

# FROM DATA TO KNOWLEDGE IN MEDICAL INFORMATICS



FACULTAD DE  
INFORMÁTICA

[4909] Biomedical Information Systems

MSc New Technologies in Computer Science

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# OUTLINE

## A. Data types in medical informatics.

Patient's data types

Temporal data

Imaging

## B. Information and knowledge in medicine.

Sources, learning, research paradigms

Procedure Knowledge & EBM

## C. New information sources.

Big challenges, QoA, CCG



## A. Data types in medical informatics

1. Patient's data types: Information System.
2. Temporal data.
3. Medical imaging.





## 1. Patient's data type:

- Unstructured
- Document oriented
- Strongly structured
- Hybrids



- Patient's data type: unstructured
  - Natural language.
  - Easily interpreted by clinicians.
    - Similar to traditional
  - Computer = Typewriter
  - Example of Clinical Information Systems:
    - Private doctor's office system
    - Records of small clinics.



# Data types in medical informatics

- Patient's data type: unstructured
  - Pros:
    - Easy to implement (smooth learning curve).
    - Easy to implant.
  - Cons:
    - Queries (computational cost).
    - No control on data introduced.

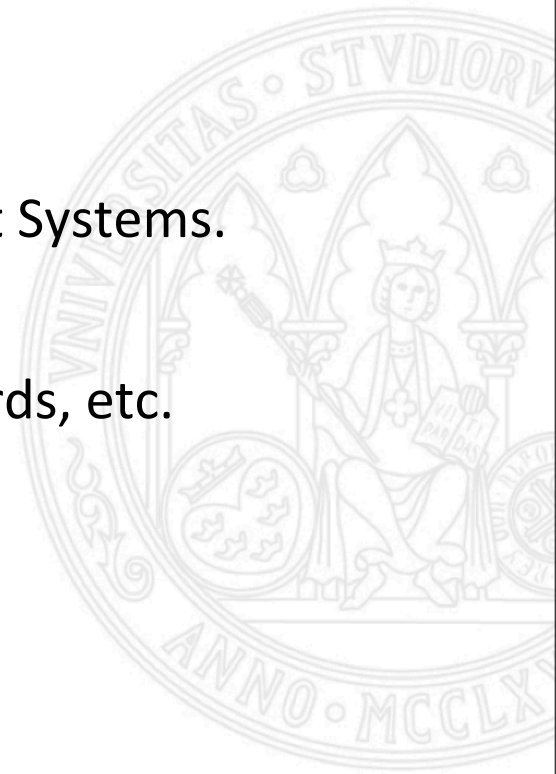


# Data types in medical informatics

- Patient's data type: document oriented
  - Natural language + Controlled text fields
  - Accepted by clinicians with minor changes.
  - In essence, Document Management Systems
    - Documents
    - Timestamps
    - Keywords: indexing.
    - Meta-data: e.g. Document labelling.
  - Example of Clinical Information Systems:
    - Clinics or small private hospitals.
    - Dental surgery
    - Rest home



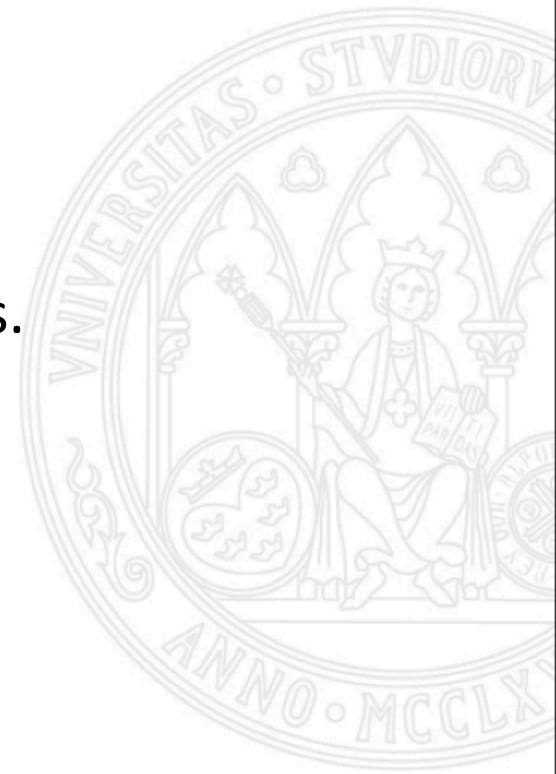
- Patient's data type: document oriented
  - Pros:
    - Smooth learning curve.
    - Easy to develop.
    - Wide experience in Document Management Systems.
    - Document monitoring: traceability, etc.
    - Queries: indexed by document type, keywords, etc.
  - Cons:
    - Redundancy in document content.
    - Queries about the document content.
    - Medical research almost impossible.



- Patient's data type: strongly structured
  - Data fields defined a-priori.
  - Great effort on requisite acquisition
  - Patient History = Form

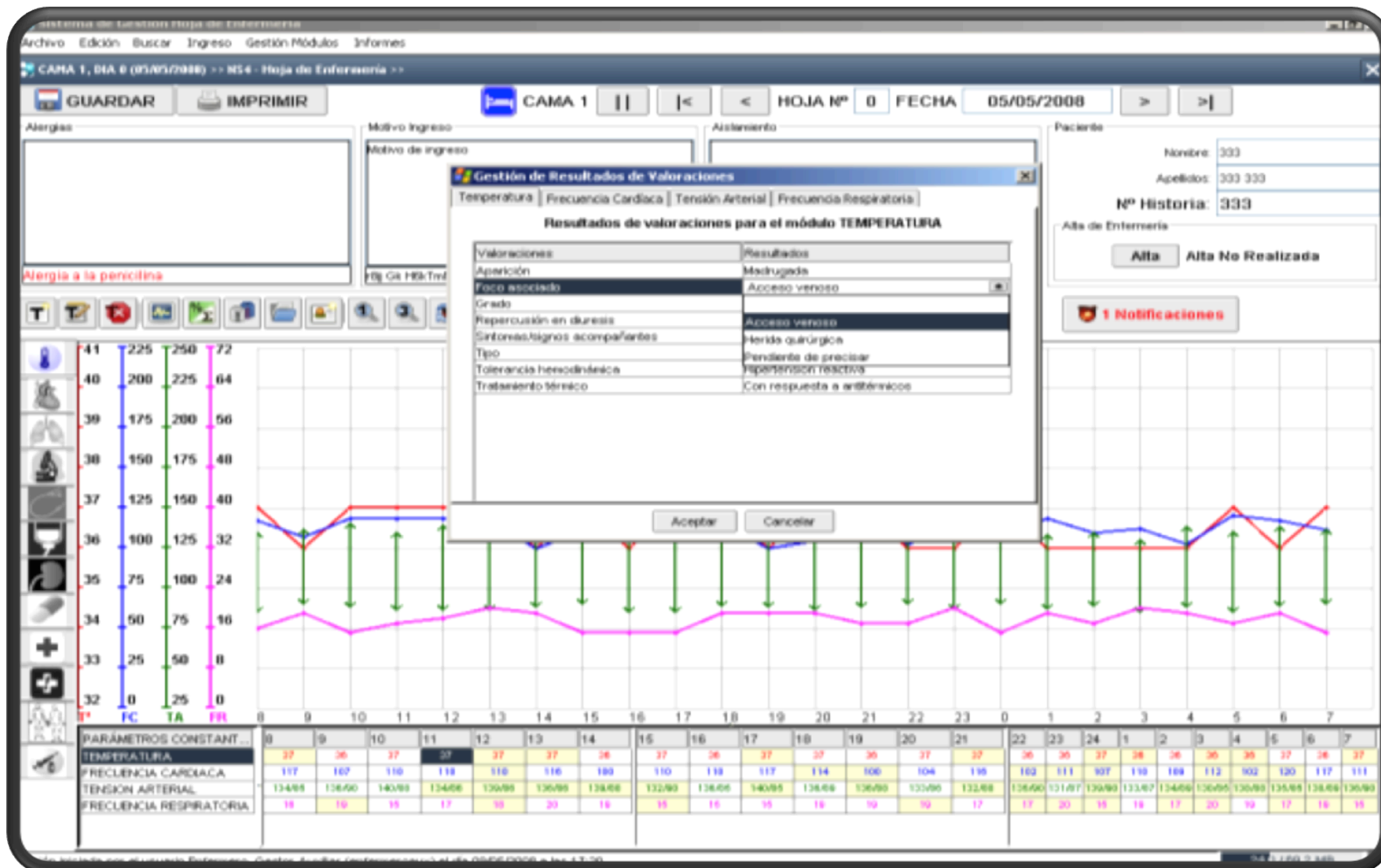


- Patient's data type: **hybrids**.
  - A. Highly structured + free text field.
    - Partial tolerance by clinical teams.
    - High probability of data redundancy.
    - Steep slope of the learning curve.
  - B. Document oriented + dynamic documents.
    - Accepted by clinical teams.
    - Possible data redundancy.
    - High maintenance cost (versions).
    - Medium learning curve.



# Data types in medical informatics

- Practical example: CH4-UCI



Source: Juárez-Campos-Morales-Palma-Marin, Applications to Temporal Reasoning in Intensive Care Units, HealthCare Engineering Journal, Sept, 2010.



# A. Data types in medical informatics

1. Patient's data type: Information System.
2. Temporal data.
  - Nature of time
  - Explicit vs. Implicit
  - Absolute vs. Relative
  - Temporal relations



- Temporal data.
  - Examples of medical activity :
    - Diagnosis of a clinical problem.
    - Evolution prediction.
    - Medical prescription.
    - Evolution monitoring.
    - Etc.

Time plays an essential role to solve these tasks!!

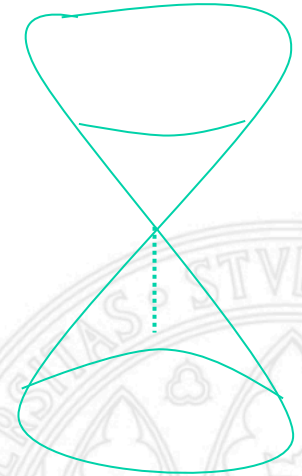
## WHAT IS TIME??

More about this topics in IKTAM course:

*Técnicas Avanzadas de Sistemas Inteligentes*



- Temporal data.
  - Time
    - Abstract concept.
    - Physical property.
    - Strongly linked to spatial dimensions.
    - Omnipresent in human activities.
    - Granularities.
  - Time management (timestamp)
    - Coordinating Universal Time (UTC): time zones.
    - Daylight saving time (DST): advancing clocks



- Temporal data
  - Time in clinical information:
    - Explicit vs. Implicit.
    - Absolute vs. Relative.
    - Time Relations.



