CDSS

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CLINICAL DECISION SUPPORT

The Road Ahead

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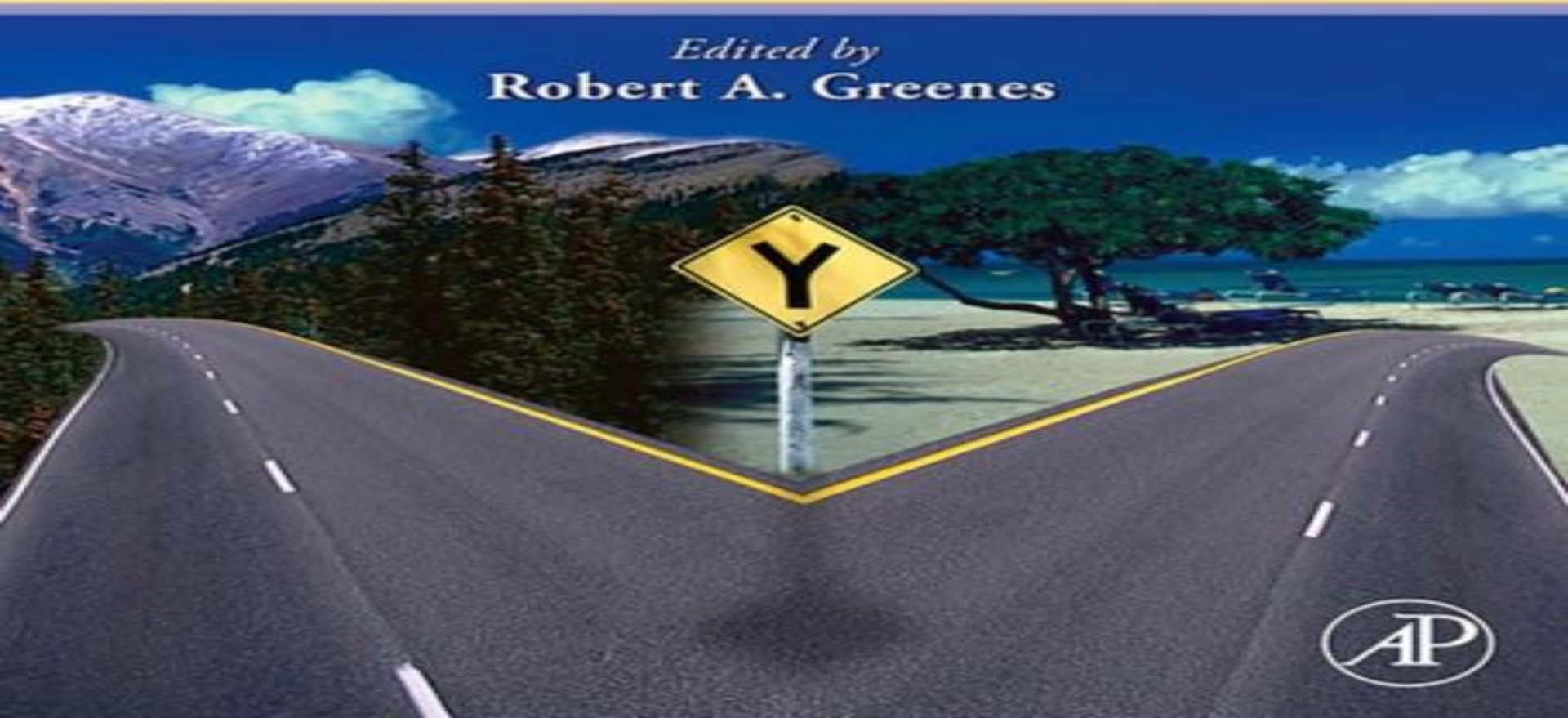


Course outline

- Define-Computer, Medicine, System, CDSS
- Types of Decision
- Process of CDSS
- Application areas of CDSS
- Pros & Cons
- Historical Perspective of CDSS
- EBM, Data Mining, EK,NLP
- Standard
- Ethics
- Benefits ,Challenges of CDSS

Definition

Computer:

A device that computes, especially a programmable electronic machine that performs high-speed mathematical or logical operations or that assembles, stores, correlates, or otherwise processes information.

Medicine:

The scientific study or practice of diagnosing, treating, and preventing diseases or disorders of the body or mind of a person or animal.

Definition (Contd.)

System:

System is a set of interrelated components with a clearly defined boundary working together to achieve a common set of objectives

CDSS:

Clinical decision support is a process for enhancing health-related decisions and actions with pertinent, organized clinical knowledge and patient information, to improve health and healthcare delivery.

Type of Decision

The requirements for excellent decision-making fall into three principal categories:

- Accurate data
- Pertinent knowledge, and
- Appropriate problem-solving skills.

