Towards standards for management and transmission of medical data in web technology

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Medicine challenges

- Increase of elderly people
  - Cronical diseases
  - Cardiovascular diseases
  - Cancer
  - Neuropathologies
- Infectious diseases
- Genetic causes of diseases
- Diseases prevention (epidemiology)
- Rehabilitation
- Home care assistance
- Citizens/patients ask for more information

Needs of health assistance and biomedical research

- Circulation of knowledge, information and data with the aim of achieving productivity management control and of maintaining high standards of healthcare;

- Population ageing with leads to demand for continuous treatment and care improving quality;

- Globalization of health, seems as market and demands of ever more qualified health services.

Focus

- Medical record
  - Electronic patient record
  - Patient data card
  - …….
    - Record linkage
    - Integration of health database
    - Epidemiology
    - Evaluation of care and structures quality
    - Clinical research
    - Networking
    - Telemedicine (teleconsulting/telediagnosis)
    - Teleassistance/telemonitoring
    - Internet in health care
    - Medical www

4

Medical record (**BLOIS 1984**)

Set of patient information useful to diagnosis and care at different level:

- outpatient clinic

- hospital

- emergency

- GPs

- ……..

Clinical database

Set of medical records of different patients, useful for clinical research and epidemiological studies.

MULTIMEDIA MEDICAL RECORD

The Electronic Medical Record (EMR) must be complete as possible, containing also biomedical signals and images, video, etc.

This constitutes

the Multimedia Medical Record (MMR).

MULTIMEDIA MEDICAL RECORD

MMR contains :

❑ **anagraphycal and administrative data**

❑ **clinical data**

❑ **anamnestic data**

❑ **lab tests**

❑ **diagnostic referrals (ECG, EEG, X-Ray, TC, MRI, ECO, …)**

MMR improve:

❑ **information availability,**

❑ **a fast data access and analysis**

❑ **a better control of patients workflow**

COMPUTERISATION OF MR IS:

- A VERY IMPORTANT TECHNOLOGY FOR HEALTH CARE.

OFFERS:

- BETTER AND FASTER MANAGEMENT OF PATIENT DATA FOR CLINICAL RESEARCH AND EPIDEMIOLOGICAL STUDIES.

PREPUBLICATION COPY

THE COMPUTER-BASED PATIENT RECORD:
AN ESSENTIAL TECHNOLOGY FOR HEALTH CARE

Committee on Improving the Patient Record

Division of Health Care Services
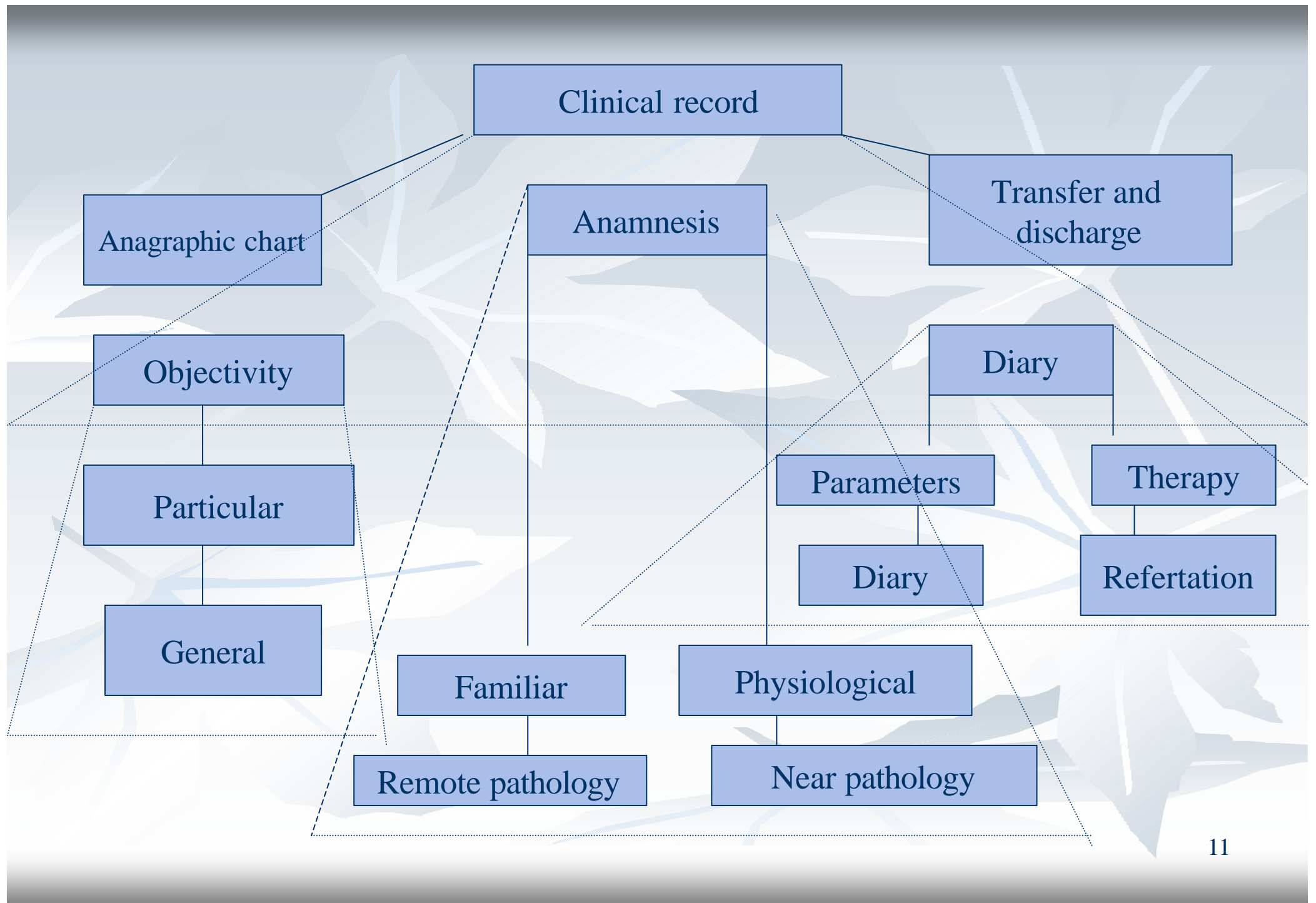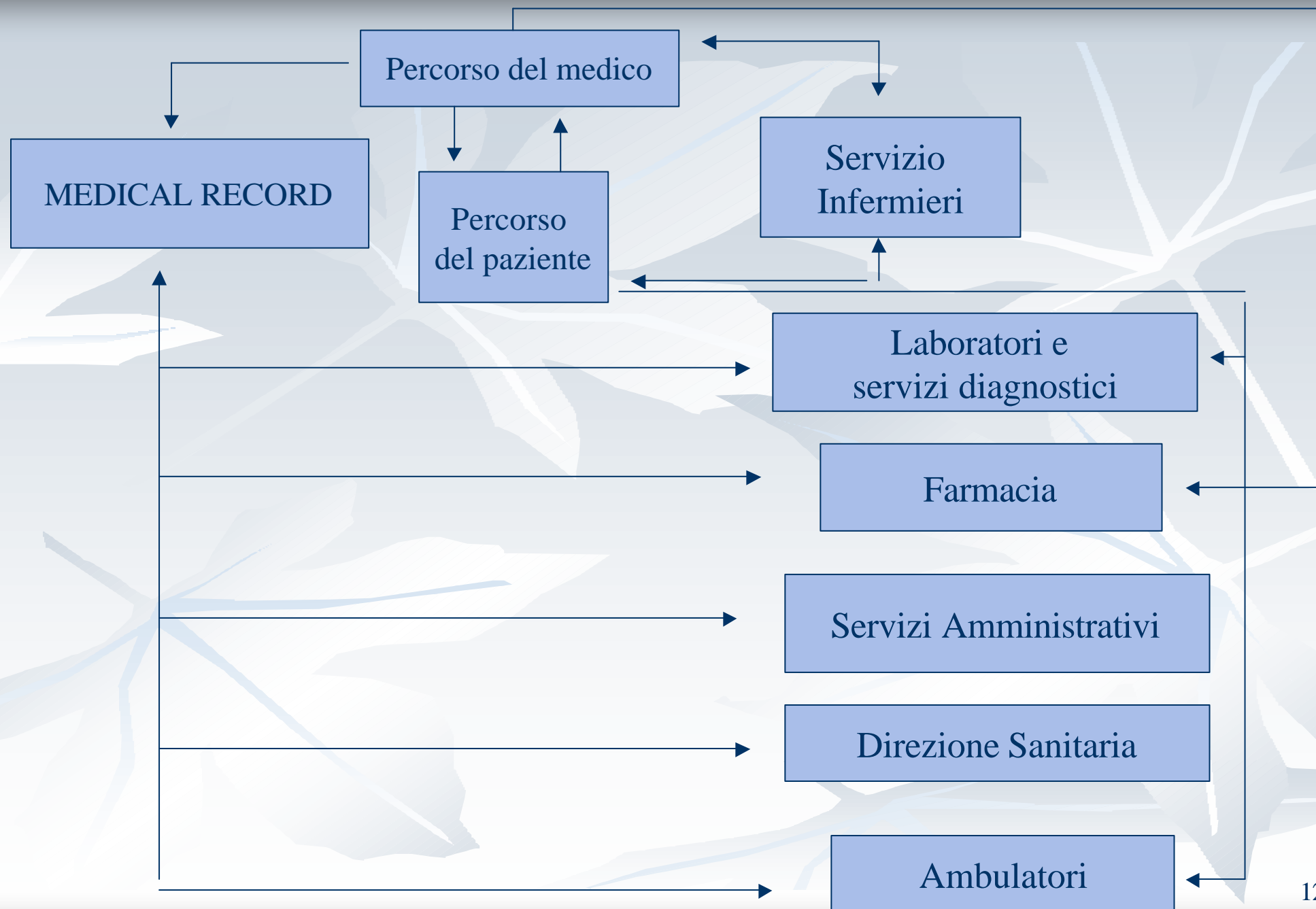INSTITUTE OF MEDICINE

