Health Search

From Consumers to Clinicians

Slides available at

https://ielab.io/russir2018-health-search-tutorial/

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Who am I

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- PhD @ Glasgow on formal models of search (quantum IR)
- Postdoc @ Australian e-Health Research Centre (CSIRO) on health data mining, search and classification
- Senior Lecturer @ QUT - research interests:
    - Formal models of search
    - Retrieval models & evaluation for health search

Why health search?

- Large societal impact
    - Advances in health search, could potential translate in better health/ society/economy
    - Good field for attracting research funding
- Fundamental problems are the same/similar to other area of IR, just exacerbated
    - Semantic gap
    - Query formulation
    - Result understanding
    - Cognitive biases, incorrect information fake news, etc

Course Objectives

1. **Summarise the basics** of search in health domain;
2. Present different **end user** requirements for multiple user groups in health search, including **tasks**;
3. Provide an **overview** of the current use of **IR techniques** in the health domain;
4. Provide a **hands-on** introduction to **domain-specific tools** which can be exploited in health search;
5. Present **resources** and campaigns for **evaluation** in health search, including novel evaluation approaches;
6. Present **challenges** and **opportunities** for further research in the health domain and discuss how these could be met.

Outline

https://ielab.io/russir2018-health-search-tutorial/

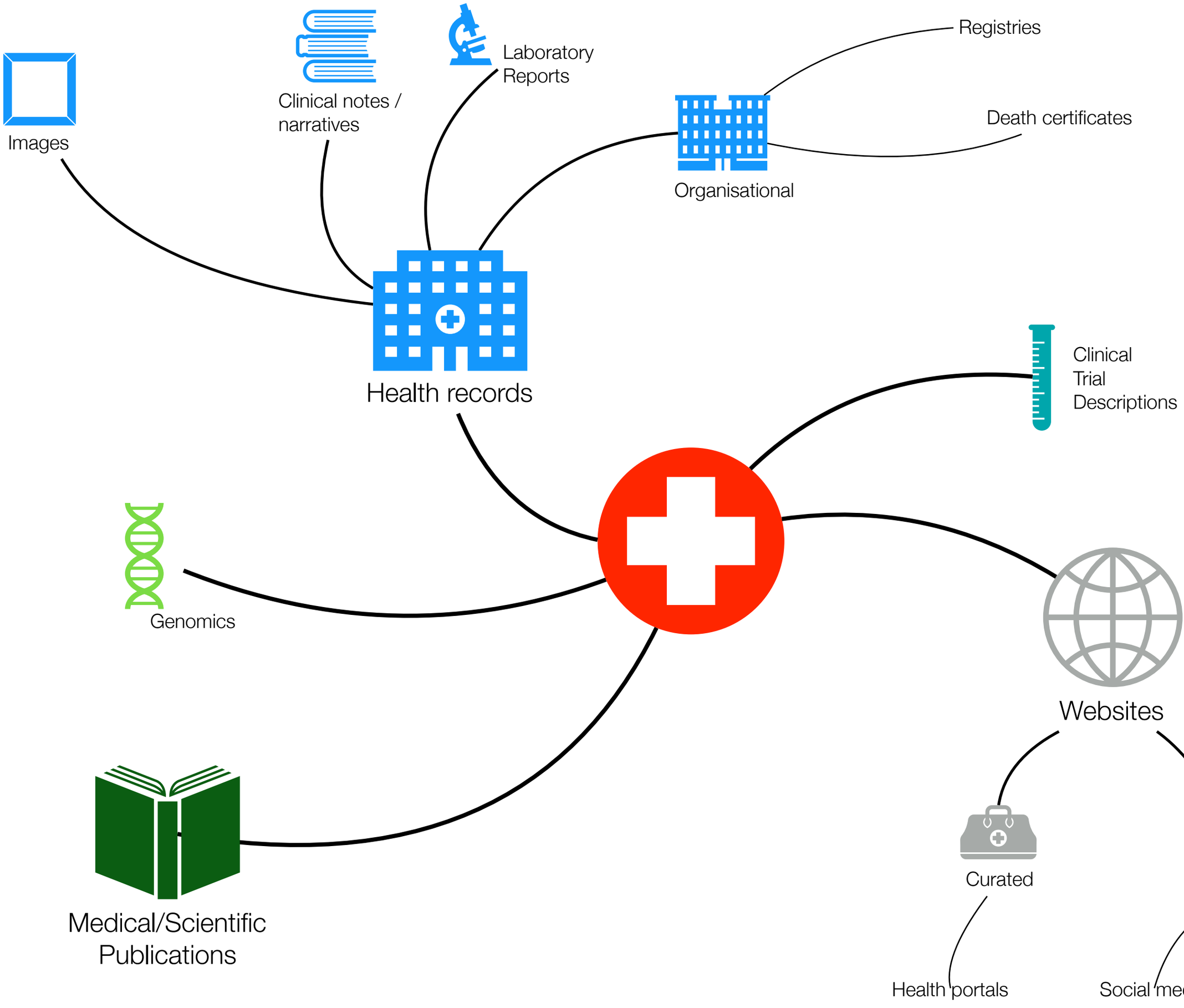
- **Session 1 (Monday)**: Health Information, End Users & Tasks
- **Session 2 (Tuesday)**: Techniques and methods + hands on demo (part 1) - resource @ https://hub.docker.com/r/ielabgroup/health-search-tutorial
- **Session 3 (Thursday)**: Techniques and methods + hands on demo (part 2)
- **Session 4 (Friday)**: Evaluation, open challenges and future directions

We separately discuss tasks and methods because:

