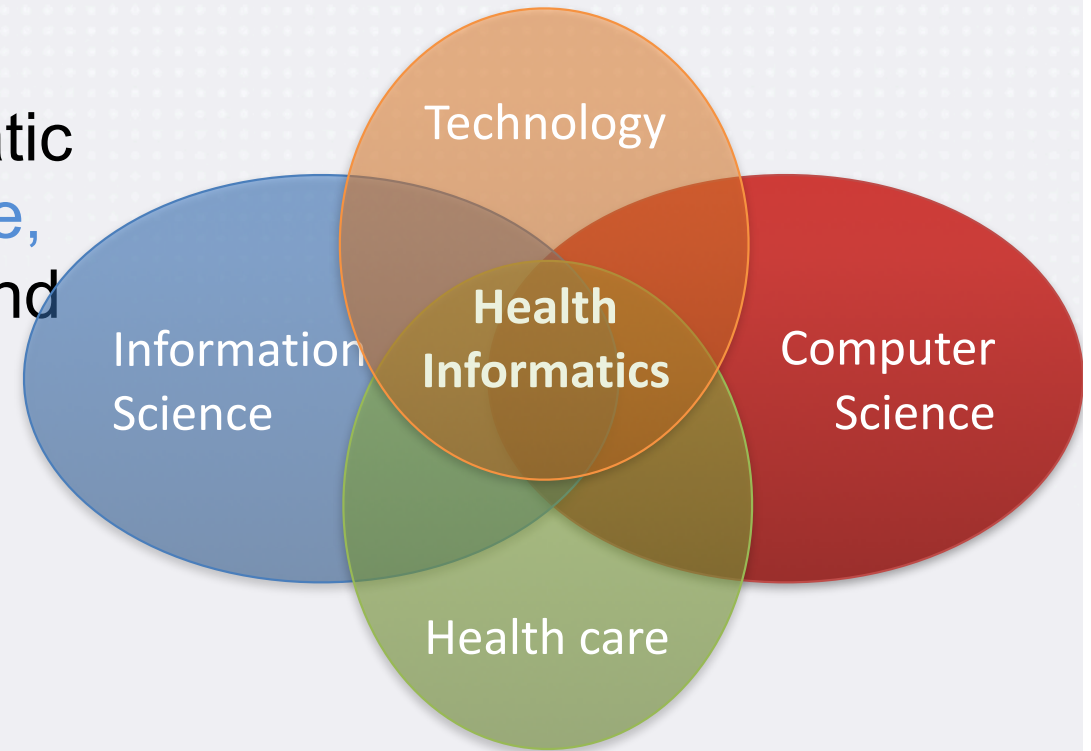
Technology

Information Science

Health Informatics

Computer Science

Health care

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Information Science

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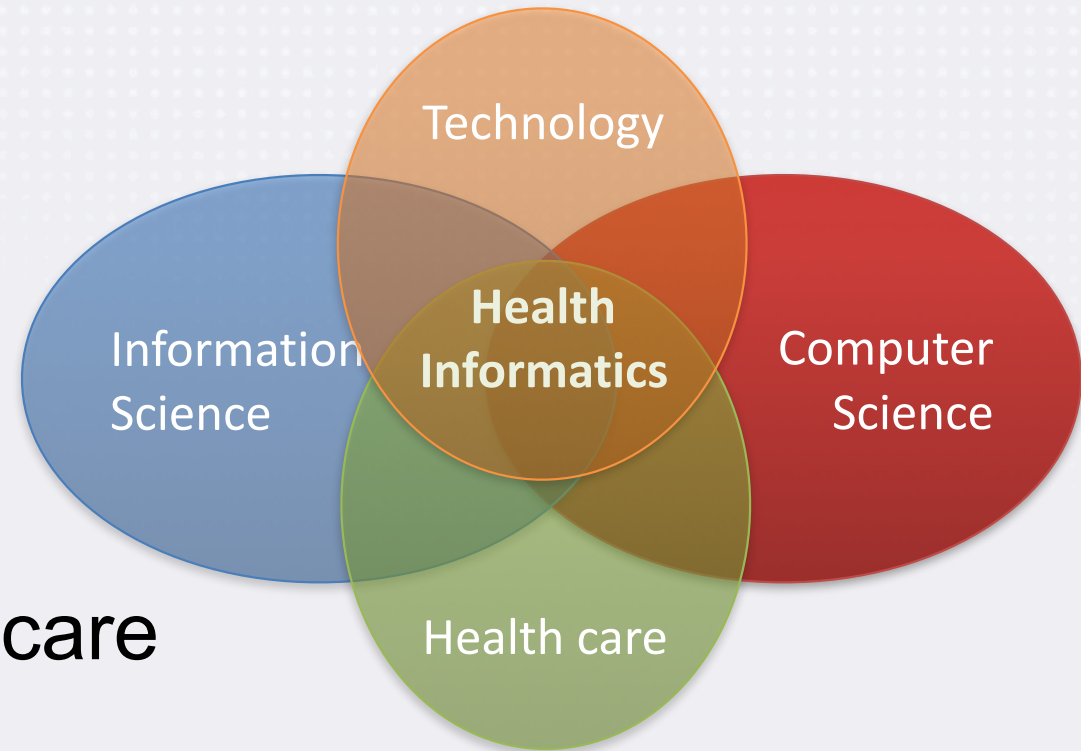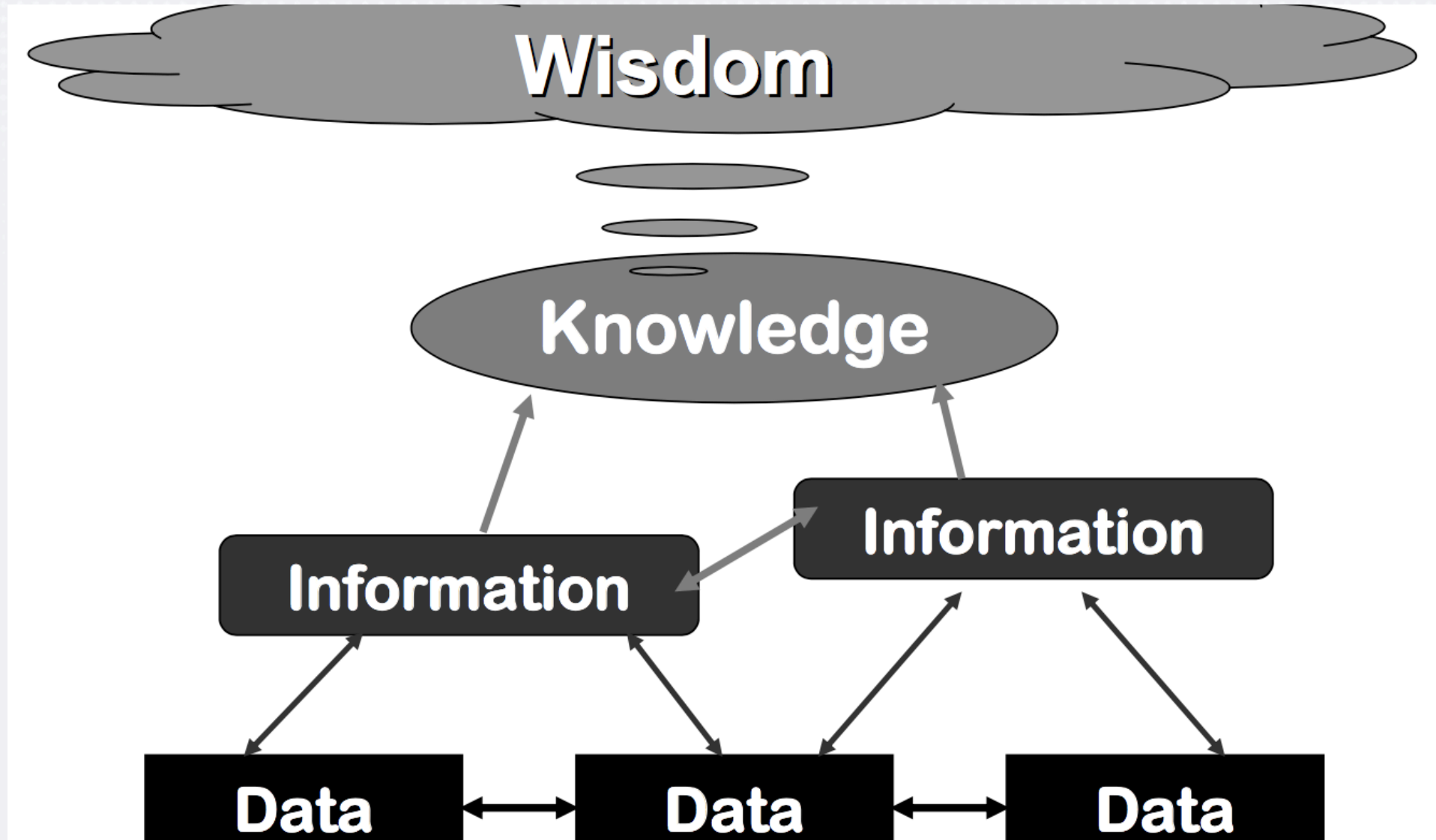
The Central Dogma, Informatics
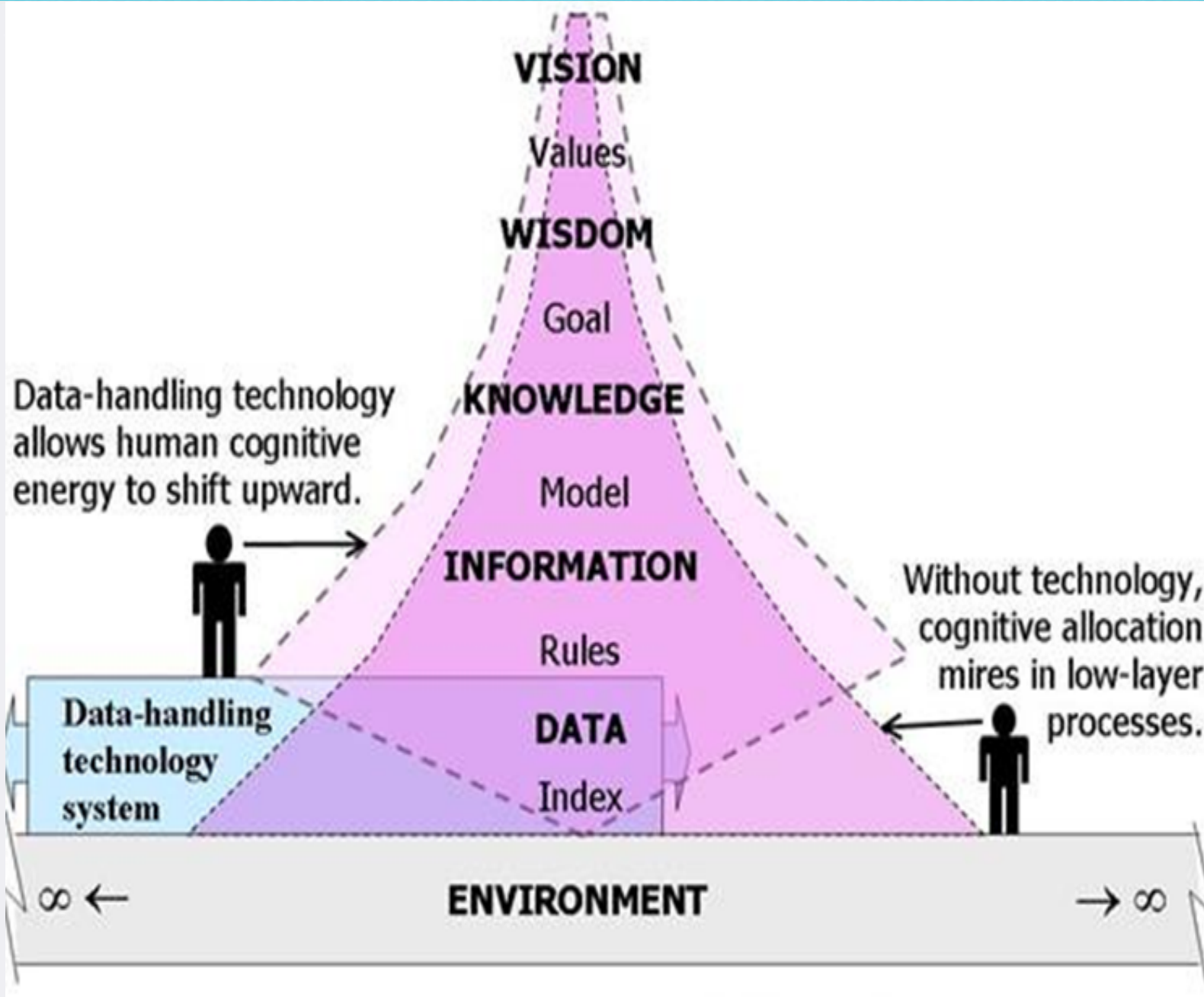
Information Science: Data