Process of CDSS

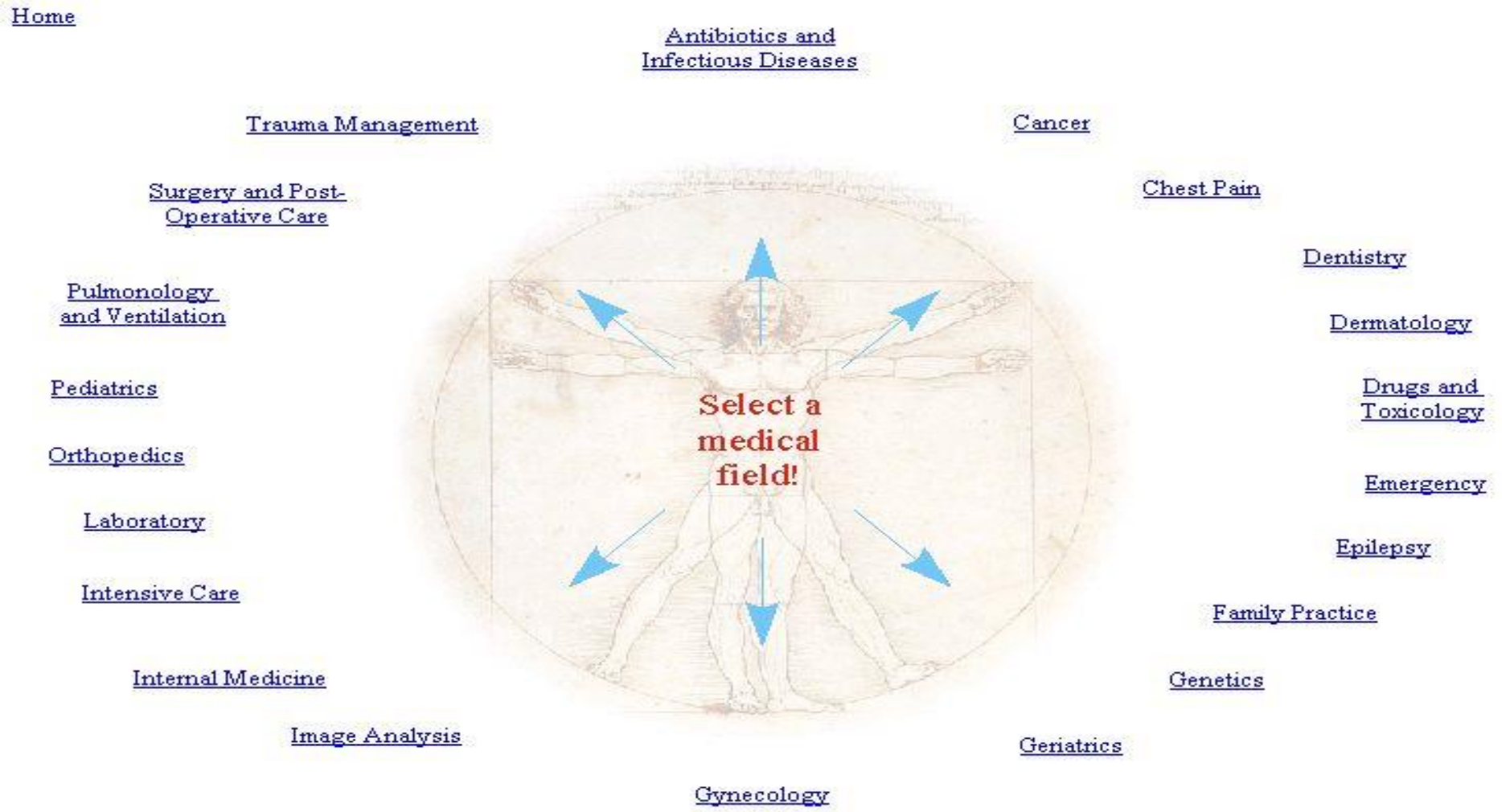
Nobel Prize–winning economist Herbert Simon described decision making as a three-step process (Oz, 2004; Stair & Reynolds, 2003). The steps involve:

1. Intelligence: collecting facts, beliefs, and ideas. In health care these facts may be stored as data elements in a variety of data stores.

2. Design: designing the methods with which to consider the data collected during intelligence. These methods may be models, formulas, algorithms, or other analytical tools.

3. Choice: making the most promising choice from the limited set of alternatives.

Application Areas



Historical Perspective

- Leeds Abdominal Pain System [De Dombal et al., 1972]
- MYCIN-[Shortliffe,1976]
- HELP [Warner, 1979]

Example of MYCIN

Rule507

IF:
1) The infection which requires therapy is meningitis,
2) Organisms were not seen on the stain of the culture,
3) The type of infection is bacterial,
4) The patient does not have a head injury defect, and
5) The age of the patient is between 15 years and 55 years

THEN: The organisms that might be causing the infection are diplococcus-pneumoniae and neisseria-meningitidis

FIGURE 16.1. A typical rule from the MYCIN system. Rules are conditional statements that indicate what conclusions can be reached or actions taken *if* a specified set of conditions is found to be true. In this rule, MYCIN is able to conclude probable bacterial causes of infection if the five conditions in the premise are all found to be true for a specific patient. Not shown are the measures of uncertainty that are also associated with inference in the MYCIN system.

