Clinical Decision Support e-Learning Module for Pre-license BSN Students

Learning Objectives:

• Verbalize a clear definition and purpose of CDS tools
• Explore various CDS tools and recognize application in nursing examples
• Describe how CDS tools impact quality care and patient safety
• Demonstrate CDS use through simulation/role play scenario
• Discuss ethical issues related to CDS systems in the application of nursing science use

The following is a beginning tutorial on the foundations of Clinical Decision Support. It was created by Aretha Thurman in fulfillment of her Doctor of Nursing Practice Practicum, 2014, University of Minnesota School of Nursing.
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Content Topic Outline

A. Clinical Decision support
   • Definition
   • CDS Tools and application
     i. Examples: Problem list, medication list, medication allergy list, demographics, lab tests and value results, vital signs

B. How clinical decision support is presented and used
   • Information Retrieval
   • User-Initiated
   • Taxonomy-based and Ontology based searches
   • Free Text search
   • Semi-automated or Automated

C. Exploring logical conditions used in clinical decision support
   • Decision tables
   • Logical expressions
   • Alerts
   • Reminders

D. CDS use in High priority health conditions

E. Patient Safety implications
   • Medication error rate
   • Filtered knowledge
   • Population health outcomes

F. Global Impact

G. Knowledge Sources

H. CDS application in Nursing Care

I. CDS and Ethics
A. Clinical Decision Support (CDS)

Definition

Clinical decision support is clinical relevant information provided or made available as a resource to allow comprehensive clinical decisions. Individual users of CDS include physicians, nurses, other medical staff or patients. Clinical decision sport aims to provide person specific information, accurate information at the point of care or decision regarding care to enhance health and health care. In defining CDS, recognize the emphasis is on support, because CDS aims to aid health care decision making, rather than make the clinical decision.

To further clarify the concept of clinical decision support, consider a non-clinical but popular health related scenario involving the decision to purchase and smoke a pack of cigarettes. In this scenario, at the point of sale the purchaser obtains a package of cigarettes with the following warning on the package “The Surgeon General’s Warning” (See figure 1). The display of this label is required on all cigarette (individual or carton) packaging. The warning label functions as an alert to the purchaser that smoking is known to cause serious health conditions. This alert is from a reputable source and is evidenced based. Therefore, the purchaser is provided evidenced based information which increases his/her knowledge (acquaintance with facts, truth, or principles, (Merriam-Webster, Inc. 2014) and now the purchaser makes a decision.
In health care, CDS have the same components as the above example except the intervention is a clinical or health care related versus a recreational activity. But the similarities among the recreational and health care functions can be easily determined.

Clinical decision support exists in both computer based and non-computer based resources; the content in this module will focus on computer based clinical decision support. Computer based clinical decision support include resources such as medication alerts, evidenced based care guidelines and printed resources of the same content. Clinical decision support tools can provide the most up to date information to facilitate decisions regarding patient wellbeing and health care delivery.
The following images display examples of how CDS tools may appear. Various technologies are in use therefore it is reasonable to access CDS from any of the devices. The first example (*Image 1*) displays decision support tools developed by iCare (select text to learn more about iCare).

*Image 1: iCare EHR: A cloud based EHR documentation system*

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In summary, clinical decision support focuses on support, not making the health care decision. The key messages are listed here under clinical decision support key point.
Clinical Decision Support Key Points:

- Knowledge and person-specific information
- Intelligently filtered or presented at appropriate times
- Aims to enhance health and health care

CDS Tools and Application

Clinical decision support tools display in the computer interface of an electronic health record in various forms. Some commonly encountered CDS tools are alerts regarding drug allergy, a drug to drug interaction, or an abnormal blood test results etc.). Additionally, evidenced based care guide lines (example: urinary catheter care ), Info buttons, patient education tools, clinical reminders or other relevant resource may be used to aid in a clinical decision for a specific individual. Therefore CDS is triggered by the following data: identified problem list, medication list, medication allergy list, demographics, laboratory tests and values, results and vital signs entered into the patient’s electronic medical record. Several CDS tools are shown using iCare software in examples throughout this module. In figure 2, a patient’s electronic health record (EHR) example displays the iCare Cover Sheet, which display detail medical information such as allergies, problems (diagnoses), active medication and clinical reminders. The individual data is entered on the Cover Sheet analyzed at the point of interaction between the user and the EMR. The relevant information is triggered to facilitate the best intervention for that patient.
Figure 2: iCare Cover Sheet. The topics highlighted with the red boxes represent data that will trigger or activate a CDS tool.

