

CLINICAL DECISION SUPPORT SYSTEM

Summary of the Book



Color index:

- **Important**
- ★ **Golden notes**
- **Doctors notes**

Intro to CDS & CDSS

Clinical decision support (CDS) provides **clinicians, staff, patients or other individuals** with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care.” (The Office of the National Coordinator for Health IT (ONC))

Clinical Decision Support System (CDSS)—Information technology systems that support electronic CDS.

- **Early on:** CDS was thought of only in terms of reminders & alerts.
- **Now:** CDS can include **diagnostic help, cost data, calculators (drug-drug interactions), up-to-date, etc.**
- **Vision:** CDS data to be electronic, structured, and computable. Apply technology to it easily And help in moving data from system to another

Though,we can use the Internet's potent search engines to **answer questions**, many organizations promote CDS as a major strategy **to improve patient care and safety**. The main goal: provide you the correct information at the right time.

Five Rights of CDS

- For CDS to be effective
 1. **Right** Time
 2. **Right** Channel **EHR, Email, message.**
 3. **Right** Intervention format **Alert**
 4. **Right** People
 5. **Right** Information **high level of evidence**

Historical prospective

- As early as the 1950s scientists predicted computers would aid medical decision making.
- CDS programs appeared in the 1970s and were standalone programs that eventually became inactive.
- You can find all of the resources [here](#).

Decision support systems			Current Date
HELP Health Evaluation Through Logical Processing Knowledge-based hospital information system			<input type="checkbox"/> CLINICAL <input type="checkbox"/> AI systems in clinical practice
developed by	clinical domains	keywords	<input type="checkbox"/> JMEDIA <input type="checkbox"/> CDSS <input type="checkbox"/> English <input type="checkbox"/> Epidemiologic Assistant <input type="checkbox"/> EBA <input type="checkbox"/> GDEBN <input type="checkbox"/> HELP <input type="checkbox"/> HealthConsult <input type="checkbox"/> SIRD <input type="checkbox"/> SPROB <input type="checkbox"/> SIBDI <input type="checkbox"/> JEMIRL <input type="checkbox"/> LISA <input type="checkbox"/> MCOB <input type="checkbox"/> OPRMS <input type="checkbox"/> Outpatient <input type="checkbox"/> PARS <input type="checkbox"/> QMR <input type="checkbox"/> RALD <input type="checkbox"/> RADIOL <input type="checkbox"/> Therapy Edge <input type="checkbox"/> Theravision CS-MS <input type="checkbox"/> TUCENT
Department of Medical Informatics, University of Utah, Salt Lake City	Multiple	Knowledge-based hospital information system	
Hospital of Intermountain Health Care (IHC), Utah, a trademark of the IHC Corporation	1975 (Paug et al., 2002) or 1987 (Gardner et al., 1995)	In routine use. HELP II is under development.	
Description			
HELP is a complete knowledge-based hospital information system. It supports not only the routine applications of an HIS including A/C, Order Entry, Charge Capture, Pharmacy, Radiology, Nursing documentation, CDS Reporting, but also supports a robust decision support function. The decision support system has been actively incorporated into the functions of the routine HIS applications. Decision support has been used to provide appropriate, timely, data interpretation, patient diagnosis, patient management suggestions and clinical protocols. Activation of the decision support is provided interactively within the applications and automatically through data and flow drive mechanisms. The data driven activation is implemented as clinical data is stored in the patient's comprehensive medical record. Time driven activation of medical logic is triggered at defined time periods. The HELP system supports an integrated database structure which facilitates the decision support functions of HELP. The database structure also lends itself to design of application independent patient reports.			

Examples of CDS tools

CDS Tool name	Approach used	Purpose
De Dombal's system	Bayes theorem <i>theoretical & statistical approach</i>	Differential diagnoses for acute abdominal pain
Internist-1	IF-THEN statements	Predict diagnoses
MYCIN	Rule-based system	Diagnosis and treatment of infections
SnapDx Positive (Apple iOS)	Positive and negative likelihood ratios from medical literature	Diagnosis (App covers about 50 common medical)
Isabel	Inference engine uses natural language processing and supported by 100,000 documents	Diagnosis tool
DxPlain	Based on clinical findings (signs, symptoms, laboratory data) the program generated a ranked list of diagnoses related to the clinical manifestations.	Justifies the diagnoses, suggests further steps and describes atypical manifestations

Isabel Story *Read it if you're interested*

Why the name Isabel?

