
Lecture 2

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OUTLINE

- Objectives of Medical Informatics
- Coding information
- International systems used to measure quantities and speeds and their applications
- Data – Information - Knowledge
- Medical data

MEDICAL INFORMATICS

- Health informatics, Health care informatics or medical informatics is the intersection of information science, computer science, and health care.
 - 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:
 - Computers
 - Clinical guidelines
 - Formal medical terminologies
 - Information and communication systems.

MEDICAL INFORMATICS

- Electronic medical records
- Health information systems used for billing, scheduling, and research
- Decision support systems
- Standards (e.g. DICOM, HL7) - to facilitate the exchange of information between healthcare information systems
- Controlled medical vocabularies (CMVs):
 - Systematized Nomenclature of Medicine
 - Clinical Terms (SNOMED CT)
 - MEDCIN
 - Logical Observation Identifiers Names and Codes (LOINC)
 - MeSH

MEDICAL INFORMATICS

- European Federation for Medical Informatics
- Health informatics law:
 - legal principles as they apply to information technology in health-related fields
 - Addresses to:
 - ✦ Privacy
 - ✦ Ethical
 - ✦ operational issues
 - ✦ arises when electronic tools, information and media are used in health care delivery.
 - Applies to all matters that involve information technology, health care and the interaction of information.
 - It deals with the circumstances under which data and records are shared with other fields or areas that support and enhance patient care.

"The purpose of statistical science is to provide an objective basis for the analysis of problems in which the data depart from the laws of exact causality. A general logical system of inductive reasoning has been devised that is applicable to data of this kind, and is now widely used in scientific research."

D. J. Finney

MEDICAL / DENTISTRY STATISTICS

- Definition: it is a mathematical science pertaining to the collection, analysis, interpretation or explanation, and presentation of *data*
 - improve the quality of data
 - with the design of experiments
 - survey sampling
 - provides tools for prediction and forecasting using data and statistical models
- Branches:
 - Descriptive statistics
 - Inferential statistics

MEDICAL / DENTISTRY STATISTICS

- Descriptive statistics:
 - Summarize or describe a collection of data
- Inferential statistics:
 - Used to draw inferences about a population from a sample:
 - Estimation: parameter and confidence interval
 - Hypothesis testing (null and alternative hypotheses): determine whether the data are strong enough to reject the null hypothesis

QUANTITY OF INFORMATION

- Used to express storage capacity:

1. International Electrotechnical Commission (binary system)

- Byte / octet: 1 Byte 8 bits
- Kilobyte / 1 Kibioctet : 1 KB = 1024 bits
- Megabyte: 1 MB = 1024 Ko
- Gigabyte: 1 GB = 1024 MB
- Terrabyte: 1 TB
- ...

BITS AND BYTES

- A bit (b) is the smallest unit of data comprised of just {0,1}
- 1 nibble (-) = 4 bits (cutesy term with limited usage; mostly bitfields)
- 1 byte (B) = 8 bits (you could also say 2 nibbles)

QUANTITY OF INFORMATION

■ Used to express storage capacity:

1. International Electrotechnical Commission (binary system)

- ❑ 1 kibibyte (**KiB**) = 1,024 B = $1,024^1$ B = 1,024 B
- ❑ 1 mebibyte (**MiB**) = 1,024 KB = $1,024^2$ B = 1,048,576 B
- ❑ 1 gibibyte (**GiB**) = 1,024 MB = $1,024^3$ B = 1,073,741,824 B
- ❑ 1 kibibit (**Kib**) = 1,024 b = $1,024^1$ b = 1,024 b
- ❑ 1 mebibit (**Mib**) = 1,024 Kb = $1,024^2$ b = 1,048,576 b
- ❑ 1 gibibit (**Gib**) = 1,024 Mb = $1,024^3$ b = 1,073,741,824 b...