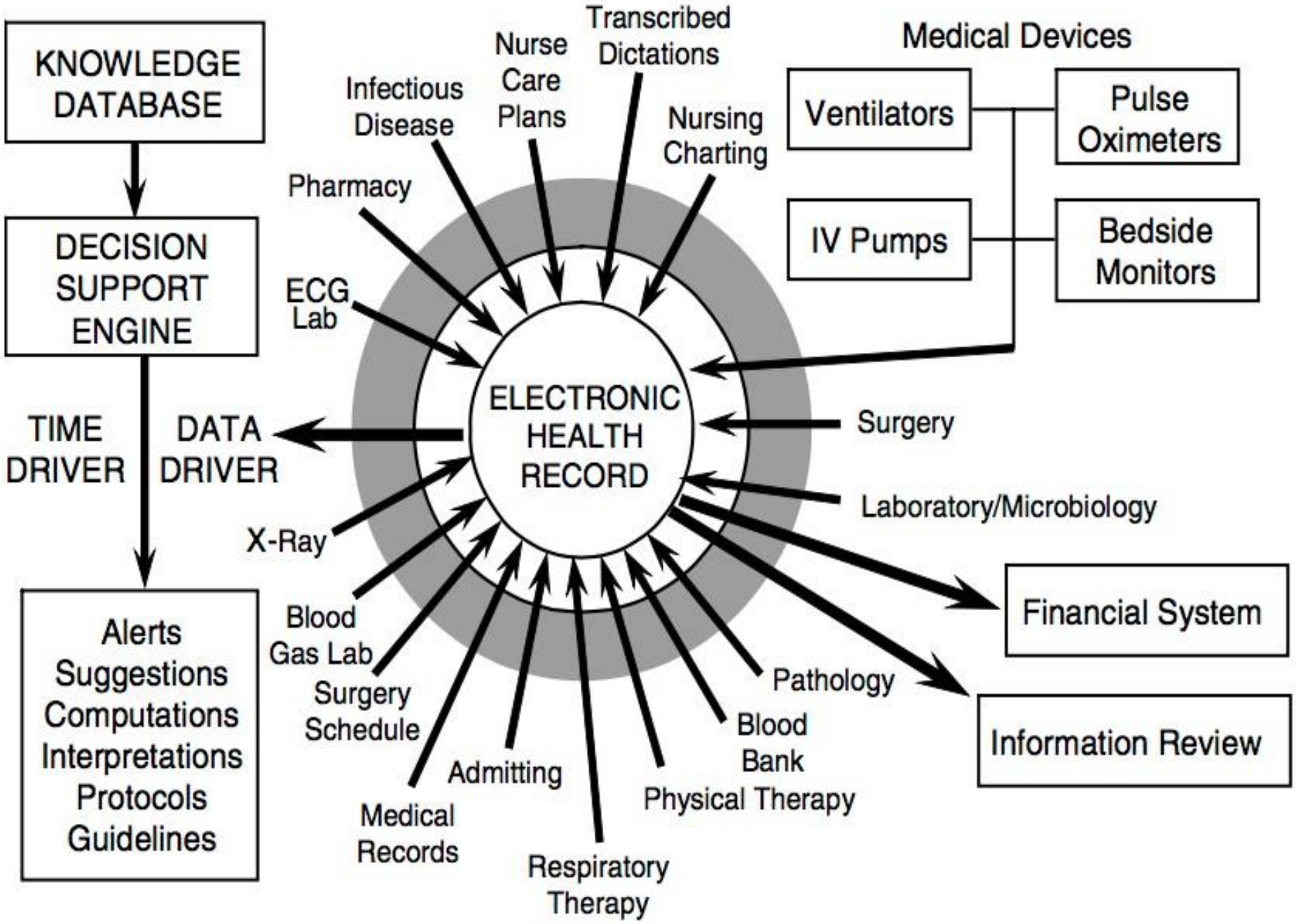


FIGURE 6-1 Architecture and key features of the HELP hospital information system.

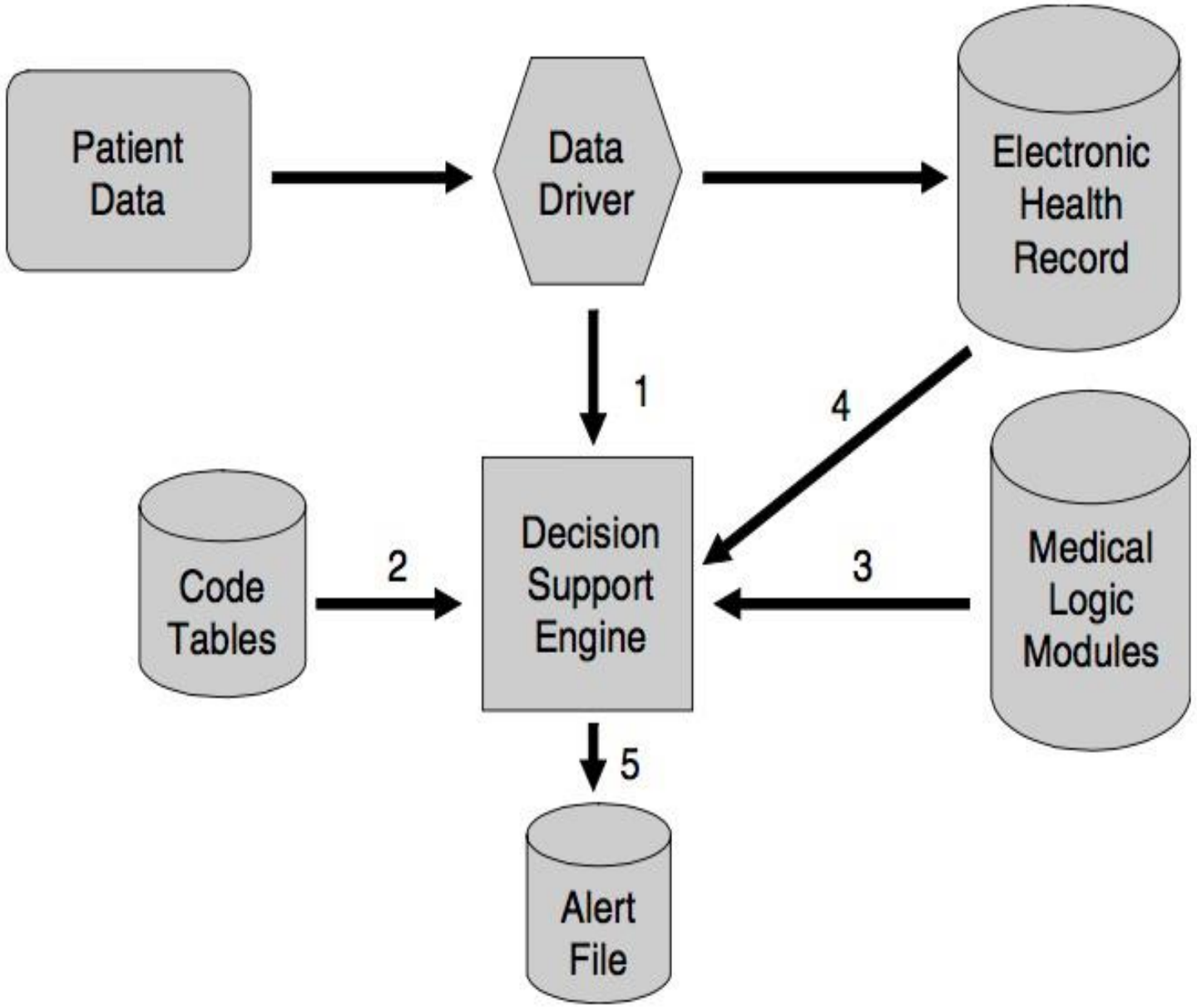


FIGURE 6-2 Main functional processes of the data-driver on the HELP hospital information system.

