Allergies, Alerts and Flags - An Introduction to Clinical Decision Support Systems

Foundational Curricula:

Cluster 5: EHR Systems

Module 9: EHR Modules – Medications, Allergies, Clinical Decision Support and Order Entry

Unit 2: Allergies, Alerts and Flags - An Introduction to Clinical Decision Support Systems

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Curriculum Developers: Angelique Blake, Rachelle Blake, Pauliina Hulkkonen, Sonja Huotari, Milla Jauhiainen, Johanna Tolonen, and Alpo Värri

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Unit Objectives

- Review how technology supports clinical decision and alert tools and applications within the clinical management, healthcare delivery, medication administration and records documentation processes

- Identify various types of clinical decision support systems

- Recognize how technology is used to collect and display patient medications and medication allergies

- Identify technology systems and applications in health IT/eHealth used to collect and display patient medications and medication allergies, dispense and deliver medications, and perform medication administration and reconciliation

- Describe evidence-based medicine, clinical practice guidelines, and quality indicators in medicine

- Explain expert and web based information systems and clinical care pathways in clinical practice

How technology and systems support clinical management and healthcare delivery

- So far, this course has covered how systems and technology support clinical management and healthcare delivery
- This support comes in the form of:
  - Systems such as electronic health records, departmental systems, modules and submodules that enable providers and allied health professionals to document care
  - Picture archiving and communications systems, which help translate static pictures into digital images for inclusion into an electronic health record, saving time and making diagnosis more efficient
  - Patient identification, product identification and medication administration management tools such as barcodes, RFID and biometrics, which improve the quality of care, can reduce errors, save time and increase security

- These systems, technology and tools allow patients to be more aware of their health and enable them to take an active role in the care process

- They also allow providers to deliver higher quality healthcare and to manage clinical processes more efficiently and effectively

- Another technology that enables providers to deliver high quality care in the electronic health care environment is clinical decision support, which we will discuss in more detail in this unit

Clinical Decision Support

Clinical Decision Support

- **Clinical decision support (CDS)** can be defined as systems that aim to improve decision-making around diagnoses (clinical prediction rules), prevention and disease management (routine care reminders to doctors or patients), and treatment (electronic medication prescribing)

- Technically speaking, medical manuals, texts and journals, colleague consultations, published articles and practice guidelines in any form can all be considered clinical decision support, as they help providers make decisions such as arriving at diagnoses, selecting tests to order, and making treatment choices

- In the electronic health records environment, clinical decision support more commonly takes the form of **clinical decision support systems (CDSS)**, which include information, technology and systems that link health observations with health knowledge to help guide clinicians in making decisions for improved health care

Clinical Decision Support Systems

- Clinical Decision Support Systems (CDSS) match patient-specific information to general clinical knowledge (population databases)

- In the early days, CDSSs were conceived of as being used to literally make decisions for the clinician. The clinician would input the information and wait for the CDSS to output the "right" choice and the clinician would simply act on that output

- Current methodology of using CDSSs to assist in decision making means that the clinician interacts with the CDSS, utilizing both their own knowledge and the CDSS, to make a better analysis of the patient's data than either human or CDSS could make on their own

- Typically, a CDSS makes suggestions for the clinician to look through, and the clinician is expected to pick out useful information from the presented results and eliminate erroneous CDSS suggestions

The Two Main Types of CDSS

- There are two main types of CDSS. The first type is Knowledge-based:
  - **Knowledge-based**: Most CDSSs consist of three parts: the knowledge base, an inference or "rules" engine, and a mechanism to communicate. The inference engine combines the rules from the knowledge base with the patient's data. The communication mechanism allows the system to show the results to the user as well as have input into the system. Knowledge-based CDSSs are most commonly used with EHRs
    - The **knowledge base** contains the rules and associations of compiled data which most often take the form of IF-THEN rules.
    - If this was a system for determining drug interactions, then a rule might be as follows:
      - IF drug X is taken AND drug Y is taken -> THEN alert user
    - Using another interface, a system maintainer could edit the knowledge base to keep it up to date with new drugs