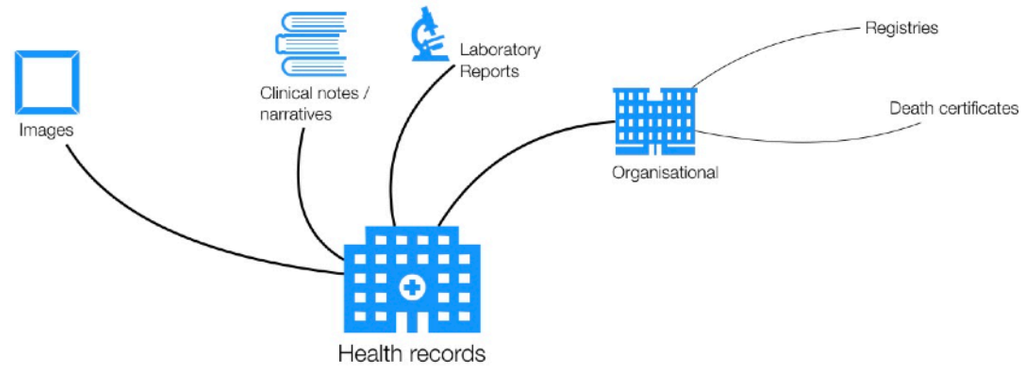
- Some methods have been applied across tasks
- Some tasks are affected by the underlying same problems

Session 1: Health Information, End Users & Tasks

The myriad of health information

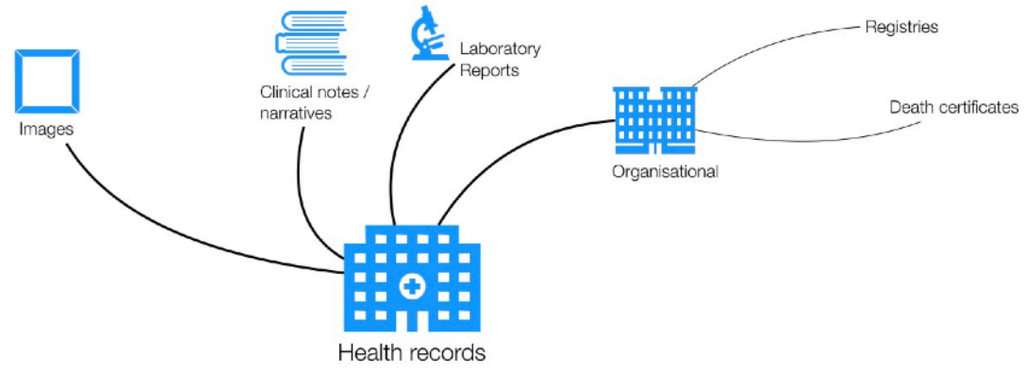

Images
Clinical notes / narratives
Laboratory Reports
Registries
Death certificates
Organisational
Health records
Clinical Trial Descriptions
Genomics
Websites
Curated
Un-curated
Health portals
Social media
Forums
Medical/Scientific Publications

Health Records: Clinical Notes



- Main **purpose** of health records: to communicate information between clinicians
- Often notes contain instructions from one person to another; e.g. from doctor to nurse
  - written by both physicians and nurses
- **record events** during a patient's care
  - to compare past status to current status,
  - to communicate findings, opinions and plans between physicians/nurses
  - for retrospective review of case details

Health Records: Clinical Notes



Samuel J. Smith

1234567-8

4/5/2006

HISTORY OF PRESENT ILLNESS: Mr. Smith is a 63-year-old gentleman with coronary artery disease, **hypertension**, **hypercholesterolemia**, **COPD** and tobacco abuse. He reports doing well. He did have some more knee pain for a few weeks, but this has resolved. He is having more trouble with his sinuses. I had started him on Flonase back in **December**. He says this has not really helped. Over the past **couple weeks** he has had significant congestion and thick discharge. **No fevers or headaches** but does have diffuse upper right-sided teeth pain. He **denies any chest pains**, palpitations, **PND**, **orthopnea**, edema or syncope. His breathing is doing fine. **No cough**. He continues to smoke about half-a-pack per day. He plans on trying the patches again.

CURRENT MEDICATIONS: Updated on CIS. They include **aspirin, atenolol, Lipitor, Advair, Spiriva, albuterol** and will add **Singulair** today.

ALLERGIES: Sulfa caused a rash.

SOCIAL HISTORY: Smokes as above.

REVIEW OF SYSTEMS: CONSTITUTIONAL: Weight stable. GI: No abdominal pain or change in bowel habits.

PHYSICAL EXAMINATION:

VITAL SIGNS: Weight is **217 lbs**, blood pressure **131/61**, pulse **63**.

HEENT: TMs clear bilaterally, mild maxillary sinus tenderness on the right, nasal mucosa boggy with moderate discharge, teeth in good repair with no erythema or swelling

LUNGS: Clear, even with forced expiration.