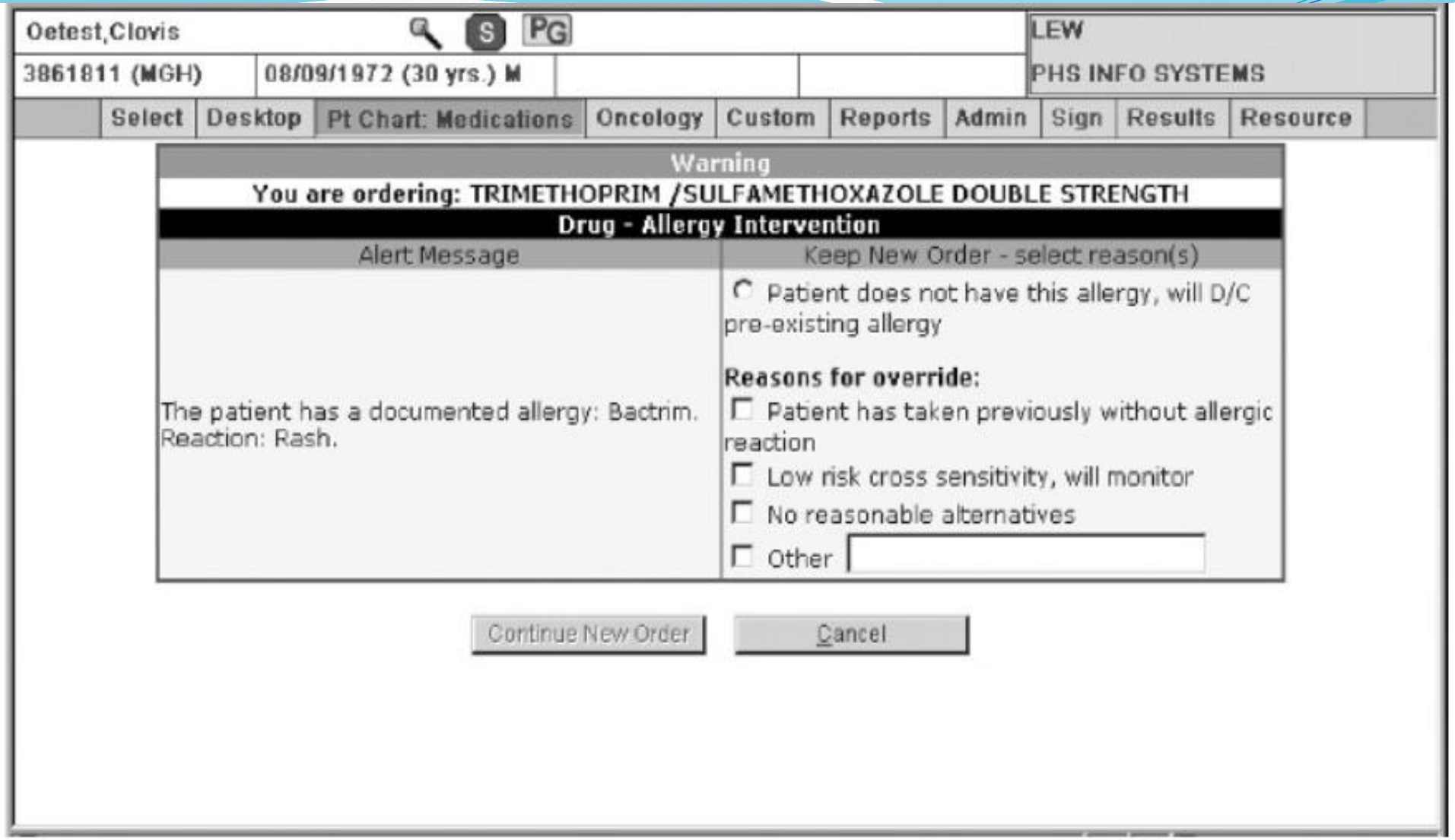


FIGURE 5-7 Drug–allergy alert. Here, the patient has a prior rash to sulfa, and trimethoprim/sulfamethoxazole has been ordered. This warning is a Level 2, which means in these systems that the alert is interruptive, and that the clinician must provide a reason for overriding, but is allowed to do so.

Pros

- Limited resources - increased demand Physicians are overwhelmed.
- Insufficient time available for diagnosis and treatment.
- Need for systems that can improve health care processes and their outcomes in this scenario