Isabel is not an acronym but the name of the little girl whose illness inspired a medical tool diagnosed to help prevent misdiagnosis.

In 1999, 3 year old Isabel Maude nearly fatally misdiagnosed by her family doctor and hospital when her chickenpox developed, undetected, into Necrotizing fasciitis and Toxic Shock Syndrome. The result of this error was two months in hospital including a month in PICU struggling to survive from multiple organ failure and cardiac arrest. Against all odds, she survived her ordeal and, despite undergoing reconstructive surgery nearly two decades later, she is now an ambitious first class honors graduate pursuing a career in London. Surviving this life-threatening illness has given her a determination to live life to the full - conquering Mount Kilimanjaro is just the beginning!



CDS Benefits & goals

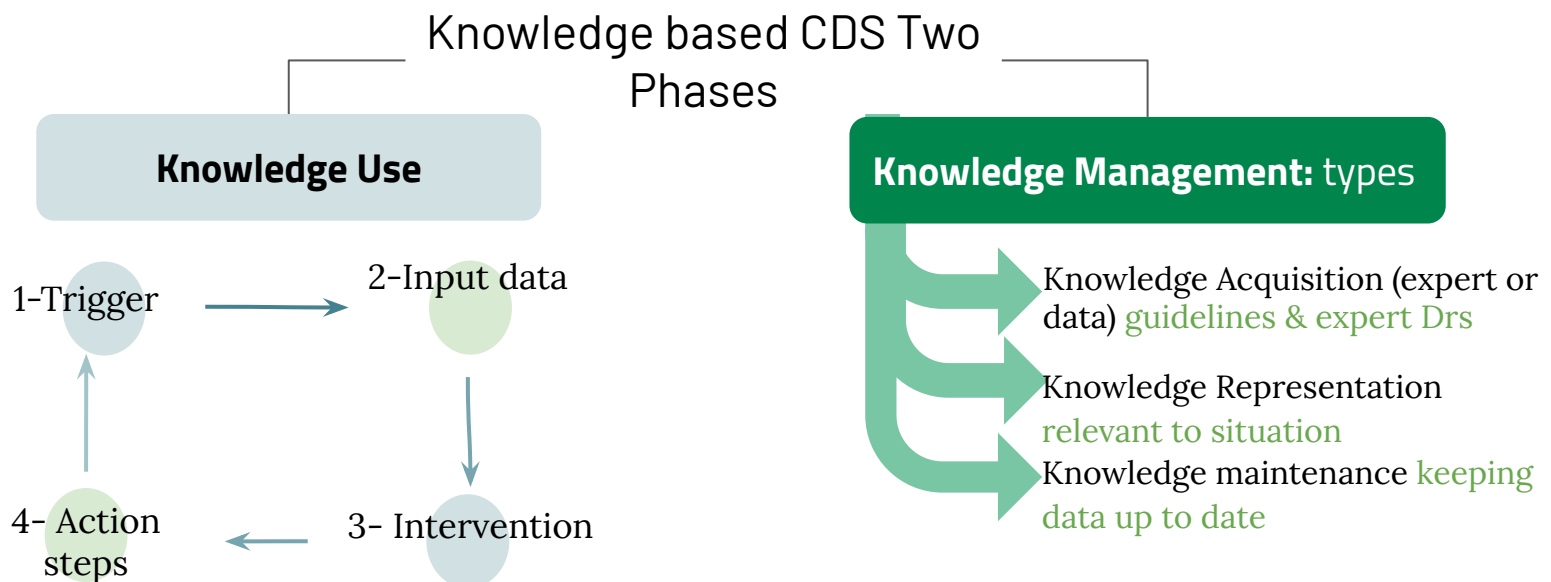
1. Improvement in patient safety, patient care, & population health
2. Reduction in healthcare costs *decrease duplicated cost.*
3. Management of complex clinical issues
4. Monitoring clinical details
5. Management of administrative complexity *Transfer patient, insurance billing.*
6. Support clinical research *clinical trial, Cohort.*
7. Dissemination of expert knowledge