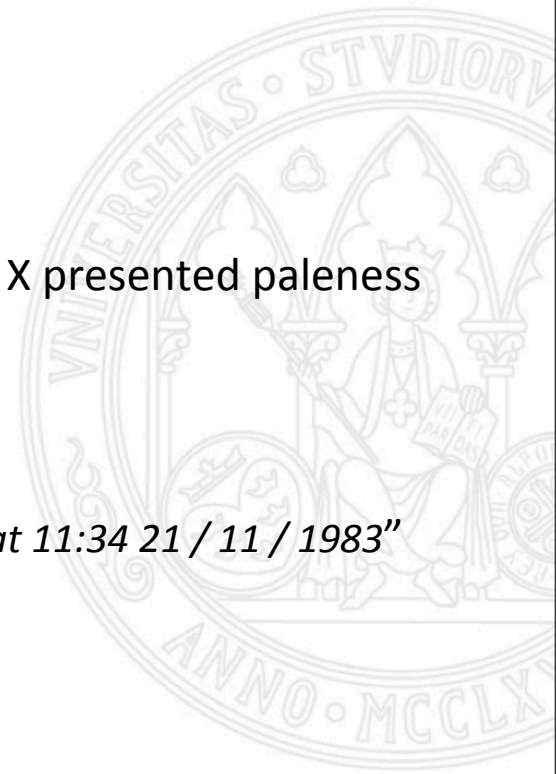
# Data types in medical informatics

- Temporal data
  - Time in clinical information:
    - Explicit vs. Implicit
      - E.g. Patient's antecedents include ...
      - E.g. Patient X presents another AMI during the second day after admission.



# Data types in medical informatics

- Temporal data
  - Time in clinical information:
    - Absolute vs. Relative
      - Reference to time origin:
        - “The second day after the admission, patient X presented paleness and capillary filling problems”
      - Absolute information:
        - *“Patients ECG showed a ST-segment re-elevation at 11:34 21 / 11 / 1983”*



# Data types in medical informatics

- Temporal data
  - Time in clinical information:
    - Time Relations.

*“**Before** tissue hypoperfussion (HT), patient X presented paleness. Capillary filling problems were observed 2 minutes **after** HT.”*

*“The chest radiography is always suggested **early after** the hospital admission for the evaluation of heart failure, aspiration pneumonia or other possible early heart or pulmonary complications” . Synthesis 9-3. 4th ed. of **Italian Guidelines for Stroke Prevention and Management**.*

- Quantitative / Qualitative relations.
- Time points / Interval entities.

- Temporal data
  - Explicit in clinical data
    - Single temporal data.
    - Time series.
    - Event sequences.
    - Heterogeneous event sequences.
    - Interval sequences.



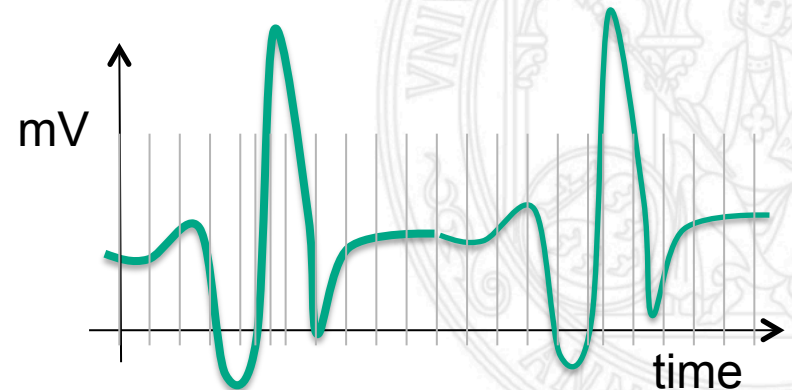
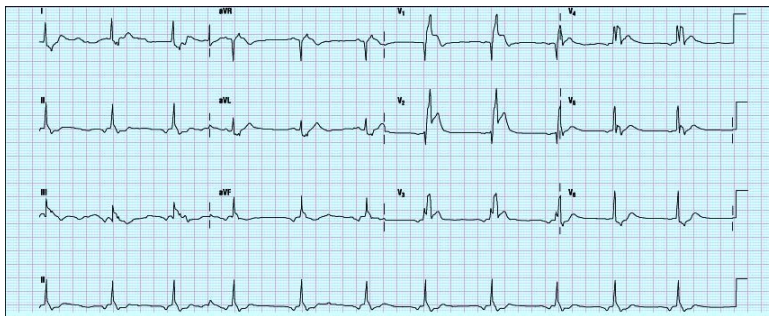


- Temporal data
  - Explicit in clinical data
    - Single temporal data.
      - Admin. information: date/hour admission, discharge,...
      - Demographic: age,...
      - Clinical actions performed.
      - Etc.



# Data types in medical informatics

- Temporal data
  - Explicit in clinical data
    - Time series.
      - Numerical values of a parameter over time (periodic samples).
      - E.g. ECG, EEG, PCG, ...etc.



More about this topic:

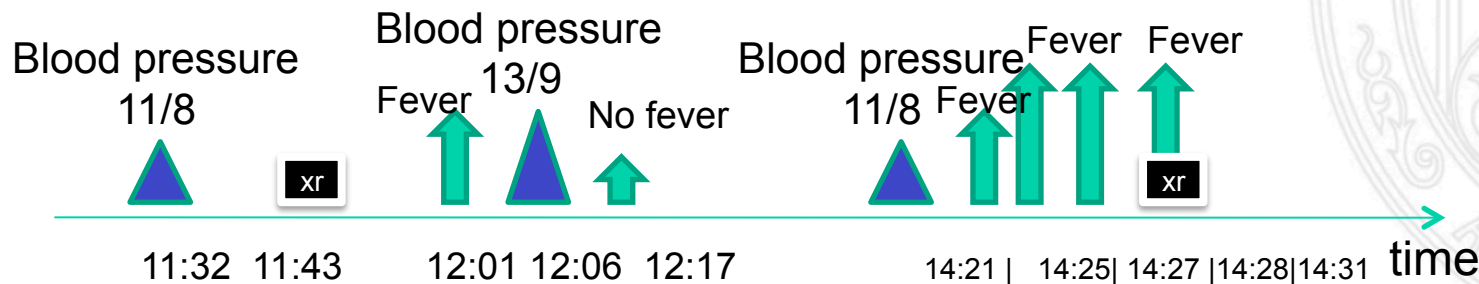
1. Seminar "Biosignal processing" (by Félix: BLOCK 2)
2. IKTAM course: Técnicas Avanzadas de Sistemas Inteligentes

- Temporal data
  - Explicit in clinical data
    - Event sequence (non periodic samples).



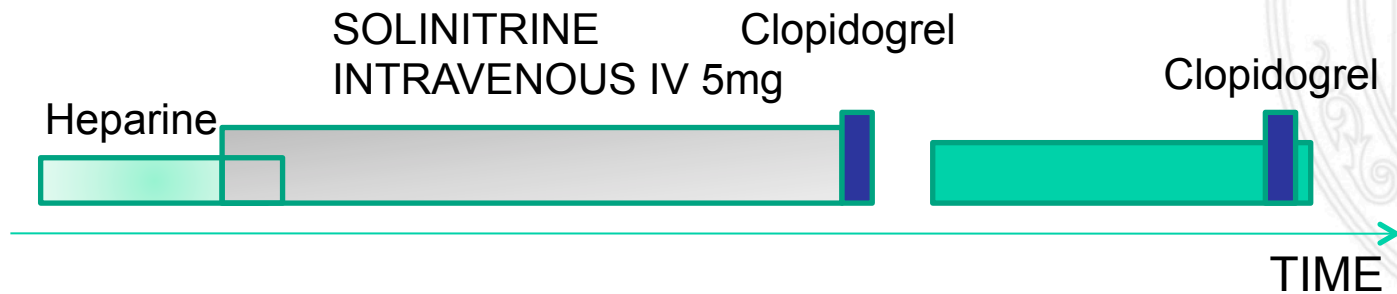
# Data types in medical informatics

- Temporal data
  - Explicit in clinical data
    - Heterogeneous event sequence



# Data types in medical informatics

- Temporal data
  - Explicit in clinical data
    - Heterogeneous interval sequence



# Data types in medical informatics

- Temporal data
  - Temporal reasoning:
    - Time relation as a constraint
    - Constraint Satisfaction Problem
    - Temporal constraint propagation
    - Check consistency of temporal networks
    - ...

More about this topic in IKTAM course:

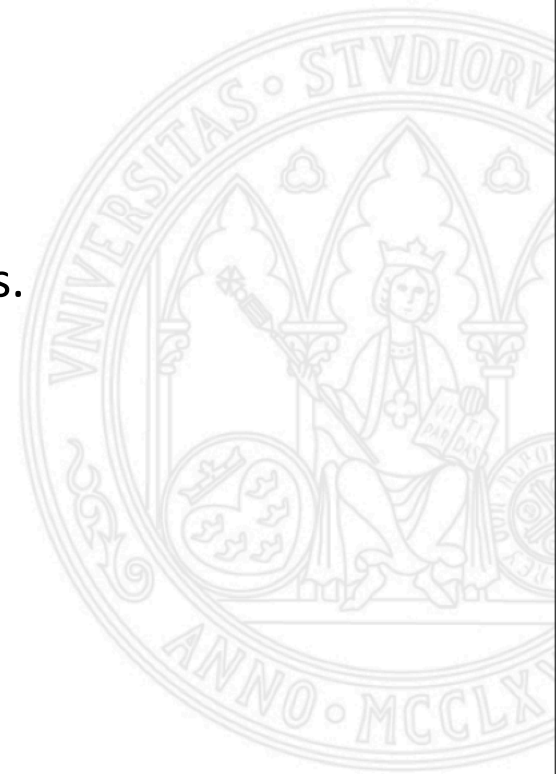
*IKTAM course: Análisis Inteligente de Datos*



# Data types in medical informatics

- Temporal data
  - Current research: *[combi et al 2010]*
    - Temporal data management: store and retrieval of heterogeneous temporal data (Database community).
    - Temporal reasoning and abstraction: discipline of A.I.
    - Design of Temporal Medical Information Systems: to solve complex problems in medicine (diagnosis, therapy planning, etc.).

- Temporal data
  - Developments in industry
    - Specialised medical applications:
      - Biosignal pattern detection and alarms.
      - Therapy administration alerts (reminders).
      - Management of timetables, personnel duties.
    - Example: ANDROID ECG





# A. Data types in medical informatics

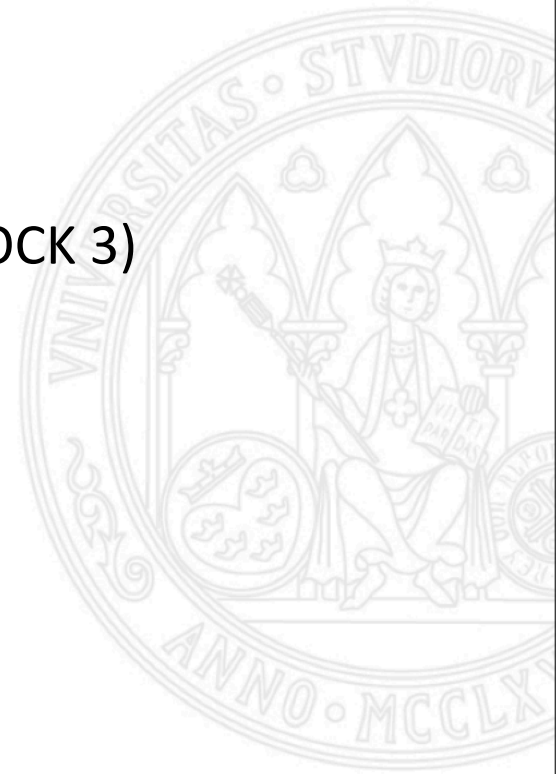
1. Patient's data type: Information System.
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# Data types in medical informatics

- Imaging
  - General image formats
  - Clinical image formats

Seminar of Biomedical Imaging (by Ginés: BLOCK 3)



# OUTLINE

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Patient's data types

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## B. Information and knowledge in medicine.