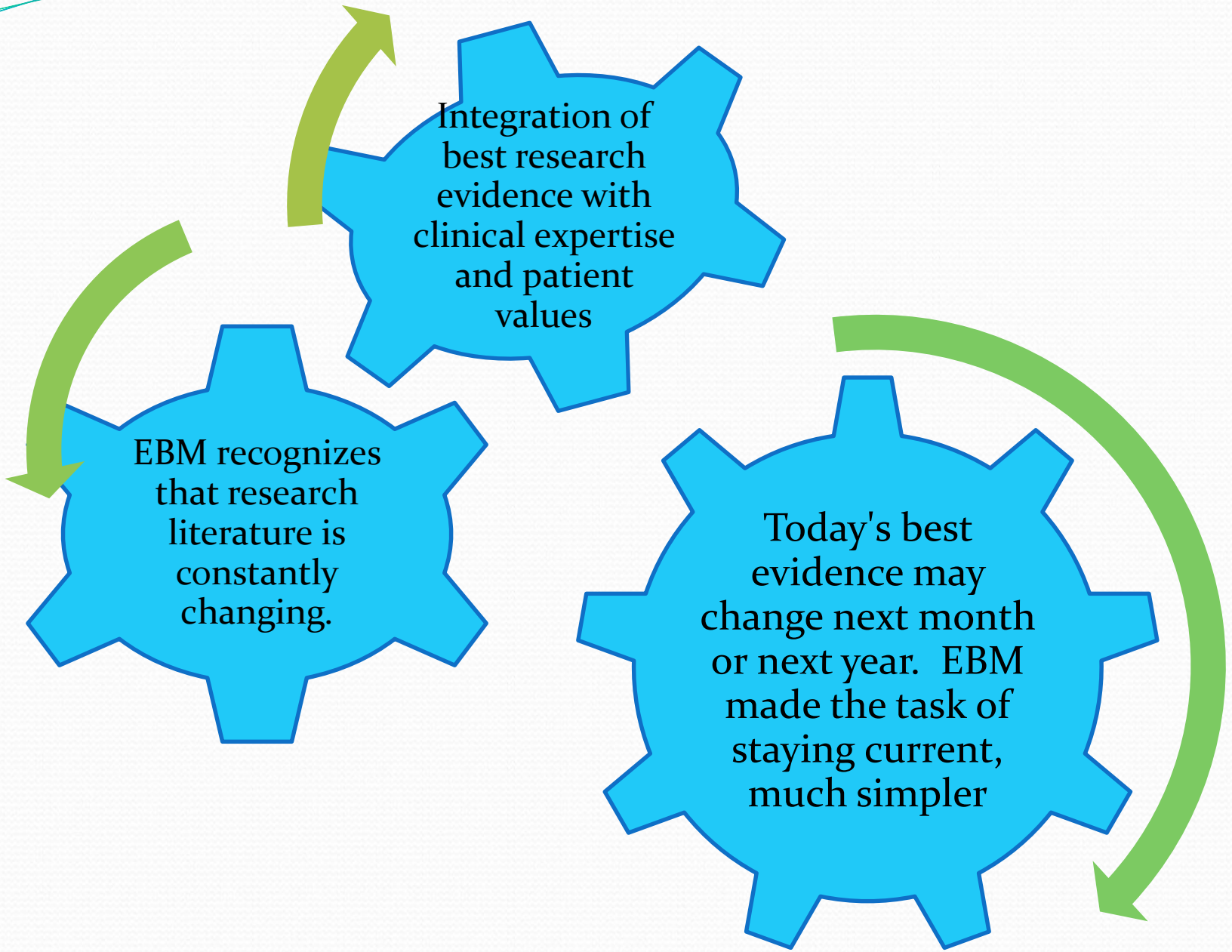
Cons

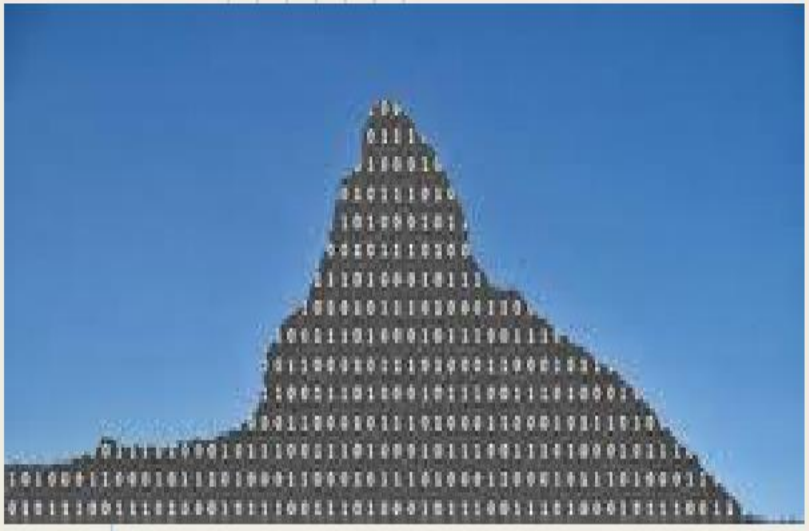
- Changing relation between patient and the physician
- Limiting professionals' possibilities for independent problem solving
- Legal implications - with whom does the obligation of responsibility lie

Eminence based Medicine

Eminence based medicine: A senior physician give less importance on the need for evidence. These colleagues have a touching faith in clinical experience, which has been defined as "making the same mistakes with increasing confidence over an impressive number of years." The eminent physician's white hair and balding pate are called the "halo" effect.

What is evidence-based medicine?





Mountains of Data

Evolution of Database Technology

- 1960s: Data collection, database creation, and network DBMS
- 1970s: Relational data model, relational DBMS implementation
- 1980s: RDBMS, advanced data models (extended-relational, object oriented, deductive, etc.) and application-oriented DBMS (spatial, scientific, engineering, etc.)
- 1990s—2000s: Data mining and data warehousing, multimedia databases, and Web databases
- 2000s: Post-RDBMS, NOSQL databases (key-value stores), massive databases
- 2010s: Big Data