- Data = undigested observations and unvarnished facts

  – Fact, text, graphic, image, sound

  – Without meaningful relation to anything else

  – A thing

[Cleveland, 1983]

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Information Science: Information

- Information = organised data, Formatted, filtered,

    – structured, interpreted, summarised data

    – **data + meaning = information**

    – Relates to a description, definition or perspective (what, who, when , where)

[Cleveland, 1983]

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Information Science: Knowledge

- Knowledge = information that has been organised, internalised and integrated with experience, study, or intuition

  - Case, rule, process, model, ideas
  - Rules and procedures that guide **decisions** and **actions**

  - **Information + application = knowledge**
    Comprises of strategy, practice, method, or approach (how)

[Cleveland, 1983]

Information Science: Key Elements

- **Vocabularies -** A vocabulary is a set of words known to a person or other entity, or that are part of a specific language

- **Classifications -** A classification consists of tables of subject headings and classification schedules used to assign a class number to each item being classified

- **Taxonomies -** A hierarchical taxonomy is a tree structure of classifications for a given set of objects; it may also apply to relationship schemes other than hierarchies, such as network structures. A taxonomy might also be a simple organization of objects into groups, or even an alphabetical list

- **Ontologies –** seek to describe the basic categories and relationship of being or existence to define entities and types of entities within its framework.

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[...] DEFINITION

Health Informatics is the systematic application of information science, computer science, Healthcare and technology to health practice, research, and learning

[applied science]

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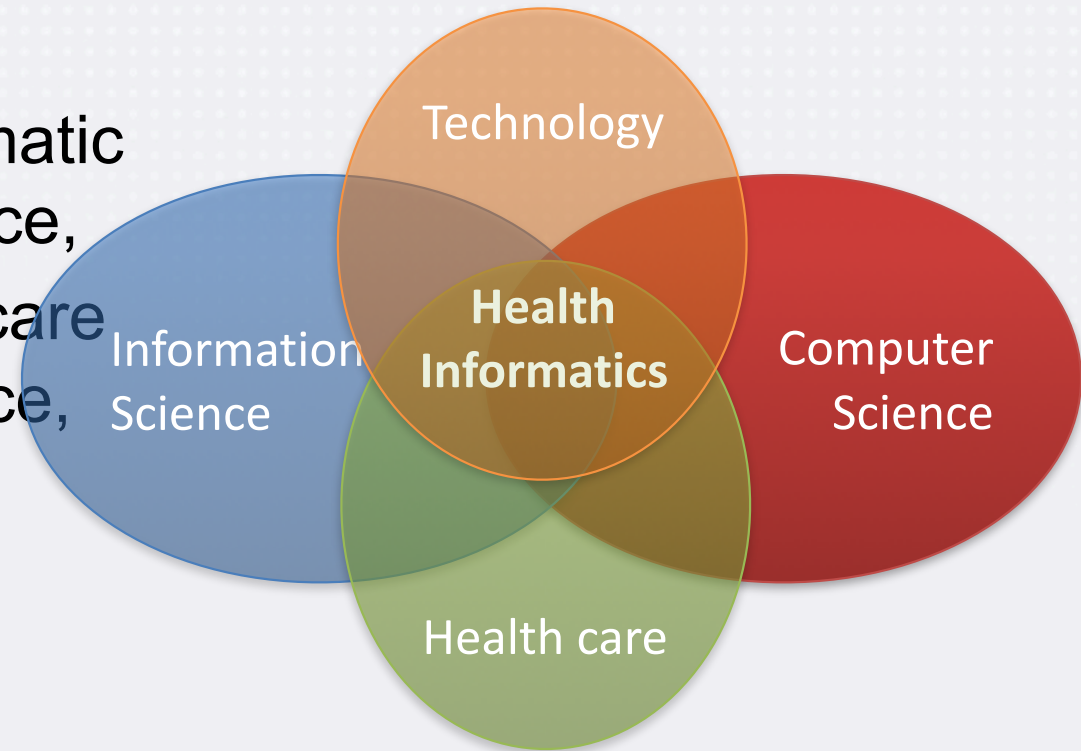
Computer Science

- Simplistically, related, can be termed as

  "the systematic study of algorithmic processes that describe and <u>transform</u> data and information – including the theory, analysis, design, efficiency, implementation and application "

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Computer Science

- Simplistically, related foundational concepts in computer science are:

    - **Algorithm** is a procedure (a finite set of well-defined instructions) for accomplishing some task which, given an initial state, will terminate in a defined end-state.

    - **Data Structure or Data model**: is an abstract representation of information or a concrete representation of an information model. It represents the entities, properties, relationships and operations defined in an information model in a manner that allows actual instances of those entities to be managed, manipulated, stored, operated upon and verified.

[...] DEFINITION

Health Informatics is the systematic application of information science, computer science, Healthcare and technology to health practice, research, and learning

[applied science]

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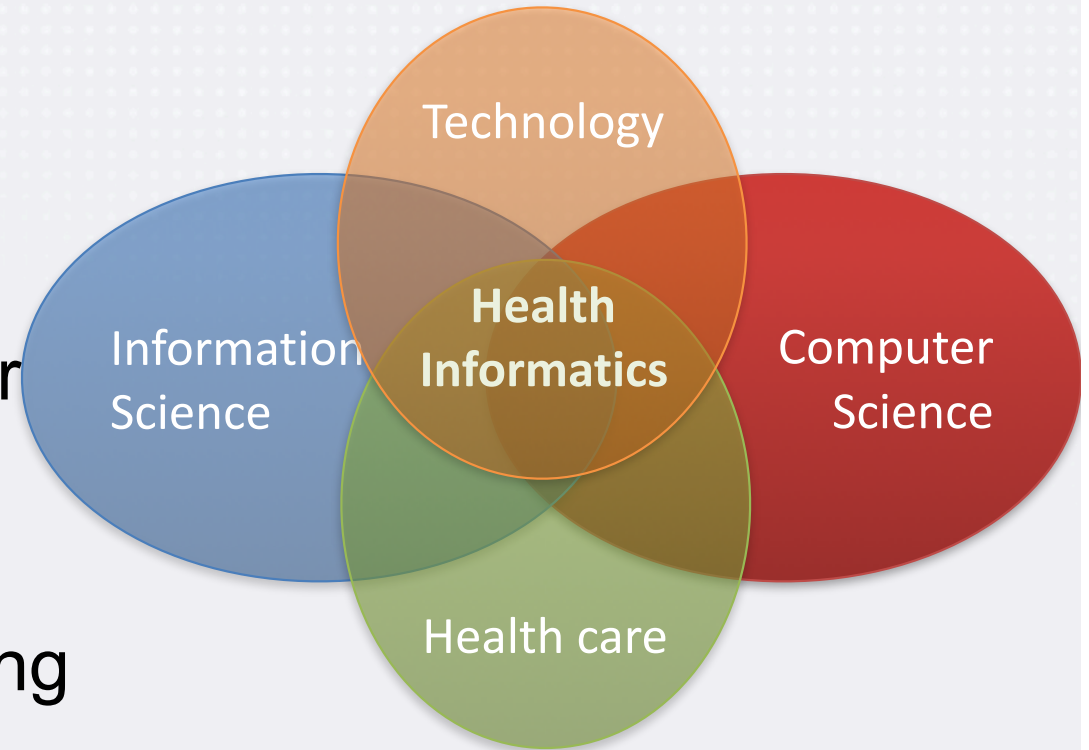
Information Technology

- Simplistically, can be termed as:

  "Information technology is the development and use of hardware, software, and supporting infrastructure to manage and deliver information."