Sources, learning, research paradigms

**Procedure Knowledge & EBM**

## C. New information sources.

Big challenges, QoA, CCG



## B. Information and knowledge in medicine

1. Information source.
2. Learning.
3. Research paradigms.
4. Procedure Knowledge.
5. Evidence-Based Medicine.



- Information sources:
  - Professional colleagues.
  - Documents.
  - Web portal.



- Information sources:
  - Professional colleagues
    - Medical teams
    - Clinical sessions
    - Specialised conferences and workshops
    - Forum and specialised societies.
    - Groupware.



- Information sources.
  - Books
    - Atlas.
    - Specialised bibliography
    - Vademecum
    - Manuals, protocols, clinical guidelines.



- Information sources.
  - Publications

<http://www.ncbi.nlm.nih.gov/pubmed/>

NCBI Resources ▾ How To ▾ My NCBI Sign In

**PubMed.gov**  
U.S. National Library of Medicine  
National Institutes of Health

Search: PubMed ▾ Limits Advanced search Help



## PubMed

PubMed comprises more than 20 million citations for biomedical literature from MEDLINE, life science journals, and online books. Citations may include links to full-text content from PubMed Central and publisher web sites.

### Using PubMed

[PubMed Quick Start Guide](#)

[Full Text Articles](#)

[PubMed FAQs](#)

[PubMed Tutorials](#)

### PubMed Tools

[Single Citation Matcher](#)

[Batch Citation Matcher](#)

[Clinical Queries](#)

[Topic-Specific Queries](#)

### More Resources

[MeSH Database](#)

[Journals Database](#)

[Clinical Trials](#)

[E-Utilities](#)



- Information sources
  - Publications

<http://www.nlm.nih.gov/medlineplus/spanish/>

The screenshot shows the MedlinePlus website in Spanish. At the top, the MedlinePlus logo is displayed with the tagline 'Información de salud para usted'. Below the logo, there are links for 'Sobre MedlinePlus', 'Índice', 'FAQs', and 'Contáctenos', along with a green 'ENGLISH' button. A search bar is labeled 'Busque en MedlinePlus' with a 'BUSCAR' button. A large red banner features the text 'Nuestros videos de anatomía valen más que cien mil palabras' and 'Visite esta página para aprender cómo funciona su cuerpo', accompanied by an image of a brain. Below the banner are three orange buttons: '→ Temas de salud', '→ Medicinas y suplementos', and '→ Videos y multimedia'. On the left, a 'BÚSQUEDAS MÁS FRECUENTES' (Most Frequent Searches) widget lists terms like 'anemia', 'artrosis', 'diabetes', 'memoria', and 'tuberculosis'. The main content area is titled 'Acerca de su salud' (About your health) and includes tabs for 'Todos' (All), 'Personas mayores' (Elderly), 'Hombres' (Men), 'Mujeres' (Women), and 'Niños' (Children). Under the 'Niños' tab, a list of health topics is provided, including 'Control de peso', 'Depresión', 'Diabetes', 'Dolor de espalda', 'Ejercicio y estado físico', 'Embarazo', 'Enfermedad de obstrucción pulmonar crónica', 'Enfermedades de la piel', and 'Enfermedades del corazón'. On the right, a 'Noticias sobre la salud' (Health News) section dated '17 oct' features articles such as 'Caminar de seis a nueve millas por semana podría ayudar a salvar la memoria', 'El astigmatismo es más común en los preescolares hispanos', and '¿Es el amor romántico el analgésico de la naturaleza?'. A 'más noticias de salud' (more health news) link is also present.

Un servicio de la Biblioteca Nacional de Medicina de EE.UU.  
NIH Institutos Nacionales de la Salud

Sobre MedlinePlus Índice FAQs Contáctenos **ENGLISH** Busque en MedlinePlus  **BUSCAR**

**Nuestros videos de anatomía valen más que cien mil palabras**  
Visite esta página para aprender cómo funciona su cuerpo

→ Temas de salud → Medicinas y suplementos → Videos y multimedia

**BÚSQUEDAS MÁS FRECUENTES**

alzheimer **anemia**  
artritis **artrosis** asma  
colesterol **diabetes**  
gastritis gonorrea  
hemorroides hipotiroidismo  
**memoria**  
tuberculosis

Comparta este widget **Vea más**

**Acerca de su salud**

**Todos** Personas mayores Hombres Mujeres  
**Niños**

Control de peso  
Depresión  
Diabetes  
Dolor de espalda  
Ejercicio y estado físico  
Embarazo  
Enfermedad de obstrucción pulmonar crónica  
Enfermedades de la piel  
Enfermedades del corazón

**17 oct** **Noticias sobre la salud**

[Caminar de seis a nueve millas por semana podría ayudar a salvar la memoria](#)

[El astigmatismo es más común en los preescolares hispanos](#)

[¿Es el amor romántico el analgésico de la naturaleza?](#)

[más noticias de salud](#)

## B. Information and knowledge in medicine

1. Information source.
2. **Learning.**
3. Research paradigms.
4. Procedure Knowledge.
5. Evidence-Based Medicine.



# Information and knowledge in medicine

- Learning from experience
  - Knowledge types:
    - Tacit knowledge
    - Explicit knowledge
    - **Episodic knowledge**←



# Information and knowledge in medicine

## Sanidad confirma 15 casos de paperas en un brote epidémico en la provincia de Segovia

- Ninguno de los pacientes ha precisado hospitalización



Complejo Asistencial de Segovia - GOOGLEMAPS



ABC

Segovia - Actualizado: 23/09/2019 14:28h



1

La consejera de Sanidad de la Junta de Castilla y León, Verónica Casado, ha confirmado este lunes la existencia de **15 casos**



Publicidad

¿QUIERES DESCUBRIR  
LAS FRONTERAS  
DE LA CIENCIA?

La nueva newsletter  
de ABC.es Ciencia.

Susíbete aquí

ABC.es Ciencia  
Para los que buscan respuestas.



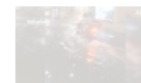
LO MÁS LEÍDO EN ABC

Castilla y León

ABC

1

VÍDEO: Inundaciones  
en Valladolid



2

Mueren dos personas  
tras caer a un pozo en  
una empresa de  
piensos en Valladolid



Guillermo Garabito

Guillermo Garabito



# Information and knowledge in medicine

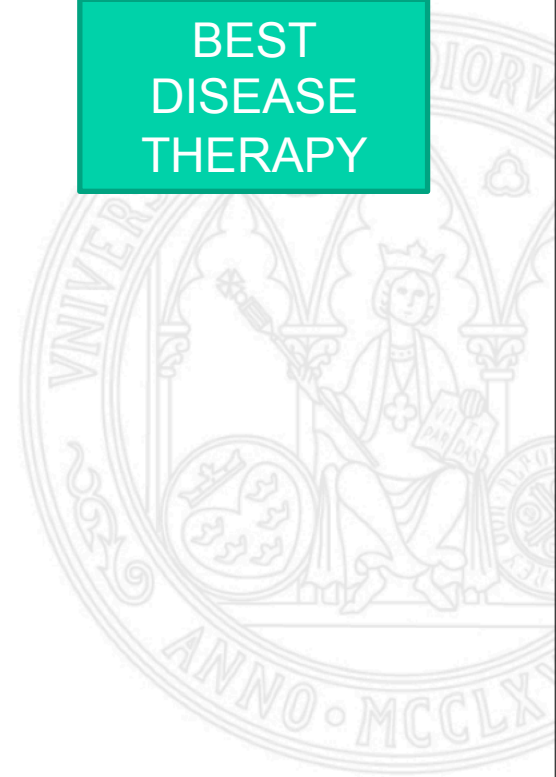
- Learning from experience

DISEASE  
EXISTENCE

DISEASE  
FORM

DISEASE  
PROGRESS

BEST  
DISEASE  
THERAPY



# Information and knowledge in medicine

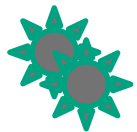
- Learning from experience

DISEASE  
EXISTENCE

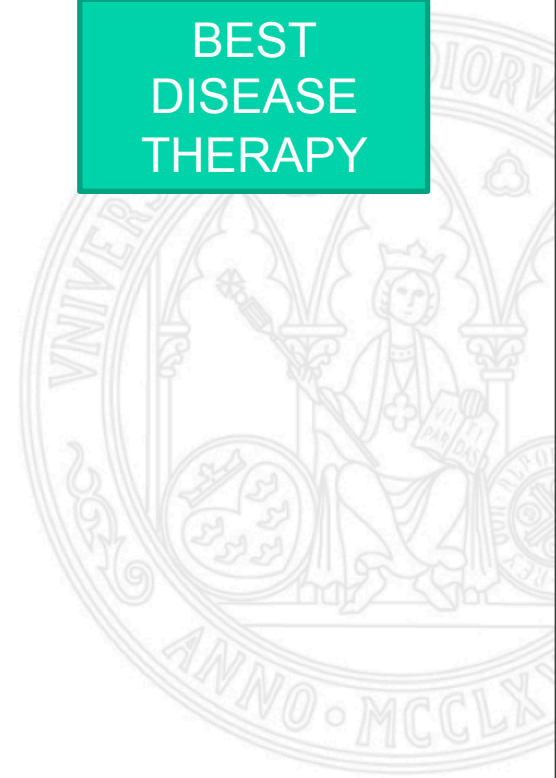
DISEASE  
FORM

DISEASE  
PROGRESS

BEST  
DISEASE  
THERAPY



UNUSUAL  
CASES



# Information and knowledge in medicine

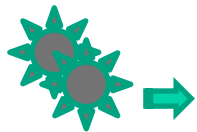
- Learning from experience

DISEASE  
EXISTENCE

DISEASE  
FORM

DISEASE  
PROGRESS

BEST  
DISEASE  
THERAPY



UNUSUAL  
CASES

OBSERVATION



# Information and knowledge in medicine

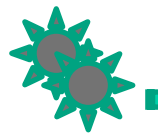
- Learning from experience

DISEASE  
EXISTENCE

DISEASE  
FORM

DISEASE  
PROGRESS

BEST  
DISEASE  
THERAPY



UNUSUAL  
CASES

OBSERVATION

ARTICLE  
DESCRIBE  
OBSERVED  
FACTS



# Information and knowledge in medicine

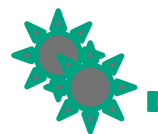
- Learning from experience

DISEASE  
EXISTENCE

DISEASE  
FORM

DISEASE  
PROGRESS

BEST  
DISEASE  
THERAPY



UNUSUAL  
CASES

OBSERVATION

ARTICLE  
DESCRIBE  
OBSERVED  
FACTS

ATENCIÓN  
ATENCIÓN  
RELEVANT  
FOR  
SPECIALISED  
GROUP OF  
INTEREST

- Learning from experience
- Case of study: “Measles/mumps/rubella vaccine” controversy

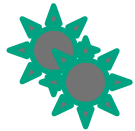
[Chap 3. Taylor06]



# Information and knowledge in medicine

- Learning from experience
- Case of study: “Measles/mumps/rubella vaccine” controversy

[Chap 3. Taylor06]



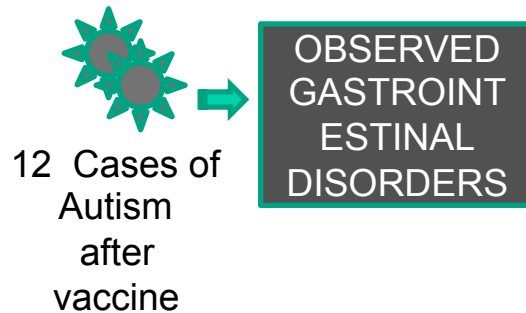
12 Cases of  
Autism  
after  
vaccine



# Information and knowledge in medicine

- Learning from experience
- Case of study: “Measles/mumps/rubella vaccine” controversy