health specific terms

acronyms

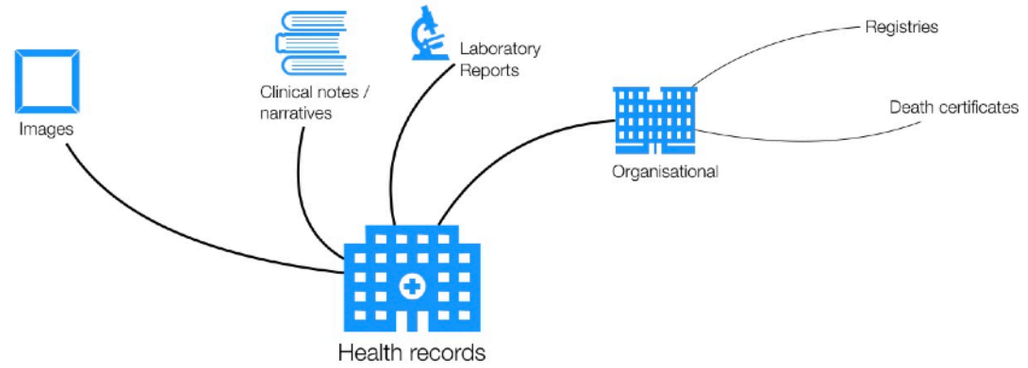
negated terms

temporal

quantities/measurements

brand name vs medication

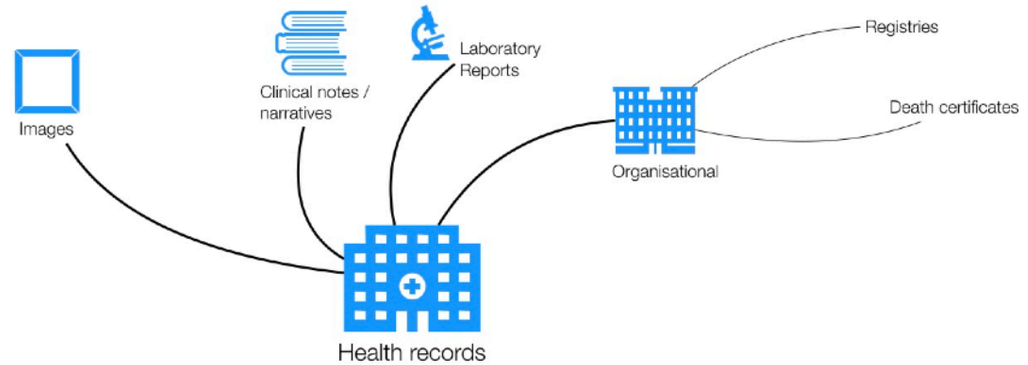
Health Records: Clinical Notes



Clinical notes often noisy:

- **Acronyms** often cannot be told apart:
  - "ARF" could mean "Acute Renal Failure" or "Acute Rheumatic Fever"
- Not consistent **headings** among notes
  - HISTORY OF PRESENT ILLNESS vs HPI
  - MEDICATIONS vs CURRENT MEDICATIONS
- **Temporal** aspects: PAST MEDICATIONS, 2 weeks, etc
- **Negations**: No fever, denies pain, etc…

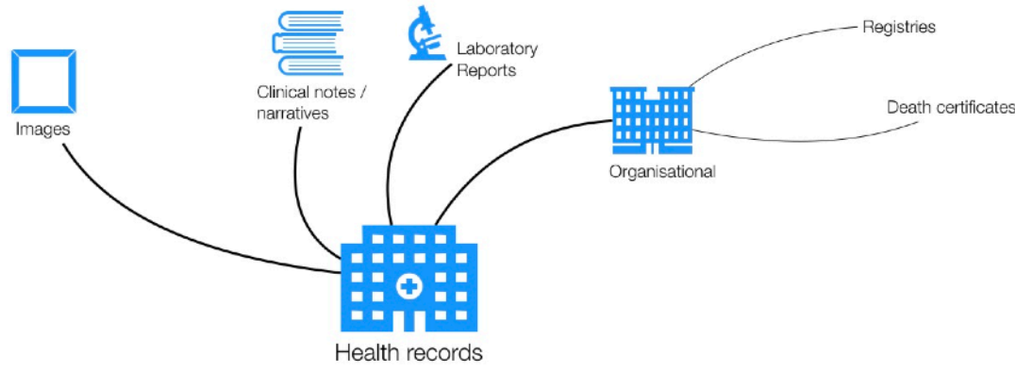
Health Records: Clinical Notes



Clinical notes often noisy:

- **Quantities & measurements** require specific parser and interpretation:
  - blood pressure 131/61: is it high? low?
- **Brand name vs medication**: requires domain knowledge
  - Atorvastatin [medication] vs Lipitor [brand name] vs Statins [medication class]
- **Health specific terms & synonyms**, requires understanding of relations
  - High blood pressure VS hypertension

Health Records: Laboratory Reports



SURGICAL PATHOLOGY REPORT

Diagnosis
Skin, left axilla, punch biopsy-
axillary granular parakeratosis.

Test, Pathologist Pathologist (Electronic Signature)

PT 02/29/2008

Microscopic Examination
Sections show parakeratotic confluent scale containing an abundance of prominent keratohyalin granules. The underlying epidermis shows psoriasiform hyperplasia without acantholysis. The histology defines axillary granular parakeratosis.

Gross Examination
Punch biopsy of skin: left axillary
Size: 0.4 x 0.4 cm
Excision depth: 0.5 cm
Specimen is bisected and entirely submitted in 1 cassette for microscopic examination.

PT /PT

Specimen
From left axillary

Pertinent History
Hailey Hailey

Often reports quantities, in tabular form

Often comes with comments/observations

Client Order ID:

Patient Information Used In Risk Calculations:		Marker	Measurement	MoM
Maternal Age at Delivery:	36.5 yrs	AFP	20 ng/mL	0.59
Estimated Due Date	June 30, 2010	hCG	30000 IU/L	1.13
Gestational Age at Draw:	16 Weeks 1 Day(s)	uE3	0.50 ng/mL	0.53
Maternal Weight:	145 lbs	Inhibin A	300 pg/mL	1.69
Maternal Race:	White	PAPP-A	800 mIU/L	0.54
Number of Fetuses:	Singleton	NT	4.00 mm	3.51
Family History of neural tube defects:	No			
Patient is medication-dependent diabetic:	No			
Crown Rump Length:	[illegible] cm			