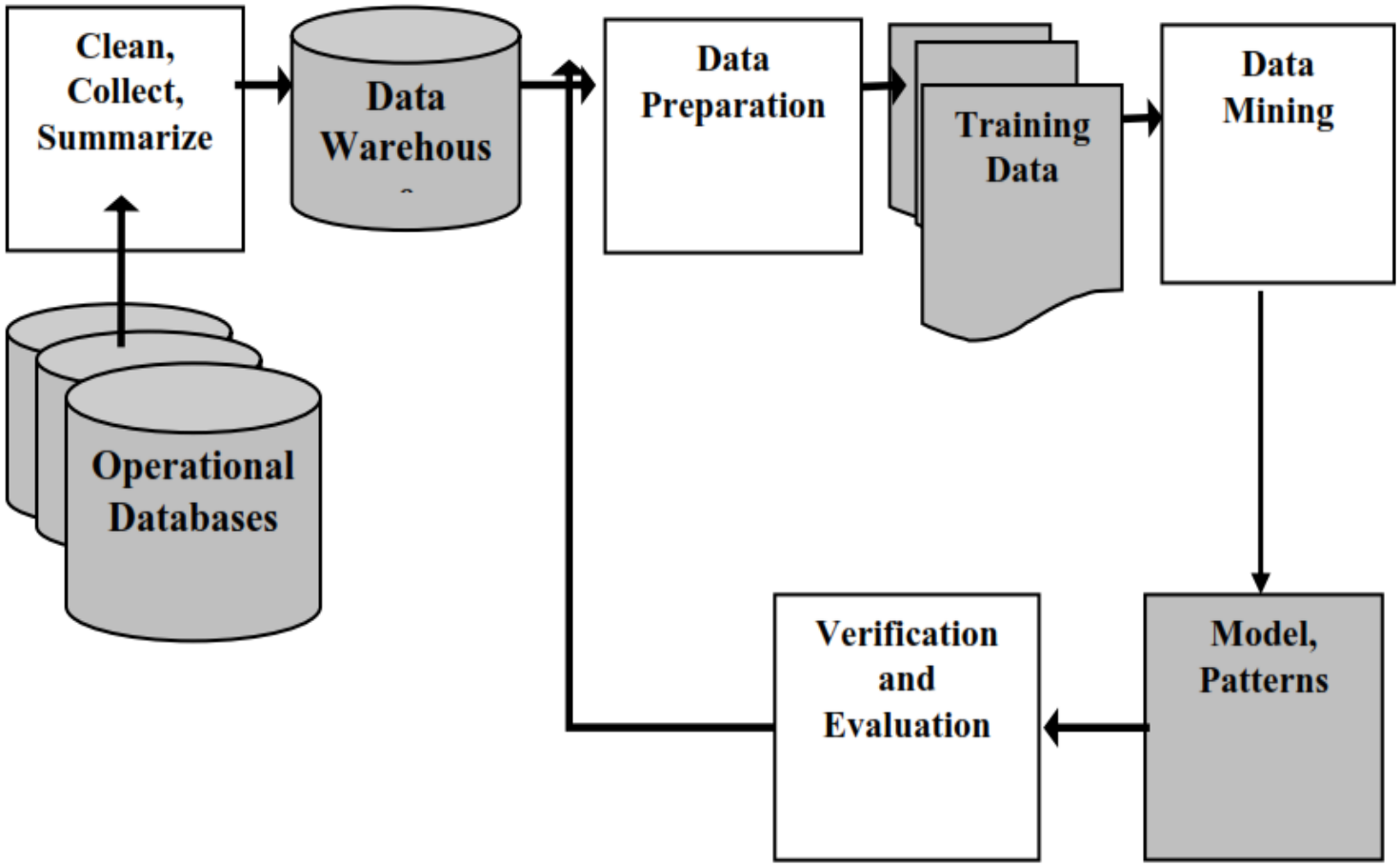
Data Mining

- **Data mining is knowledge discovery rather than question answering:**
  - May have no pre-formulated questions
  - Derived from
    - Traditional Statistics
    - Artificial intelligence
    - Computer graphics (visualization)
- Data Mining - extraction of interesting knowledge (rules, regularities, patterns, constraints) from data in large databases

Goals of Data Mining

- **Explanatory**
  - **Explain some observed event or situation**
- **Confirmatory**
  - **To confirm a hypothesis**
- **Exploratory**
  - **To analyze data for new or unexpected relationships**

Steps in KDD


Clean,
Collect,
Summarize
Data
Warehous
Data
Preparation
Training
Data
Data
Mining
Operational
Databases
Verification
and
Evaluation
Model,
Patterns

Why we need Expert Knowledge?

- There are a number of reasons why we want to capture expert knowledge (Crandall, Klein, and Hoffman 2006). These include:

Why we need Expert Knowledge? (Contd.)

- **Knowledge preservation**. We want to capture "wisdom," which develops with expertise. Such knowledge usually is not documented in any formal way, and we lose it once the expert retires or otherwise leaves the job.
- **Knowledge sharing.** Captured expert knowledge, meaningfully represented, can be reused in training programs, where trainees can train to develop expert strategies and functional efficiency. Such knowledge also can be shared among those who need to use it for a wide variety of decision-making tasks.
- **Knowledge to form the basis for decision aids.** New technology can be created based on the expert knowledge to help practitioners make better decisions. The technology, properly implemented, must embody the concepts, principles, and procedures of the work domain.
- **Knowledge that reveals underlying skills.** As the use of expert knowledge is explicated, it also reveals underlying strategies and skills.

Knowledge acquisition (KA)

- **Knowledge acquisition (KA)** may be defined as the process of identifying and eliciting knowledge from existing sources—from domain experts, from documents, or inferred from large datasets—and subsequently encoding that knowledge so that it can be verified and validated.

Knowledge acquisition (KA)

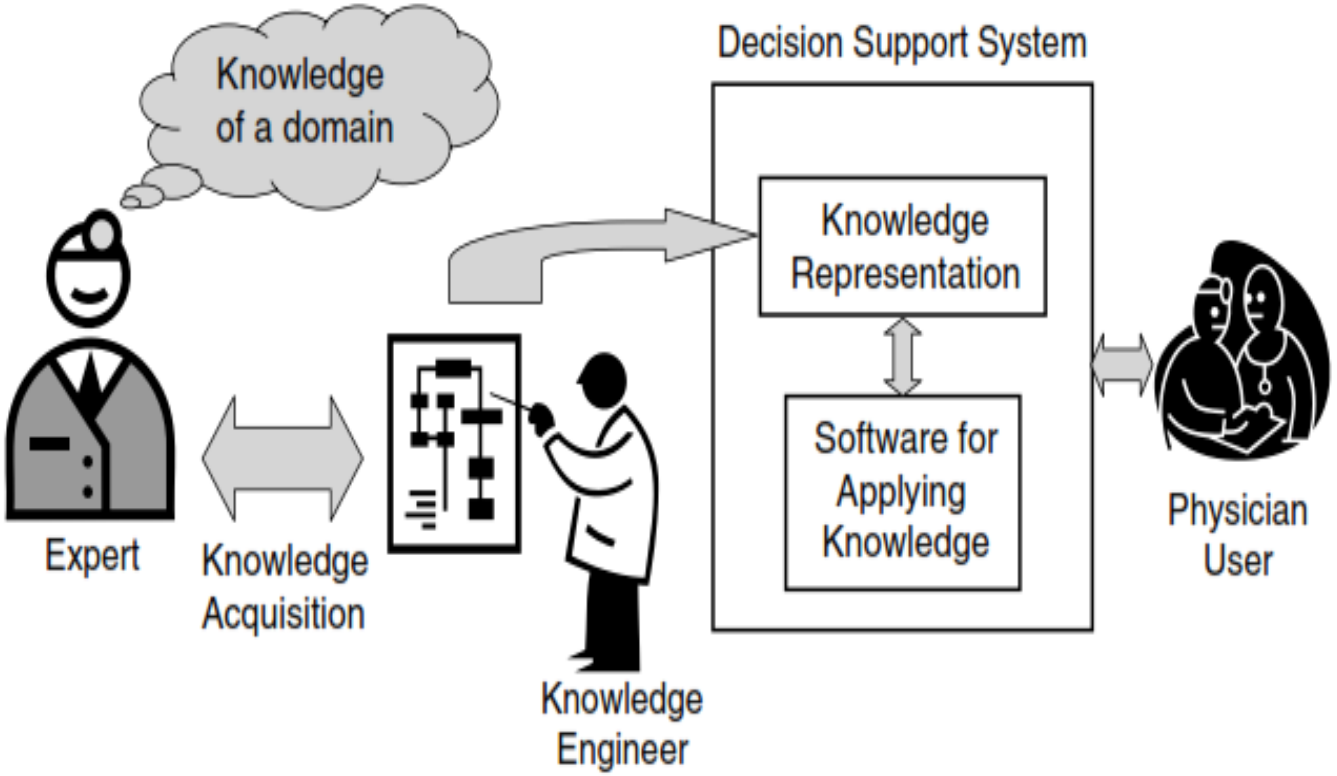


FIGURE 1 The classical view of knowledge engineering, in which an individual who knows the technical details of a system's representational conventions also has the skills of interviewing and observation necessary to work closely with an expert (or a group of experts) in order to obtain the needed knowledge and to convert it to a computationally useful form.