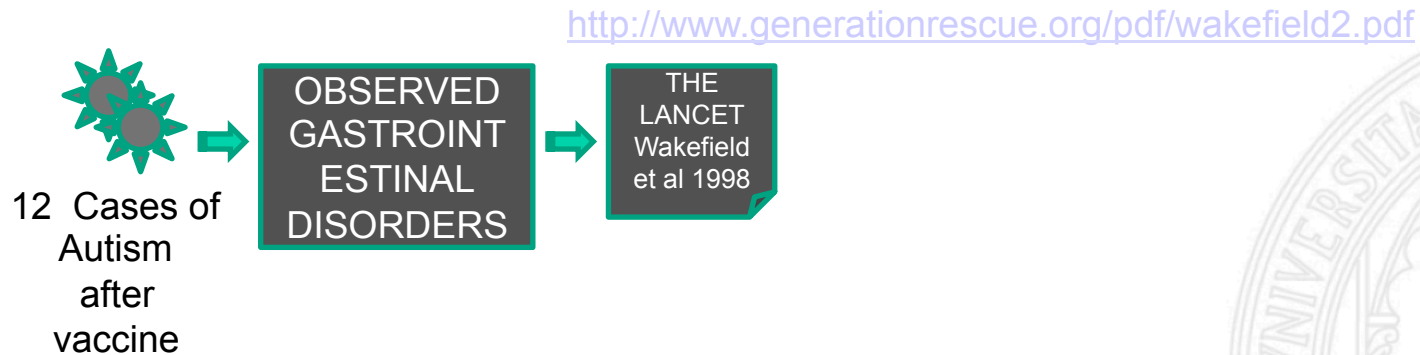
[Chap 3. Taylor06]



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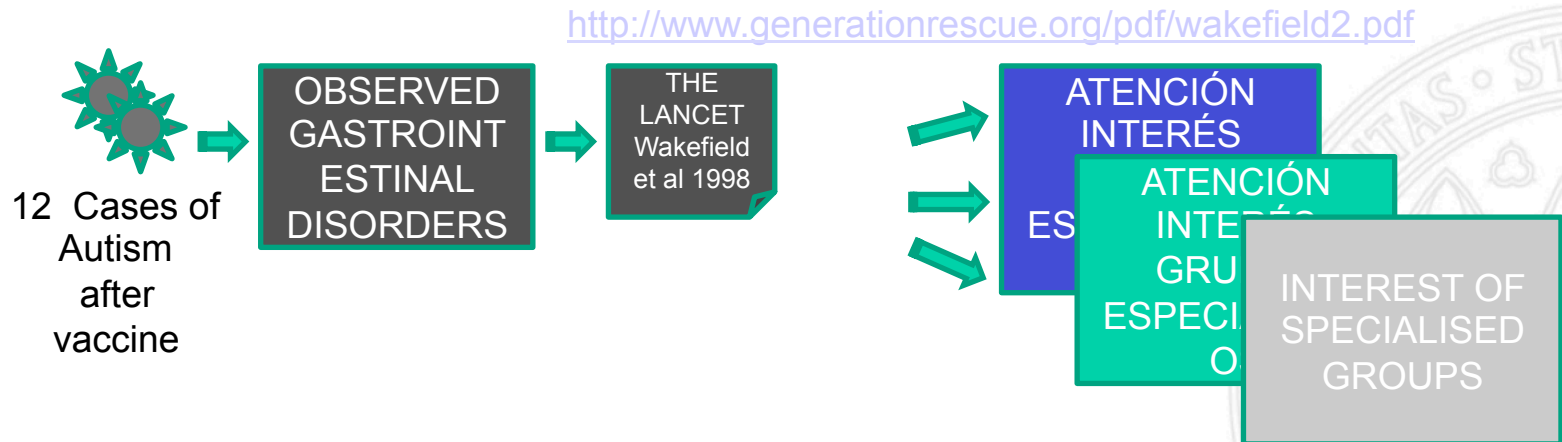
[Chap 3. Taylor06]



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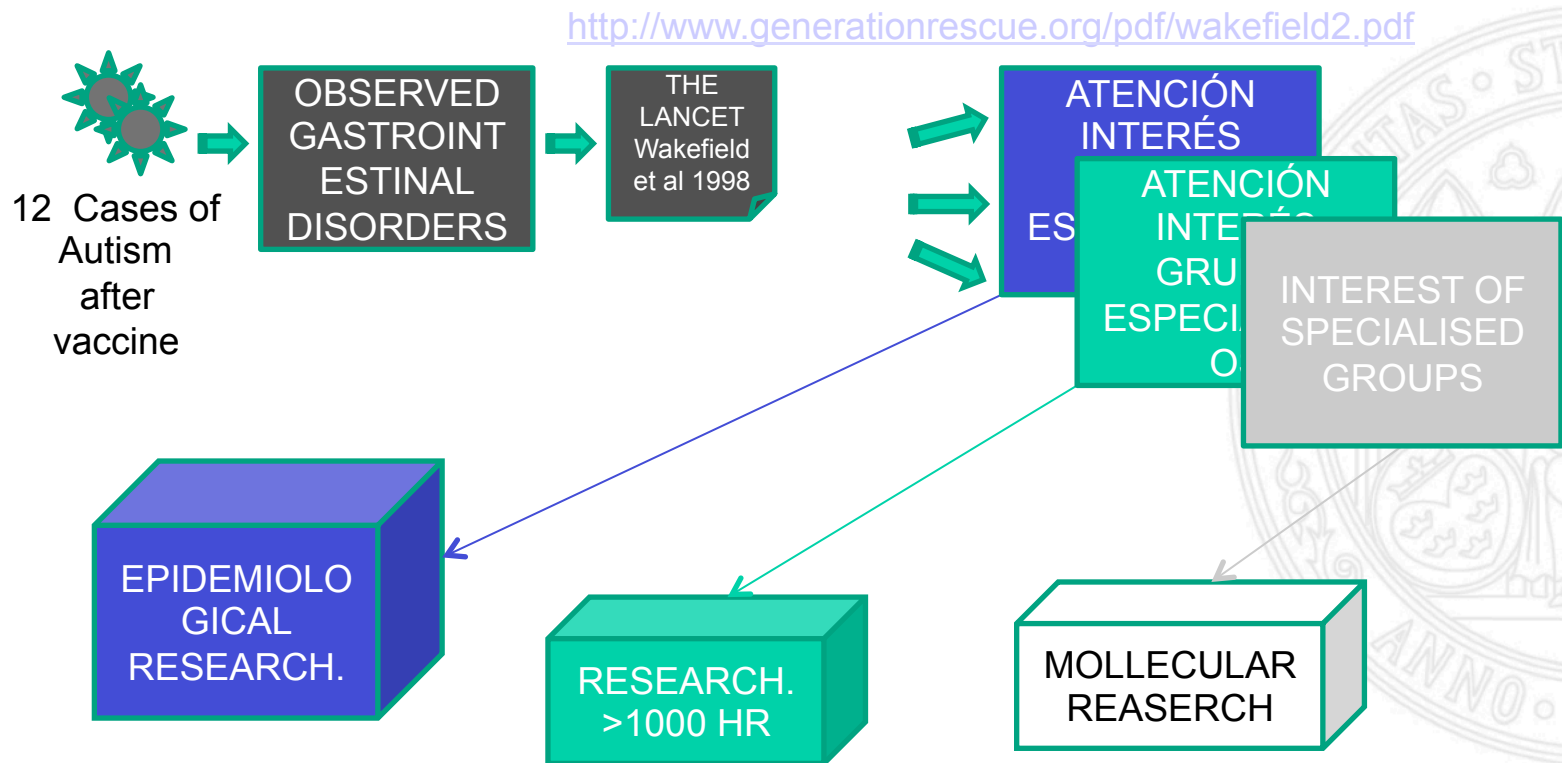
[Chap 3. Taylor06]



# Information and knowledge in medicine

- Learning from experience
- Case of study: “Measles/mumps/rubella vaccine” controversy

[Chap 3. Taylor06]



## B. Information and knowledge in medicine

1. Information source.
2. Learning.
3. **Research paradigms.**
4. Procedure Knowledge.
5. Evidence-Based Medicine.





# Information and knowledge in medicine

- Research paradigms:
  - Be objective.
  - Free of prejudices or expectations.
  - Not always possible: subjective evaluation sometimes necessary.
- Experimental research:
  - Methods: objective, experimental, quantitative.
  - Scientific methods.
  - E.g. Physical science.
- Observational Research:
  - Observational methods: low volume of data, qualitative.
  - E.g. Sociology and Psychology sciences.
- Subjective + Objective + Qualitative + Quantitative
  - E.g.: “Measure the impact of acupuncture on back pain”.
  - E.g.: “Economic study of monitoring patients with lung cancer”



# Information and knowledge in medicine

- Reserach paradigms:
  - Cases of study.
  - Longitudinal survey.
  - Clinical trial with random control.



# Information and knowledge in medicine

- Research paradigm:
  - Case of study: [chap 3. Taylor 2009]

“In September 1994 doctors at Guy’s Hospital examined a

“A  
“Both these cases were histopathologically confirmed as

- Usual cases: useful in education, explain facts in a more theoretical context.
- Unusual cases: useful to explain an scenario that cannot be classified.
- Acquisition: clinician resource used to explain professional scenarios to other non-clinical professionals (e.g. computer scientists)

# Information and knowledge in medicine

- Research paradigms: [chap 3. Taylor 2009]
  - Longitudinal survey

“Framingham is a community near Boston. Since 1948 it has also been the subject of an extraordinary exercise in the

4 ye TODAY: research on genetic aspects.

**But, how?**

igh blood

prea In Utility of this kind of study:

- lifestyle factors
- study of diseases with high impact on population
- identify and quantify risk factors

# Information and knowledge in medicine

- Research paradigms:

- Longitudinal survey.

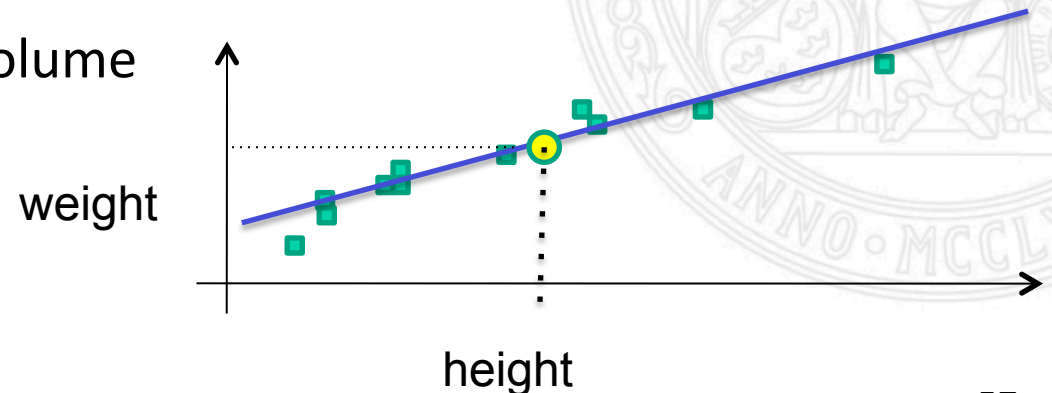
Mathematics: regression.