QUANTITY OF INFORMATION

- Used to express commercial storage capacity:

2. International System of Units (decimal system)

- 1 kilobyte (**KB**) = 1,000 B = $1,000^1$ B 1,000 B
- 1 megabyte (**MB**) = 1,000 KB = $1,000^2$ B = 1,000,000 B
- 1 gigabyte (**GB**) = 1,000 MB = $1,000^3$ B = 1,000,000,000 B
- 1 kilobit (**Kb**) = 1,000 b = $1,000^1$ b 1,000 b
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- 1 gigabit (**Gb**) = 1,000 Mb = $1,000^3$ b = 1,000,000,000 b
- *kbps* = kilobits per second → data rates

QUANTITY OF INFORMATION

- GB: hardware, memory stick, etc.
- GiB: CD, DVD, etc.
- Commercial: bit
- Internal representation: Byte
- Speed of download/upload: ... Mbps
- Speed of data processing:
 - MIPS = millions of instructions per second
 - FLOPS = FLoating-point Operations Per Second
 - Microprocessors had 4 FLOPS/cycles \rightarrow 2.5GHz = 10 billion FLOPS = 10 GFLOPS

BASIC CONCEPTS

- Data (datum) = a single piece of information, as a fact, statistic, or code; an item of data.
 - When data are processed, organized, structured or presented in a given context so as to make them useful, they are called **Information.**
- Information = consists of facts and data organized to describe a particular situation or condition

"who", "what", "where", and "when"
- Knowledge = consists of facts, truths, and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how ("how")
 - Knowledge is accumulated and integrated and held over time to handle specific situations and challenges.

INFOTMATION ≠ DATA

Data processing

- Data ↔ Information
- Medical data:
 - Patient's data
 - Health care data
 - Medical science data

Demographics &
Medical history &
Clinical data ...

Data management
...

Diseases (ICD) &
Diagnosis & Treatment &
Classifications

DATA

- ❑ Symbol set that is quantified and/or qualified.
- ❑ It simply exists and has no significance beyond its existence (in and of itself).
- ❑ It can exist in any form, usable or not.
- ❑ It does not have meaning of itself.
 - Example:
 - ❑ a spreadsheet generally starts out by holding data
 - ❑ data are the coded invariance

INFORMATION

- ❑ Data that are processed to be useful
- ❑ Provides answers to "who", "what", "where", and "when"
- ❑ Data that has been given meaning by way of relational connection. This "meaning" can be useful, but does not have to be.
- ❑ Is related to meaning or human intention
 - Example:
 - ❑ a relational database makes information from the data stored within it
 - ❑ the contents of databases, the web etc.

KNOWLEDGE

- application of data and information
- answers "how" questions
- is the appropriate collection of information, such that it's intent is to be useful.
 - Knowledge is a deterministic process.
 - **Knowledge** is embodied in humans as the capacity to understand, explain and negotiate concepts, actions and intentions.

Data, Constant, Information, Knowledge?

- Constant = something that does not or cannot change or vary

[AIDS Res Treat. 2012;2012:940580. Epub 2012 Sep 17.](#)

Morbidity and Mortality Patterns of Hospitalised Adult HIV/AIDS Patients in the Era of Highly Active Antiretroviral Therapy: A 4-year Retrospective Review from Zaria, Northern Nigeria.

[Ogoina D.](#), [Obiako RO.](#), [Muktar HM.](#), [Adeiza M.](#), [Babadoko A.](#), [Hassan A.](#), [Bansi I.](#), [Iheonye H.](#), [Iyanda M.](#), [Tabi-Ajayi E.](#)

Department of Medicine, Niger Delta University, PMB 071, Amassoma, Bayelsa State, Nigeria ; Department of Medicine, Ahmadu Bello University Teaching Hospital, PMB 06, Zaria, Kaduna State, Nigeria.

Abstract

Background. This study, undertaken in major tertiary hospital in northern Nigeria, examined the morbidity and mortality patterns of hospitalised adult HIV/AIDS patients in the HAART era. **Methods.** Between January 2006 and December 2009, admission records and causes of deaths of hospitalised medical HIV-infected patients were retrieved and analysed according to antiretroviral (ART) status. **Results.** Of the 207 HIV/AIDS patients reviewed, majority were newly diagnosed (73.4%), and most were hospitalised and died from various AIDS-defining illnesses, mainly disseminated tuberculosis and sepsis. Immune-inflammatory-reconstitution-syndrome, ART-toxicity and ART-failure, contributed to morbidity and mortality in patients receiving ART. Sixty six (31.9%) patients died, with higher mortality in males and in those with lower CD4-cell count, lower PCV, and shorter hospital stay. However, hospital stay ≤ 3 days and severe anaemia (PCV < 24%) were independent predictors of mortality. **Conclusion.** In the current HAART era, late presentation and tuberculosis continue to fuel the HIV/AIDS pandemic in Africa, with emerging challenges due to ART-related complications.