Richard S. Dick and Elaine B. Steen, editors

MEDICAL RECORD

THE **MR** IS THE COLLECTION OF PATIENT DATA USEFUL TO DIAGNOSIS AND CARE.

MR CAN BE:

- HEALTH BOOKLET

- OUTPATIENT CLINIC CARD

- CLINICAL CHART

Health/Clinical Information System

- ADT
- Wards
- Outpatient clinic
- Diagnostics/therapeutical divisions;
- Emergency care.

Clinical Information System

- Support patient activity of care (diagnosis/therapy)
- Maintain hystorical databases

Are not CIS:

- patient monitoring ssystem (not hystorical D.B.)
- Research protocol and clinical trials (does not support care activity)

Information System

- Procedures for management of information flow in an organized structure useful to decision and programming activities.

- Data management: collection, archiving, exchange, processing, retrieval, communication of data.

Elements of I.S. :

- Data

- Management procedures (SW)

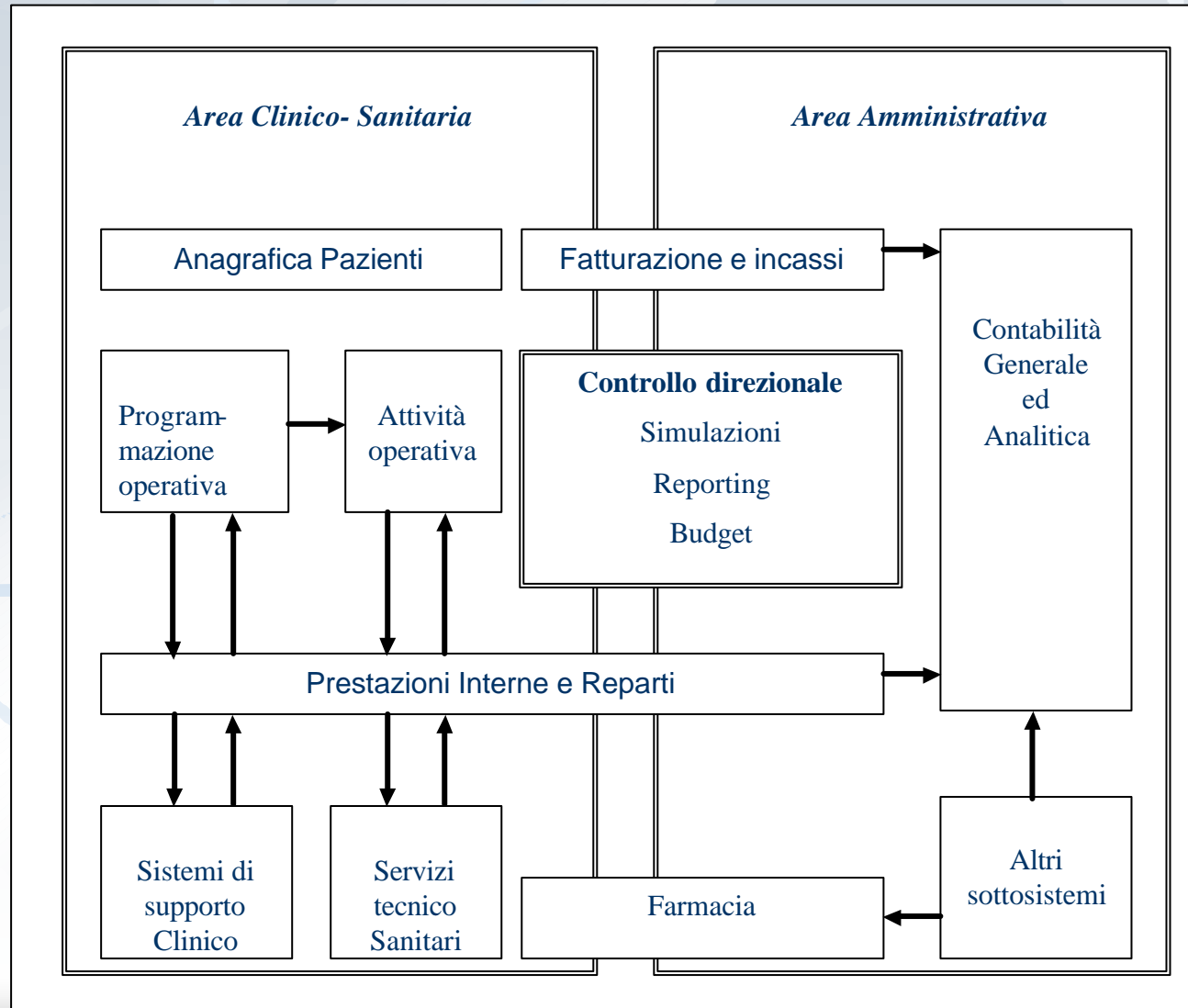- Human activities

Features of I.S.:

- Interactive

- Depending by organization

- Open process

- Changement suitable

15

Main components:

•**Administrative information sub-system**

•**Health/Clinical information sub-system**

Scheme of HIS Information flow

16

Clinical and Administrative Information Systems

<u>Clinical Orientation</u>
- Focus on patient care
- A tool for care providers
- Timely and accurate
- Administrative data a by product
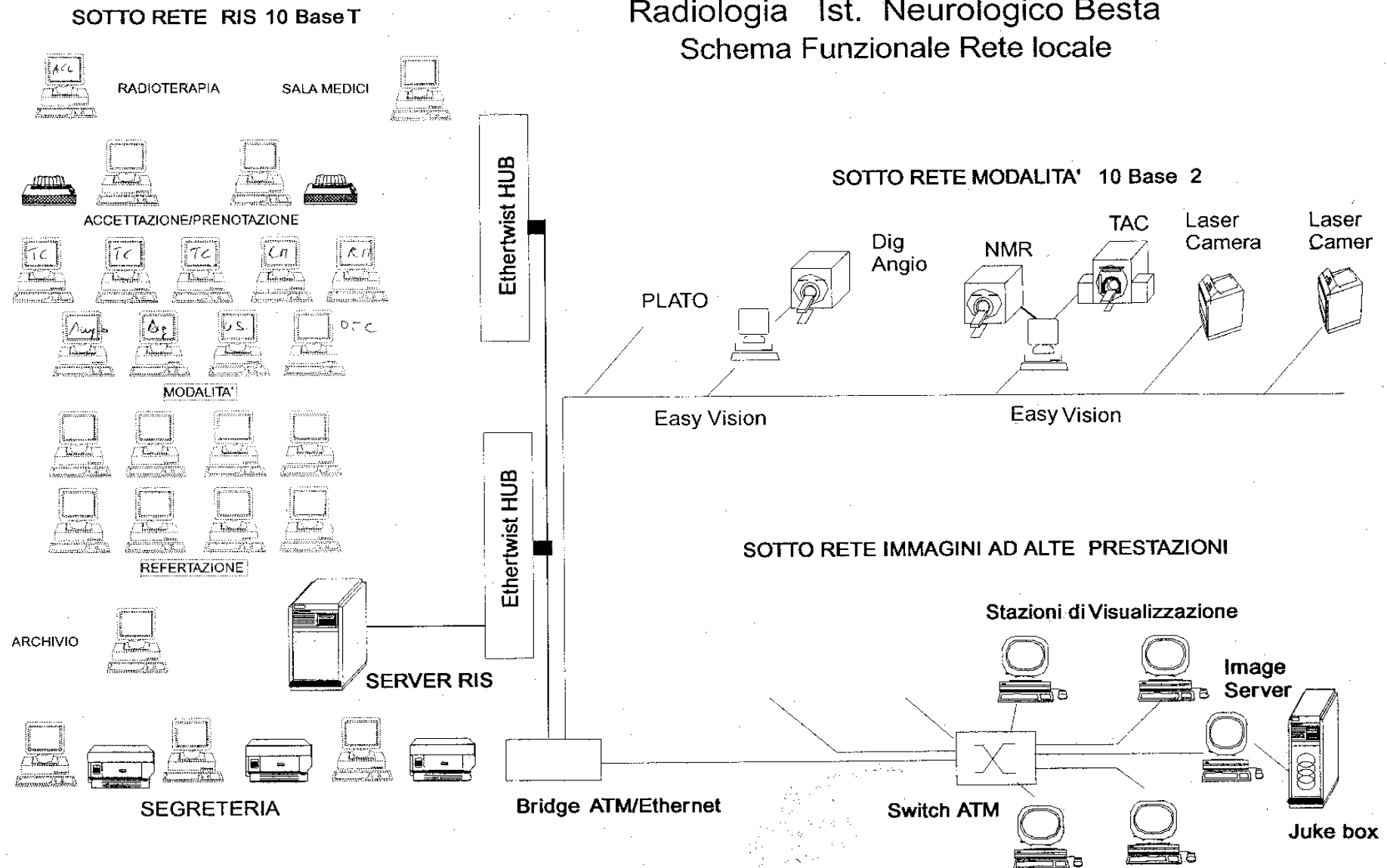
<u>Administrative Orientation</u>
- Part Institution's infrastructure
- Motivated by productivity and cost concerns
- The institutional' view dominates

<u>Some tensions:</u>
- Who are the users?
- Do clinicians see it as *their* system?
- Who makes the purchase decisions?

SOTTO RETE RIS 10 Base T

Radiologia Ist. Neurologico Besta
Schema Funzionale Rete locale

RADIOTERAPIA   SALA MEDICI

ACCETTAZIONE/PRENOTAZIONE

SOTTO RETE MODALITA' 10 Base 2

MODALITA'

Dig Angio   NMR   TAC   Laser Camera   Laser Camer

PLATO

REFERTAZIONE

Easy Vision   Easy Vision

ARCHIVIO

SOTTO RETE IMMAGINI AD ALTE PRESTAZIONI

Stazioni di Visualizzazione

SERVER RIS

Ethertwist HUB

Image Server

SEGRETERIA

Bridge ATM/Ethernet   Switch ATM   Juke box

Radiological System

EDIS-Emergency Department Information System

- Hospital Sub-System for delivery services to respond immediatly to emergency care 24 hours/24

- Services involved

- Administrative

- Diagnostic department

- Wards

- ....

- Information flow about
- Admission/discharge
- Clinical info
- Injury surveillance
- Triage data
- Patient expects
- Patient alerts
- Waiting list overview
- Daily list
- Transfer details
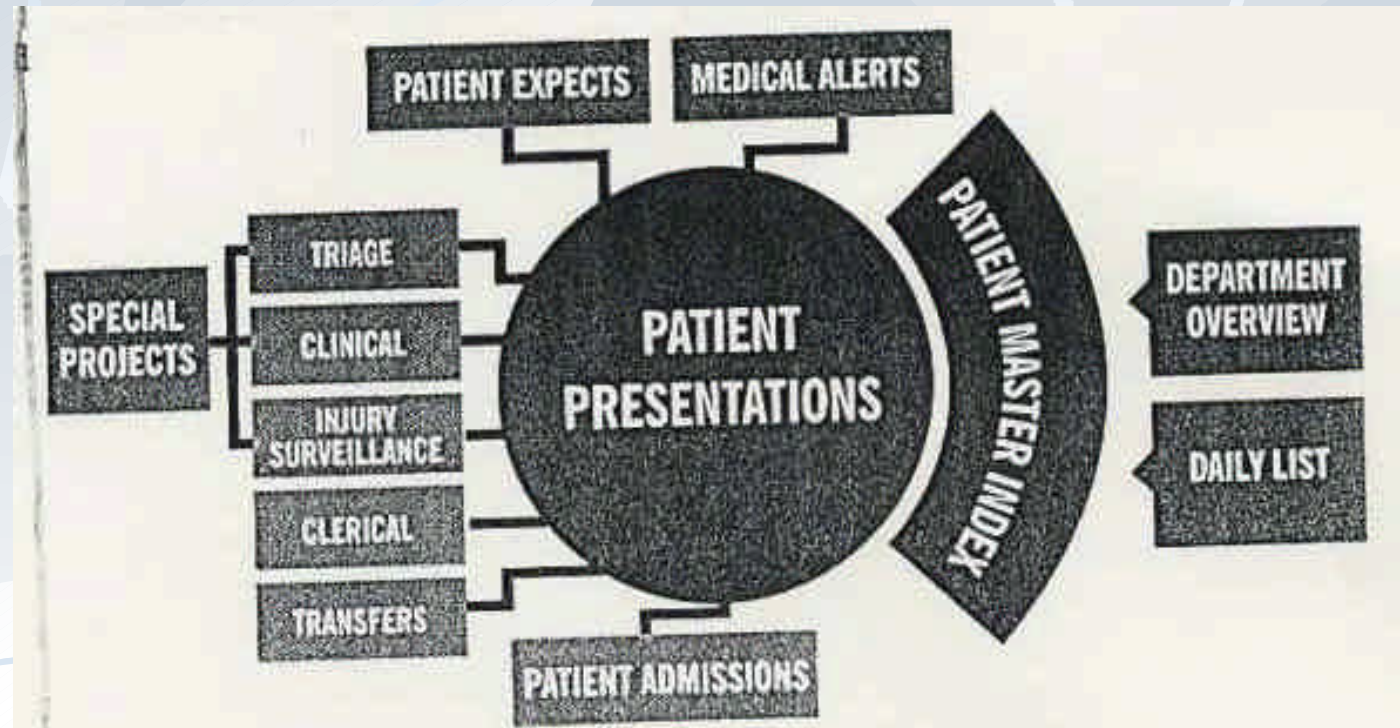
Medical record/electronic patient record

- center of health information system useful for:

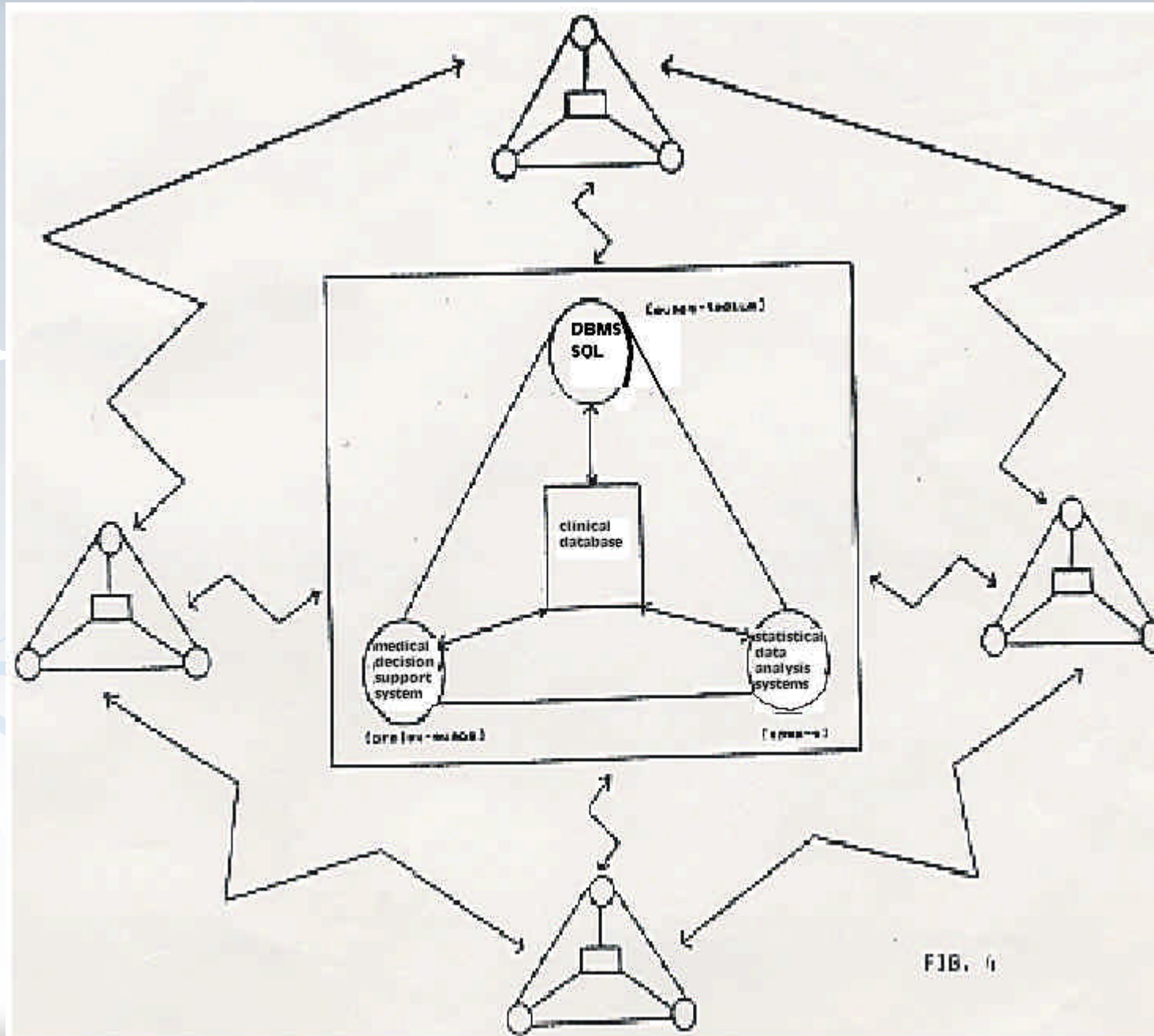- clinical practice

- medical education

MR/EPR

Is present in:

- Patient registration/booking services

- ADT hospital systems

- Clinical laboratories

- Radiological diagnostics

- Outpatient clinic

- ………

Record linkage

- Integration of medical record into IS

- Data base in health care is main component of Health Information Systems.

FIG. 4

MEDICAL RECORD AND PATIENT DATA CARD
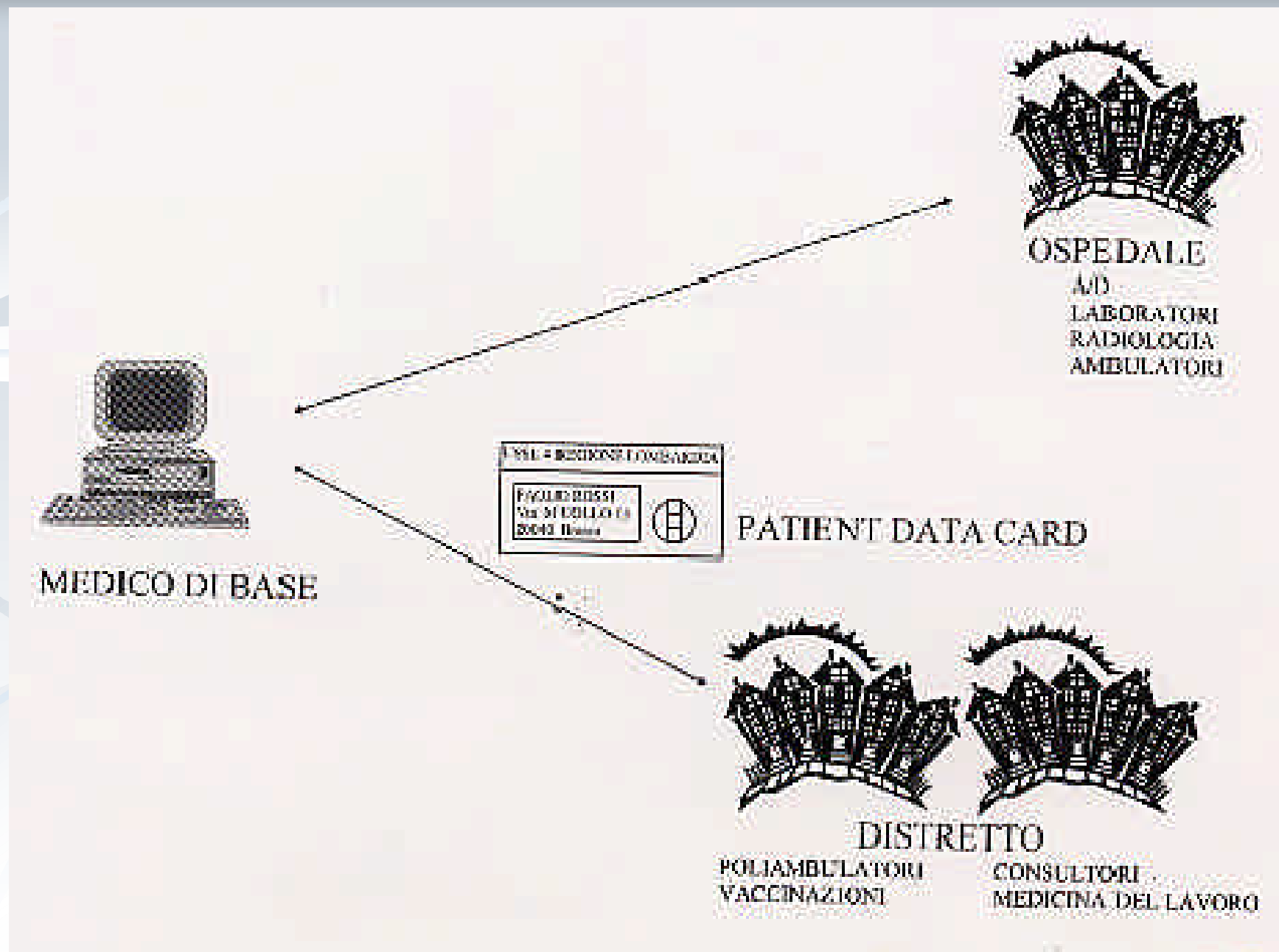
A MINIMUM BASIC DATA SET CAN BE EXTRACTED   FROM THE MR AND STORED INTO A PDC.

PDC IS:

    - A PORTABLE MEDICAL RECORD

    - RECORD LINKAGE AND COMMUNICATION TOOL

PDC CAN BE USED AS:

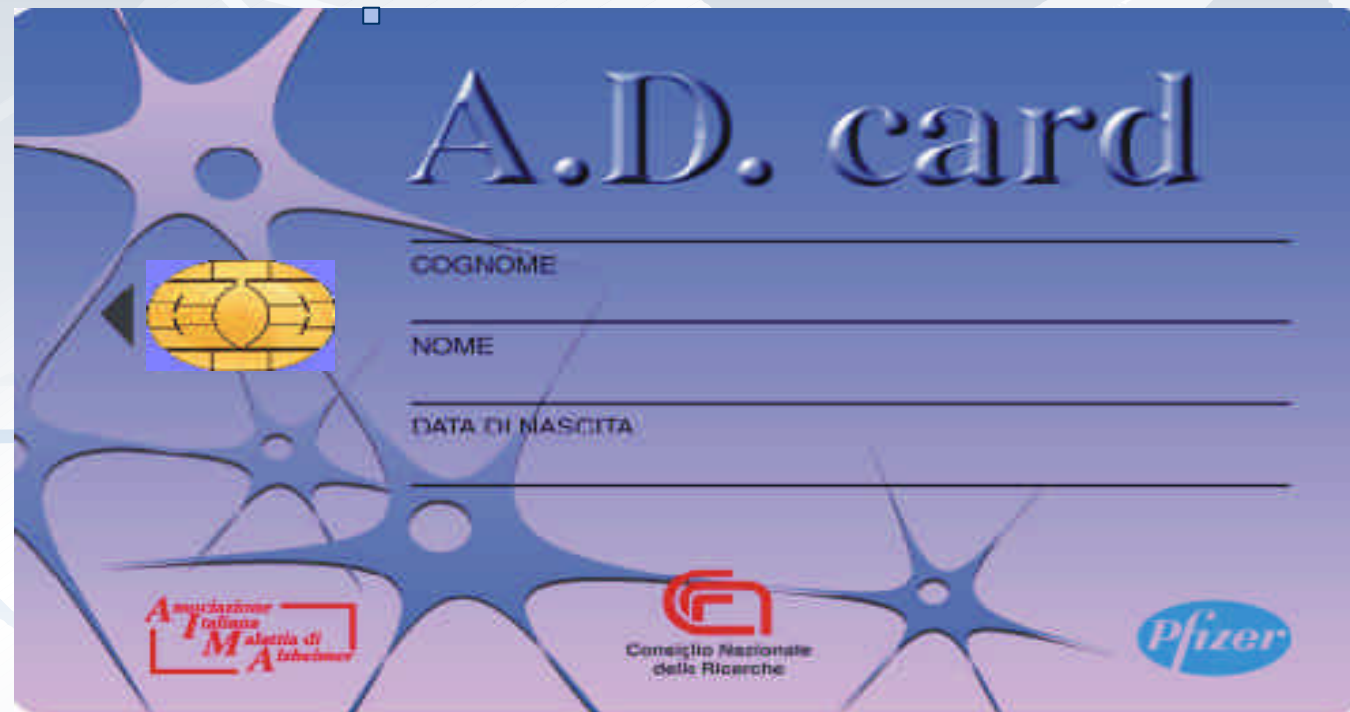   - DATA-LINKAGE AND STORAGE DEVICES

    - ACCESS KEY TO DB OF MEDICAL INFORMATION SYSTEM AND HEALTH NETWORKING

    - INTEROPERABILITY SYSTEMS BETWEEN HEALTH SERVICES

OSPEDALE
A/D
LABORATORI
RADIOLOGIA
AMBULATORI

PATIENT DATA CARD

MEDICO DI BASE

DISTRETTO
POLIAMBULATORI   CONSULTORI
VACCINAZIONI   MEDICINA DEL LAVORO

Smart Card for Alzheimer patients

Bull chip da 8 Kb

Hybrid card for neurological patients

REGIONAL SERVICE CARD

Prescriptions

Emergency health data

Personal data

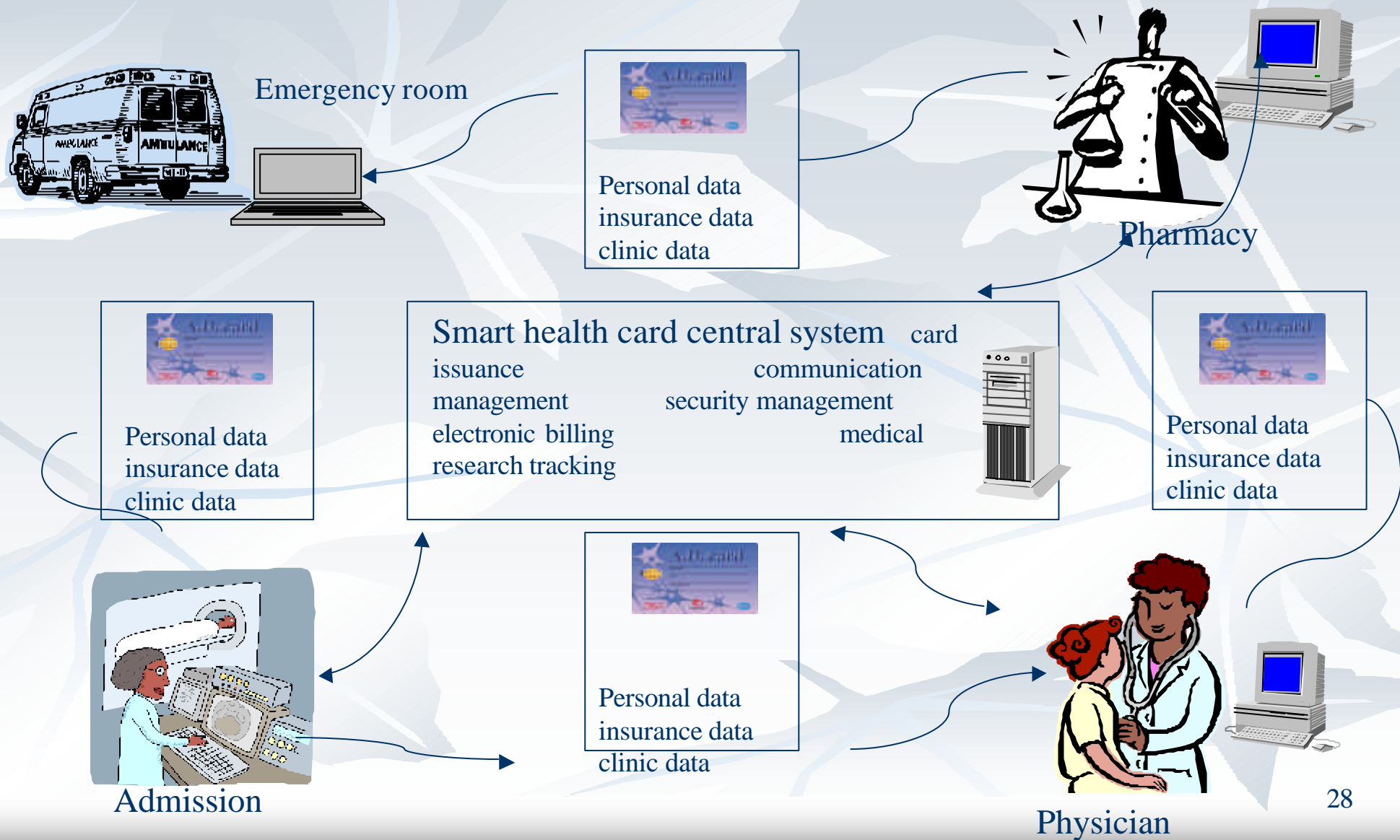Administrative health data

Electronic signature

Crypt ability

Any other data is on the network

Smart card and Services Network

Madison Wisconsin Smart Health Card Test

Emergency room

Personal data
insurance data
clinic data

Pharmacy

Smart health card central system   card
issuance   communication
management   security management
electronic billing   medical
research tracking

Personal data
insurance data
clinic data

Personal data
insurance data
clinic data

Personal data
insurance data
clinic data

Admission

Physician

28

Telemedicine uses telecommunications to deliver health care, often over great distances, with the possibility of cost savings particularly in remote and rural areas.

Telemedicine means, literally, 'medicine at a distance'. There are several different definitions, but:

the definition of telemedicine adopted by an international consultation group convened by the WHO in Geneva in December 1997 says:

"Telemedicine is the delivery of health-care services, where distance is a critical factor, by health-care professionals using information and communication technologies for the exchange of valid information far diagnosis, treatment and prevention of disease and injuries, and for the continuing education of health-care providers as well as research and evaluation, all in the interests of advancing the health of individuals and their communities."

Benefits associated with ICT and introduction of Telemedicine

- Health education of people and population;
- Employment opportunities for technicians and paramedics at a peripheral level;
- Diffusion of medical knowledge;
- Availability of normal (or on demand) health treatments, in distant areas to prevent diseases;
- Improvement of health indicators used by WHO and by national government structures;
- Telemedicine could help some countries to cut health costs. (A study carried out in the United States at the end of the last century has estimated that a figure of between 35 and 40 billion dollars could be saved by the health structures by using telecommunication and telemedicine technologies more efficiently).

Telemedicine fields:

- **Teleconsulting** (clinicians → clinicians)
- **Telediagnosis** (clinicians → phisicians)
- **Telemonitoring** (clinical centers → patients)
- **Telesurveillance** [i.e. home telecare] (health structure → patients)
- **Tele-emergency** (first aid centers → health operators → ambulances → patients)

Telemedicine and emergency

Data transmission from ambulances to ED:

- Patient vital signs/ECG (portable monitor cum defibbrillator)
- Blood pressure
- Heart rate and pulse oximetry
- Other information communicated by paramedics in ambulances (collected in notebook), ex:

    - respiratory rate, objective evidence, patient mental state (Glasgow Coma Scale).

    (SW system can compute trauma score).

    - transmission of data, before leaving site, to receiving hospital ED ad initial pre-arrival information.

ED staff can prepare therapeutical procedures, useful drugs, etc.