Linear regression:  $y=a+bx$

E.g. Height and weight of some population and **predict** weight given a new height value.

Get the best (straight) **line** that represent better the dataset ( an approximation).

Dependence on the data volume



# Information and knowledge in medicine

- Research paradigm:

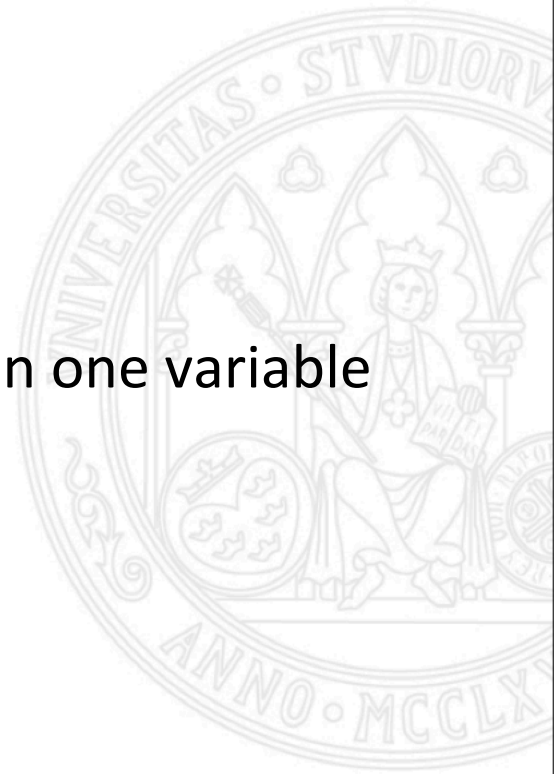
- Longitudinal survey.

Mathematics: regression.

Multivariable regression:

The parameter of study depends on more than one variable  
(extension of the linear regression model)

$$y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$$



# Information and knowledge in medicine

- Research paradigms:

- Longitudinal survey.

Mathematics: regression.

Advanced regression:

cardiovascular risk prediction depends on non numerical observations (yes/no), or limited to some numerical ranks.

Transform this values to a linear expression, calculate the regresion and revert the transformation.

This is known as **LOGIT** (replace x by  $\ln(x/1-x)$ ) and the caculi of the logistic regression

$$\ln(p/1/1-p)=a+b_1x_1+b_2x_2+..+b_nx_n$$

# Information and knowledge in medicine

- Research paradigms:

## **Random Control Trial or RCT**

*Example: "Establishment of the treatment effectiveness"*

1. *Select a set of homogeneous people.*
2. *Provide the treatment to a subset of this group "intervention group"*
3. *Analyse the evolution/state of the non treated group "control group"*
4. *Keep the experimental environment under control.*
5. *Objective collection of all effects observed.*

### **Outcome:**

*The intervention (therapy) is positive, respect to do nothing.*

### **Limits:**

*Problems with a binary solution: simple questions YES/NO*

*In most cases, unknown factors and clear answers cannot be considered.*

"On the  
Salisbury  
in gener  
knees.  
They lay  
had one  
cider a d  
upon an  
mouths.  
**Two oth**  
stomach  
  
The **cor**  
perceive  
them be  
of any in  
to the rest of the sick."



# Information and knowledge in medicine

- Research paradigms:

- Random Control Trial (RCT)

Evaluation of drug X.

Individuals = 100

Intervention Group = 50 (random selection)

Control Group = 50

Control group: overcome the disease 30 of 50

Intervention group: overcome the disease 35 of 50

Improvement using drug X :  $35/50 - 30/50 = 0.1$

**Is this improvement enough? Which proportion is significant (relevant)?**

→ Using statistics tests (bioestadistic field)



## B. Information and knowledge in medicine

1. Information source.
2. Learning.
3. Research paradigms.
4. **Procedure Knowledge.**
5. Evidence-Based Medicine.



# Information and knowledge in medicine

- Procedure Knowledge:
  - Clinical Practice Guideline (CPG).
    - Document: recommendations
    - Decision support.
      - Diagnosis, management, therapy.
    - Specialised.
      - Concrete pathology, concrete scenario.
  - CPG 'Guides' during the whole process.
    - Prevention, diagnosis, prognosis, therapy and rehabilitation.



# Information and knowledge in medicine

- Procedure Knowledge:
  - Clinical Practice Guideline.

## Italian Guideline for Stroke Prevention and Management

<http://www.spread.it/>

**Synthesis 9.1:** A stroke victim should rapidly be assessed after hospitalisation, by means of a general examination and [...]

- **Recommendation 9.1 and 9.2:** an early and standardized neurological evaluation is recommended in the setting of a qualitatively adequate management of acute stroke.
- **Recommendation 9.4:** [...] the following blood exams are recommended: complete blood count including platelets, [...], and coagulation tests [...].
- **Recommendation 9.6:** The electrocardiogram is recommended in all suspected stroke victims who are admitted to an Emergency Room.

# Information and knowledge in medicine

- Procedure Knowledge:
  - Clinical Practice Guideline: resources

<http://www.sign.ac.uk>

**SIGN**  
Scottish Intercollegiate Guidelines Network

Home

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New on the site

15 October 2010  
Prevention and management of venous thromboembolism implementation event registration form added.

17 September 2010  
Implementing GRADE - statement of principles

14 September 2010  
Implementation news added

1 September 2010  
Management of chronic venous leg ulcers published

2 August 2010  
Revised guideline programme summary

**SIGN 120 MANAGEMENT OF CHRONIC VENOUS LEG ULCERS**  
BACKGROUND

**SIGN GUIDELINE ON PREVENTION AND MANAGEMENT OF VENOUS THROMBOEMBOLISM**  
Implementation Event  
Friday 10<sup>th</sup> December 2010  
Royal College of Physicians of Edinburgh  
[CLICK HERE TO REGISTER ONLINE](#)

**CHRISTINA POTTINGER, FIRST HEAD OF SIGN**  
Christina Pottinger who was

<http://www.guidelines.gov>

U.S. Department of Health & Human Services

**AHRQ** Agency for Healthcare Research and Quality  
Advancing Excellence in Health Care

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**National Guideline Clearinghouse**

NGC is a public resource for evidence-based clinical practice guidelines.

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**New This Week**  
October 16, 2010

**New/Updated Guideline Summaries**

- CDC, EAUN, ICSI, NHCHC, RIAO, WSDLI

[View All](#)

**Announcements**

U.S. Food and Drug Administration (FDA) Advisories

- October 13, 2010: Bisphosphonates (Osteoporosis Drugs) [↗](#)
- October 8, 2010: Meridia (sibutramine) [↗](#)

[Market Withdrawal](#)

[More...](#)

## B. Information and knowledge in medicine

1. Information source.
2. Learning.
3. Research paradigms.
4. Procedure Knowledge.
5. **Evidence-Based Medicine.**



# Information and knowledge in medicine

- Evidence-Based Medicine (EBM)
  - Clinical practice model
  - Definition: *“the conscientious, explicit and judicious use of **current best evidence** in making decisions about the care of the individual patient. It means integrating individual clinical expertise with the best available external clinical evidence from **systematic research**”* [Sackett-96]
  - Individual experience
  - Systematic research technique.

# Information and knowledge in medicine

- Evidence-Based Medicine (MBE)

Example:

## **Evidence declaration:**

- Ia Evidence obtained from the meta-analysis of different RCT.
- Ib Evidence obtained from a single RCT.
- IIa Evidence obtained from a Control Trial (no random)
- IIb Evidence obtained from a quasi-experimental study
- III Evidence obtained from a good non experimental study, such as a comparative analysis, correlation study or a cases study.
- IV Evidence obtained from a expert committee report and/or the opinions of experts in the field.



# Information and knowledge in medicine

- Evidence-Based Medicine (MBE)

Example:

## Recommendations degrees:

- A** Require, at least, a RCT as part of the bibliographical references with a high quality level (Ia & Ib)
- B** Requires a clinical trial (not random, but well designed) (IIa-III).
- C** Requires the supervision of an expert committee.

# Information and knowledge in medicine

EMB

in

Clinical

Guidelines

[http://www.spread.it/files/SPREAD\\_6\\_2010\\_sintesi.pdf](http://www.spread.it/files/SPREAD_6_2010_sintesi.pdf)

28 SPREAD – Stroke Prevention and Educational Awareness Diffusion  
Ictus cerebrale: Linee guida italiane

Raccomandazione 7.5 d

Grado A

Per la prevenzione primaria dell'ictus cerebrale ischemico nei pazienti ad elevato rischio trombotico (storia di coronaropatia, vasculopatia periferica, o diabete mellito associato ad un altro fattore di rischio come l'ipertensione, livelli elevati di colesterolemia totale, bassi livelli di colesterolo HDL, fumo o microalbuminuria) **è indicato** il trattamento con ramipril raggiungendo progressivamente il dosaggio di 10 mg/die oppure con telmisartan a 80 mg.

Sintesi 7-3

Un'ampia metanalisi ha confermato che i benefici del trattamento antipertensivo sono simili nei soggetti di età maggiore di 65 anni rispetto a quelli più giovani. Lo studio HYVET ha inoltre dimostrato che i benefici del trattamento sono presenti anche in soggetti di età superiore agli 80 anni. La terapia anti-pertensiva può quindi essere continuata o iniziata anche a questa età. Dal momento che gli anziani dello studio HYVET erano in buone condizioni di salute, i dati non necessariamente possono essere estrapolati agli ultrarottantenni con altre patologie o fragili e la decisione sul trattamento andrebbe effettuata su base individuale.

Raccomandazione 7.6

Grado B

Nel paziente con fibrillazione atriale cronica e parossistica



# OUTLINE

## A. Data types in medical informatics.

Patient's data types

Temporal data

Imaging

## B. Information and knowledge in medicine.

Sources, learning, research paradigms

Procedure Knowledge & EBM

## C. **New information sources.**

**Big challenges, QoA, CCG**



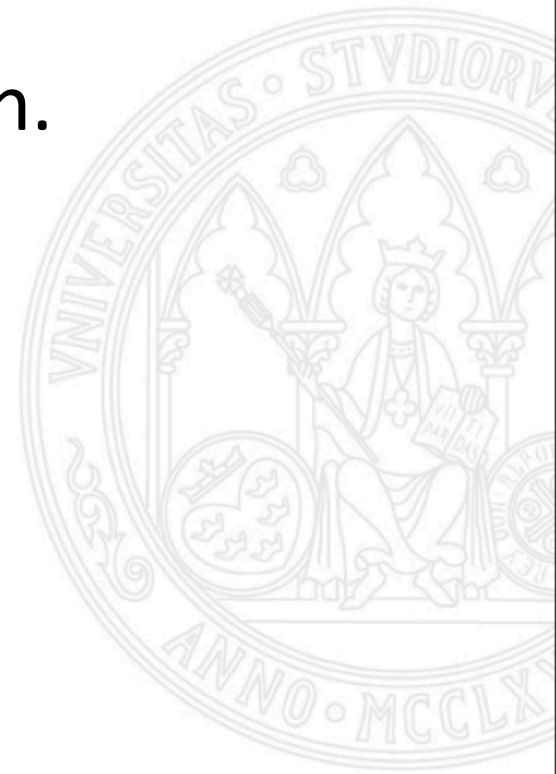
## C. New information sources in medical informatics

1. Big challenges.
2. Quality of Assistance support
3. Computational Clinical Guidelines



# New information sources in medical informatics

- Big Challenges: [Taylor06]
  - History of the Patient.
  - Medical Knowledge Construction.
  - Medical Knowledge Access.