Data

The rate of incidence
of a disease

death

AIDS Res Treat. 2012;2012:940580. Epub 2012 Sep 17.

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highly active antiretroviral
therapy

Information

AIDS Res Treat. 2012;2012:940580. Epub 2012 Sep 17.

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Knowledge

[AIDS Res Treat](#). 2012;2012:940580. Epub 2012 Sep 17.

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DATA

http://www.arcpoh.adelaide.edu.au/publications/report/research/pdf_files/rr10_migrants.pdf

This report provides information on some aspects of oral health and use of dental services among migrants in Australia. Dental studies which include ethnicity, although limited in number, have indicated that migrant groups may be disadvantaged. These differences may in part be due to cultural differences as well as language barriers in accessing dental services, leaving migrants in poorer health than their Australian-born counterparts.

DATA

http://www.arcpoh.adelaide.edu.au/publications/report/research/pdf_files/rr10_migrants.pdf

Data collection

This report uses population level data collected in a series of National Dental Telephone Interview Surveys, and the associated Dental Satisfaction Surveys conducted in 1994, 1995 and 1996. Interviews were carried out with adults selected in a stratified random sample from all States and Territories in each year. Some interviews with non-English-speaking persons were carried out by multi-lingual interviewers, while for others a proxy interview was conducted on their behalf.

Method

Method

Study design: sample

DATA

http://www.arcpoh.adelaide.edu.au/publications/report/research/pdf_files/rr10_migrants.pdf

Characteristics of sample

Information was collected from 17,691 persons aged 18 years and over (response rate = 71.5%), and included questions on use of dental services, self-reported oral health and dental visiting characteristics.

data

data

data

DATA

- Abt E. Understanding statistics 2. Evidence-Based Dentistry 2010;11:93-94.
 - disease / no periodontal disease (binary data)
 - mild, moderate, severe periodontitis (ordinal data)
 - periodontal pocket depth in millimeters (quantitative data)

DATA

<http://www.nature.com/ebd/journal/v12/n2/pdf/6400799a.pdf>

In a parallel group randomised controlled trial (RCT), investigators have compared deep scaling alone vs. deep scaling with antibiotic gel. They have found a reduction in pocket depth of 0.45mm (95%CI 0.23-0.62) in the test group.