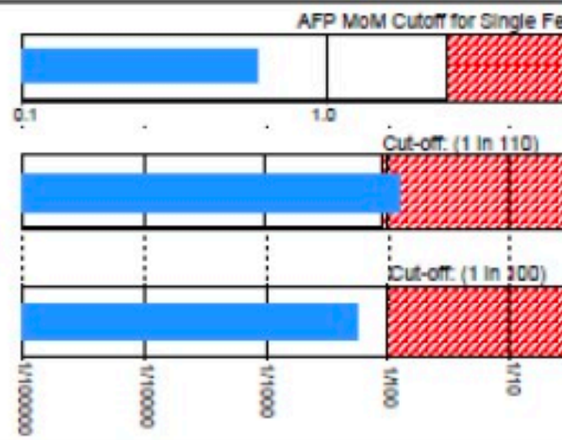
Sonographer Name:	Amie Healy
Sonographer Cert #:	P00943
Ultrasound Date:	December 14, 20

Interpretation:

Open Neural Tube Defects
Normal
Risk Before Test: 1 in 900
Risk After Test: <1 in 10000

Down Syndrome
Abnormal
Risk Before Test: 1 in 210
Risk After Test: 1 in 80 *

Trisomy 18
Normal
Risk Before Test: 1 in 2100
Risk After Test: 1 in 180



Comments:

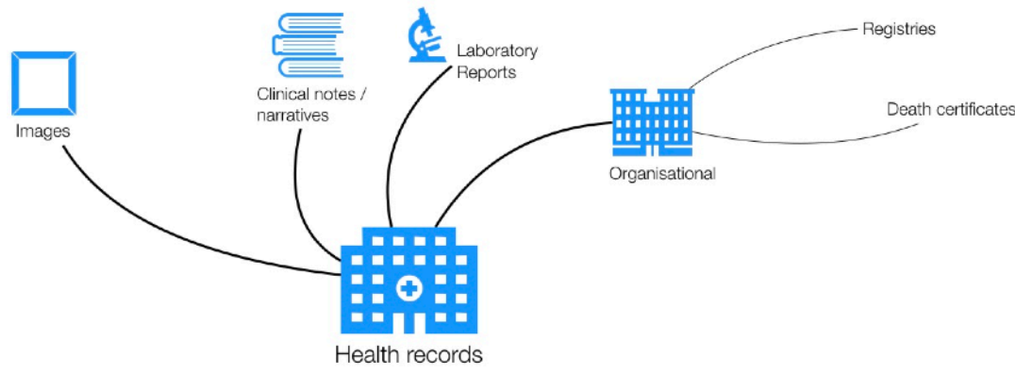
Assuming the patient information listed is correct, this maternal screen is ABNORMAL. Other possible outcomes of abnormal screens include: normal pregnancy, intrauterine fetal demise or missed abortion. If you have questions regarding this screen, please call Genetics at 800-242-2787 ext. 2020.

This is a screening test for Down syndrome, trisomy 18 and open neural tube defects. It will not detect all cases of these disorders, and its ability to identify other chromosome disorders has not been established.

The PAPP-A test uses a kit designated by the manufacturer as "for research use, not for clinical use." The performance characteristics of this test were validated by ARUP Laboratories. The U.S. Food and Drug Administration (FDA) has not approved or cleared this test. The results are not intended to be used as the sole means for clinical diagnosis or patient management decisions. ARUP is authorized under Clinical Laboratory Improvement Amendments (CLIA) and by all states to perform high-complexity testing.

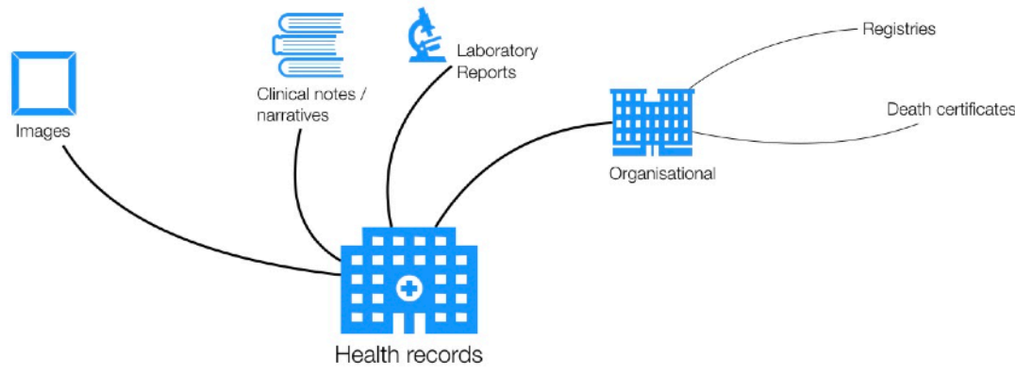
Risk estimates determined using Integrated Test Technology under license from Intema Ltd, UK.