Supporting Organizations

- **Institute of Medicine (IOM)** (now named as National Academy of Medicine (NAM)):
 - promoted “automated clinical information and CDS”
- ★ **American Medical Informatics Association (AMIA)**: developed 3 pillars of CDS in 2006
 1. Best available evidence.
 2. High adoption and effective use.
 3. Continuous improvement. **Update according to user feedback**
- ★ **Office of the National Coordinator (ONC)**: has funded research to promote excellent CDS & sharing possibilities.
- **Agency for Healthcare Research and Quality (AHRQ)** : also funded multiple CDS research projects & initiatives.
- **HL7**: has a CDS working group and developed FHIR standards, discussed later
- **National Quality Forum (NQF)**:
 - developed a CDS taxonomy (triggers, input data, intervention, & action steps)
 - **This helps evaluate CDS systems**
- **Leapfrog**:
 - promoted both CPOE and CDS
 - **Developed educational and test tools**
- **Healthcare Information Management System (HIMSS)**:
 - Their EMR Adoption Model rates EMRs from 1-7 (**Adoption levels**).
 - Full use of CDS qualifies as level 6

Types of CDS

1- Knowledge based CDS



2- Non-Knowledge based CDS

CDS Methodology

Data mining (machine learning) algorithms

- The previous knowledge representation methods were based on known data so they would be labelled “knowledge based CDS”.
- If CDS is based on data mining-related techniques it would be referred to as “**non-knowledge based CDS**”
- **Advantages of these approaches:**
 - a. Analyze large amount of data
 - b. Discovering trends and patterns & discovering new information



Supervised learning	Unsupervised learning
<ul style="list-style-type: none"> • Assumes that the user knows ahead of time what classes or categories exist. • Regression (Size of tumor, age) • Classification (Dead or alive) <ol style="list-style-type: none"> 1. Logistic regression binary (cancer recurrence, no cancer recurrence) 2. Decision Trees (could be in regression) 3. Neural networks 	<ul style="list-style-type: none"> • Clustering • Association rules (IF-THEN)

CDS Standards

- CDS developers have struggled for a long time with how to **share knowledge representation** with others or how to modify rules locally.
- It is important because it sets a standards that act as a common language for all systems to communicate
- Standards were developed to try to overcome **obstacles interoperability**
- **Fast Healthcare Interoperability Resources (FHIR)**: Developed by HL7 there is great hope that this standard will solve many **Interoperability** issues
 - It is a **restful API (like google uses)** that uses either JSON or XML for data representation.
 - It is **data and not document centric**; so a clinician could place a http request on EHR A to retrieve **just a lab value** from EHR B.
- ★ **Infobuttons**: can be placed in workflow where decisions are made with recommendations
- A button to redirect you yo up-to-date

Infobuttons

FHIR

Search Display

UpToDate*

Search Results for professional level information on hypertension in adults

Overview of hypertension in adults

Choice of therapy in primary (essential) hypertension: Recommendations

Portal hypertension in adults

Who should be evaluated for renovascular or other causes of secondary hypertension?

Hypertension: Who should be treated?

Management of severe asymptomatic hypertension (hypertensive urgencies) in adults.

Infobutton launches popup window with relevant content using:
HL7 standards
Non-PHI patient context
Provider information

Wolters Kluwer Health

```

Patient xmlns="http://hl7.org/fhir/"
  id value="glossy"/>
  meta
    <lastUpdated value="2014-11-19T11:41:00+11:00"/>
  </meta>
  resource
    <status value="generated"/>
    <div xmlns="http://www.w3.org/1999/xhtml">
      <p>Henry Levin the 7th</p>
      <p>MRN: 123456. Male, 24-Sept 1932</p>
    </div>
    <text>
      <extension url="http://example.org/StructureDefinition/trials">
        <valueCode value="trial1"/>
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    </organization>
  </Patient>
  
```

Resource Identity & Metadata

Human Readable Summary

Extension with URL to definition

Standard Data:

- Name
- MRN
- Gender
- Birth Date
- Provider

CDS Sharing

- Currently there is **no single method** for CDS knowledge can be universally shared. The approach has been to either use standards to share the knowledge or use CDS on a shared external server.
- Socratic Grid and Open CDS are open source web services platforms that support CDS.
- The FHIR standard appears to have the greatest chance for success, but it is still early in the CDS game to know.