IF drug X is taken AND drug Y is taken -> THEN alert user

- The second type of CDSSs is non-knowledge-based:
  - **Non-knowledge-based**: CDSSs that do not use a knowledge base use a form of artificial intelligence called machine learning
    - This allow computers to learn from past experiences and/or find patterns in clinical data. It eliminates the need for writing rules and for expert input
    - However, since systems based on machine learning cannot explain the reasons for their conclusions, most clinicians do not use them directly for diagnoses, for reliability and accountability reasons
    - Three types of non-knowledge-based systems are support vector machines, artificial neural networks and genetic algorithms
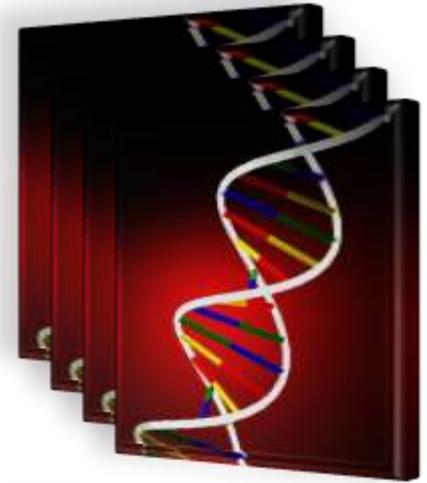
Success Factors and Barriers for Clinical Decision Support Systems

In order to be successful, a CDSS needs to:

- Be reliable
- Improve care quality by reducing medical errors
- Be integrated to the health information system and require little extra effort from the user
- Incorporate EHR users' perspectives into the design, build and maintenance of the CDSS
- Be actively fostered through a bottom-up, clinical-needs-first approach

Barriers to implementation can include:

- – Privacy
- – Confidentiality
- – User-friendliness
- – Document accuracy and completeness
- – Integration
- – Uniformity
- – Acceptance
- – Alert desensitisation

# Clinical Decision Support Systems in Practice

- CDSS are most typically used with the medication administration, allergies, ordering and diagnoses/assessment components of clinical practice
- Decision support systems can also be used for clinical processes such as:
  - Triaging medical conditions
  - Deciding on medication recommendations
  - Adverse medication interaction avoidance
  - Skin image analysis for cancer diagnoses
  - Analyzing electrocardiograms, interpreting pulmonary function tests, and early warning system for infant sepsis detection
- Three areas that can be addressed with CDSS and Electronic Health Records (EHRs), are:
  - Adverse drug events (including allergies and drug interactions)
  - Medication prescription errors
  - Other medical errors
- Next, we will look at how clinical decision support affects these processes, especially, adverse drug events, in the digital clinical environment

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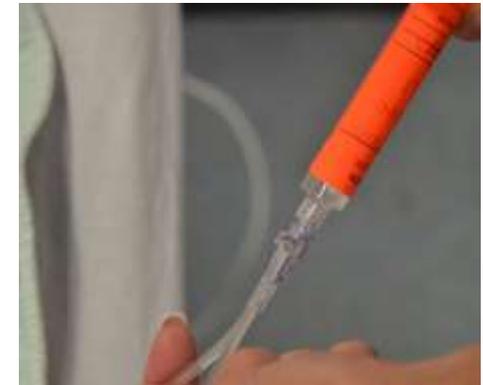
Adverse Drug Events and Reactions

- An **adverse drug event (ADE)** refers to any unexpected event, effect or experience occurring at the time a drug is used, whether or not it is identified as a cause of an injury
    - Goosebumps caused by a drug is one type of adverse drug event
- An **adverse drug reaction (ADR)** is an injury caused by taking a medication. An ADR is a special type of ADE in which a causative relationship can be shown
    - A medication allergy is one type of adverse drug reaction
- All adverse drug reactions are adverse drug events, but not all ADEs are ADRs
- ADRs may occur following a single dose or prolonged administration of a drug or result from the combination of two or more drugs
- The meaning of ADR differs from the meaning of "side effect", as side effect might also imply that the effects can be beneficial
- The study of ADRs is the concern of the field known as **pharmacovigilance**

Adverse Drug Events

Adverse Drug Reactions

Adverse Drug Events and Reactions (cont'd)

ADRs may be classified by **cause** (the producer of the effect) and **severity** (the degree of intensity)

- Causes: Two types: Type A: Augmented and Type B: Idiosyncratic
  - Cause Type A: **Augmented**
    - Constitute approximately 80% of adverse drug reactions
    - Often detected in clinical trials
    - Are usually due to the drug's primary pharmacological effect or a low therapeutic index of the drug
    - Are usually predictable
    - Are dose-related and usually mild, although they may infrequently be serious or even fatal
    - Often reversible
    - Usually disappear after dose reduction or cessation of therapy
    - The term "side effects" is often applied to minor type A reactions

– Cause Type B: **Idiosyncratic**

- Are drug reactions that occur rarely and unpredictably amongst the population. This is not to be mistaken with **idiopathic**, which implies that the cause is not known

- Not usually detected in clinical trials

- Frequently occur with exposure to new drugs, as they have not been fully tested and the full range of possible side-effects have not been discovered