The relationship of Health Informatics with the other sciences

- Two main general view of cross section of disciplines
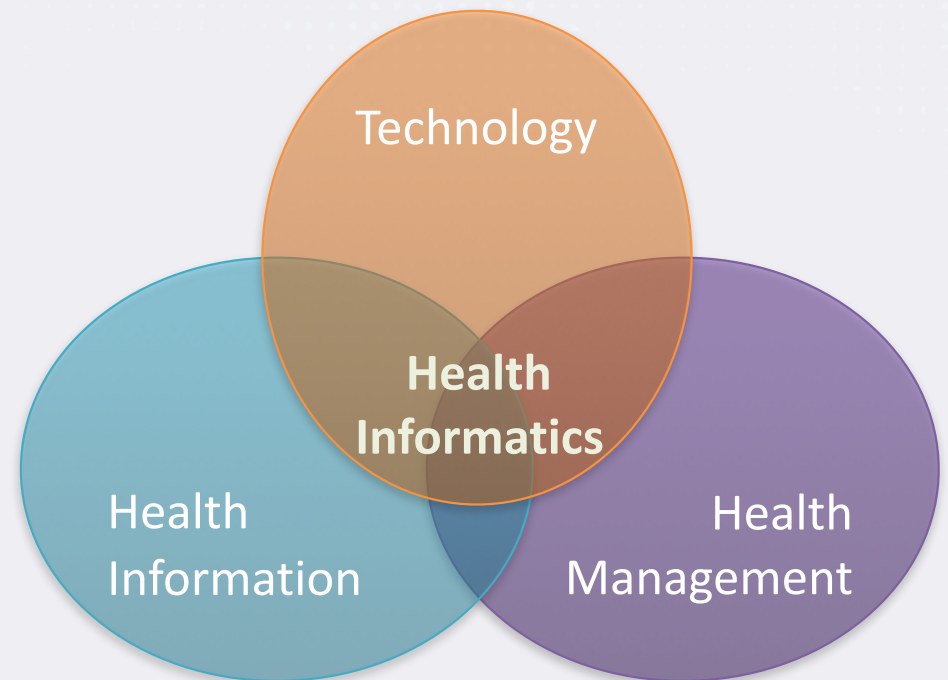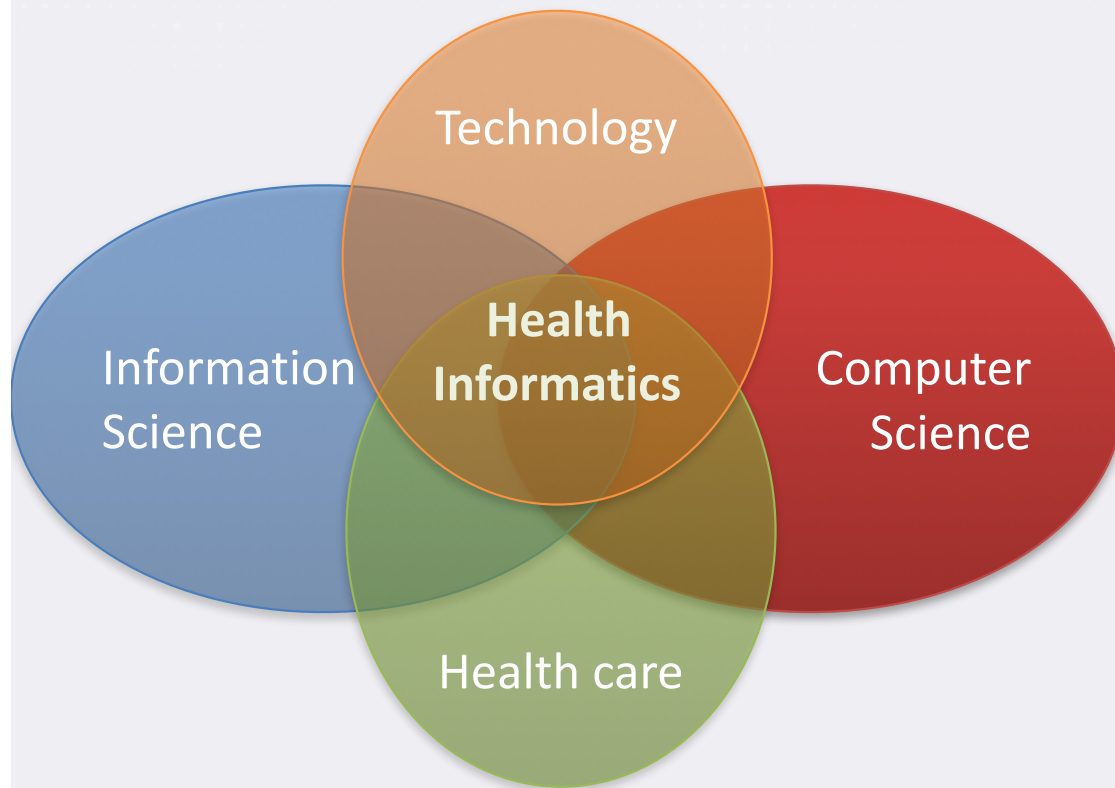
Areas of Health Informatics

- Clinical Information standards development
- Organisational aspects of informatics
  Managing enterprise systems, implementations, etc.
  Technology diffusion
- Knowledge representation
  Knowledge structures
  Terminologies and ontologies
- Information retrieval
- Decision Making -Patients
- Healthcare Decision Support to health professionals
- Medical Imaging

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Health Informatics: Sub areas

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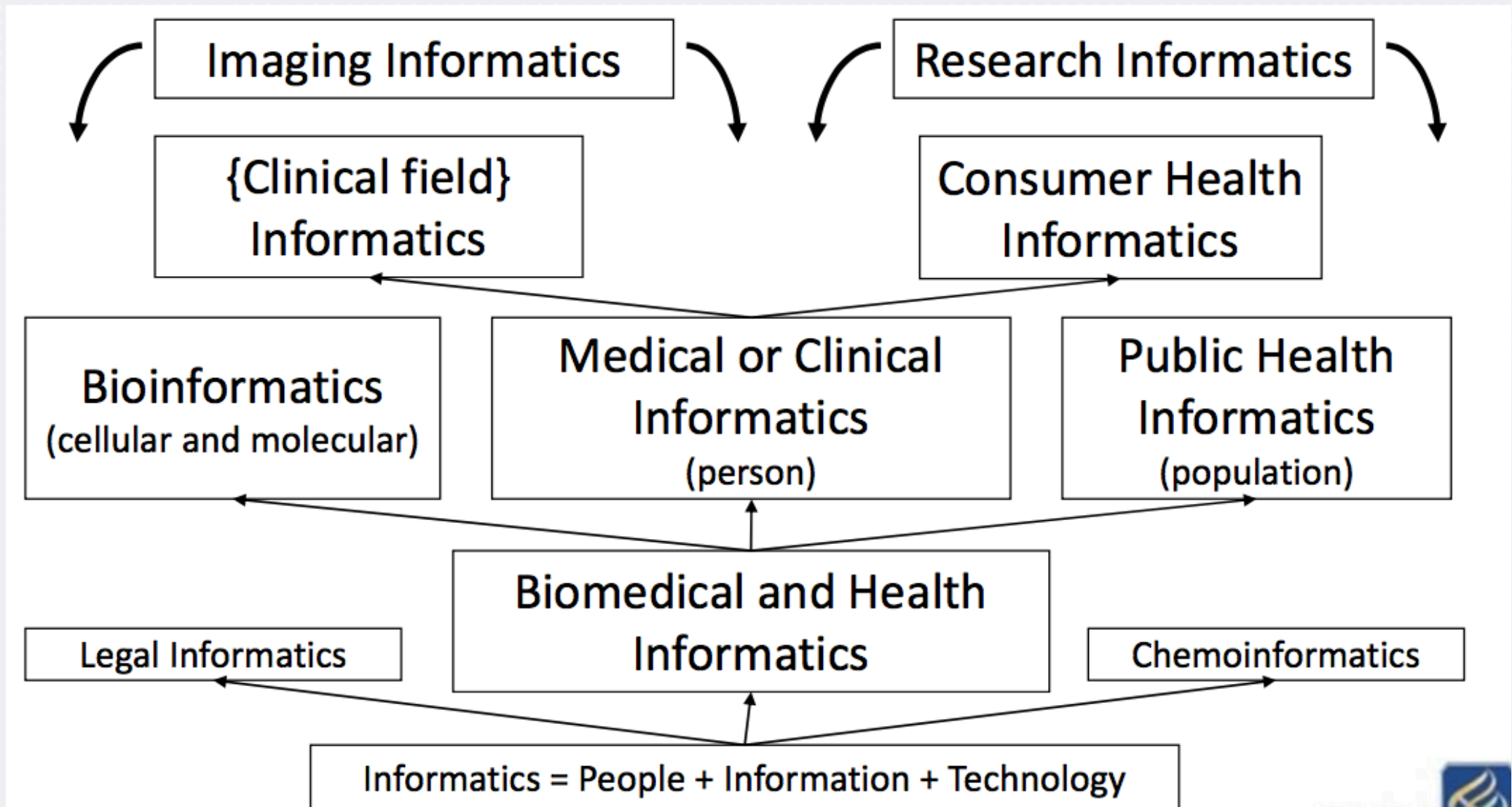
Health Informatics as a Discipline

How was it developed overtime?