Health Records: Laboratory Reports

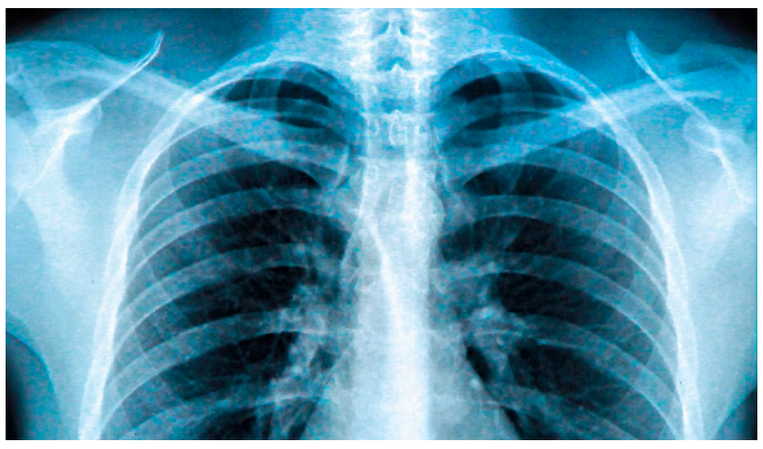
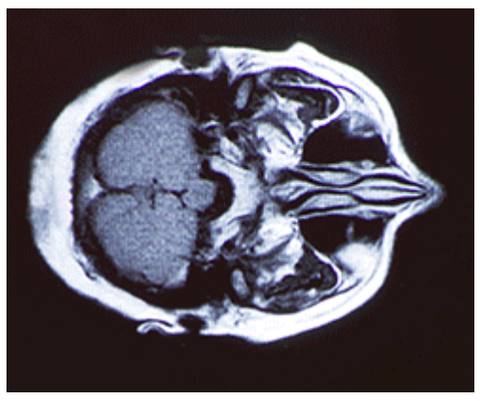
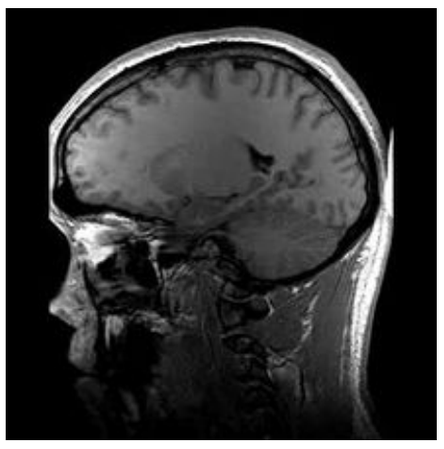


- Purpose is to communicate to clinicians the results of a test
- Often contain interpretation for the clinician
- Affected by most of the observations done for clinical notes
- Often difficult to machine-read because data is reported tabulated (and the layout is often lost)

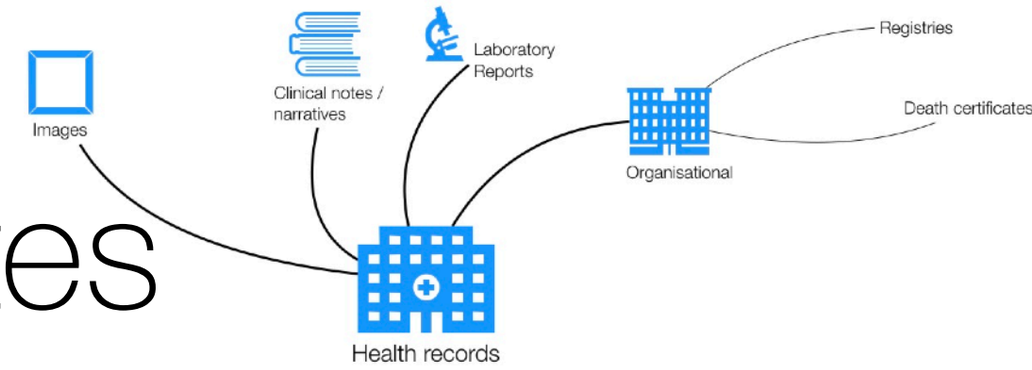
Health Records: Images



- Part of laboratory testing
- X-ray images, CT scans, MRIs, ultrasound imaging
- Sometimes images come along with textual comments/ interpretations: e.g. x-ray reports
  - Interesting for many multimodal information access tasks
- We do not discuss problems in medical image retrieval here. Plenty of work done from the community, both TBIR and CBIR. Have a look at relevant ImageCLEF tasks

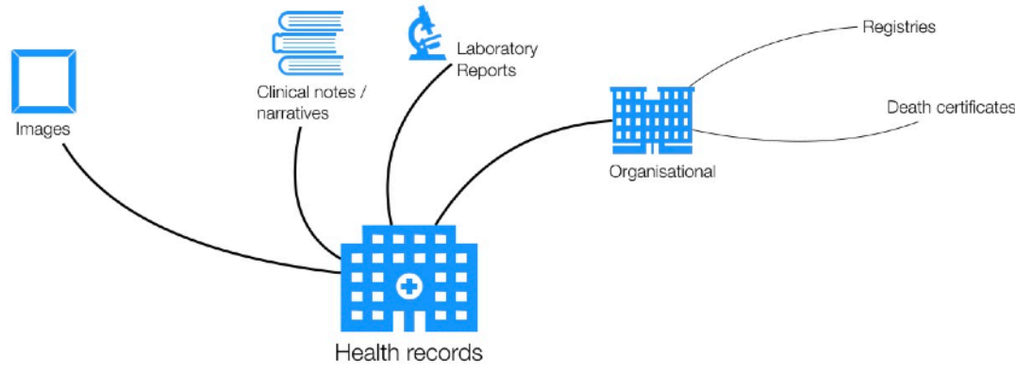





Health Records: Registries & Certificates



- Authorities collect medical data for surveillance and statistical purposes (more on these tasks later)
- Records that are collected are usually:
  - Laboratory tests and reports
  - Death certificates
  - Entries completed through forms
- Collected at population level, into purpose-built databases

Health Records: Death Certificates



Very structured: follow set template, with specific rules and meaning

Contain domain specific terminology

DEATH CERTIFICATE EXAMPLE

Name of deceased **Samuel Clock**

Date of death as stated to me **4th** day of **July** **2018** Age as stated to me **75**

Place of death **Elizabeth Infirmary, Newtown, NE3 4SA**

Last seen alive by me **3rd** day of **July** **2018**

1 The certified cause of death takes account of information obtained from post-mortem.

2 Information from post-mortem may be available later.

3 Post-mortem not being held.

④ I have reported this death to the Coroner for further action.

Please ring appropriate digit(s) and letter

ⓐ Seen after death by me.

b Seen after death by another medical practitioner but not me.

c Not seen after death by a medical practitioner.