- Are extremely rare

- Include some patients with multiple-drug intolerances

  – Patients with multiple idiopathic effects that are nonspecific are more likely to have anxiety and depression

- Appear to not be dependent on the concentration of the drug. A minimal amount of drug will cause an immune response, but it is suspected that at a low enough concentration, a drug will be less likely to initiate an immune response

- Severity
  - a serious adverse event is when the patient outcome is one of the following:
    - Death
    - Life-threatening injury
    - Hospitalization (initial or prolonged)
    - Disability (if significant, persistent, or results in a permanent change, impairment, damage or disruption in the patient's body function/structure, physical activities or quality of life)
    - Congenital anomaly
    - Requires intervention to prevent permanent impairment or damage
    - Intense pain
  - Severity is a point on an artificial scale of intensity of the adverse event in question. The terms "severe" and "serious" when applied to adverse events are technically very different. They are easily confused but can not be used interchangeably, requiring care in usage
  - A reaction is severe if it causes intense pain. Severity scales like "visual analog scale" help clinicians assess the severity
    - For example, a headache is typically not serious (but may be in case of subarachnoid haemorrhage, subdural bleed, or even a migraine if it fits the severity criteria for seriousness listed above)

Allergies

- **Allergies**, also known as allergic reactions or diseases, are a number of conditions caused by hypersensitivity of the immune system

- Allergies can be caused by exposure to something in the environment, things that are inhaled, things that are applied to the skin, or things that are put in the body or ingested, including foods or medications

    - Allergies cause reactions in hypersensitive individuals that usually cause little or no reactions in most people

    - These reactions include hay fever, atopic dermatitis, allergic asthma, and anaphylaxis. Symptoms may include red eyes, an itchy rash, sneezing, a runny nose, shortness of breath, or swelling

- Due to the routine use of medications to treat illness in healthcare, it is imperative that all allergies, especially medication allergies, for each patient are known and displayed to providers prior to administering any treatment

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Allergies (Cont'd)

- Accurate information about allergies reduces adverse effects of medication

- Reasons for missing drug allergies include:
  - poor clinical documentation of the drug allergy
  - lack of patient knowledge of the drug allergy
  - lack of a routine system in place for consumers to keep a record of their own drug allergies

- EHRs and CDSSs can play a large role in ensuring allergies are documented in a patient's record and known before potential allergens or reactants may be administered

- All allergies must be recorded into the electronic health record (EHR)
  - There is usually an indication in the patient name banner at the top of the screen, where patient allergies are indicated
  - Barcodes in hospital armbands, **bar-coded medication administration (BCMA)** are also used as a quick way to check medication allergies
- Electronic medication reconciliation systems help administrate all medications the patient is taking throughout all episodes of care
- Personal health records (PHRs) can be used to engage the patient to keep track of their own medication
- **Computerized provider order entry systems (CPOE),** a process of electronic entry of medical practitioner instructions for the treatment of patients, with CDSS help the provider avoid medication errors in the ordering/prescribing phase
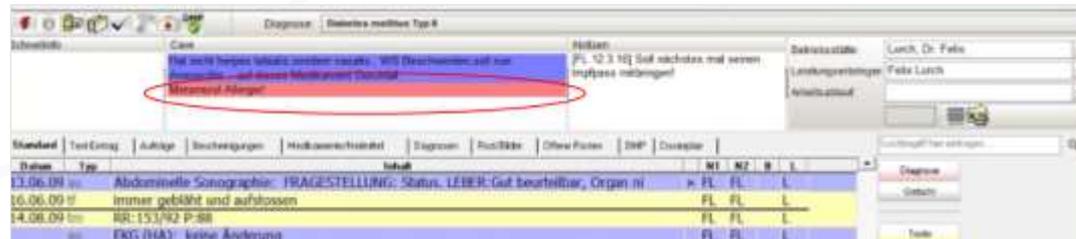
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How to Collect and Display Patient Medication and Medication Allergies

- NICE (National Institute for Health and Care Excellence, England, UK) has provided a guideline for recording medication allergies

- When a reaction or suspected reaction occurs, the following information on the patient should be recorded, whether it is:
  - ❑ A drug allergy
  - ❑ none known
  - ❑ unable to ascertain (document as soon as the information is available)

- If drug allergy status has been documented, record all of the following at a minimum:
  - the drug name
  - the signs, symptoms and severity of the reaction
  - the date and time when the reaction occurred