Health Informatics as a Discipline

- *Oznovy Informatiki* (Foundations of Informatics), 1968 (Russia)

- French article (1970):
"Study of an informatics system applied to the Public Health Services" *Hatton, et al*

- IFIP Medical Informatics Monograph Series (1974)

- MEDINFO 74: First Conference on Medical Informatics

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Health Informatics: 1960-1970

- MUMPS: Massachusetts General Hospital Utility Multi-Programming System, 1966

- Mycin (1970): Ph.D. thesis by Ted Shortliffe, MD evaluating a software program which 'suggested' antibiotic choices based on clinical information.

- COSTAR (1970-80): Electronic medical record system developed in MUMPS

- GEMISCH (Generalised Medical Information System for Community Health): Hammond, Stead,1969

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Health Informatics: 1970-1980

- Research papers published in MEDLINE (1966-1980) - 8 million citations

- Developed medical terminologies in MeSH terms (45,000)

- Developed Novel indexing and searching mechanisms

Health Informatics: Today

- MEDLINE: published more than **8 million** biomedical literature research papers/abstracts

- Decision support systems: Numerous systems developed

- Established several Standards:
  - openEHR/ CEN 13606
  - Health Information systems ISO 18308
  - UMLS: Unified Medical Language System.
  - ICD9/ICD10, SNOMED-CT ….
  - etc.

Why Health Informatics?

do we really need it?

Why Informatics?

- Introducing an in-depth understanding of healthcare information **needs** (during system design)
- Development of improved methods of information **representation** and **navigation**
- Structured Medical terminologies
  – Index Medicus (Billings, 1890)
    Roget's Thesaurus (Roget, 1911)
    MEDLARS (Rogers, 1965)
    Unified Medical Language System (1986-present)
- Development of **clinical decision support** mechanisms and evaluating their effectiveness

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Why Health Informatics?

- **Human Errors:**
  - 44,000 to 98,000 die in US annually from **medical errors**
    - at 44,000, would rank as 8th leading cause of death
      - car accidents: 43,458
      - breast cancer: 42,297
      - AIDS: 16,516
    - 7000 deaths from **medication errors** alone

(IOM Report, 1999)

Medication errors: in the US, 80,000 people died in 2004.
  (i.e. 8th cause of death)

(IOM Report, 2004)

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Why Health Informatics?
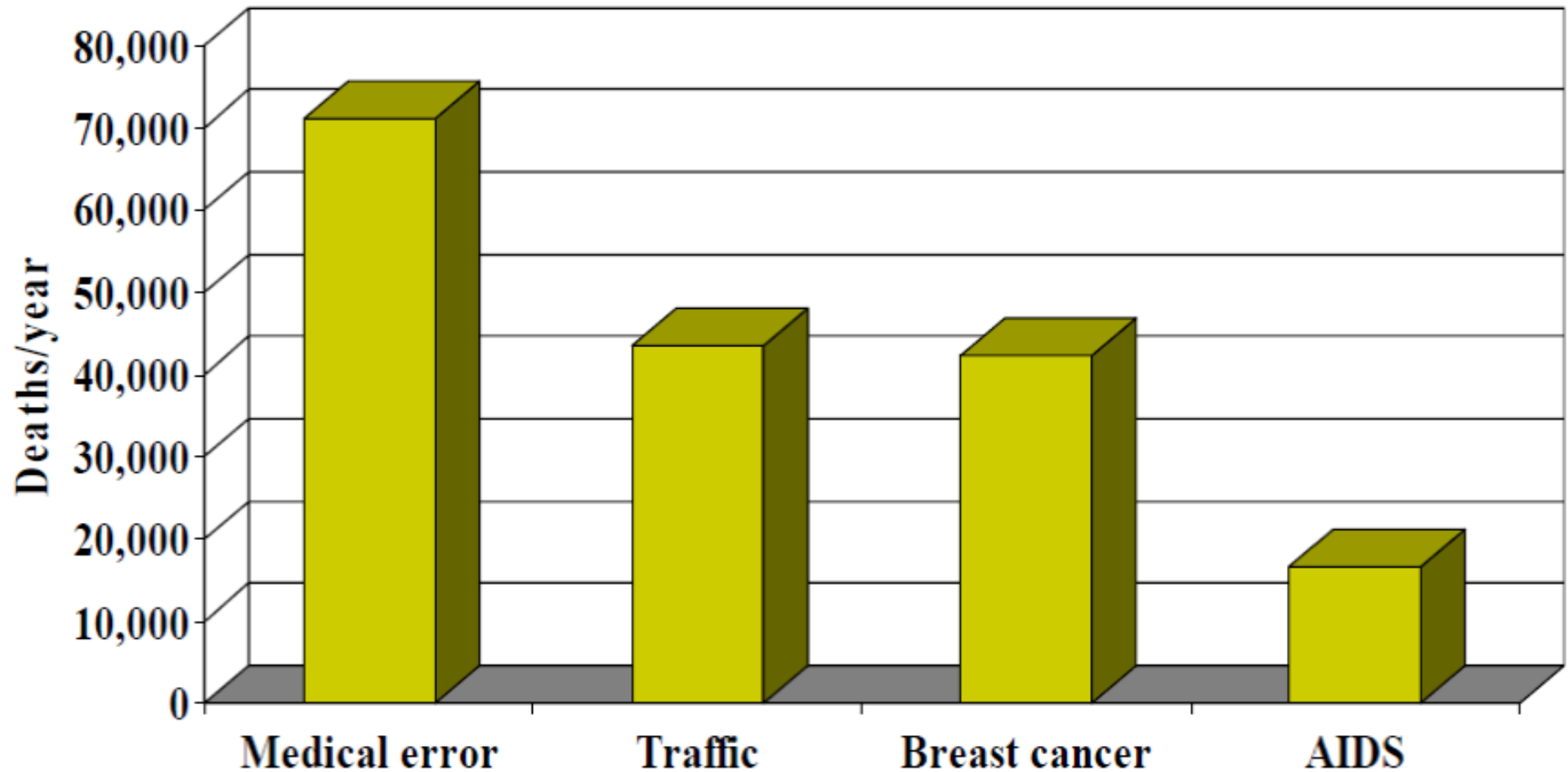
. (Source: Terendak, Malaysia)

$9 billion in annual costs

Why Health Informatics?

- Health Informatics reduce
  - Serious medication errors--55%
  - Prescribing errors-- 19%
  - Transcription errors-- 84%
  - Dispensing errors-- 68%
  - Administration errors--59%
  - Preventable Adverse Drug Events (ADE's)-- 17%
  - Non-intercepted potential ADE's-- 84%

[Source: Terendak, Malaysia]

Why Health Informatics?

- 23% of questions could be answered by using medical literature: journal, textbook, MEDLINE

- 52% were facts that should have been in the medical record

- 337 "clinical information" requests observed in a 17 hour period by one Internal Medicine care team

- Conclusion: **75%** of 'medical information needs' require accessing the medical record or medical references

Why Health Informatics?

- **81%** of the cases, **information** needed by clinicians in the decision making process was **not available**.

- Finding information took **38%** of a clinician's time during a patient visit.

- **50%** of paper-based medical records are either missing or contain incomplete data

source: Institute of Medicine (IOM), 1996

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Why Health Informatics?

- **11%** of laboratory tests **reordered** due to lost results

- **30%** of treatment orders are not documented

- Clinicians spend **35%** of their time doing **paperwork** (US Dept. of Commerce, 1996)

- **20-30%** of national healthcare **expenditures** are associated with information **paperwork**

source: Institute of Medicine, 1996

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Why Health Informatics?

- Information is needed to make decisions on
  - care and treatment for patients
  - managing health as a business

- Patient safety relies on the <u>right</u> information made available at the <u>right</u> time to the <u>right</u> carers

- …. Health informatics plays a critical part in effective, efficient and efficacious **service delivery**

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Why Health Informatics?
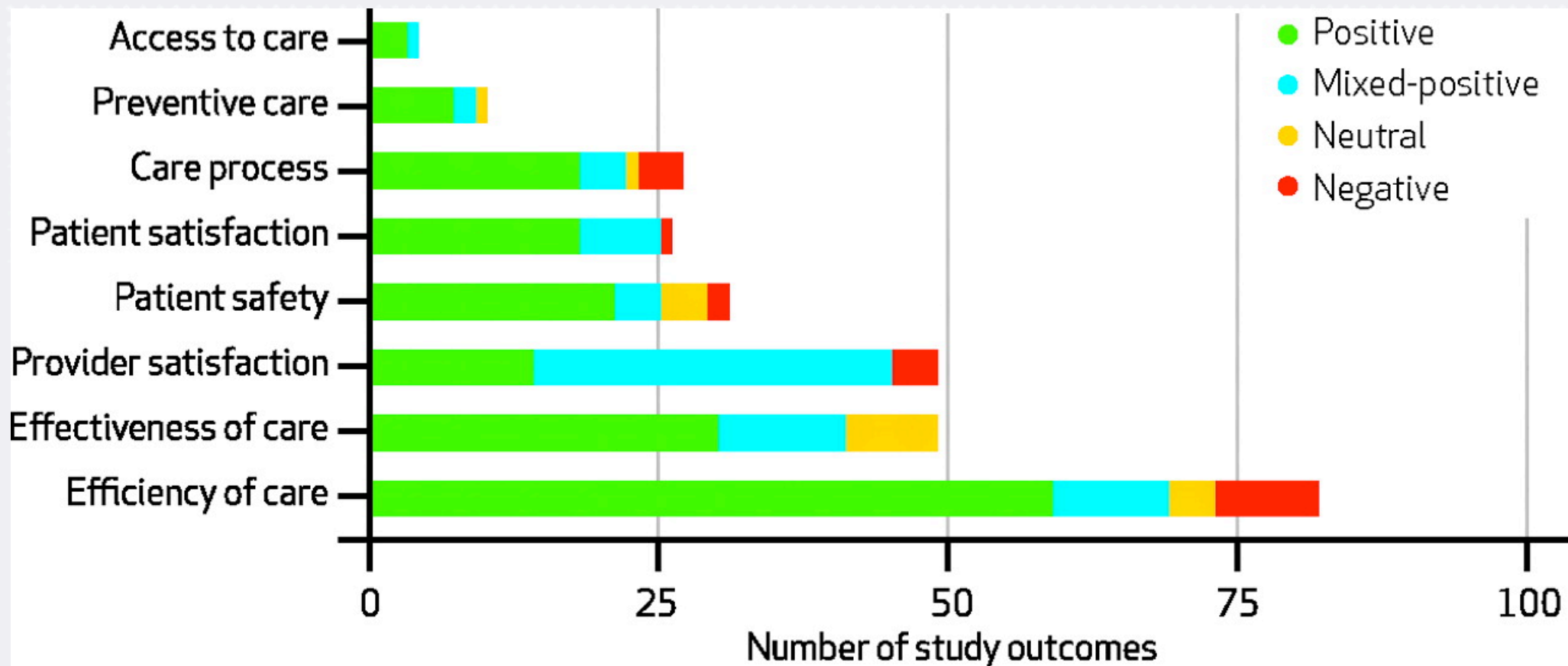
Evaluations Of Outcome Measures Of Health Information Technology, By Type And Rating.