information

data

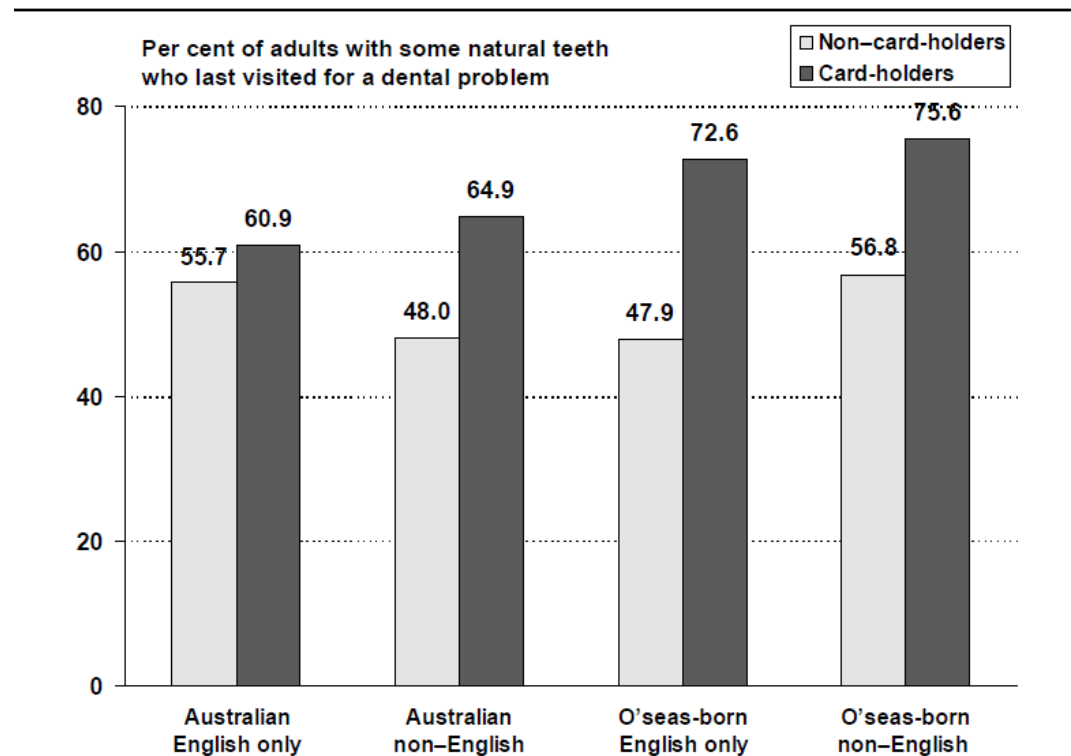
data

information

INFORMATION

http://www.arcpoh.adelaide.edu.au/publications/report/research/pdf_files/rr10_migrants.pdf

Figure 2: Last visit for a dental problem, 1994 to 1996



Source: National Dental Telephone Interview Survey 1994, 1995, 1996

INFORMATION

http://www.arcpoh.adelaide.edu.au/publications/report/research/pdf_files/rr10_migrants.pdf

Table 2: Time since last dental visit – dentate adults, 1994 to 1996

	Australian-born		Overseas-born	
	English only	Non-English	English only	Non-English
Card-holders				
<1 year	52.4	66.3	53.7	52.9
1–<2 years	18.1	*16.8	19.6	19.9
2–<5 years	15.0	*5.1	15.7	16.9
5+ years	14.5	*11.7	10.9	10.2
Non-card-holders				
<1 year	56.2	56.1	60.5	57.1
1–<2 years	18.5	22.9	17.5	19.4
2–<5 years	15.3	13.0	12.3	14.1
5+ years	10.0	7.9	9.7	9.4
Total				
<1 year	55.5	57.9	59.2	55.9
1–<2 years	18.4	21.9	17.9	19.7
2–<5 years	15.3	11.7	12.9	14.8
5+ years	10.8	8.6	9.9	9.6

* estimate has a relative standard error greater than 25%

Source: National Dental Telephone Interview Survey 1994, 1995, 1996

DATA OR INFORMATION ?

- <http://www.nature.com/ebd/journal/v12/n1/pdf/6400780a.pdf>

Question: Is there a relationship between coffee and tea intake and head and neck cancers?

Data extraction and synthesis Data from individual studies were checked for inconsistencies and pooled in a standardised way into a common database, including a range of sociodemographic, behavioural, lifestyle and health information. Data on consumption across studies were then converted into cups of de/caffeinated tea or coffee per day. The association between head and neck cancers and caffeinated coffee, decaffeinated coffee or tea intake was assessed by estimating the odds ratios (OR) and the corresponding 95% confidence intervals (95% CI) using a two-stage random-effects logistic regression model with the maximum likelihood estimator. Pooled ORs were also estimated with a fixed-effects logistic regression model. In addition, a test for heterogeneity among studies was conducted.

DATA OR INFORMATION ?

- <http://www.nature.com/ebd/journal/v12/n1/pdf/6400780a.pdf>

Question: Is there a relationship between coffee and tea intake and head and neck cancers?

Results Caffeinated coffee intake was inversely associated with the risk of cancer of the oral cavity and pharynx: the ORs were 0.96 (95% CI, 0.94–0.98) for an increment of one cup per day and 0.61 (95% CI, 0.47–0.80) in drinkers of >4 cups per day versus non-drinkers. This latter estimate was consistent for different anatomic sites (OR, 0.46; 95% CI, 0.30–0.71 for oral cavity; OR, 0.58; 95% CI, 0.41–0.82 for oropharynx/hypopharynx; and OR, 0.61; 95% CI, 0.37–1.01 for oral cavity/pharynx not otherwise specified) and across strata of selected covariates. No association of caffeinated coffee drinking was found with laryngeal cancer (OR, 0.96; 95% CI, 0.64–1.45 in drinkers of >4 cups per day versus non-drinkers). Data on decaffeinated coffee were too sparse for detailed analysis, but indicated no increased risk. Tea intake was not associated with head and neck cancer risk (OR, 0.99; 95% CI, 0.89–1.11 for drinkers versus non-drinkers).