Teleradiology

A teleradiological platform for Teconsulting/Telediagnosis can be composed by:

- personal computer of recent generation;

- connection in geographic net between the headmasters, realized through the introduction of suitable net apparatuses;

- software for elaboration and acquisition of the images with registration functionality according to the DICOM3 standard;
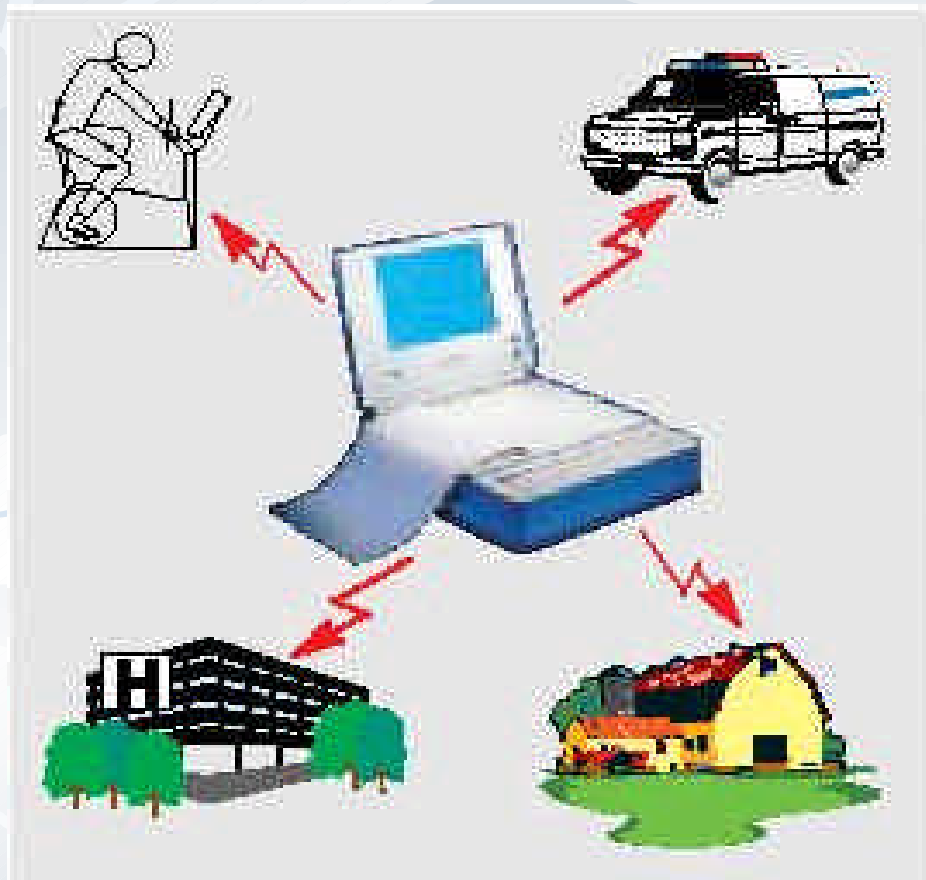
- monitor for the reporting with 2 Mpixel resolution.

TELECARDIOLOGY

A TeleCardiological system is set of :

❑ peripheral equipment of survey of the data and clinical parameters

❑ telecommunication net that allows the connection of the equipment

❑ operating platform of receipt, treatment and reports of the data

❑ operating protocol

Telecardiological system

Telepathology

- Telepathology is a practical activity of the pathology to distance, able to have the images of the slides seen on a screen instead than through the microscope.

- The transmitted images can be used for primary diagnoses, second opinion, check of quality control, ability tests and widening at distance.
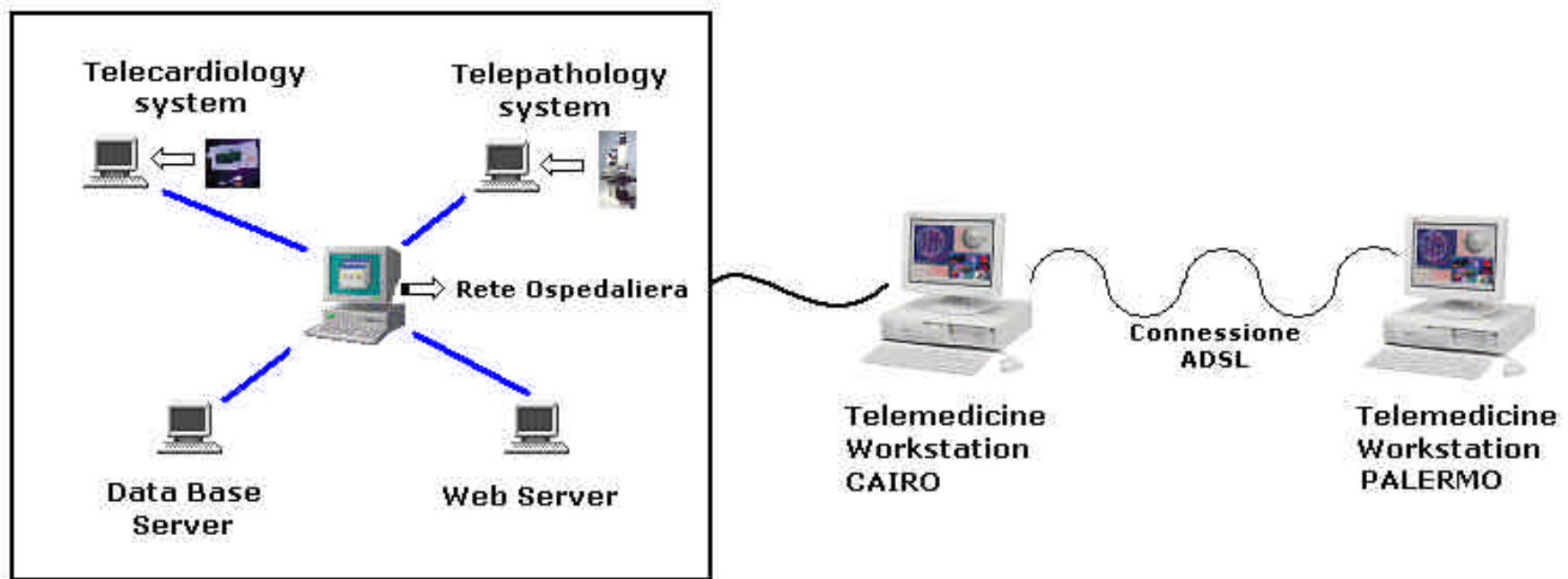
Telepathology