CAUSE OF DEATH

I (a) Disease or condition directly leading to death **COMMUNITY ACQUIRED PNEUMONIA** — Approximate interval between onset and death **14 days**

(b) Other disease or condition, if any, leading to I(a) **PLEURAL MESOTHELIOMA**

(c) Other disease or condition, if any, leading to I(b)

II Other significant conditions CONTRIBUTING TO THE DEATH but not related to the disease or condition causing it **ISCHAEMIC HEART DISEASE, TYPE 2 DIABETES MELLITUS**

The death might have been due to or contributed to by the employment followed at some time by the deceased ☑

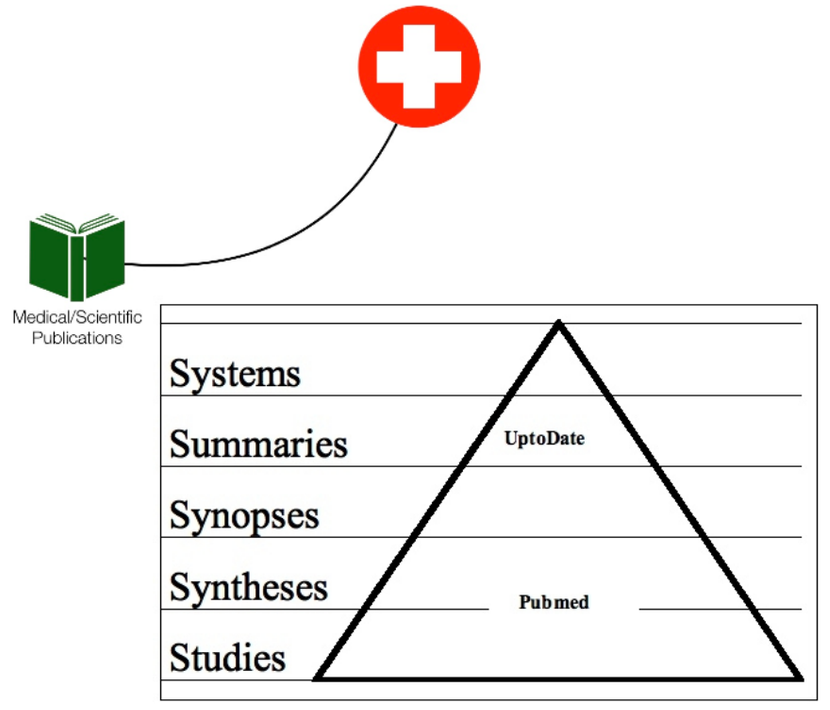
I certify that this death certificate is accurate

Signature *MSmith* **Dr Michael Smith** Qualifications **MBBS (Medicine & Surgery) - GMC 4939**

Residence **Ward 32, Elizabeth Infirmary, NE3 4SA** Date **4/7/18**

Consultant responsible for the above-named patient **Dr Tyvand**

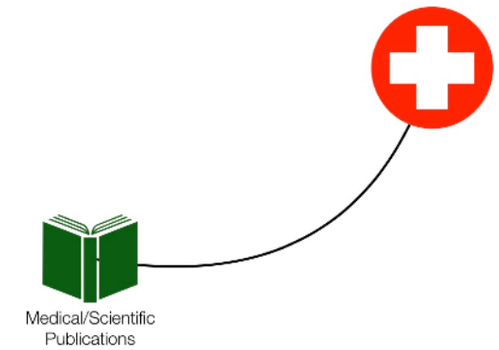
Medical Scientific Publications



[Haynes, 2007; Hoogendam et al., 2008]

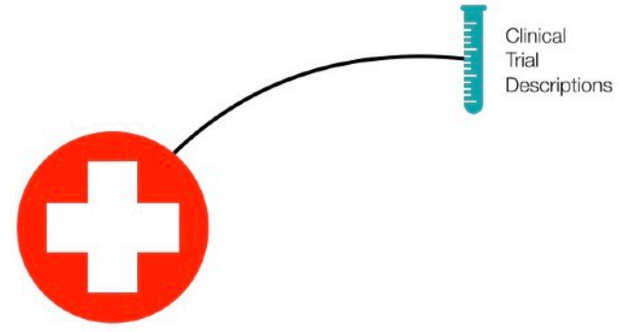
- Classification of scientific publications
- **Primary** research:
  - **Published** in journals conference proceedings, technical reports, books, etc.
    - Includes **re-analysis**, e.g., meta-analysis and systematic reviews
- **Secondary** research:
  - reviews, condensations, synopses of primary literature
  - **textbooks** and **handbooks**
  - **Guidelines** important for normalising care and measuring quality

Medical Scientific Publications



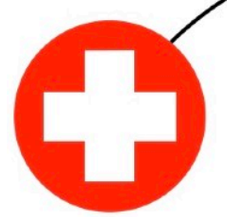
- Publications form the basis for evidence-based medicine: this is why they are important
- Often available as abstracts (full-text freely available for open publications)
- **Primary Literature**: PubMed/Medline
  - Pubmed is an interface used to search Medline, as well as additional biomedical content.
- **Secondary Literature**: Guidelines, handbooks

Clinical Trial Descriptions



- Clinical trials are experiments/observations done in clinical research
- Designed to answer specific questions about biomedical or behavioral interventions, including treatments and interventions
- Clinical trial protocol (description): document used to define and manage the trial.
    - prepared by panel of experts
    - describes scientific rationale, objective(s), design, population, methodology, statistical considerations and organization of the trial
    - Contains inclusion/exclusion criteria of participants
- Clinical trials descriptions are also used to advertise and recruit participants for the trial

Clinical Trial Descriptions



Study Description

Go to

Brief Summary:

Surgery to the shoulder may be performed with patients seated upright in a position known as the "Beach Chair Position (BCP)." This position has certain advantages compared to alternative surgical positions (e.g. side lying) in some situations. However, it has been found that surgery in the BCP can temporarily decrease the amount of oxygen in the brain as a result of the combined effects of gravity and anaesthesia. This can result in complications following surgery such as some memory loss and confusion. Rarely, more serious complications have been reported in the past including death and stroke.