Clinical Reminders:
Examples:
- Hepatitis C Risk Assessment
- Diabetes Mellitus Type 2
- Immunization Registry
The *info button* links the user to relevant clinical knowledge and patient education material to the point of care. This resource effectively filters the correct information to the correct user at the point the information is needed. Selecting the info button initiates a text box with just the information to facilitate decision on care options. For example, in the EMR, an info button next to the diagnosis of severe hypertension, may display the most up to date medication or link to the latest evidenced based guideline for treatment.

![Figure 3. Info button](image)
Additional Info button examples:

### Treatment recommendation Example

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Example of window text display for diagnosis of Diabetes and Severe Hypertension Recommendations:</th>
</tr>
</thead>
</table>
| Severe Hypertension | Patients with diabetes with hypertension (SBP ≥ 140 or DBP ≥ 90) should:  
|             | a. Begin antihypertensive therapy with an angiotensin converting enzyme inhibitor or a diuretic  
| Diabetes   | This recommendation is specific to the patient’s diagnosis and available to the user at the point clinical decisions are made. In this case the prescriber (physician or APRN) may see this information as they are writing orders to a new patient with diagnosis of Diabetes and severe hypertension |

### Drug to Drug Interaction Example

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Example of window text display for diagnosis of Diabetes and Severe Hypertension Information text box might read:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Hypertension</td>
<td>The effects of drug A are enhanced by the administration of drug B.</td>
</tr>
</tbody>
</table>
Drug–Allergy Interaction Example

| Diagnosis       | Example of window text display for diagnosis of Diabetes and Severe Hypertension
|-----------------|----------------------------------------------------------------------------------|
| Severe Hypertension
| Medication X is a derivative of the medication Y, which Mr. Johns has a documented allergy |
| Diabetes        | This recommendation is specific to the patient’s diagnosis and available to the user at the point clinical decisions are made. In this case the prescriber (physician or APRN) may see this information as they are writing orders to a new patient with diagnosis of Diabetes and severe hypertension |

**Evidence Based Guidelines**

Evidence based guidelines are treatment plans demonstrated through clinical evidence to be effective for a specific health care need. Incorporating the most up to date evidenced based guidelines for a specific patient and diagnosis demonstrates decision
support at the point of care. The point of care is the point at which care is about to be provided and there is an interaction occurring between the provider, the patient and the use of technology.

The next example (figure 3a and 3b) displays the Problem tab which provides the clinician detail information regarding diagnoses requiring treatment. In this scenario, the patient is diagnosed with a hip fracture and three problems are generated from this diagnosis. On the right side of the screen, the health care team has access to evidenced based guidelines, active clinical trials for this condition, and patient education tools for this specific diagnosis.
Figure 3a. Example: Appropriate clinical guidelines which can be consulted to make decision concern care options for patient diagnosed with hip fracture.
Figure 3b: Info Button examples

This image display “Info button” examples. These option provide point of care information or link to literature or other relevant
The image in figure 4a is an example displaying a diagnostic image and results. The decision maker is able to view the information from facility computers and determine the appropriate next step.

**Figure 4a:** Image display diagnostic assessment to facilitate follow up intervention

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**Dashboard Use as CDS Tool**

A digital dashboard display on single page critical information required to make operational decisions. The display is formatted in graphs and charts which allows decision makers to obtain a visual of the critical information for easy comprehension.