Knowledge acquisition (KA)

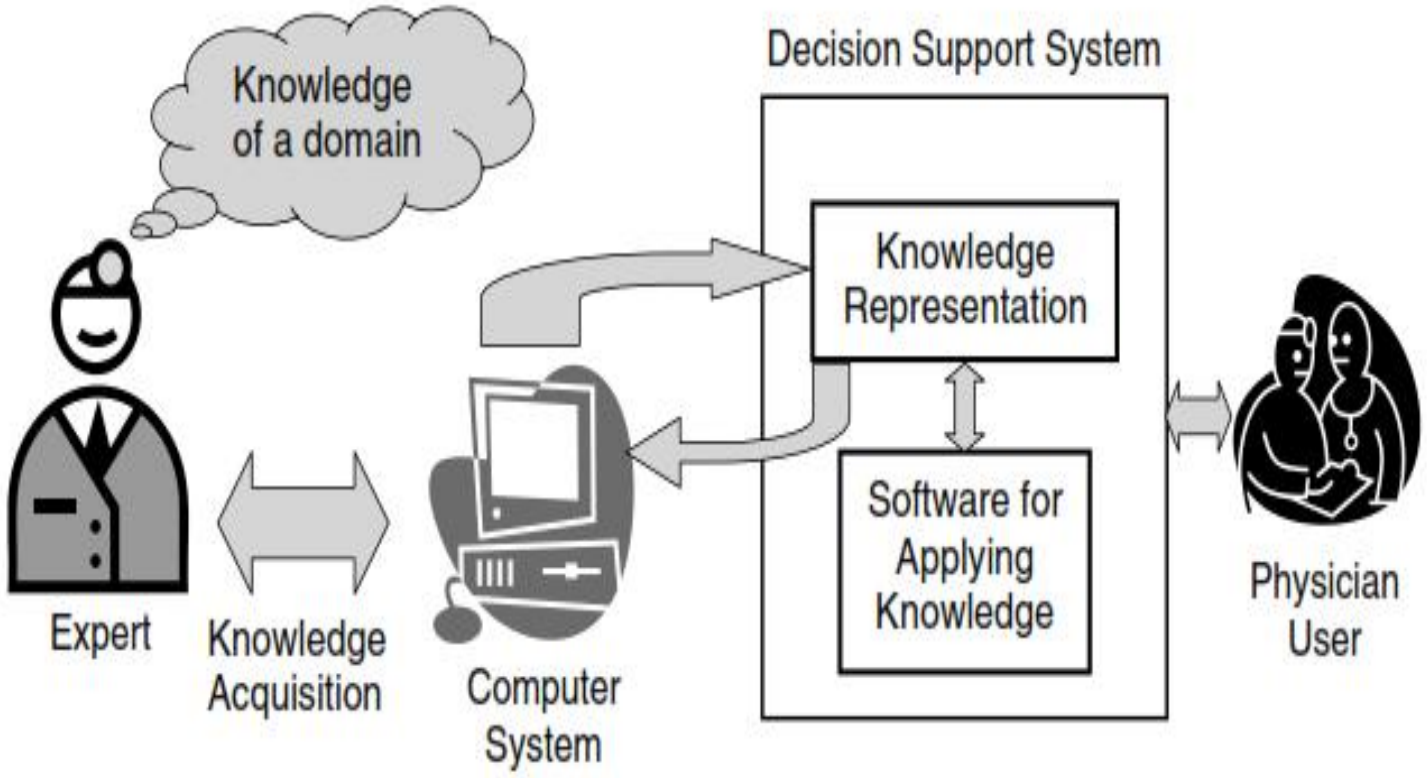
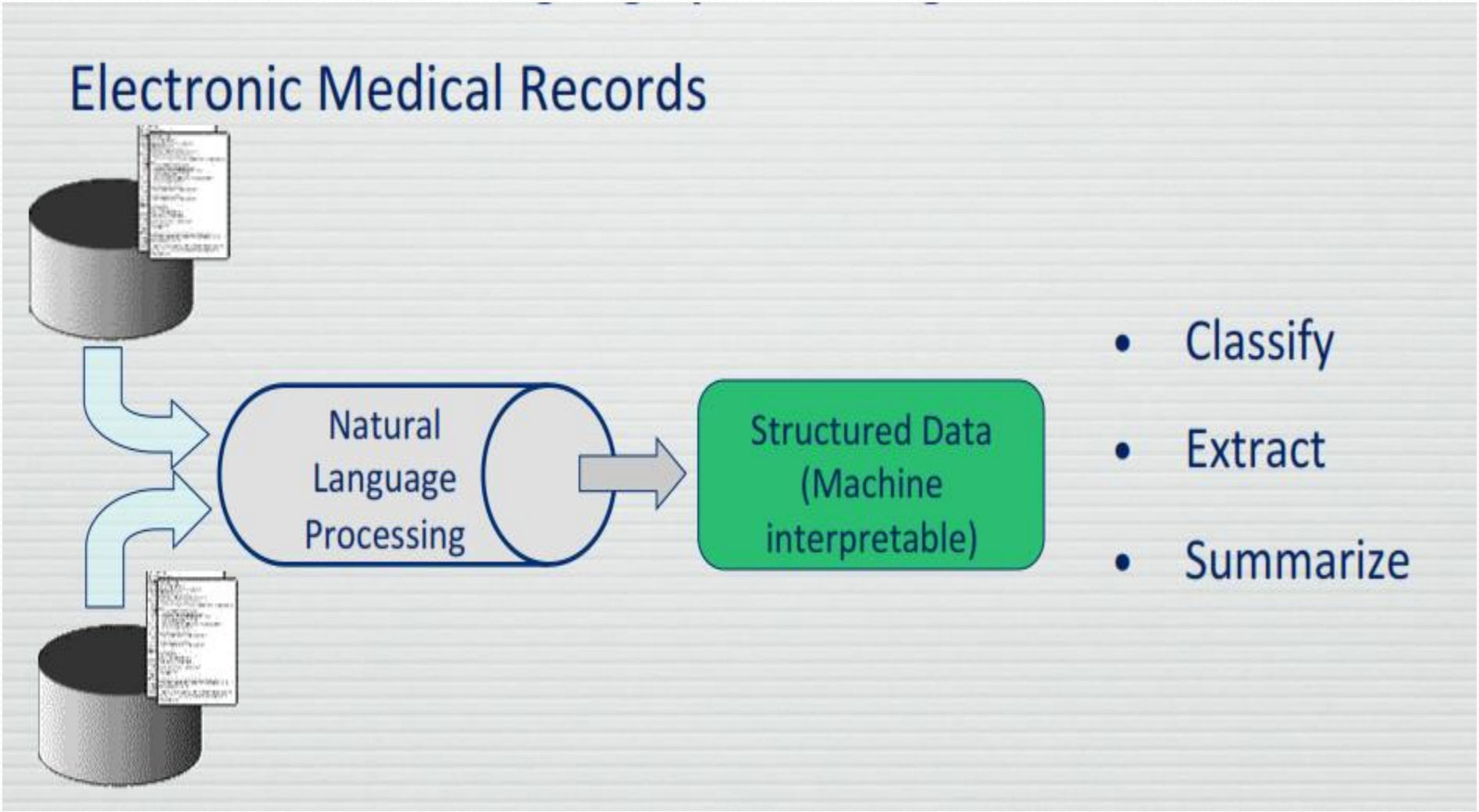