Due to these reported complications the use of "cerebral oximetry" during shoulder surgery in the BCP has become more common. Before and during surger monitor placed on the patients forehead measures the amount of oxygen present in the brain to help control this to an acceptable level. A number of monitors are now commercially available. Two monitors are commonly discussed in the literature; the INVOS™ 5100 and th actual relationship between the supply of oxygen to the brain during surgery and the chance of later developing p "post operative cognitive decline" - POCD) is not clear. It is also not known if one monitor is more accurate than a

Therefore, the main aim of this study is to examine the relationship between cerebral oxygen levels during shoulde problems with memory and thinking). A second aim is to compare the INVOS™ 5100 and FORE-SIGHT® monitor cerebral desaturation events (CDEs) as well as the importance of other key clinical variables (e.g. blood pressure,

Condition or disease	Intervention/treatment
Cognitive Dysfunction	Device: Dual-monitoring

Detailed Description:

PURPOSE OF THE INVESTIGATION The purpose of this investigation is to generate evidence about cerebral oxyg incidence of POCD. Currently, evidence relating to POCD following surgery is conflicting and relates mostly to out strong need to explore this relationship in the specific context of shoulder surgery in the BCP.

INTERVENTION GROUPS This study will involve a single prospective cohort. Patients who meet the selection crit

Eligibility Criteria

Go to

Information from the National Library of Medicine

NIH NLM

Choosing to participate in a study is an important personal decision. Talk with your doctor and family members or friends about deciding to join a study. To learn more about this study, you or your doctor may contact the study research staff using the contacts provided below. For general information, Learn About Clinical Studies.

Ages Eligible for Study:	18 Years to 99 Years (Adult, Older Adult)
Sexes Eligible for Study:	All
Accepts Healthy Volunteers:	No

Criteria

Inclusion Criteria:

- Receiving treatment primarily by, but not restricted to, one of the Primary investigators for a shoulder condition that requires surgery in the BCP.
- Over 18 years of age
- Able to read and speak English

Exclusion Criteria:

- Under 18 years of age
- Pregnant women
- Pre-operative Mini-Mental State Examination (MMSE) < 24
- Pre-existing cerebrovascular disease as reported by the assessing medical consultant and recorded in patient charts
- Orthostatic hypotension
- American Society of Anaesthesiologists (ASA) physical status III, IV and V*
- History of drug and/or alcohol abuse

https://clinicaltrials.gov/ct2/show/NCT03036345

Websites

- Curated websites:
  - **Health portals**: webmd, mayoclinic, medlineplus, uptodate, medscape, everydayhealth, etc
    - Often from govt, company, edu
  - Generalist knowledge bases: **Wikipedia** (EN: 4.8 billion pageviews in 2013) and other wikis (https://en.wikipedia.org/wiki/List_of_medical_wikis)
  - **Symptom checkers**: provide diagnoses and triaging based on Q&A interaction
    - E.g. https://symptoms.webmd.com
- Provide carefully collated health information, reliable, clearly written
- Sometimes inconclusive, e.g. “consult a doctor”
- Symptom checkers often incorrect, or inconclusive
  - [Semigran et al, 2015]: 23 symptom checkers studied:
    66% of cases misdiagnosis; 43% of mis-triaged

Websites

- Un-curated websites:
  - promotional: attempt to promote a service/treatment/etc
  - experiential: reporting on the experience with a disease/ treatment/service provider
  - informational: provide info about a product/service
  - Often from company, individual (doctor, health advocate, patient), news
- Widely vary in quality, trustworthiness and ease of understanding
- Often forcefully driving to a specific choice/solution

Websites

- Un-curated:
  - **Forums**: reddit AskADoctor (et al), PatientsLikeMe, HealthTap, patient.info
    - Often connect patients with doctors
    - Of varying quality and control, e.g. Reddit VS HealthTap
  - **Social media**: increasing use of Facebook, Twitter for sharing health content [Benetoli et al., 2017]
    - Healthcare promotion, but also promotion of products/services
    - Asking/sharing health advice among personal network, personal experiences

Quality of health information online

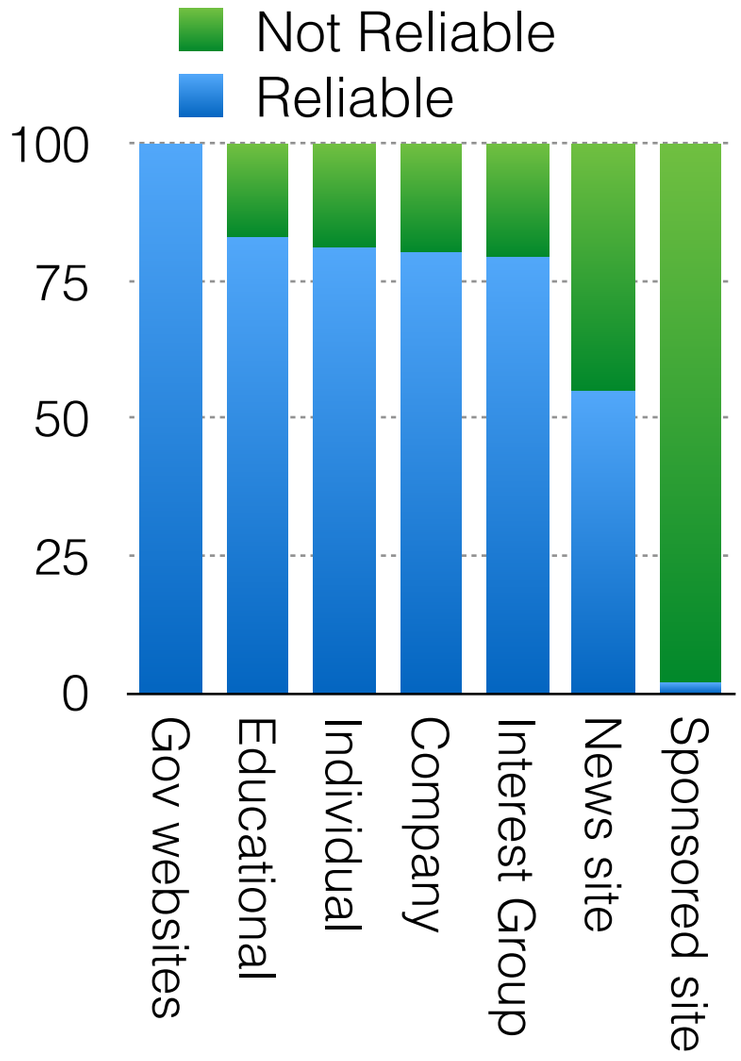
[Zhang et al., 2015]: systematic review of literature on quality of online health information (N=165). Literature has measured