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- Additionally, the following information should be documented, if known:
  - generic and proprietary names of the drug, strength, batch number and formulation
  - the indication for the drug being taken (if there is no clinical diagnosis, describe the illness)
  - the number of doses taken or number of days on the drug before onset of the reaction
  - the route of administration
  - which drugs or drug classes to avoid in future
- Allergies should be requested from the patient or family members at all encounters, admissions, at times of medication reconciliation, and when new medications are given

Evidence-Based Medicine

- **Evidence-based medicine (EBM)** is an approach to medical practice that optimizes decision-making by emphasizing the use of evidence from well-designed and well-conducted research

- EBM includes a set of tools and a disciplined approach to clinical decision-making

- It allows the clinical experience (of the caregiver) to be integrated with best clinical science (theory, knowledge and databases)

- There are different kind of clinical guidelines for different medical subsets, e.g., national and specific guidelines for medical specialties, regions, hospital districts, etc., influenced by medical literature via the internet and databases

Individual Clinical Expertise

Patient's Values & Expectations

Improved Patient Outcomes

Best Available Clinical Evidence

Evidence-Based Medicine

- Evidence-based decision making is based on collecting information from several sources (filtered and unfiltered) and the expertise of the caregiver, and results in the best possible diagnosis and treatment

- The reason for decisions are based on theory but take into account the patient as an individual

Filtered Information

Unfiltered Information

Systematic Reviews

Critically-Appraised Topics [Evidence Syntheses]

Critically-Appraised Individual Articles [Article Synopses]

Randomized Controlled Trials (RCTs)

Cohort Studies

Case-Controlled Studies Case Series / Reports

Background Information / Expert Opinion
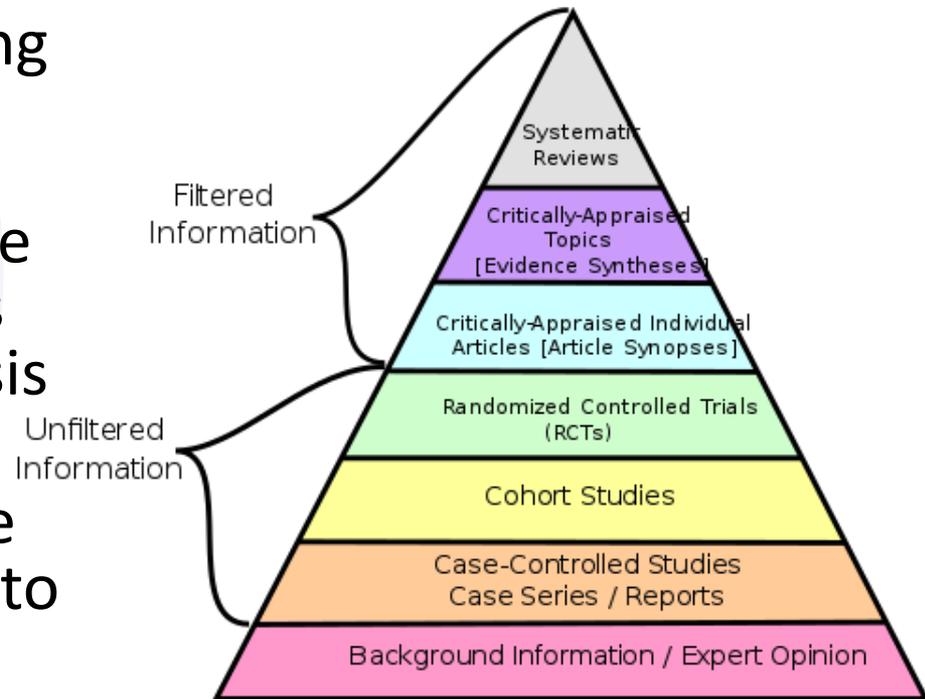
Clinical Practice Guidelines

- The Institute of Medicine defines **Clinical Practice Guidelines** (CPG) as "statements that include recommendations, intended to optimize patient care, that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options"

- Clinical practice guidelines are the general guidelines for the process of diagnosis and treatment of patients
    - Clinical practice guidelines should be provided in electronic form, encoded in decision logic
    - They may not apply in complex patients; thus the guidelines are not absolute

- Clinical decision support systems integrate both evidence-based medicine and clinical practice guidelines in their build, deployment and use

Quality Indicators in Medicine

- **Quality indicators (QIs)** are measures that can be used to gage performance in health care
- The QIs are evidence-based and can be used to identify variations in the quality of care provided on both an inpatient and outpatient basis
- Quality needs to be
  - measured to make objective observations and improvements
  - standardized across the country / region / EU-US / world
- Measurable processes can be compared and improved. These processes include:
  - Avoiding injuries to patients from care
  - Avoiding overuse and misuse of care
  - Providing care that is unique to a patient's needs
  - Reducing wait times and harmful delays
  - Avoiding waste in all aspects: supplies, workforce, technology
  - Providing equal quality care for all patients independent of the culture or personal characteristics