KNOWLEDGE

- <http://www.nature.com/ebd/journal/v12/n1/pdf/6400780a.pdf>

Question: Is there a relationship between coffee and tea intake and head and neck cancers?

- Which is the risk to develop head or neck cancers if I drink more than 4 cups of coffee per day?



[Bull World Health Organ](#). 2012 Sep 1;90(9):699-704. Epub 2012 Jun 18.

Implementing early infant diagnosis of HIV infection at the primary care level: experiences and challenges in Malawi.

[Dube Q](#), [Dow A](#), [Chirambo C](#), [Lebov J](#), [Tenthani L](#), [Moore M](#), [Heyderman RS](#), [Van Rie A](#); for the CHIDEV study team.

Malawi-Liverpool-Wellcome Trust Clinical Research Programme, Queen Elizabeth Central Hospital, Blantyre, Malawi.

Abstract

PROBLEM: Malawi's national guidelines recommend that infants exposed to the human immunodeficiency virus (HIV) be tested at 6 weeks of age. Rollout of services for early infant diagnosis has been limited and has resulted in the initiation of antiretroviral therapy (ART) in very few infants.

APPROACH: An early infant diagnosis programme was launched. It included education of pregnant women on infant testing, community sensitization, free infant testing at 6 weeks of age, active tracing of HIV-positive infants and referral for treatment and care.

LOCAL SETTING: The programme was established in two primary care facilities in Blantyre, Malawi.

RELEVANT CHANGES: Of 1214 HIV-exposed infants, 71.6% presented for early diagnosis, and 14.5% of those who presented tested positive for HIV. Further testing of 103 of these 126 apparently HIV-positive infants confirmed infection in 88; the other 15 results were false positives. The initial polymerase chain reaction testing of dried blood spots had a positive predictive value (PPV) of 85.4%. Despite active tracing, only 87.3% (110/126) of the mothers of infants who initially tested positive were told their infants' test results. ART was initiated in 58% of the infants with confirmed HIV infection.

LESSONS LEARNT: Early infant diagnosis of HIV infection at the primary care level in a resource-poor setting is challenging. Many children in the HIV diagnosis and treatment programme were lost to follow-up at various stages. Diagnostic tools with higher PPV and point-of-care capacity and better infrastructures for administering ART are needed to improve the management of HIV-exposed and HIV-infected infants.



PLoS One. 2012;7(8):e43141. Epub 2012 Aug 27.

Controlling HIV Epidemics among Injection Drug Users: Eight Years of Cross-Border HIV Prevention Interventions in Vietnam and China.

Hammett TM, Des Jarlais DC, Kling R, Kieu BT, McNicholl JM, Wasinrapee P, McDougal JS, Liu W, Chen Y, Meng D, Doan N, Huu Nguyen T, Ngoc Hoang Q, Van Hoang T.

Abt Associates Inc., Cambridge, Massachusetts, United States of America.

Abstract

INTRODUCTION: HIV in Vietnam and Southern China is driven by injection drug use. We have implemented HIV prevention interventions for IDUs since 2002-2003 in Lang Son and Ha Giang Provinces, Vietnam and Ning Ming County (Guangxi), China.