- Telepathology platform is constituted by: microscope,telecamera, PC, communication network, architecture client/server, relational DBMS, SW Firewall, SW of compression of the images (i.e. Jpeg).
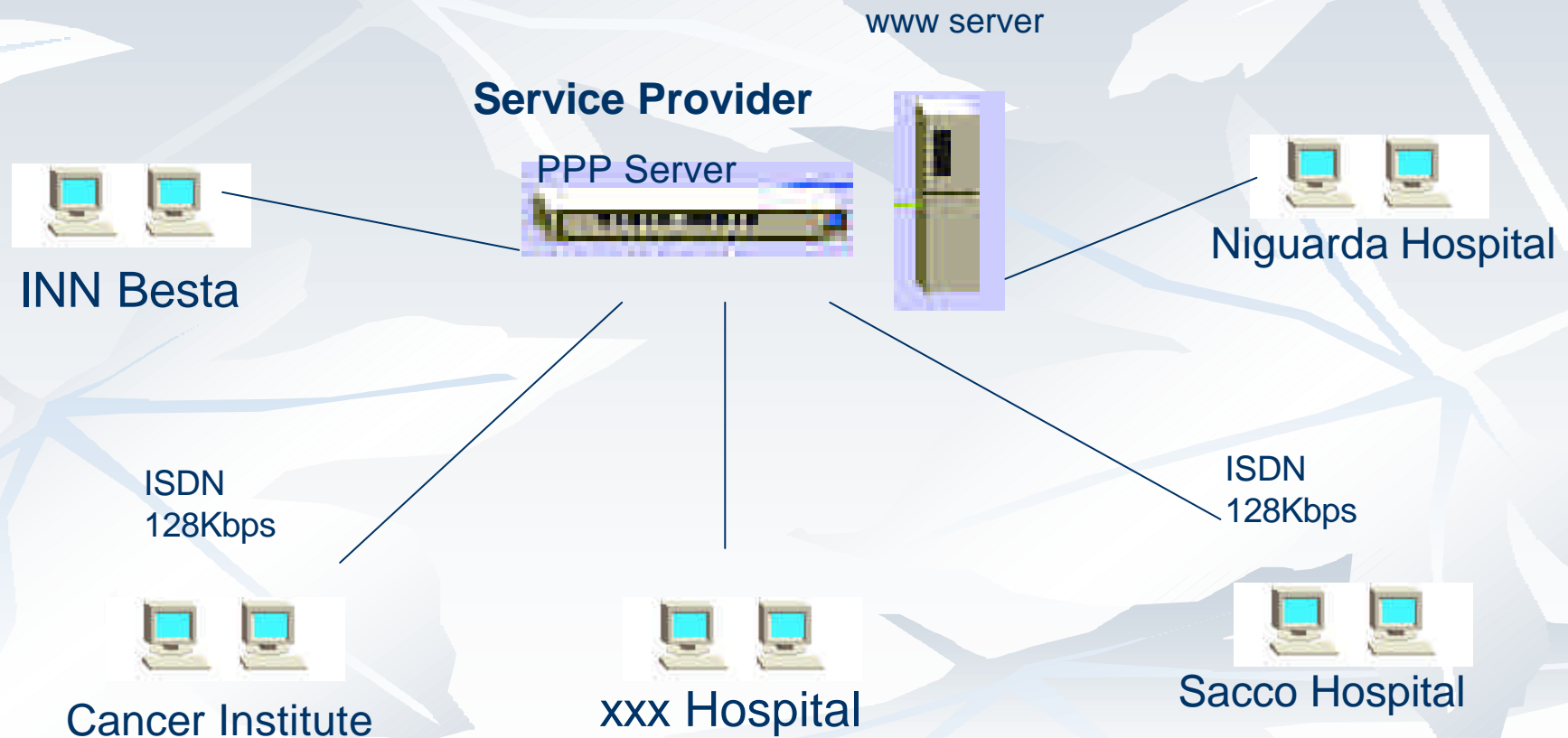
Telemedicine Project   ITALY (Palermo) -EGYPT (Cairo)

Internet in Medicine

- Diffusion of Internet services in healthcare;

- Building of web sites and portals in medical fields;

- To share and to access to clinical information (protocols of care, guidelines, etc.);

- Teleconsulting and telediagnosis in peripherical health structures and also at home;

- Costs reducing.

Example:
Milan Network for Neuro Radiological Teleconsulting

www server

Service Provider

PPP Server

INN Besta

Niguarda Hospital

ISDN
128Kbps

ISDN
128Kbps

Cancer Institute

xxx Hospital

Sacco Hospital

WEB TECHNOLOGY: PORTAL IN MEDICINE

Web Portal to access clinical database and for teleconsulting/telediagnosis.

Creation of Medical Network, in order to improve healthcare information dissemination, to facilitate the access to clinical data base and therapeutical diagnostic protocols and to permit teleconsultation and telediagnosis; it is based on a multifuctional platform integrated with clinical and diagnostic services, located in large hospitals and Medical Research Institutes.

The MED PORTAL project can provide integration among services aready available to the local communities or extended to a wider geographical area.

It can favorite the access to clinical information and processing in the health services for clinical activity to users (doctors, radiologists, etc.) and the clinical activity of teleconsulting and telediagnosis.

It can also offer the opportunity to integrate and co-ordinate methods of care and diagnostic/therapeutical protocols).
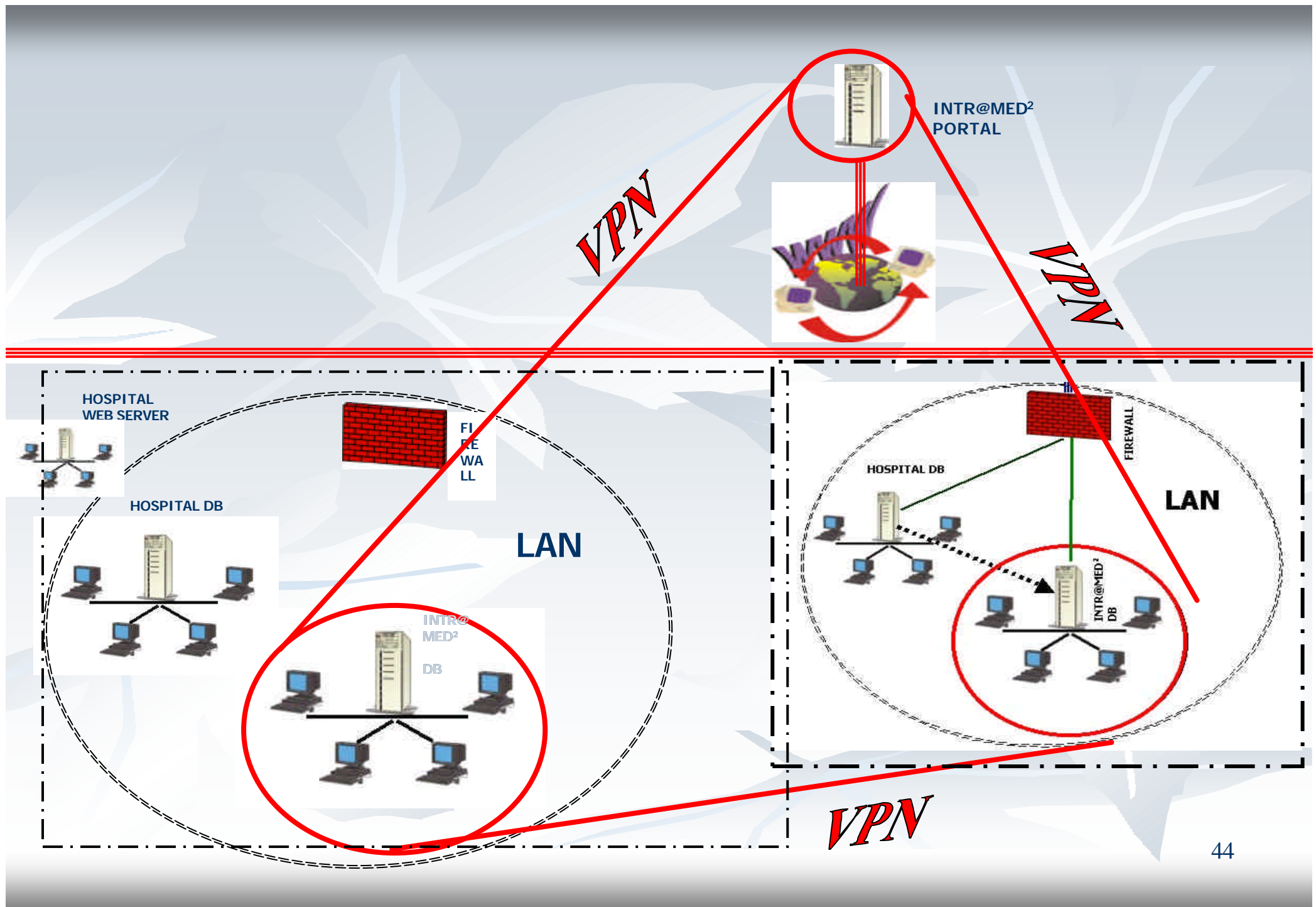
2nd opinion.

MED PORTAL:

- Based on a **multifuctional platform** integrated with clinical and diagnostic services, located in large hospitals and Medical Research Institutes.

- Aimed to integrate several hospitals database developed by RDBMS, using XML as a glue language to improve users accessibility and information distribution in a standard WEB enviroment.

- Standards: HL7, DICOM, CORBAMED,….
- GRID

INTR@MED² PORTAL

VPN

VPN

VPN

HOSPITAL WEB SERVER

HOSPITAL DB

LAN

FIREWALL

INTR@MED² DB

HOSPITAL DB

FIREWALL

LAN

INTR@MED² DB

From INTERNET to GRID technology

- As the net evolues, all machines and people will become nodes on one network.

- Rapid improvements in communications technologies are leading many to consider more decentralized approaches to the problem of computing power.

- In the world there are about 500 million of PC.

- Internet computing and GRID technologies promise to change the way we tackle complex problems.

- They will enable large scale aggregation and sharing of computational data and other resources across institutional boundaries.

LIFE in the GRID 2000-2010

GRID technology opens perspective of large computational power and easy accessibility to heterogeneous data services.

GRID was coined in 1995 to denote a proposed distributed computing infrastructure for advanced science and engineering.