In healthcare, dashboards can display detail information regarding patients and facilitate decision regarding staffing to support patient different levels of health care needs. The Dashboards can be organized to provide analyses of patients on service, which service (unit) patients are assigned, organize patients by diagnosis and so forth. In this way, clinical decision support is used to ensure quality of care and patient safety by providing clinical information to management. A dashboard example of the iCare software is displayed in (Figure 5) demonstrating how it may appear as patient location, diagnosis and admission or discharge status is entered into the EMR.
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Figure 5: iCare Dashboard example

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B. How clinical decision support is presented and applied

Clinical decision support tools are presented at the point the user requires specific information to make a choice regarding an action. The CDS tools are knowledge resources presented to users in response to rules designed to display information depending on input from the user regarding a specific patient. For example, a medication allergy alert will only appear once the medication is entered in the EHR and the medication is listed on the allergy list or the medication is in the same pharmaceutical family as the medication listed in the allergy list.

This section discusses different formats of clinical decision support. Types of CDS in this section include: Information retrieval, user-initiated, taxonomy-based and ontology based searches, free text search and semi-automated CDS formats.
Information Retrieval

Information retrieval refers to the ability to find information relevant to a problem. An example is determining whether a clinical lab test is abnormal or a vaccine administration schedule. This is seen on lab reports where the value is out of normal range may be highlighted to bring attention to the reported value (Figure 6).

This table displays lab results as they may appear with the abnormal values highlighted in blue and designated high or low in the analysis column depending on normal results entered in to the computer for comparison.

**Figure 6: Lab test information retrieval example**

<table>
<thead>
<tr>
<th>Electrolytes</th>
<th>Value</th>
<th>Normal results</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>150</td>
<td>70-100 mg/dL</td>
<td>High</td>
</tr>
<tr>
<td>Potassium</td>
<td>3.2</td>
<td>3.7 to 5.2 mEq/L</td>
<td>Low</td>
</tr>
<tr>
<td>Sodium</td>
<td>140</td>
<td>136 to 144 mEq/L</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>8.9</td>
<td>8.5 to 10.9 mg/dL</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>75</td>
<td>96-106 mmol/L</td>
<td>Low</td>
</tr>
<tr>
<td>BUN</td>
<td>10</td>
<td>7 to 20 mg/dL</td>
<td></td>
</tr>
<tr>
<td>Creatinine</td>
<td>1.0</td>
<td>0.8 to 1.4 mg/dL</td>
<td></td>
</tr>
</tbody>
</table>
The “User” is anyone who accesses a resource (a database) for the purpose of seeking information allows the person to make a well informed decision. WebMD is a popular consumer health information website where consumers must enter a topic of interest into the search box or review the different topic menus to obtain specific information of interest. The use of the WebMD site is an example of user initiated information used by consumers. Another example is demonstrated by health care professional’s use of health professional websites such as the Cumulative Index of Nursing and Allied Health Literature (CINAHL) to facilitate decision making process. The use of CINAHL is initiated by the health care professional to gain evidence based information on a certain condition of interest. See the CINALHL example below to review the search results when terms are entered into the search window.

Figure 7a: Image 1 of 2 Displays CINAHL search page with
Figure 7b: Show free text terms entered in the entry boxes and the literary results which included the terms of interest.

Taxonomy-based and Ontology based searches

Taxonomy is a system of classifying and organizing terms (Polit & Beck, 2008). Taxonomy-based searches describe information or terms of a particular category. The information is classified in a hierarchical format using controlled terms to structure a conceptual framework of the area of interest. The hierarchical display starts with a concept that has further descriptive terms beneath the main conception (Greenes, pg. 34, 2007). A taxonomy example can be seen when performing research Example: Medical Subject Headings (MeSH) tree displayed during a literature search.
Ontology based searches: Also a means of describing a knowledge domain; uses controlled vocabulary to formally represent concepts that describe objects and the relations among them (Greenes, pg. 34, 2007). Ontology based searches use terms with relational meanings and is used to describe concepts, characteristics and associations. Additionally, ontology based searched follow a set of formal rules and constraints about how terms are defined and relations are specified. An example is displayed in figure 8, showing the concepts in the International Classification of Nursing Practice terminology used in some EMR systems. In the ICNP the search is guided by the need to define the information in a specific area of interest which in this case the area of interest is nursing.
Figure 8: International Classification of Nursing Practice classifies patient data and clinical activity in the domain of nursing (WHO, 2014)

Free Text search:

Free text search involves enter the desired term into the search box of a search engine to obtain information. A common tool in non-medical area is Google. The use of Google (see figure 9) results in thousands of matched to the desired search and the user simply continues to adjust the terms until the desired information is located. Direct text based little effort by the user. Alternative terms are used until user obtains the desired outcome.