CDS Functionality

CDSSs can be classified in multiple ways:

Knowledge	Relevance to EHR	Activation timing	Alert type
<ol style="list-style-type: none"> 1. Knowledge based 2. non-Knowledge based 	<ol style="list-style-type: none"> 1. Internal to EHR 2. External to EHR up-to-date 	<ol style="list-style-type: none"> 1- during patient encounter 2- before 3- after 	<ol style="list-style-type: none"> 1- interruptive: physician cannot continue task until alert is addressed 2- non-interruptive

Function	Example
	Taxonomy help in evaluation of CDS system
Patient safety	<ul style="list-style-type: none"> - Medication alerts - Critical lab alerts - Ventilator support alerts - Improved drug ordering for warfarin and glucose - Infusion pump alerts - Risk calculation - Improved legibility - Diagnostic aids
Cost	<ul style="list-style-type: none"> - Reminders to use generic drugs or formulary recommendations - Fewer duplications we don't do more tests that we already do, so we reduce the cost - Reminders about costs of drugs, lab tests, and imaging studies - Reduce Medicare penalties for readmissions - Reduce medication errors - Reduce malpractice claims - Better utilization of blood products
Patient Care	<ul style="list-style-type: none"> - Embedded clinical practice guidelines, order sets, and clinical pathways - Better chronic disease management - Identify gaps in recommended care - Immunization aids - Diagnostic aids - Sepsis alerts (see case study infobox) - Antibiotic duration alerts - Prognostic aids - Patient reminders - Pattern recognition for images, pulmonary function tests and EKGs, blood gases, pap smear interpretation
Disseminating Expert Knowledge	<ul style="list-style-type: none"> - Use of infobuttons for clinician and patient education we provide the patient with resources to support him after leaving the clinic - Provide evidence based medicine with embedded clinical practice guidelines and order sets
Managing complex clinical issues	<ul style="list-style-type: none"> - Reminders for preventative care for chronic diseases - Care management - Predictive modeling based on demographics, costs, and clinical parameters
Managing complex administrative issues	<ul style="list-style-type: none"> - Decision modeling - Research recruitment