## C. New information sources in medical informatics

1. Big challenges.
2. **Quality of Assistance support**
3. Computational Clinical Guidelines



# New information sources in medical informatics

- Quality of Assistance Support



## WOMKA project

Hospital-Clinic Virgen de la Vega, Paediatric Service (Murcia).

Goals:

itinerant staff

improve the quality of reports

make persistent the knowledge of the service

not overload the physicians

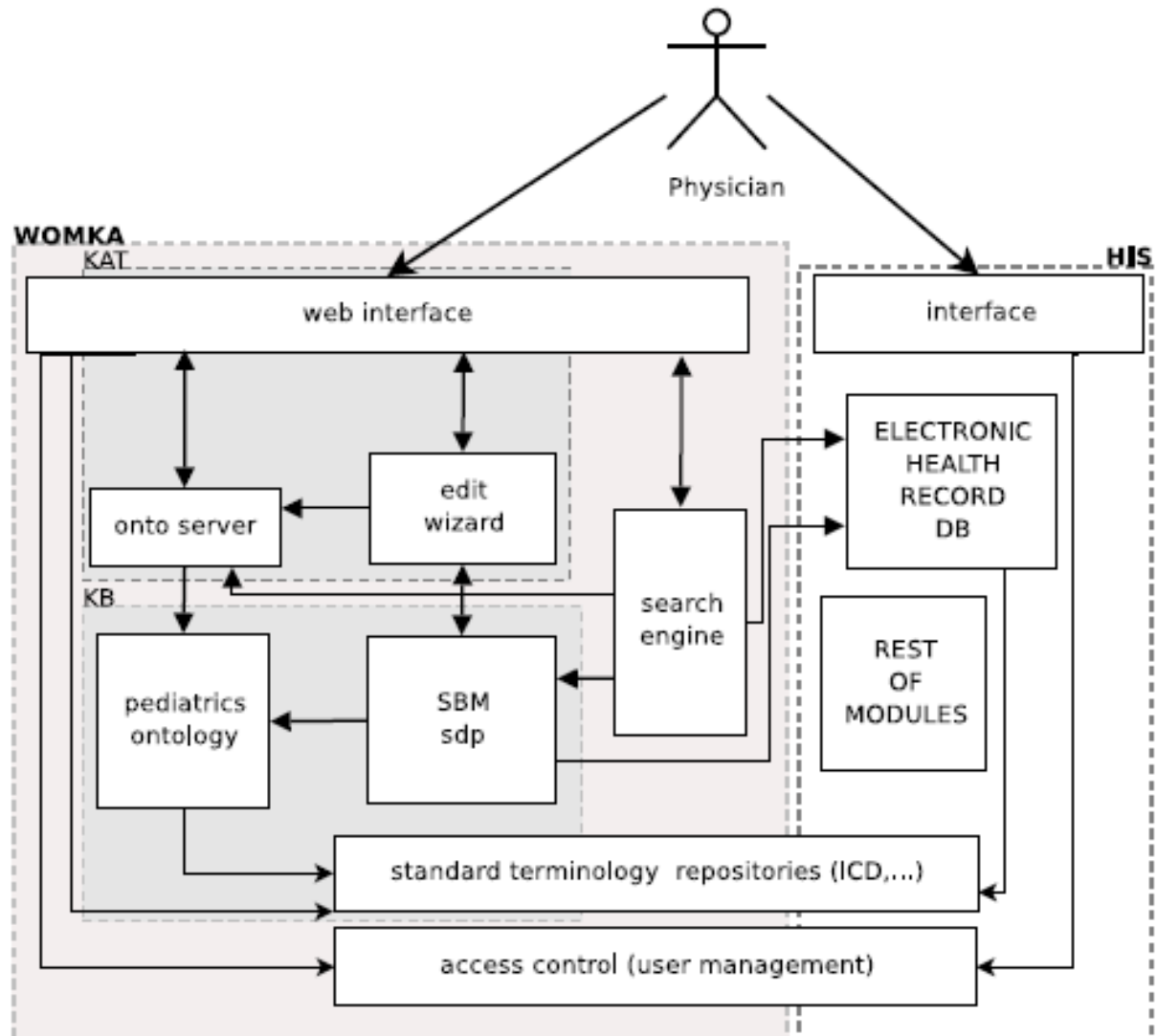
EBM support



# New information sources in medical informatics

- Computerised EBM: Medical Knowledge Management

## WOMKA PROJECT





# New information sources in medical informatics

- Computerised EBM: Medical Knowledge Management  
**WOMKA PROJECT**

**WEB OF MEDICAL KNOWLEDGE ACQUISITION**

Project Management  
User Management  
Ontology Management  
Advanced management

CHANGE PARADIGM    CITIES    EXIT

Pattern Information ENN\_factoresPredisponentes    Domain Ontology: OntologiaPediatria

**Pattern**

Pattern Name	Pattern Description	note	
		name	value
ENN_factoresPredisponentes	ENN para factores predisponentes	comment	factores predisponentes

**Diagnosis**

Diagnosis	attributes/notes	
	name	value
ENN_factoresPredisponentes	comment	diagnostico ENN

**Manifestation List**

Manifestation Name
Mortalidad Intestinal
Prematuridad
Isquemia-reperfusion-reoxigenacion

**Manifestation Details**

Manifestation Name	attributes/notes	
	name	value
Mortalidad Intestinal	no attributes/notes	
Prematuridad	Presencia	yes
Isquemia-reperfusion-reoxigenacion	Presencia	yes

**Terminology details**

Concept	Repository	Assigned concept
Isquemia-reperfusion-reoxigenacion	CIE10	P910 -> ISQUEMIA CEREBRAL NEONATAL

**Domain Ontology: OntologiaPediatria**

```

graph TD
    ENN_factoresPredisponentes --> MortalidadIntestinal[Mortalidad Intestinal]
    ENN_factoresPredisponentes --> Prematuridad[Prematuridad]
    ENN_factoresPredisponentes --> IsquemiaReperfusionReoxigenacion[Isquemia-reperfusion-reoxigenacion]
  
```

**A** **B**

Copyright © 2007 - 2008 (4th edition) - WOMKA

# New information sources in medical informatics

- Computerised EBM: Medical Knowledge Management  
WOMKA PROJECT

The screenshot displays the 'WEB OF MEDICAL KNOWLEDGE ACQUISITION' interface. On the left is a navigation menu with links: Project Management, User Management, Ontology Management, and Advanced management. The main content area is titled 'PROJECT Proyecto Pediatria' and contains two steps for search criteria selection.

**Step 1. Select a search criteria:** (highlighted with a green box and labeled 'A')

- ☐ Pattern name
- ☐ Diagnosis
- ☐ Manifestation
- ☒ Diagnosis Terminology
- ☐ Manifestation Terminology

An 'accept' button is located below the list.

**Step 2. Select repository:** (highlighted with a blue box and labeled 'B')

Options: CIE9, CIE10. An 'accept' button is located to the right.

**Search Criteria List:** (highlighted with a blue box and labeled 'C')

Operator	Search by	Value	attributes		
			name	value	
	Pattern	ENN			delete
AND	Diagnosis	ENN_factoresPredisponentes			delete
AND	Manifestation	Prematuridad	Presencia: yes		delete
AND	Manifestation Terminology	CIE10	P910	ISQUEMIA CEREBRAL NEONATAL	delete

A 'Search' button is located below the table.

**Search Result List:** (highlighted with a red box and labeled 'D')

PATTERN NAME	DESCRIPTION	ACTIONS
ENN_factoresPredisponentes	ENN para factores predisponentes	see  modify

Copyright © 2007 - 2008 Webmaster: MKT

## C. New information sources in medical informatics

1. Big challenges.
2. Quality of Assistance support
3. **Computerised Clinical Guidelines**



# New information sources in medical informatics

## Computerised Clinical Guidelines

1. Computerising Clinical Guidelines
2. Workflow Management Systems



# New information sources in medical informatics

## Computerising Clinical Guidelines:

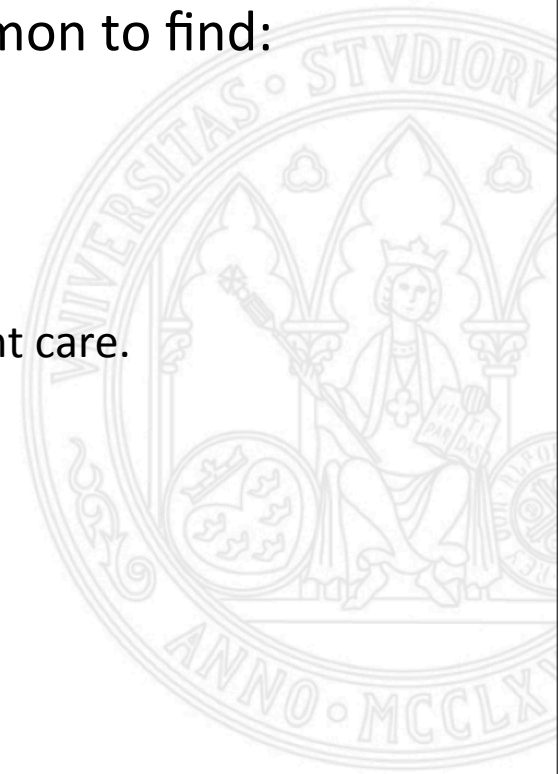
- Electronic Health Record (EHR)
- Clinical Guidelines (procedimental document)
- Goal:
  - Make computable the clinical guideline.
  - Traces of CG in the EHR
- Effect:
  - To improve decision making
  - To support EBM
  - To improve Quality of Assistance



# New information sources in medical informatics

## Computerising Clinical Guidelines:

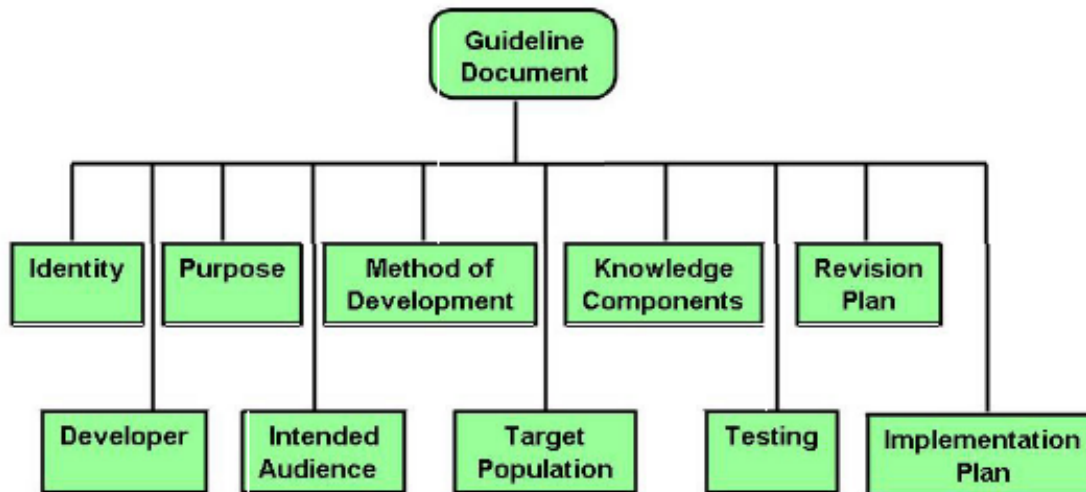
- Parts of a CG
  - There is not a fix structure, however is common to find:
    - General description section.
    - Scope of the CG
    - Recommendations:
      - Prevention, Diagnoses, Treatment, Outpatient care.
      - EBM valoration
    - Appendix and References