1. **substance** of content: **accuracy** and completeness
2. **formality** of content: currency, **credibility** (**trustwortiness**), **readability** (**understandability**)
3. **design** of platforms: accessibility, aesthetics, navigability, interactivity, privacy, cultural sensitivity

- quality of health information **varied across medical domains and websites**
- overall **quality is problematic** (55.2% negative, 6.1% positive)
- most analysed work has not used “real” queries

Trustworthiness of health information online

- [Scullard et al., 2010]: evaluated first 100 search results for 5 paediatric web queries
- 39% gave correct information; 11% were incorrect and 49% failed to answer the question
- Correctness varied across topics, gov sites gave uniformly accurate advice

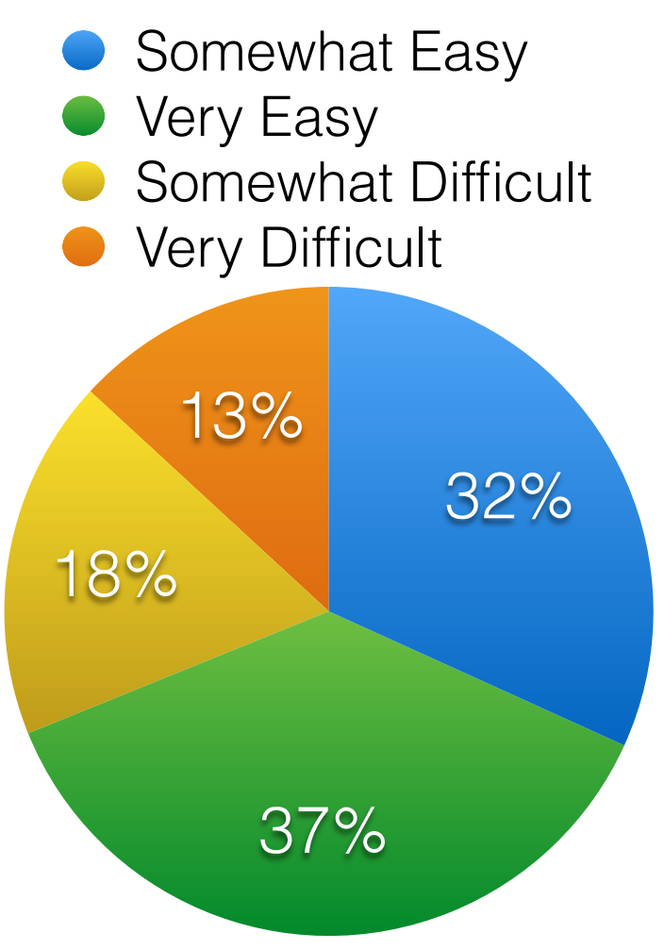


Trustworthiness of health information online

- [Rains et al., 2009]: studies what **influence credibility** of health web pages (N=86, students)
  - **structural features of pages** and **message characteristics** related to perceptions of credibility
  - **Credible** websites have: **navigation menus, links to external web sites, organisation's physical address**, **statistics, references&quotes, and identification of authorship**
- [Sbaffi&Rowley, 2017]: review of literature on health web pages trust (N=73)
  - Positive effect on trust: ease of use, content, website design, clear layout, interactive features, authority of owner/author
  - **Negative** effect on trust: **advertising**

Readability of health information online

- Many studies on readability/understandability of health web pages
- Based on **measures** of readability, e.g. [Hutchinson et al., 2016]:
  - Used Flesch Kincaid Grade Level, Gunning Fog Score, SMOG index, Coleman Liau Index, Automated Readability Index
  - Top Google results hard to understand for grade <9; NIH recommendation grade 6-7.
- Based on **assessments**:
  - [Palotti et al., 2015] analysis of CLEF 2015 CHS qrels: people trust they well understand only ~40%



High quality health webpages: HON Guidelines

- Health On the Net (HON): organisation that promotes transparent and reliable health information online
- HON **guidelines** for web pages: https://www.hon.ch/HONcode/Guidelines/guidelines.html
- This could be used as features to determine quality of page:
    - Indication of authorship (if collaborative platform: whether moderated)
    - Purpose of website
    - Confidentiality & privacy
    - Referencing and dating
    - Justification of claims, all brand names identified
    - Website contact details/contact form
    - Disclosure of funding sources
    - Advertising policy

Genomics

- Biology **literature**/research articles
- **EntrezGene**: integration of gene information and annotation of function (using GeneOntology)
  - nomenclature, reference sequences, maps, pathways, variations, phenotypes, links to genome-, phenotype-, and locus-specific resources
- **GeneRIF**: functional annotation of genes
- Model Organism Genome Databases and other databases

Users and tasks

User Task

Users & Tasks