Melinda Beeuwkes Buntin et al. Health Aff 2011;30:464-471

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Benefits

How does it really make a difference?

Healthcare-Ultimate objectives

- Increase healthcare **quality**

- Decrease healthcare **costs**

- Reduce healthcare **complexities** ->Easier to use

- Improve Healthcare **efficiency**

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Areas with most Impact

Area	2012	2011
Improving Quality Outcomes	38%	41%
Reducing Medical Errors	22%	25%
Standardizing Clinical Care	16%	12%
Supporting Staff Productivity	7%	6%
Providing Competitive Advantage	6%	9%
Sharing Information Externally	5%	3%
Enabling Remote Access of Data	3%	1%
Ensuring that Data is Secure/Private	0%	1%
Providing Remote Monitoring of Patients	0%	0%

N = 302

Source: 2012 Annual HIMSS Leadership Survey

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Where does Health Informatics happen?

- Enable health professional to support better healthcare delivery in **hospitals**, **community** locations and GP/**family practices**
  - Used by nurses, doctors, other clinical professionals and managers

- Enable health Manager plan better care for patients, to cover activity and resources, **strategic planning** and **performance monitoring**

- Enables Engineers with health professionals design more **effective** health systems
- Enables Engineers with health professionals develop new **innovative diagnosis** solutions

- Enables scientists make **new discoveries** from collected knowledge.

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How does Health Informatics make immediate difference?

- To support a health service to **collect** and **analyse** information, **monitor** health trends and to make the **best use** of clinical and health related resources

  - brings together more information from several locations for _effective decision making_ by clinical professions

  - helps plan effective _integrated patient_ care in hospital, primary care or at home

  - enables _complex analyses_ and calculations about drugs, procedures and interventions with accuracy

  - enables _24/7 access_ to patient records by all authorised staff, regardless of location, media or type of record or content

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Health Informatics helps to answer key questions: Examples

- **Specific Questions - patient**
  - What drugs and interventions a patient is having now, have been having for the last two years, and have had 5 years ago?
  - What are the lab tests or vital signs (e.g. the blood pressure) of a patient and how it has been for the last 2 years.
  - Has this hospital got the current capacity to cope with the victims of a major accident that has just occurred ?
  - Is the health service locally as efficient, effective and efficacious as it could be?

- **Generic questions – patients**
  - Which patients are at hypertension risk?
  - What is the best way to deal with blood clots?
  - What is the most effective treatment for a particular patient, for a particular disease?

- **General Questions- organisations**
  - What are the healthcare quality issues in this hospital?
  - How to improve care quality across integrated organisations?
  - What are the healthcare needs (e.g. drugs) of hospitals in a city, in next month?

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How Health Informatics can help?

- **develop or formulate new models** for acquiring, representing, processing, displaying, transmitting, or sharing/exchanging health information or knowledge.

- **develop new approaches or computer systems** that use the models to deliver the information or knowledge

- **deploy information technology systems** to support the models

- **develop analysis methods to assess outcomes** regarding the effects to the overall health care system

- **develop new solutions** to improve healthcare management, medical assessments, diagnosis, interventions etc.

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Health Informatics Benefits for a **<u>Country's</u>** Health

- **Identify safety problems.** EHR systems can identify and notify patients who may be at risk due to unsafe drugs or medical devices.

- **Detect epidemics**. EHRs to find unexpected increases in diseases within a community. Patterns of prescribing in pharmacy records could even help identify unusual occurrence of disease.

- **Improve overall health care**. Researchers exploring which treatments are most effective.

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Health Informatics Benefits for a **Patient's** Health

- **Electronic Health Records (EHRs) reduce your paperwork**. EHR, makes data available immediately. Thus less forms for the patient to fill.
- **EHRs get your information accurately** at point of need. This critical, particularly in a crisis, to make best possible decisions.
- **EHRs help your doctors coordinate**. All healthcare providers can see your medical record and history to coordinate your care and protect your safety
- **EHRs reduce unnecessary tests and procedures**. EHR can avoid repeating medical tests, carers can have access to all your test results and records at once.
- **Patients access their own health records**. to see your health records, thus identify wrong and missing information and make additions or corrections as needed.

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Health Informatics Benefits for **Healthcare Providers**

- **Financial Benefits**: about **50%** of healthcare costs are wasted due to **inefficient** processes.
  - Implementing healthcare IT in large hospitals in the US saves between $37M and $59M in a period of five years.

- **Faster Lab Results**: more than **75%** of laboratory clinicians that use EHRs allowed them to receive lab results faster than through the conventional method.

- **Time Savings**:
  - Over 82% healthcare professionals reported that electronic prescriptions save time and reduce efforts.
  - Faster audit patient records in 1.4 hours versus 3.9 hours through paper auditing systems.

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Health Informatics Professionals

What sort of tasks do they do?

Health Informatics: applied

- Health professionals
  - Use of information (*per se*) for <u>professional</u> (healthcare) effectiveness

- Patient or Users
  - Use of information technology for <u>personal</u> (healthcare) effectiveness

- Engineers and Developers
  - Develop information solutions and systems to improve the effectiveness of the **(1)** <u>healthcare</u>, **(2)** <u>health enterprise</u> and **(3)** <u>health service</u>.

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What sort of tasks Health Informatics Professionals Do?

- **Develop new solutions** for higher quality and error-free care in more efficient and effective ways, including improved decision support**.**

- **Develop (and maintain) systems** to capture, store and organize patients' medical and peripheral data.

- **Develop policies and systems** to maintain patient confidentiality

- **Develop analytical methods** to assess healthcare quality and outcomes.

- Ensure that **patient records are complete**, accurate and easily accessible to the right medical professionals.
  - Health data quality
  - Proper use of medical terminology and coding

- Troubleshoot and **improve all technologies** that are necessary for healthcare and healthcare IT.

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2008 Health Informatics Professionals Need?

Clinical Application Support — 39%
Network/Architecture Support — 26%
Systems Integration — 25%
Process/Workflow Design — 23%
Clinical Informaticists — 20%
Clinical Transformation — 19%
Help Desk — 17%
User Training — 16%
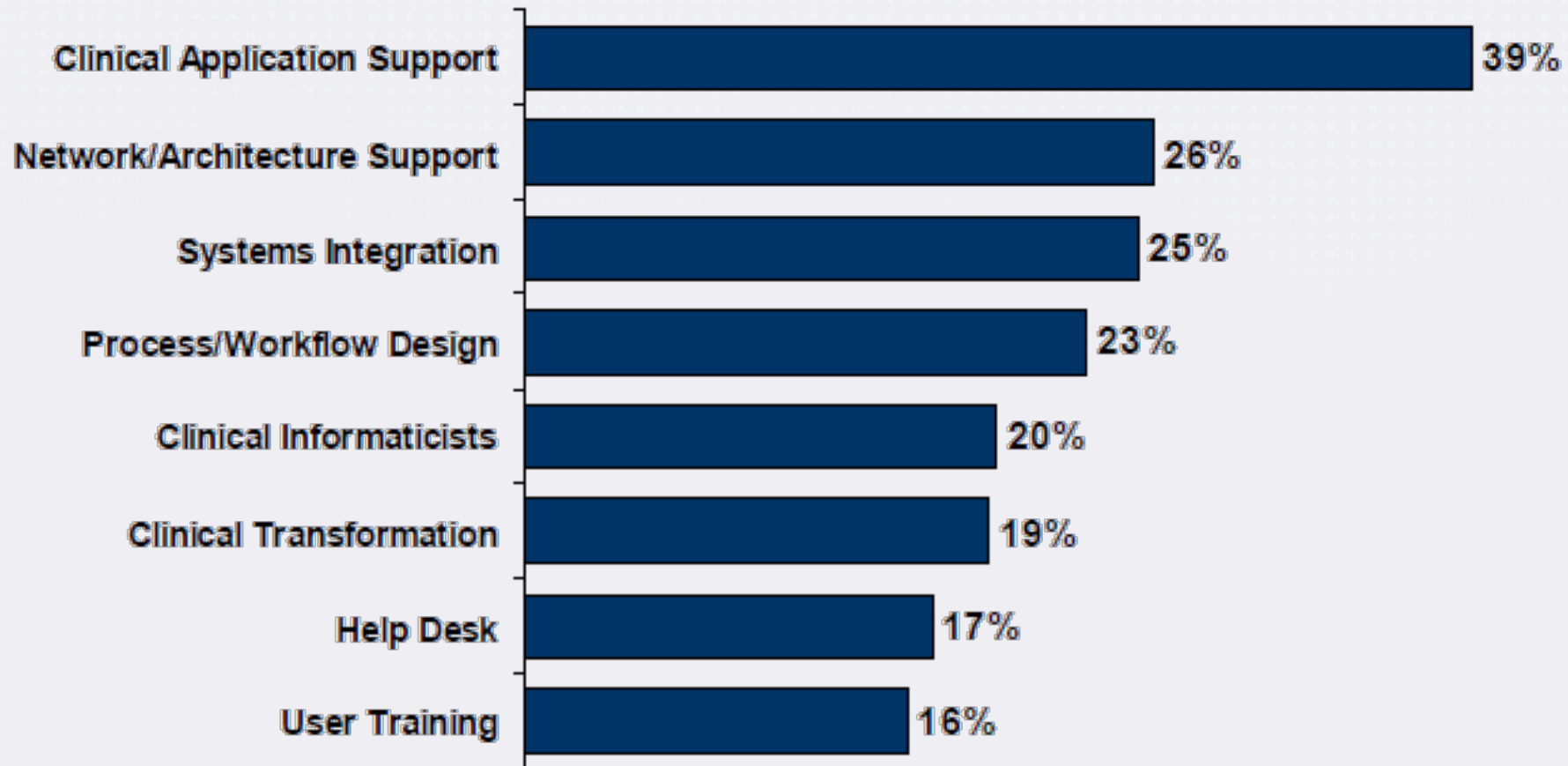
Source: 2008, 20ʰ Annual HIMSS Leadership Survey Sponsored by ACS HealthCare Solutions