# New information sources in medical informatics

## Computerising Clinical Guidelines:

- Labelling
  - Manually text mark-up.
  - Add computational interpretability to the text
  - A-priori definition of labels (taxonomies)
  - Example: GEM II



**Gem Project**

<http://gem.med.yale.edu>



# New information sources in medical informatics

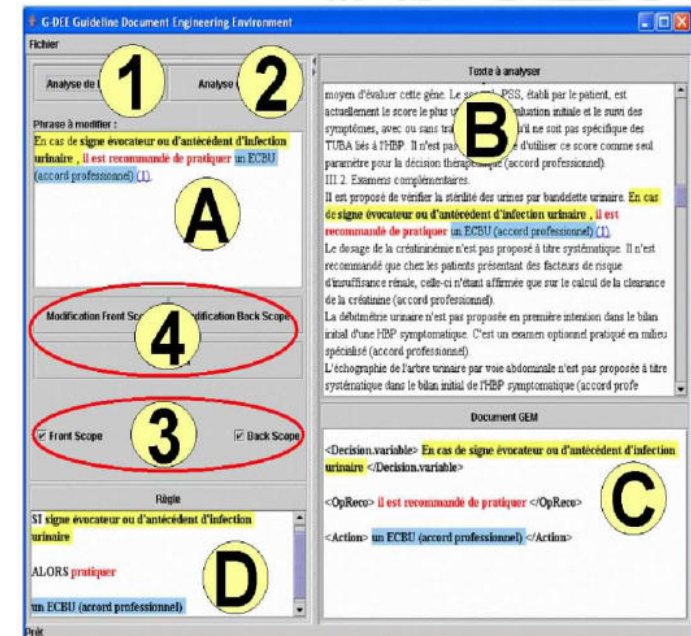
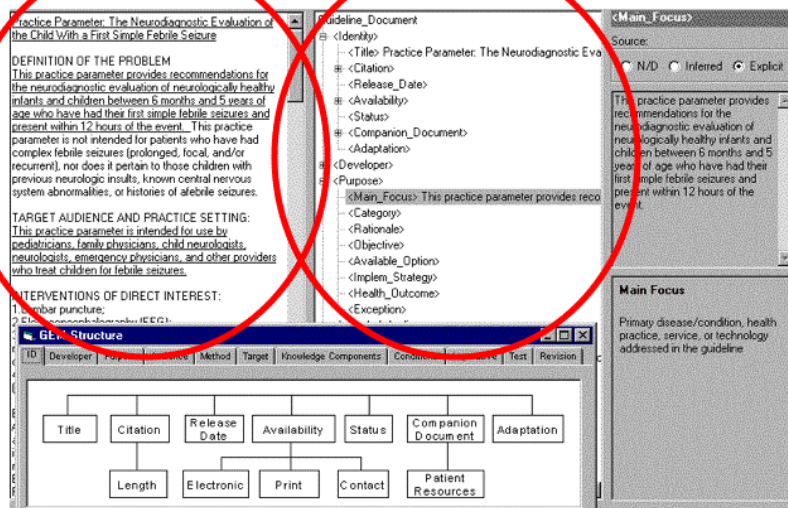
## Computing Clinical Guidelines:

- Label Tools

## G-DEE system

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1560744/>

### GEM Cutter



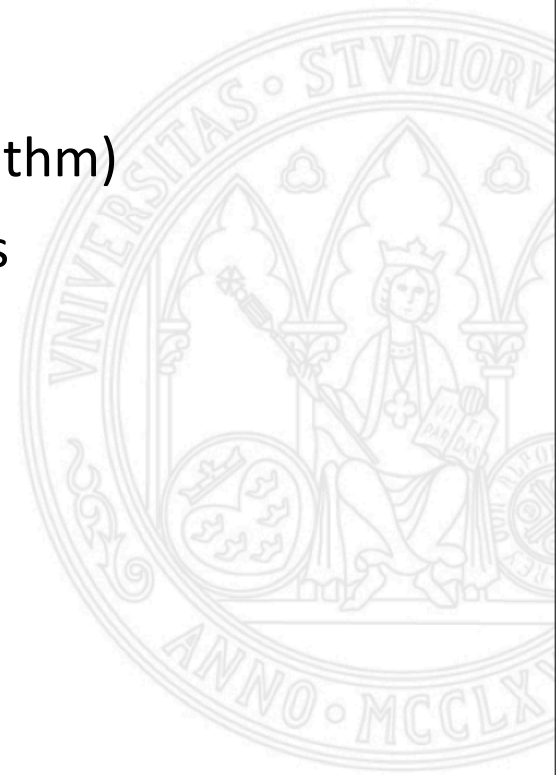
[http://gem.med.yale.edu/Presentations/Gin\\_Implementation.htm](http://gem.med.yale.edu/Presentations/Gin_Implementation.htm)



# New information sources in medical informatics

## Computing Clinical Guidelines:

- Algorithms: language
  - Once we labelled the text
  - Formalise the procedure parts (text -> algorithm)
  - Specific high level “programming” languages
  - Often these languages include:
    - The idea of the TASK.
    - Roles, instruments, resources.
    - Precedence and temporal relations.



# New information sources in medical informatics

## Computing Clinical Guidelines:

- Algorithms: Language example: ASBRU

PLAN	Check-for-jaundice>2-weeks
TIME ANNOTATION	
PREFERENCES	
INTENTIONS	Achieve overall state: (known(possibility-of-cholestatic-disease))
CONDITIONS	<b>Filter-condition:</b> (jaundice-clinically-significant = yes), ([_,2 weeks], [2 weeks, _], [_,_], Birth-Date)
EFFECTS	
PLAN-BODY	Sequential subplans: <i>Continuation specification:</i> all Any-order subplans: <i>Continuation specification:</i> all Ask physical-exam-OK Ask colour-stools Ask colour-urine If ((physical-exam-OK = no) OR (colour-stools = light) OR (colour-urine = dark)) Then Ask direct-serum-bilirubin Possibility-of-cholestatic-disease = yes <b>Exit-possibility-of-cholestatic-disease</b> Else Possibility-of-cholestatic-disease = no <b>Exit-provide-routine-care</b>

Figure 9. Plan Check-for-jaundice>2-weeks.

# New information sources in medical informatics

## Computing Clinical Guidelines:

- Algorithms: Language example: GLIF

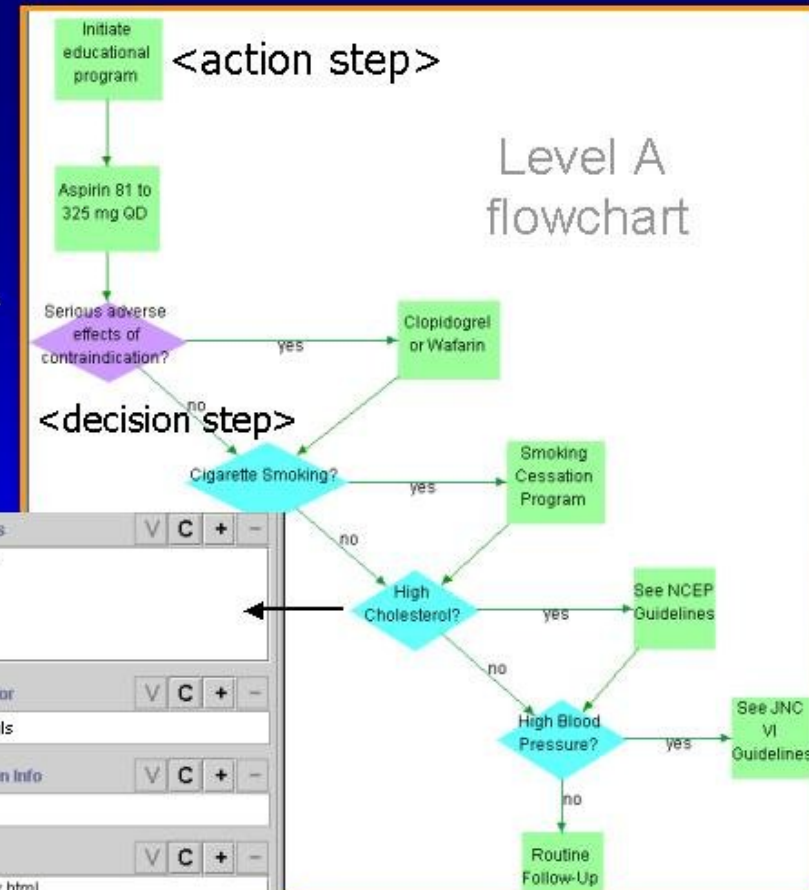
[http://www.openclinical.org/gmm\\_glif.html](http://www.openclinical.org/gmm_glif.html)

Stable Angina:  
Education and risk  
Factor modification

subguideline

Level B  
decision criterion

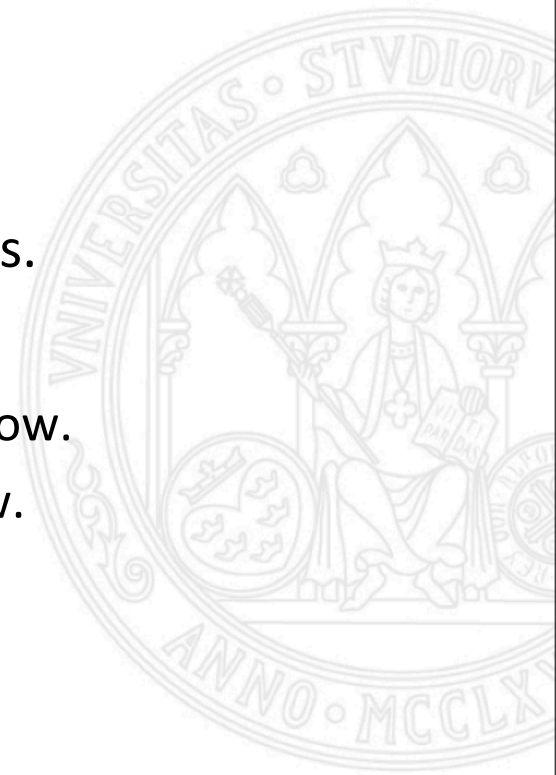
Name	Options	V	C	+	-
High Cholesterol?	yes no				
Condition	V	C	+	-	
LDL_Cholesterol > 160 mg/dL					
Decision Detail	V	C	+	-	Operator
					equals
Default Next Step	V	C	+	-	Iteration Info
Didactics	V	C	+	-	
http://www.acc.org/clinical/guidelines/june99/index.html					



# New information sources in medical informatics

## Computing Clinical Guidelines:

- Algorithms: Clinical Workflows
  - Formal Model
  - Experienced in the industry
  - Used with BPM to model company processes.
  - Basic components:
    - Workflow Schedule: definition of the data flow.
    - Workflow Engine: execution and control flow.
    - Task
    - Precedence
    - Synchronization