Quality Indicators in Medicine

- Quality indicator areas of measurement of healthcare provision include:
  - Equitability (free from change or variations)
  - Safety (free from the occurrence or risk of injury, danger, or loss)
  - Effectiveness (producing the intended or expected result)
  - Patient-Centeredness (focused on the patient and family)
  - Efficiency (able to accomplish tasks with the least waste of time and effort)
  - Timeliness (occurring at a suitable time)
- Diagnoses made, medications administered, treatments rendered, procedure performed, etc., can all be measured by each of these quality indicators

EQUITABILITY

SAFETY

EFFECTIVENESS

PATIENT-CENTEREDNESS

EFFICIENCY

TIMELINESS

Clinical Care Pathways

- A **clinical care pathway** is a multidisciplinary management tool based on evidence-based practice for a specific group of patients with a predictable clinical course

- In a clinical care pathway, the different tasks (interventions) by the professionals involved in the patient care are defined, optimized and sequenced either by the hour (for example, in the Emergency Department), by the day (in acute care) or by visit (outpatient or homecare)

- Outcomes are tied to specific interventions

- The clinical care pathway is one of the main tools used to manage the quality in healthcare concerning the standardization of care processes

Clinical Care Pathways (cont'd)

- Experiences of the most successful ways of treating a disease have enabled the design of recommended steps to be taken when the disease has been diagnosed
  - These recommended steps are the "pathways" for the clinical care

- Information systems can be used to recommend these pathways for the care personnel, including worklist steps, health maintenance advisories, and reminders for contacting patients when considered appropriate

- Clinical care pathways frequently integrate web-based and expert systems such as CDSS to manage quality in healthcare

Unit Review Checklist

❑ Reviewed how technology supports clinical decision and alert tools and applications within the clinical management, healthcare delivery, medication administration and records documentation processes (GGB04)

❑ Identified various types of clinical decision support systems (CB02)

❑ Recognized how technology is used to collect and display patient medications and medication allergies (ML01)

❑ Identified technology systems and applications in health IT/eHealth used to collect and display patient medications and medication allergies, dispense and deliver medications, and perform medication administration and reconciliation (MB01)

❑ Described evidence-based medicine, clinical practice guidelines, and quality indicators in medicine (CB03)

❑ Explained expert and web based information systems and clinical care pathways in clinical practice (CB01)

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Unit Review Exercise/Activity

1. What are the two classifications of ADRs?

2. What are the two types of causes of ADRs?

3. What are the six quality indicators in healthcare?

Unit Exam

1. "Information, technology and systems that link health observations with health knowledge to help guide clinicians in making decisions for improved health care" describes:
   a) CDSS
   b) CDS
   c) PACS
   d) CPG

2. Which of the following is <u>true</u> about CDSS?
   a) Modern clinical decision support systems cannot access EMRs
   b) In the early days, CDSSs were conceived of as being used to literally make decisions for the clinician
   c) Paper-based medical manuals, texts and journals are the most commonly used forms of CDSS
   d) Currently, a clinician inputs data and waits for the CDSS to output the "right" choice; the clinician simply acts on that output without any decision making

3. Which of the following statements is <u>false</u> about CDSS?
   a) Most CDSSs consist of three parts: the knowledge base, an inference or "rules" engine, and a mechanism to communicate
   b) The knowledge base contains compiled data which most often take the form of IF-THEN rules
   c) Three types of non-knowledge-based systems are support vector machines, artificial neural networks and genetic algorithms
   d) Doctors, nurses and pharmacists usually edit the knowledge base to keep it up to date with new drugs

4. Which of the following statements is <u>false</u>?
   a) ADRs may occur following a single dose
   b) Side effects can sometimes be beneficial
   c) All Adverse Drug Events are Adverse Drug Reactions
   d) All Adverse Drug Reactions are Adverse Drug Events

5. When a drug allergy has been noted, which of the following are important to be documented in the patient's chart (minimum information):
   a) food intolerances
   b) drug name and signs, symptoms and severity of the reaction
   c) the drug lot, manufacturer date and manufacturer's contact information
   d) a genetic survey of all medications to be avoided in the future

6. Which of the following are quality indicators in medicine?
   a) Safety, Economical and Provider-Centeredness
   b) Patient-centeredness, Timeliness and Privacy
   c) Timeliness, Safety and Inexpensiveness
   d) Equitability, Patient-Centeredness and Efficiency