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2009 Health Informatics Professionals Need?
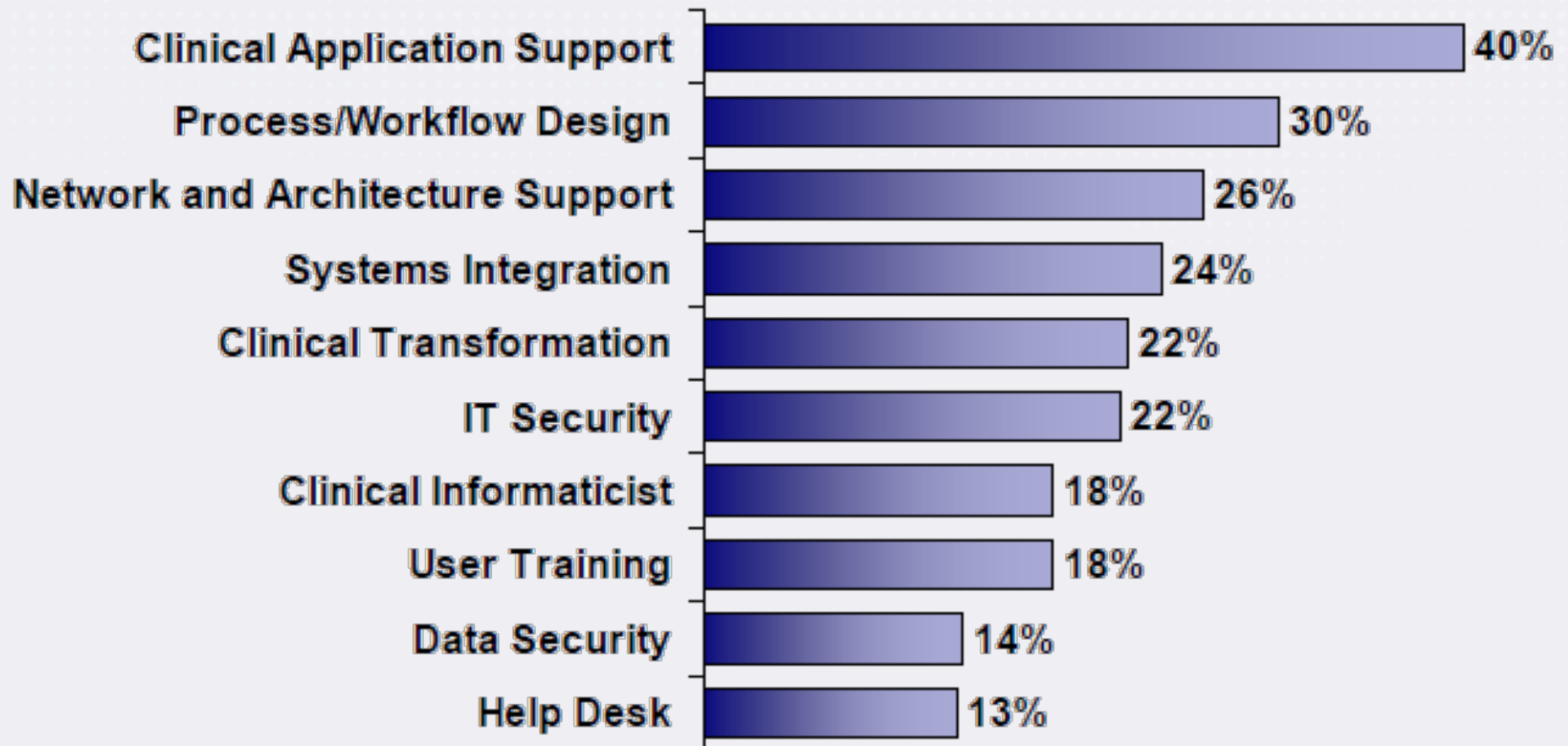
Source: 2009 Annual HIMSS Leadership Survey

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2012 Health Informatics Professionals Need?

Clinical Application Support	43%
Network/Architecture Support	22%
Clinical Informatics	20%
System Integration	17%
IT Security	14%
Clinical Transformation	13%
Database Administration	12%
PC/Server Support	12%
Process/Workflow	10%
System Design/Implementation	10%

N =302

Source: 2012 Annual HIMSS Leadership Survey
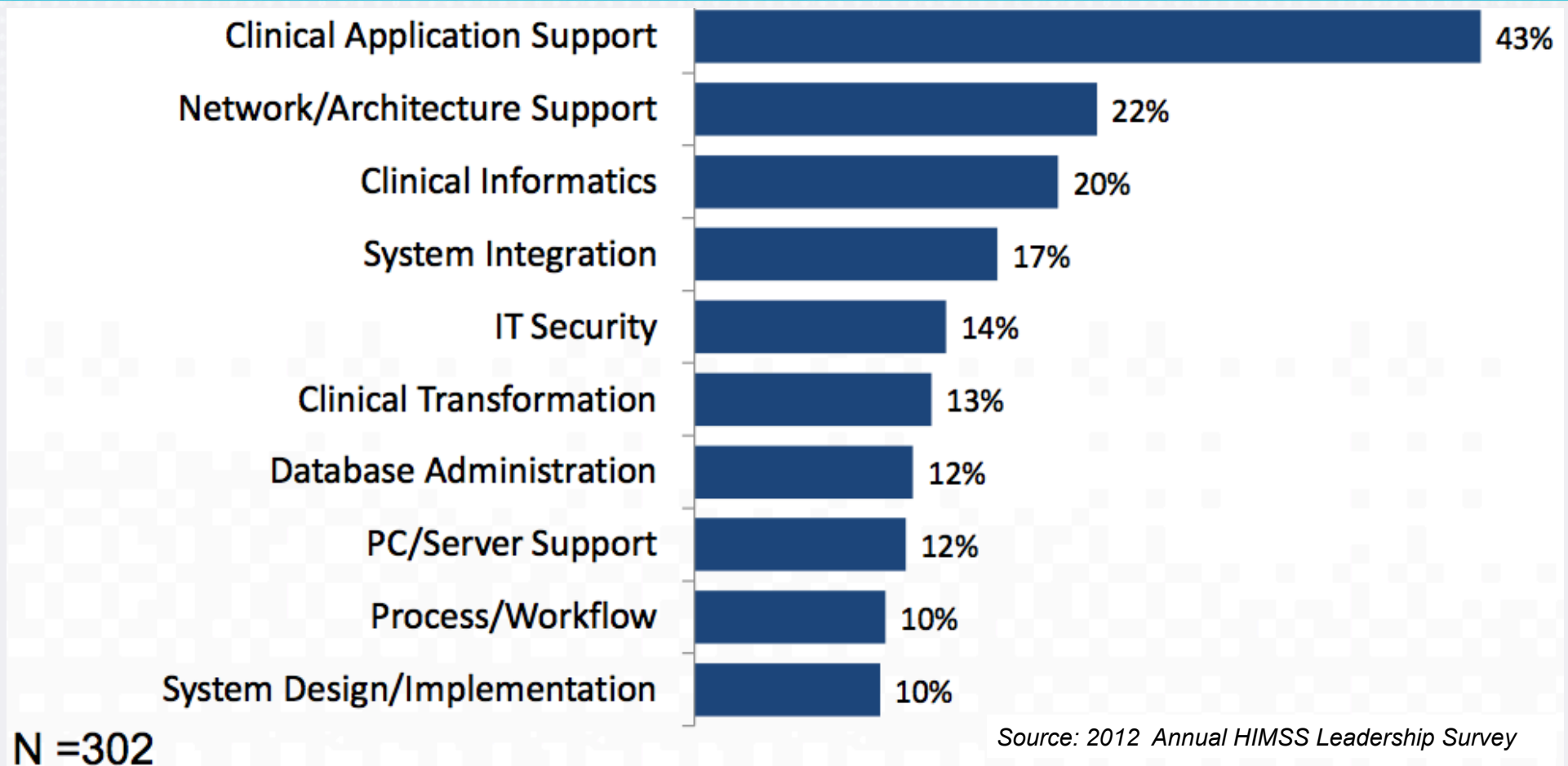
Demands for qualified, experienced Health Informatics staff are growing to around 200,000 (from 25,000 now) (NHS, UK)

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Health Informatics Adoption

Why is it difficult to adopt health informatics in healthcare?