Figure 9: Google Free text search
C. **Exploring logical Conditions in Clinical Decision Support**

The Merriam-Webster dictionary defines *logic* as the science that studies the formal processes used in thinking and reasoning. In Clinical Decision Support many forms of logic contribute to the formation of recommendations displayed to clinicians at the point of care. In this section we will explore the logical condition of the Decision Tree and the Decision Table.

**Decision Tree and Decision Table**

**Decision Tree**

The determination of a clinical decision follows the answer to a series of question by the decision maker. The questions are usually logical beginning with the follow up question(s) leading to a path to come to some conclusion of necessary action. First consider a non-clinical decision involving a policeman’s assessment of a citizen observed driving a car erratically on the highway. The diagram display (figure 10) the officer’s questions in the form of a Decision Tree which results in a decision for action.
Policeman encountering the following scenario may use the following rules to make a decision to act:

- **Condition:** Suspect suspicious DWI
  - Driver speeding 80 miles/hour in 35 mile/hour zone

- **Possible no alcohol use while driving, Continue confirm no alcohol use while driving**

  - **Yes**
    - Able to walk a straight line
    - **Yes**
      - Able to perform finger touch nose tip task
      - **Yes**
        - Decrease probable use of alcohol while driving, Continue to confirm no alcohol use while driving
      - **No**
    - **No**
      - Alcohol concentration test .08
      - **Yes**
        - Confirmed Alcohol use while driving
      - **No**

- **No alcohol use while driving**

**Figure 10: Non-medical Decision Tree example**
In health care patient assessments provide data from which nurses must determine the appropriate action(s). Similar to the policeman, a nurse’s initial interaction with patients involves assessment. Consider the following scenario: Upon initial assessment of an assigned Diabetic patient, the nurse reviews the labs in figure 11, which displays in the EMR. This information must be factored into the planned intervention. Interventions for this scenario may include reviewing medication orders for insulin, considering the time of day and which procedures are planned.

| Glucose | 150 | 70-100 mg/dL | High |

The Glucose reading represents data. Data are raw, uninterrupted facts without meaning (Saba and McCormick, 2011, pg. 69). The number 150 has no meaning, however identified as a glucose value, the number now represents information. The nurse must interpret this information in the correct context in order for the information to become knowledge. For example, if this diabetic patient’s labs were drawn 30 minutes before eating breakfast, the nurse has knowledge about how to interpret the value in this scenario. The knowledge will allow the nurse to make a good decision based on knowledge, which is wisdom. Therefore, interventions may include reviewing insulin orders and administering insulin as ordered. A second example using a non-Diabetic patient with the same glucose value but whom had labs drawn 30 minutes after eating provides the nurse different knowledge and
context to interpret the same values. The knowledge of the second scenario allows the nurse to display wisdom involving not administering insulin because this glucose level is more likely the result of time proximity between obtaining the lab and eating breakfast.

**Decision Tables**

Decision tables organize data to allow analysis of data. The table entries are connected with the aim to relate an appropriate action to the entry. In nursing, entries such as the patient’s symptoms, physical examination and lab results are decision variables. Nursing actions may include initiating a treatment or administering a medication. The decision tables are used to incorporate evidence based guidelines into the EHR knowledge base to provide clinical decision. Consider a scenario involving infusion catheter care, information in the decision table may display patient’s status of IV catheter, medication and diagnosis (see Figure12).
Figure 12: Decision Table

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Action entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intravenous infusion catheter</td>
<td>Yes Yes Yes No</td>
</tr>
<tr>
<td>Total parenteral nutrition</td>
<td>Yes Yes No No</td>
</tr>
<tr>
<td>Diabetes (Type 1 or Type 2)</td>
<td>Yes No No No</td>
</tr>
<tr>
<td>Treatment: Blood glucose check protocol –EB Guideline</td>
<td>x X - -</td>
</tr>
</tbody>
</table>