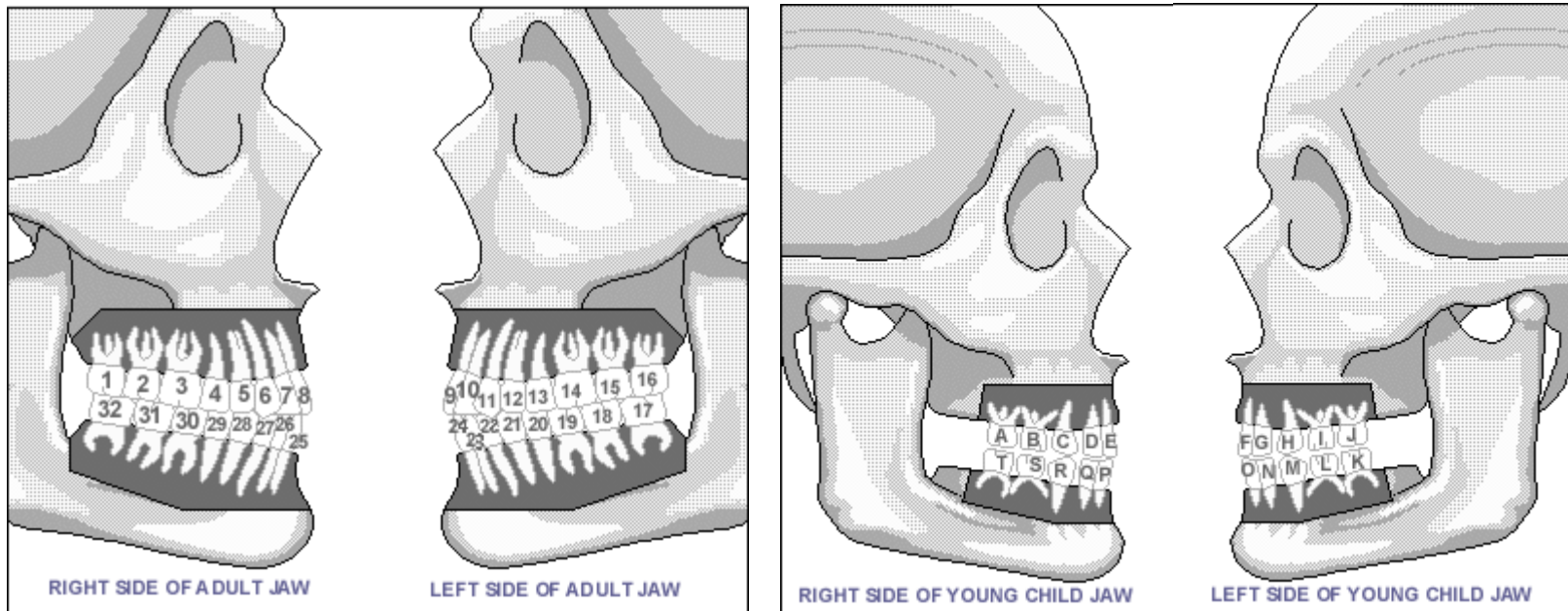
METHODS: Interventions provide peer education and needle/syringe distribution. Evaluation employed serial cross-sectional surveys of IDUs 26 waves from 2002 to 2011, including interviews and HIV testing. Outcomes were HIV risk behaviors, HIV prevalence and incidence. HIV incidence estimation used two methods: 1) among new injectors from prevalence data; and 2) a capture enzyme immunoassay (BED testing) on all HIV+ samples.

RESULTS: We found significant declines in drug-related risk behaviors and sharp reductions in HIV prevalence among IDUs (Lang Son from 46% to 23% [$p < 0.001$], Ning Ming: from 17% to 11% [$p = 0.003$], and Ha Giang: from 51% to 18% [$p < 0.001$]), reductions not experienced in other provinces without such interventions. There were significant declines in HIV incidence to low levels among new injectors through 36-48 months, then some rebound, particularly in Ning Ming, but BED-based estimates revealed significant reductions in incidence through 96 months.

DISCUSSION: This is one of the longest studies of HIV prevention among IDUs in Asia. The rebound in incidence among new injectors may reflect sexual transmission. BED-based estimates may overstate incidence (because of false-recent results in patients with long-term infection or on ARV treatment) but adjustment for false-recent results and survey responses on duration of infection generally confirm BED-based incidence trends. Combined trends from the two estimation methods show sharp declines in incidence to low levels. The significant downward trends in all primary outcome measures indicate that the Cross-Border interventions played an important role in bringing HIV epidemics among IDUs under control. The Cross-Border project offers a model of HIV prevention for IDUs that should be considered for large-scale replication.

DATA OR CONSTANT ?

- Number of teeth of a specific patient
- Normal number of teeth
(http://www.dentistry2000.com/dentalhealthcare/teeth_numbering.html)



TASK

- Look at the following 3 abstracts:

- <http://www.ncbi.nlm.nih.gov/pubmed/24069382>
- <http://www.ncbi.nlm.nih.gov/pubmed/24049294>
- <http://www.ncbi.nlm.nih.gov/pubmed/23956899>

- and identify:

- Variable
- Data
- Information
- Knowledge