Technology Adoption Curve

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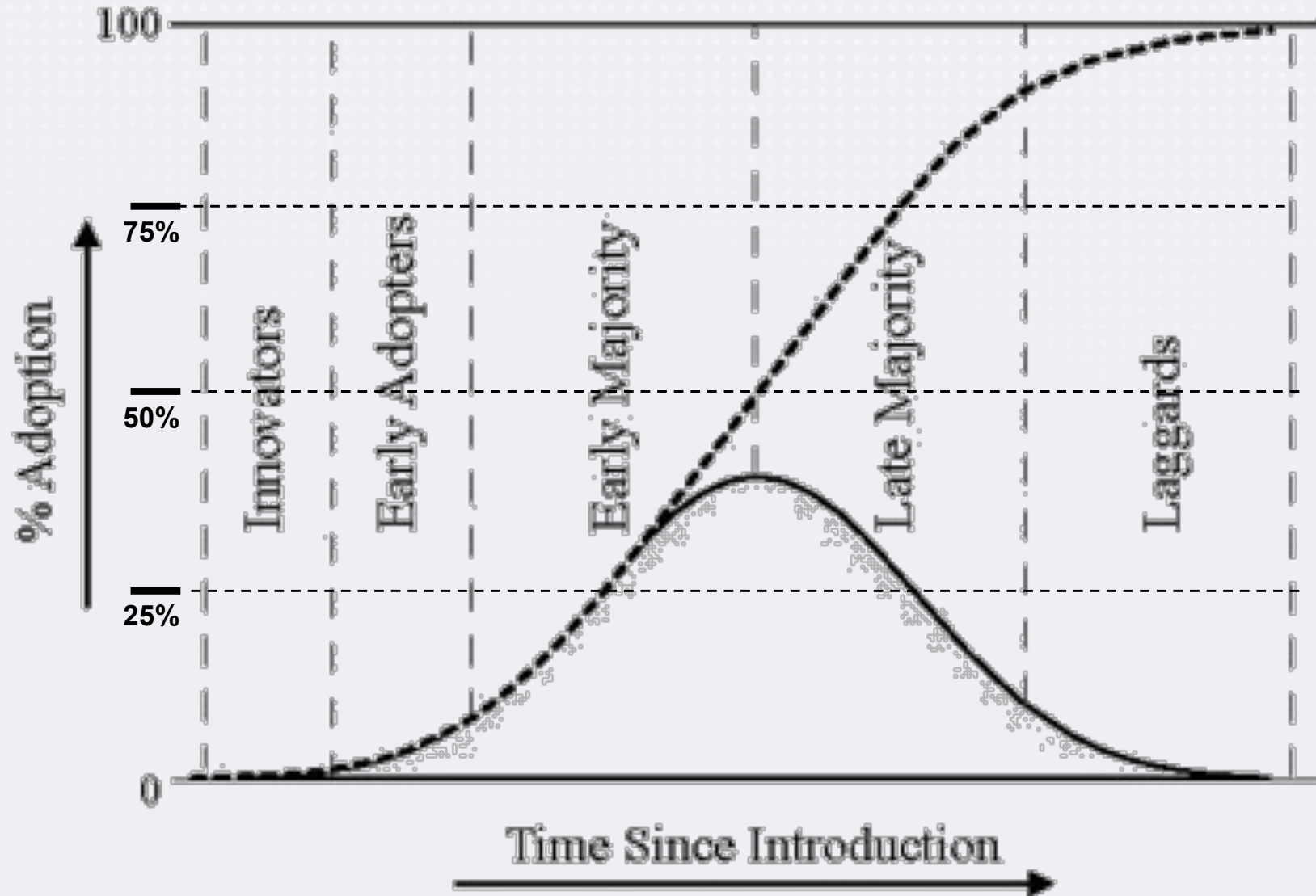
Why is Health Informatics Adopted Slowly?

- Lags behind other industries by 10-20? years
- **Complex regulations** - e.g.
  - Access to Patient health data/records
  - Privacy and confidentiality regulations
- Lack of interoperability/standards between health systems
- Clinicians **resist** using IT systems
- Scale – hospitals can have large number of systems and staff

Health Serv Res. 2003 Apr; 38(2): xi–xxii.

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Why is Health informatics Adopted Slowly?

Integration of IT

Public Services
(Health...)

2010 - WRONG!

Business Services
(Banks)

Manufacturing

1980   1990   2000
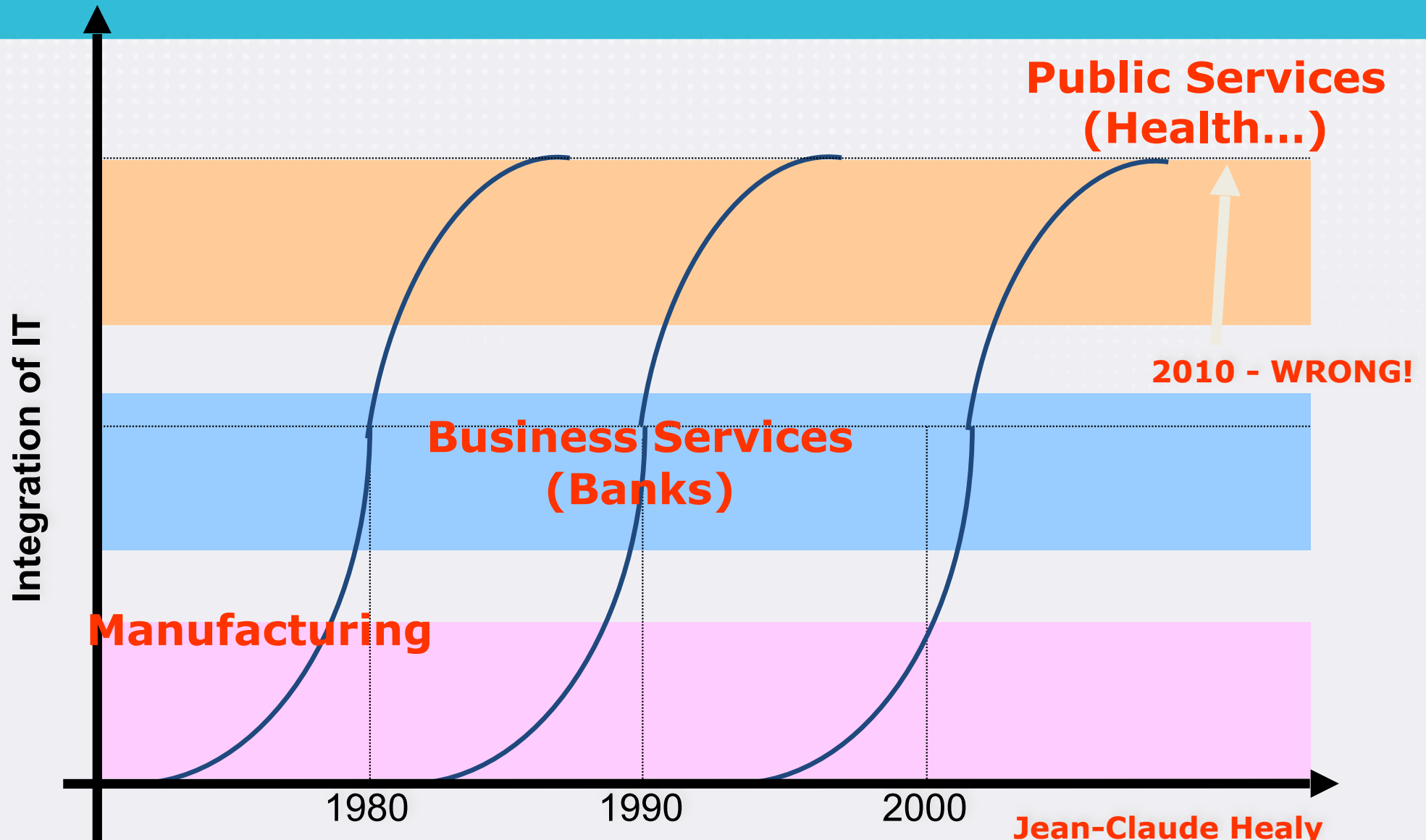
Jean-Claude Healy
May 2000

IT as a gadget
Trojan horse: networks, …
Full Integration of IT into Business (Organisational, Legal) Re-engineering of the system

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Why is Health Informatics Adopted Slowly?

Risks using health software

- Potential for errors due to **software bugs**
- **Badly developed Software**: e.g. Highly coupled systems - greater risk of catastrophe
- **Decision support systems** may produce **mass mistakes**
- **Privacy** – electronic data vulnerable to **cyber attack**
- Many projects cancelled after massive investment
  - Report by Standish Group ('95):
    - **$250 billion** each year on 175,000 IT projects
    - 31% projects cancelled before completion = **$81 billion** for canceled projects
    - 53% of projects cost 190% of estimated costs

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Barriers to Implementing Health Informatics

Lack of Staffing Resources — 21% (2012), 17% (2011)
Lack of Adequate Financial Support — 14% (2012), 18% (2011)
Vendor Inability to Deliver Product — 12% (2012), 11% (2011)
Difficulty in End User Acceptance — 9% (2012), 10% (2011)
Lack of Time Commitment from Clinicians — 7% (2012), 7% (2011)
Lack of Clinical Leadership — 6% (2012), 4% (2011)
Difficulty Proving ROI — 4% (2012), 5% (2011)
Lack of Top Management Support — 4% (2012), 3% (2011)
Lack of Interoperable Systems — 4% (2012), 5% (2011)
Lack of Strategic IT Plan — 3% (2012), 4% (2011)

■ 2012
■ 2011

N = 302
Top 10 Responses

Source: 2012 Annual HIMSS Leadership Survey

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Harnessing Health Informatics?

- But given the complexity of modern medicine:
  - Inevitable Health informatics will play an ever increasing role in improving health care quality.