FIGURE 2 The interactive transfer of expertise using a computer program for knowledge acquisition. Note that such programs will generally both create new knowledge and use preexisting knowledge to guide the knowledge acquisition process.

NLP


Electronic Medical Records
Natural Language Processing
Structured Data (Machine interpretable)
Classify
Extract
Summarize

NLP

- **Natural Language Processing (NLP)**
  - Computers use (analyze, understand, generate) natural language
  - A somewhat applied field

Application areas

- Text-to-Speech & Speech recognition
- Natural Language Dialogue Interfaces to Databases
- Information Retrieval
- Information Extraction
- Document Classification
- Document Image Analysis
- Automatic Summarization
- Text Proofreading – Spelling & Grammar
- Machine Translation
- Story understanding systems
- Plagiarism detection

Standard

- Standards provide the foundation for many of the innovative communication features and options we have come to take for granted, and they contribute to the enhancement of our daily lives – often invisibly.

- **HL7 (Health Level 7)** is the accepted messaging standard for communicating clinical data.
- **DICOM or the Digital Imaging and Communications in Medicine** standard was developed for the transmission of images and is used internationally for **Picture Archiving and Communication Systems (PACS).**
- **CMVs or Controlled medical vocabularies** provide a way to organize biomedical knowledge for subsequent retrieval

- ***Controlled medical vocabularies (CMVs)*** *like the Systematized Nomenclature of* Medicine, Clinical Terms (*SNOMED CT), MEDCIN, Logical Observation Identifiers* Names and Codes (*LOINC).*

  Logical Observations: Identifiers, Names and Codes (LOINC) *is a coding system* for the electronic exchange of laboratory test results and other observations. It was developed and is maintained by the Regenstrief Institute, Inc.:

- www.regenstrief.org/loinc

Systematized Nomenclature of Medicine, Clinical Terms (SNOMED-CT) *has been* created from the combination of SNOMED-RT (Reference Terminology) .

The ***Unified Medical Language System (UMLS)*** *is a compendium of many CMVs in* the biomedical sciences. It is designed and maintained by the National Library of Medicine (***NLM).***

- The ***Current Procedural Terminology (CPT)*** *code set is maintained by the American* Medical Association (AMA) through the CPT Editorial Panel. These codes are used for the billing of medical procedures.
- http://www.ama-assn.org/ama/pub/category/3113.html
- The ***International (Statistical) Classification of Diseases (*ICD*)*** *originated from the WHO* as a classification of causes of deaths and today is also used to represent morbidity. It was first edited in 1892, and it has been revised ten times so far, most recently in 1992 (ICD-10).

Ethics

- Ethics :The study of a system of decision-making based on moral Principals.
- “Ethics brings structure & order to the decision-making process about our responsibilities for patient care and institutional management”

Larry McCullough, PhD.

“Medicine is the science of uncertainty and the art of probability”

-W.Osler, M.D.

Recent Health care privacy violation-Example

- A computer that contained the files of people with AIDS and other STDs was put up for sale by the state of Kentucky (2003)
- Due to software flaw , individuals who had requested drug and alcohol treatment information had their names and addresses exposed through a government-run website.

Top 5 Benefits of Clinical Decision Support in the ED

- High-acuity patients and surging patient volumes combine to make the **emergency department** (ED) a care setting with high variability and potential for medical error.
- Following are five key reasons why CDS should be used in the hospital ED:

1. **Reduce the risk of medication errors.** Determining accurate medication doses can be daunting — and especially critical for infants and children in emergency situations. Calculations involving complex formulas are often difficult to memorize, and mathematical errors can still occur even when the formulas are accurately recalled.

More than 37 percent of harmful pediatric medication errors are caused by an improper dose or quantity. In the ED, CDS can give physicians and nurses easy and quick access to drug-specific dosing calculators, full drug monographs with age, weight, disease and renal adjustment dosing, and much more. Accurate medication information and dosing calculators, easily accessible within the clinical workflow, can provide a significant reduction in errors.

2. Reduce misdiagnoses. Approximately 10-30 percent of medical errors are diagnosis errors. Decision support can drastically improve the margin of diagnostic error. When the diagnosis is not immediately obvious during a care crisis, ED professionals can use differential diagnosis support tools as an aid to rapidly identify diagnostic possibilities.

3. Provide the entire care team with consistent, reliable information. Finding the most relevant evidence-based knowledge can be a difficult task, especially when time is critical. Internet search engines can return thousands of results with varying degrees of relevance and reliability.

4. **Improve efficiency and patient throughput.** The Institute of Medicine estimates that $17-29 billion is spent annually on unnecessary or inaccurate patient care due to misdiagnosis. If clinicians can rapidly determine the correct dose, calculation or diagnosis, they can order relevant tests and make appropriate referrals, saving time and eliminating unnecessary costs for the patients and the ED.

5. Access all information in one place. Reference textbooks are generally outdated by the time they are published, take up valuable space in the ED and often cannot be found when needed.

Current issues and challenges in CDSS

- Ethical
- Legal
- Integrations
- Knowledge Base Maintenance
- Speed
- Usability and workflow
- Avoiding over-alerting
- Cultural change
- Management backing
- Clinical leadership

Thanks

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