CDS Functionality

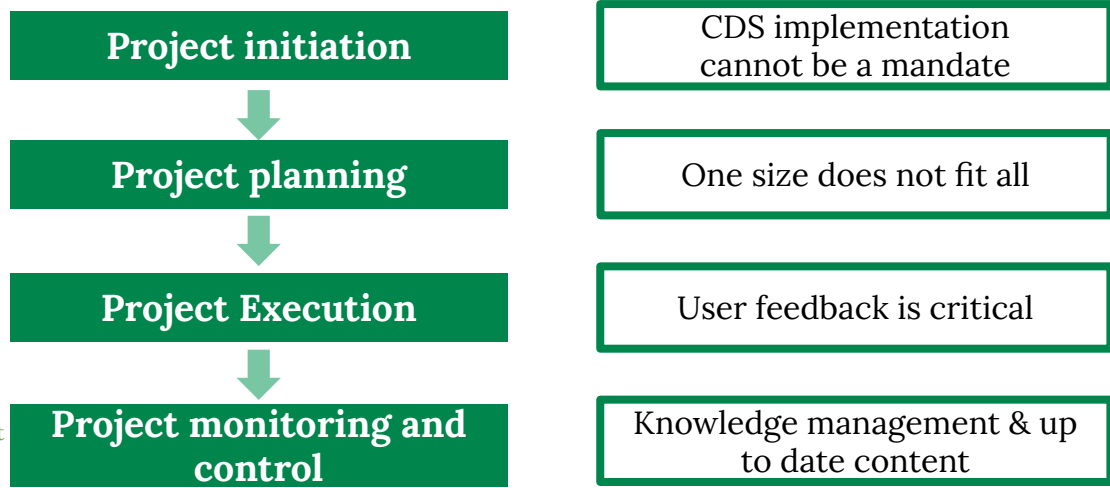
1. Ordering Facilitators

Order sets	<ul style="list-style-type: none">• Are EHR templated commercial or home grown orders that are modified to follow national practice guidelines .• For example, a patient with a suspected heart attack has orders that automatically include aspirin, oxygen, EKG, etc.
Therapeutic support	<ul style="list-style-type: none">• include commercial products such as Theradoc and calculators for a variety of medical conditions. <i>provide clinical surveillance like infection control assistantship to help in monitoring hospital acquired infections</i>
Smart forms	<ul style="list-style-type: none">• Are templated forms, generally used for specific conditions such as diabetes. They can include simple check the boxes with evidence based recommendations. <i>Template that provide structural questions to fill information but it will be report information because you just fill information according to the questionnaire</i>
Alerts and reminders	<ul style="list-style-type: none">• Are the classic CDS output that usually reminds clinicians about drug allergies, drug to drug interactions and preventative medicine reminders. This is discussed in more detail in the chapter on EHRs and the chapter on patient safety.

2. Relevant information display

Hyperlink, Infobuttons, mouse over	Common methods to connect to evidence based information <i>Shows up when it is relevant to case</i>
Diagnostic support	<ul style="list-style-type: none">- Most diagnostic support is external and not integrated with the EHR; (e.g. Sim Consultant)- Isabel is an example automatically pull coded signs & symptoms
Dashboards	Can also be patient, and not population level, so they can summarize a patient's status and thereby summarize and inform the clinician about multiple patient aspects

CDS Implementations & lessons learned



SWOT analysis
Consider 5 rights
Provide educationally material

Keep getting a feedback
Further improvements

Training for users and get a feedback through a training process

CDS Challenges

General	Exploding medical information that is complicated and evolving. Tough to write rules we need methods more powerful to handle these large data beyond the rule system
Organizational support	CDS must be supported by leadership, IT and clinical staff. Currently, only large healthcare organizations can create robust CDSSs needs cooperation of all teams
Lack of a clear business case	Evidence shows CDS helps improve processes but it is unclear it affects behavior and patient outcomes. Therefore, there may not be a strong business case to invest in CDSSs we could use taxonomy here!
Unintended consequences	Alert fatigue The physician may ignore the alert either because it is wrong or appear in a wrong place or in a wrong way
medico-legal	Adhering to or defying alerts has legal implications confidentiality and privacy
Clinical	Must fit clinician workflow and fit the 5 rights We need to understand clinician workflow, for example: physician need a system to develop by a an IT. On the other hand, IT said the physicians don't use it so we need more communication
Technical	Complex CDS requires an expert IT team
Lack of interoperability	Must be solved for CDS to succeed
Long term CDS benefits	Requires long term commitment and proof of benefit to be durable it is not just an implantation we need to follow up and evaluate for further improvement

Future Trends

If the FHIR standard makes interoperability easier we may see new CDS innovations and improved adoption enable liquidity of data

Quiz

Q1: “It provides the right information to the right person in the right format through the right channel at the right point in workflow to improve health care decisions and outcomes”

Which one of the following describes the above statement?

- A)CDSS
- B)PACS.C)ICD10.
- D)RIS.

Q2: “Pop up alerts” is a feature of which of the following functional components of EHR?

- A)integrated view of patient data.
- B)CDSS.
- C)Access to knowledge resources
- D)communication and reporting tools.

Q3)Which of the following is a Drawback of CDSS?

- A)flexibility
- B)Legal implication
- C)Faster use
- D)changing relation between patient and the physician

Q4)Which one of the following is an example of CDSS?

- A)MYCIN
- B)PACS
- C)HIPPA
- D)CPOE

Q5)Why do we need expert system in CDSS?

- A)Preservation of knowledge
- B)Sharing of knowledge between clinician
- C)Aid in decision making
- D)Collection of data.

Q6)Which of the following is a example of unsupervised learning?

- A)Assumes that the user knows ahead of time what classes or categories exist.
- B)Regression
- C)Clustering
- D)Classification

Good Luck!

TEAM LEADER
JUDE ALOTAIBI

TEAM LEADER
KHALID ALKHANI

DONE BY OUR AMAZING MEMBER:
Safana Alomar

NOTE TAKEN BY OUR SHARP MEMBER:
Khalid (sadly nothing rhymes with his name..)