    - "Information technology must play a central role in the redesign of the health care system if a substantial improvement in quality is to be achieved over the coming decade." (IOM, 2003)

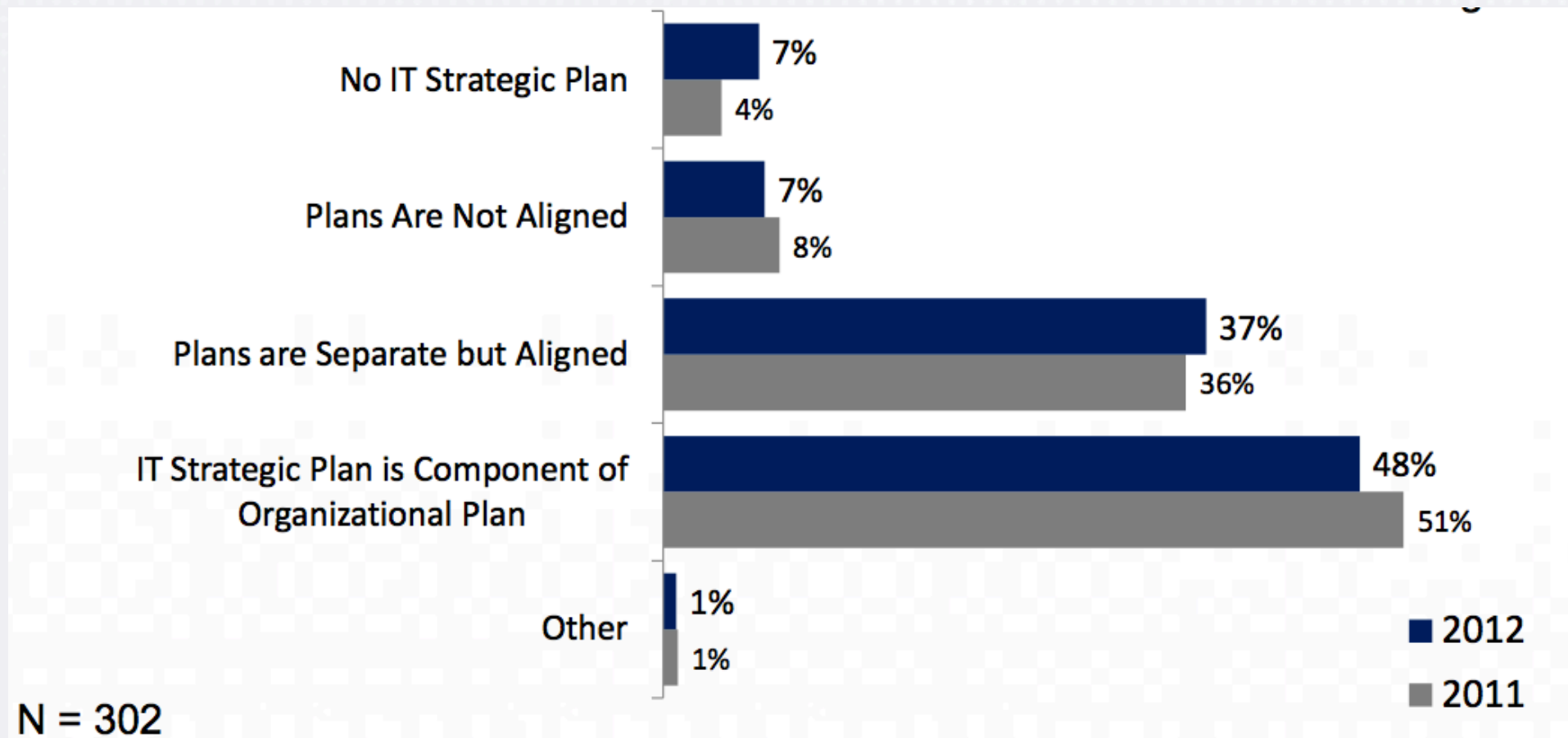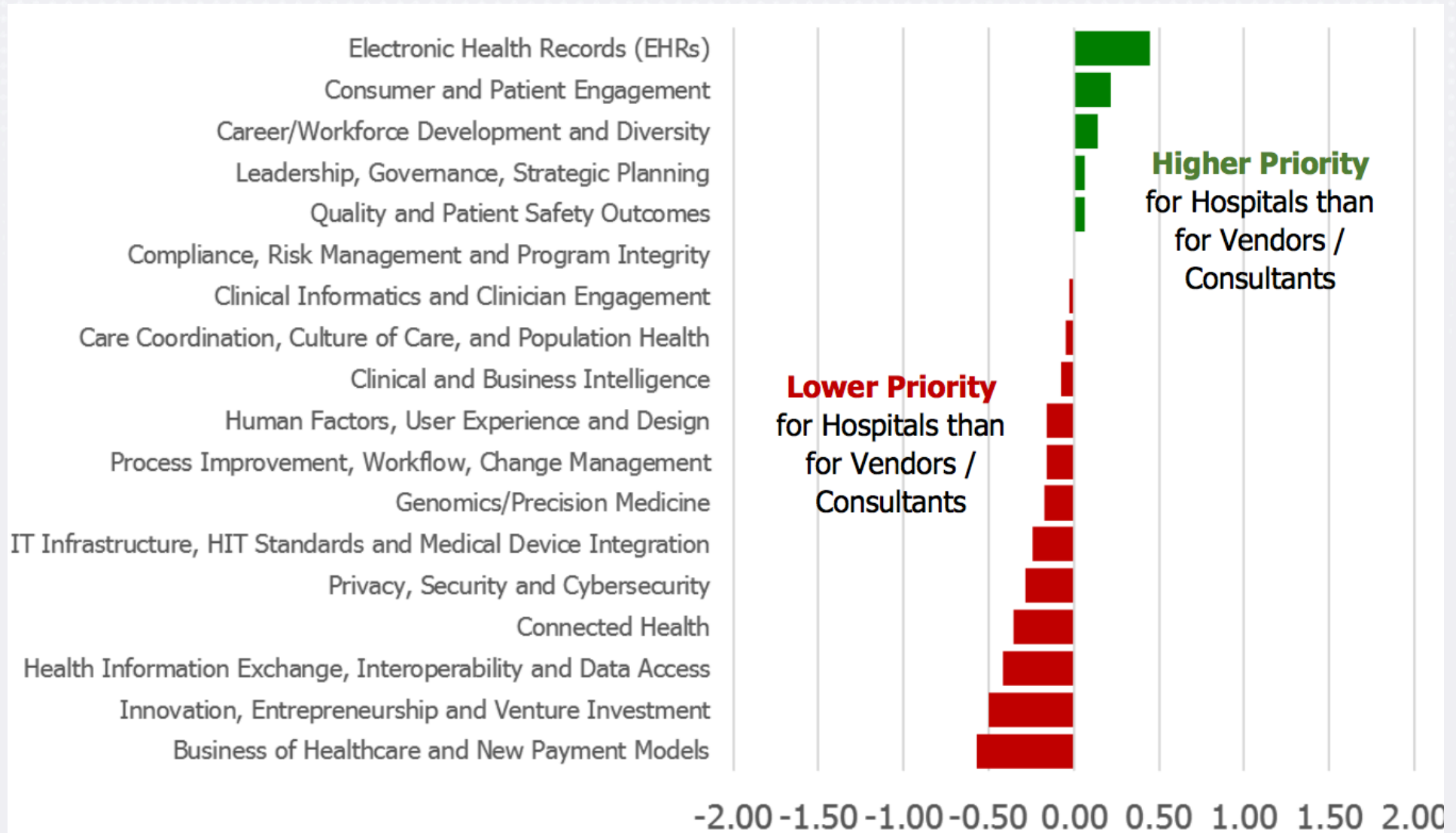- However, it requires a major re-engineering of the health care delivery system.

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Health Informatics Adoption

Source: 2012 Annual HIMSS Leadership Survey

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Priorities Gap between Hospitals and Vendors

Electronic Health Records (EHRs)	
Consumer and Patient Engagement	
Career/Workforce Development and Diversity	
Leadership, Governance, Strategic Planning	**Higher Priority** for Hospitals than for Vendors / Consultants
Quality and Patient Safety Outcomes	
Compliance, Risk Management and Program Integrity	
Clinical Informatics and Clinician Engagement	
Care Coordination, Culture of Care, and Population Health	
Clinical and Business Intelligence	**Lower Priority** for Hospitals than for Vendors / Consultants
Human Factors, User Experience and Design	
Process Improvement, Workflow, Change Management	
Genomics/Precision Medicine	
IT Infrastructure, HIT Standards and Medical Device Integration	
Privacy, Security and Cybersecurity	
Connected Health	
Health Information Exchange, Interoperability and Data Access	
Innovation, Entrepreneurship and Venture Investment	
Business of Healthcare and New Payment Models	

-2.00 -1.50 -1.00 -0.50 0.00 0.50 1.00 1.50 2.00

Source: 2017 Annual HIMSS Leadership Survey

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Health Informatics Organisations

- American Medical Informatics Association (http://www.amia.org)
- Other organisations around the world:
  - International Medical Informatics Association (IMIA)
  - American Medical Informatics Association (AMIA)
  - Australian Health Informatics Association (SA)
  - Belgium Medical Informatics Association (MIM)
  - Brazilian Health Informatics Society (SBIS)
  - British Medical Informatics Society (BMIS)
  - French Medical Informatics Association (AIM) (French)
  - German Medical Informatics Association (GMDS)(German)
  - Japanese Association for Medical Informatics (JAMI)
  - Association for Informatics in Medicine, Singapore (AIMS)
  - The Society for the Internet in Medicine
  - Thai Medical Informatics Society (TMI)

Organizations (cont.)

- <u>HIMSS</u> (Healthcare Information and Management Systems Society)- an international trade organisation of health informatics technology providers

- <u>American Society for Testing and Materials</u> - a consortium of scientists and engineers that recommends international standards

- <u>Open EHR</u> - promotes open source EHR guidelines

- <u>Canada Health Infoway</u> - a private, not-for-profit organisation that promotes the development and adoption of EHRs in Canada

- <u>World Wide Web Consortium</u> (W3C) - promotes Internet-wide communications standards to prevent market fragmentation

- <u>Clinical Data Interchange Standards Consortium</u> (CDISC) - a non-profit organisation that develops platform-independent healthcare data standards

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Thanks!
Any questions?

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