Health GRID would provide framework for sharing, computing and storaging resources, promoting standards and fostering synergy between Bio-Informatics and Medical Informatics.

- Integrating genetic data into medical record.
- Researching individualized health care.

GRID: Networking and intelligent processing

- Computational and data GRID are new frontier in development of a world wide distributed computing model.

- GRID uses all computing and archieves resources spread out in its test bed and makes them available in a secure way to whoever is authorized to utilize them.

- **Virtual Organization** in the world needs:
  - Interoperability
  - Portability
  - Code sharing
  - Standard protocols

GRID Projects:

- ❖ **DATAGRID**
- ❖ **CROSSGRID**
- ❖ **EUROGRID**
- ❖ **BIOGRID**
- ❖ **MAMMOGRID**
- ❖ **GEMSS**

- GRID and medical simulation services.

- Distributed medical support system for drug therapy of HIV infection.

- Diseases prevention, GRID for public health promotion.

- E-Heart GRID

GRID concept and technology are in the R&D projects of EC.

GRID in BIO-MEDICINE

- **BIOGRID**
- **MAMMOGRID**
- **TUMORI RARI**
- **CARDIOLOGIA (E-HEART GRID)**
- **SIMULATIN WITH BIOMEDICAL IMAGES GEMMS**
- **NEUROSCIENCES**
- **EPIDEMIOLOGY**

- ✓ MULTIDISCIPLINARY
- ✓ NEEDS OF COLLABORATION BETWEEN OPERATORS
- ✓ INTERNET SERVICES (E-MAIL, SITI WEB, ECC.) PERMIT TO COOPERATE
- ✓ CONNECTION BETWEEN COMPUTERS, DATA AND RESOURCES

49

Standardization in medical informatics

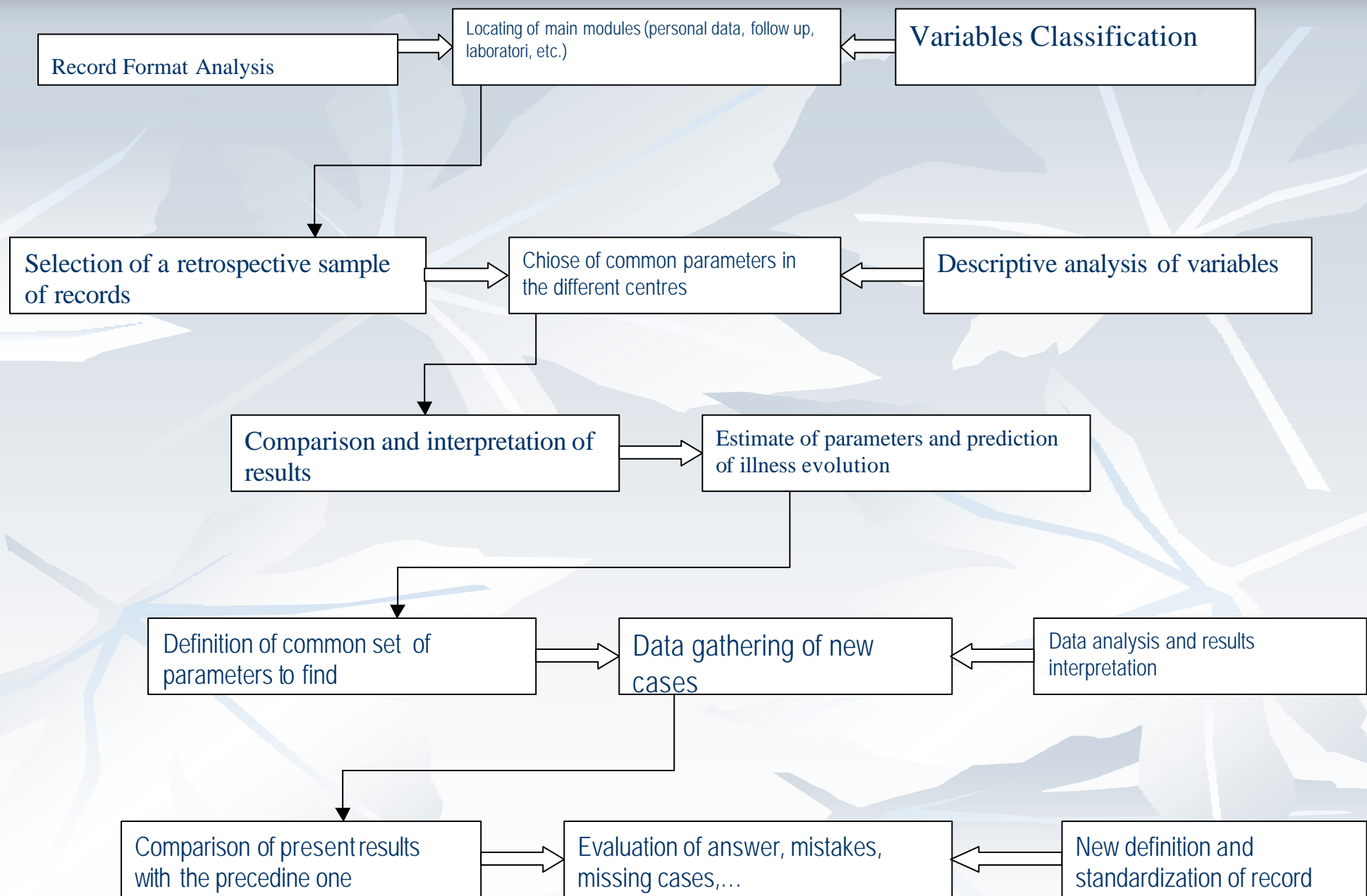**Standards used for data/images management are different and include:**

- **EDIFACT**

- **DICOM**

- **X-12**

- **HL7**

- **XML**

MEDICAL RECORD Standardization

Phases of medical record standardization process:

1. structure analysis of medical records;

2. random retrieval and review of records of cases;

3. comparison of the results among the different records;

4. recording of data from new cases using a common record format.

Record Format Analysis → Locating of main modules (personal data, follow up, laboratori, etc.) ← **Variables Classification**

Selection of a retrospective sample of records → Chiose of common parameters in the different centres ← **Descriptive analysis of variables**

Comparison and interpretation of results → Estimate of parameters and prediction of illness evolution

Definition of common set of parameters to find → **Data gathering of new cases** ← Data analysis and results interpretation

Comparison of present results with the precedine one → Evaluation of answer, mistakes, missing cases,… ← New definition and standardization of record

52

Medical Record in XML

From EDI messages to Internet Technology, using a "structured clinical message" in XML language.

XML : eXtensible Markup Language

- Meta-language: universal language developed by the World Wide Web Consortium (W3C) in 1998

- Permits to Internet applications to "understand each other" and to control the communication between these one and the traditional software.

- Extensibility

- Another important aspect: it is possible to re-use the typologies of XML documents, simply extending them with new tags

eXtensible Markup Language

Use of XML in MMR (Multimedia Medical Record) realization

- **Structure of Database :**

  DTD (Document Type Definition) realization

- **Multimedia data (images, viedeo) are considered in .jpeg and .mpeg format.**

eXtensible Markup Language

■ **DTD (Document Type Definition)**

```
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT  Esami.table (Esami)+ >
<!ELEMENT  Esami (CodESAM, Emoglobina,
Ematocrito, Globuli_bianchi, Piastrine,
TLinfociti, Urea, Creatinina, Livello_CSA,
CodPaz) >
<!ELEMENT  CodESAM  (#PCDATA) >
<!ATTLIST CodESAM
            Type CDATA  "number"
            Size CDATA  "4">


<!ELEMENT  Emoglobina (#PCDATA) >
<!ATTLIST Emoglobina
            Type CDATA  "number"
            Size CDATA  "2">


………….
………….
```

```
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT  MD.table (MDATA)+ >
<!ELEMENT  MDATA (CodMD, PesoPaz,
AltezzaPaz , Voltaggio, RitmoAtr, FrqVentr,
PrSist, Prdiast, PrGiug, Tracciato, Eco,
RxTorace, CodPaz) >
<!ELEMENT  CodMD (#PCDATA) >
<!ATTLIST CodMD
            Type CDATA  "number"
            Size CDATA  "4">


<!ELEMENT  PesoPaz (#PCDATA) >
<!ATTLIST PesoPaz
            Type CDATA  "number"
            Size CDATA  "2">


……........
………….
```

eXtensible Markup Language

- **XML documents**