# New information sources in medical informatics

## Computerised Clinical Guidelines

- Algorithms: Workflow example

### Italian Guideline for Stroke Prevention and Management

<http://www.spread.it/>

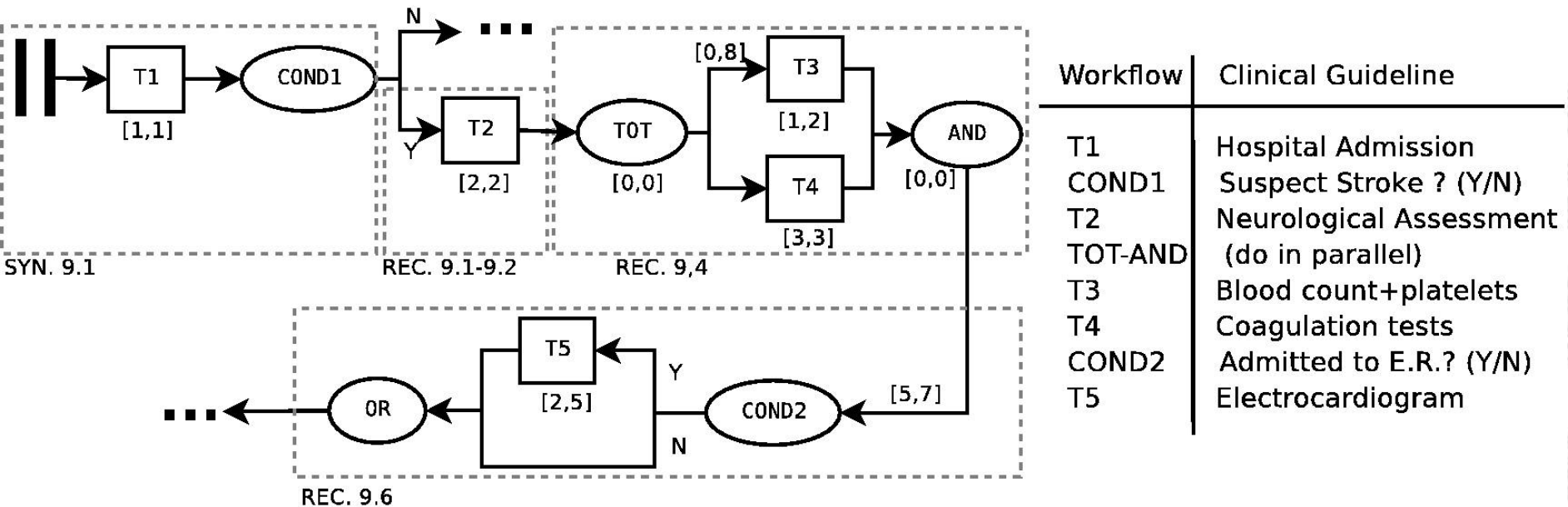
**Synthesis 9.1:** A stroke victim should rapidly be assessed after hospitalisation (**T1**), by means of a general examination and [...]

- **Recommendation 9.1 and 9.2:** an early and standardized neurological evaluation (**T2**) is recommended in the setting of a qualitatively adequate management of acute stroke (**Cond1**).
- **Recommendation 9.4:** [...] the following blood exams are recommended: complete blood count including platelets (**T3**), [...], and coagulation tests (**T4**) [...].
- **Recommendation 9.6:** The electrocardiogram (**T5**) is recommended in all suspected stroke victims who are admitted to an Emergency Room (**Cond2**).

# New information sources in medical informatics

## Computerised Clinical Guidelines

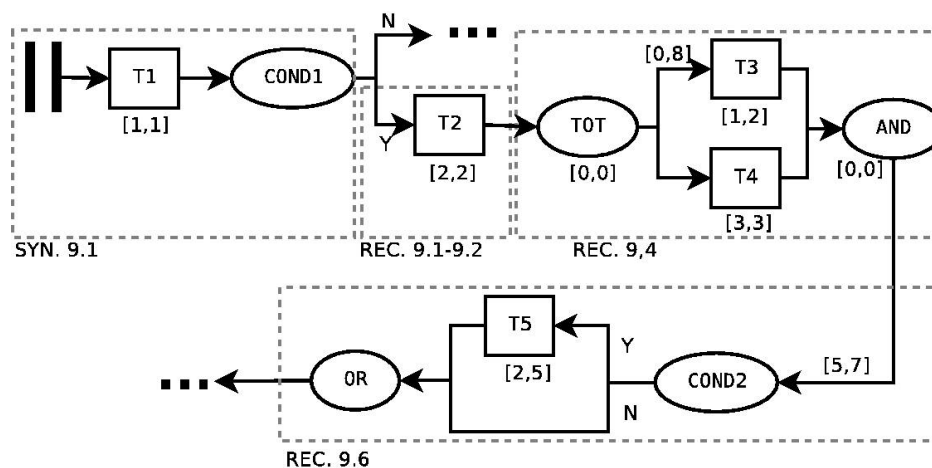
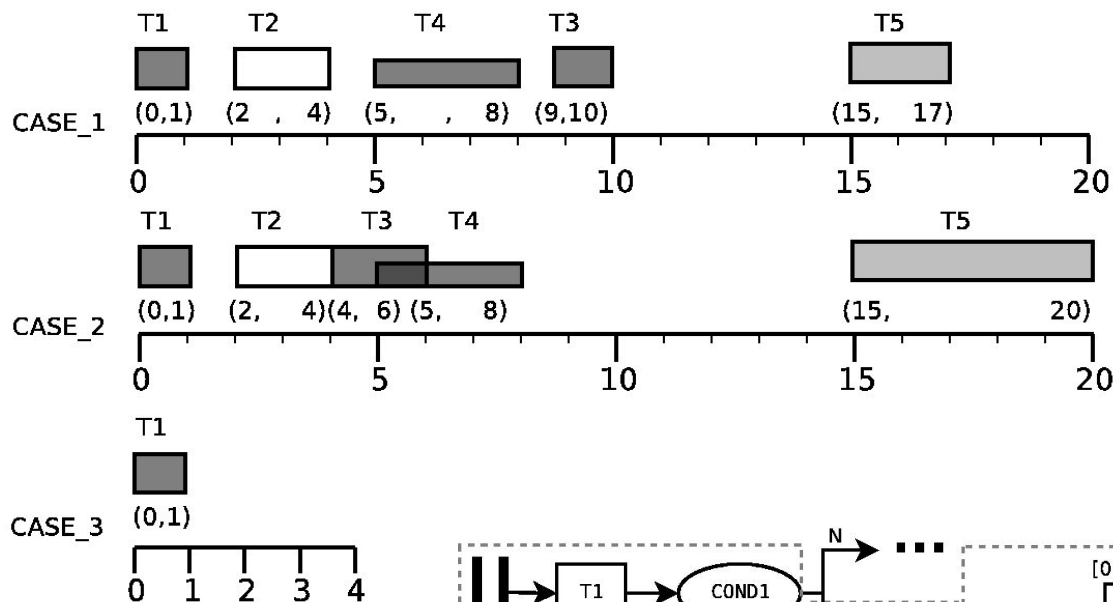
- Algorithms: Workflow example [Combi07]



- Synthesis 9.1:** A stroke victim should rapidly be assessed after hospitalisation (**T1**), by means of a general examination and [...]
- Recommendation 9.1 and 9.2:** an early and standardized neurological evaluation (**T2**) is recommended in the setting of a qualitatively adequate management of acute stroke (**Cond1**).
- Recommendation 9.4:** [...] the following blood exams are recommended: complete blood count including platelets (**T3**), [...], and coagulation tests (**T4**) [...].
- Recommendation 9.6:** The electrocardiogram (**T5**) is recommended in all suspected stroke victims who are admitted to an Emergency Room (**Cond2**).

# New information sources in medical informatics

## Computing Clinical Guidelines: Workflow: Example



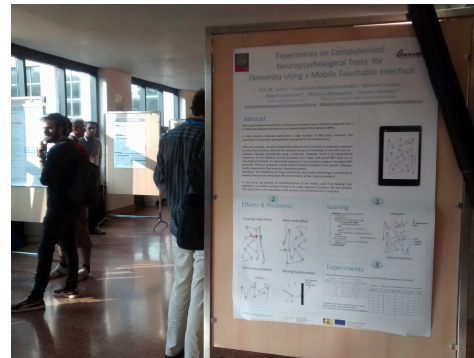
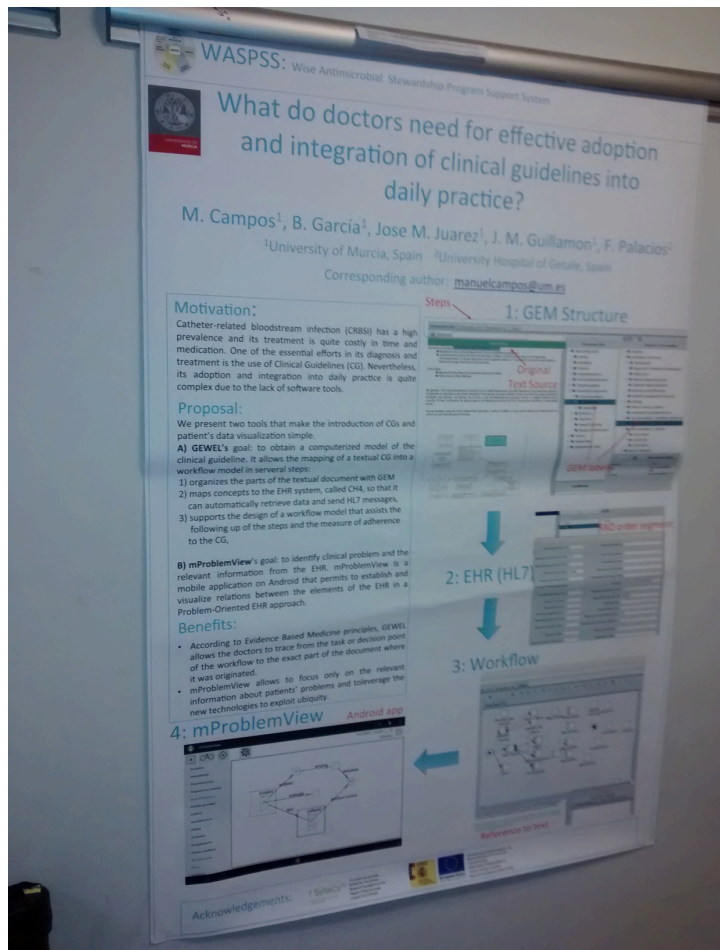
Workflow	Clinical Guideline
T1	Hospital Admission
COND1	Suspect Stroke ? (Y/N)
T2	Neurological Assessment
TOT-AND	(do in parallel)
T3	Blood count+platelets
T4	Coagulation tests
COND2	Admitted to E.R.? (Y/N)
T5	Electrocardiogram



# New information sources in medical informatics



What do doctors need for effective adoption and integration of Clinical guidelines into daily practice? M. Campos, B. Garcia, Jose M. Juarez, J.M. Guillamón and F. Palacios  
IEEE ICHI, Verona, 2015.





# New information sources in medical informatics

- Decision Support Systems.
  - Specialised Tools
  - Medical Decision Support: diagnosis, therapy, etc.
  - Based on theoretical models:
    - Probabilistic models (e.g. Bayesian Networks)
    - Causal modelling (e.g. Rule-based Systems)
    - Biology Inspired (Neuronal Networks)
    - Experience (Case-based reasoning)
    - etc.

More information, IKTAM course:  
*Técnicas Avanzadas de Sistemas  
Inteligentes*



# New information sources in medical informatics

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- Carlo Combi, Matteo Gozzi, José M. Juárez, Roque Marín, Barbara Oliboni: Querying Clinical Workflows by Temporal Similarity. AIME 2007: 469-478