X indicate treatment recommended by EBG
- Indicate the treatment is not recommended

D. CDS use in High Priority Health Conditions

The objective of CDS is to improve quality of care across the nation and have the potential to transform health care. Conditions considered high priority health conditions include cancer screenings, special care needs children, immunizations, conditions which affects the elderly, ischemic heart disease, medication management, pain management, preventable chronic conditions (obesity), and tobacco use (Office of the National Coordinator for Health Information technology, U.S. Department of Health and Human Services (n.d.)).
The implementation of Clinical Decision Support is required in electronic health records with an objective to improve performance on high priority health conditions described above. As of 2014, the following CDS the following components are federal electronic health record requirements: Evidenced based decision support interventions, linked referential clinical decision support, specific clinical decision support configurations, the EHR automatically and electronically interact with user, source attributes are accessible or made available to the user, and the ability to perform drug –drug and drug allergy interaction check (Centers for Medicare and Medicaid Services, 2012).

E. Patient Safety implications-

The aim of CDS is to improve patient outcomes by providing the most up to date evidenced based knowledge (information) to clinicians at the point of care. Medication administration comprises a significant quantity of the nurse’s work time, thus CDS engagement at this intervention has the potential to decrease medication errors and avoid medication related adverse events. Nurses may use bar code readers located on patients arm bands to confirm his or her identify prior to administering medication. Other examples include drug-drug interaction and drug to allergy -interactions, both interactions are triggered by the entry of a patient’s current medications, physician orders and other demographic information. Furthermore, consistent communication during patient transfer or discharge to home requires a complete list of medication with the appropriate instructions. In the following
screen shot (figures 13a, b & c), the medication list display an entry section for inpatient, outpatient and home medication. As seen in an earlier section of the module, each medication has an info button nurses can select to immediately obtain detail information.
Figure 13a: the type of medication lists that may be seen in the EHR. This display shows the Inpatient, outpatient and home medication lists.
Figure 13b: Infobutton option links to detail medication information

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Data entered into the EMR can be coded within the system to allow for analysis of many data points such as how many patient diagnosed with certain illness were treated with which medication(s) and what were the outcomes. This information is vital to evaluation outcomes in response to medications prescribed to treat certain illnesses. Over time, trends are discovered and used to develop or refine treatment plans or medication regimens related to improve outcomes.

F. Global Impact (View perspective of different cultures/Shift in population)
The US population is shifting to a predominately diverse society. This change in the population introduces different languages, culture, beliefs and possibly unfamiliar health conditions. Clinical decision support resources can be used to access information to best support patient education needs and to inform clinicians about unique needs of diverse populations. Also, as CDS knowledge bases are reviewed and updated, databases must be updated with appropriate data to properly reflect the new evidence and clinical guidelines for the nation.

G. Patient

The technology age provide patients to be more engaged in their care. This may be in the form of website searches, the use of a work health promotion website or the use of electronic patient charts which allow patients to view or enter information into their personal medical record from a personal non-health computer. The CDS on patient portals filter information preventing the person from attempting to search from the general resources on the World Wide Web.
H. Knowledge source

The innovations of technology in health care enable clinicians to access health resources any time. The Computers capacity for information is limitless, however humans are not. Therefore, information in CDS must be presented to the appropriate user and at the appropriate time. For example, an ICU nurse working with adult patients should not receive an alert regarding medication considerations for pediatric patients. Also, evidenced based guidelines are more highly regarded by clinicians than guidelines developed by experts. Initially expert guidelines are appropriate until evidence based guidelines are developed. To this end, knowledge sources within the CDS must be maintained and kept up to date to be relevant to the users of the knowledge.
I. CDS application in Nursing Care

Nursing care must be documented in a way that is understood by the computer. This action is possible by using specific terms and codes agreed upon at the federal and local level and integrated into the electronic health record system. The entry of specific nursing interventions can be accessed by researchers to analyze outcomes from present care implemented, correlations among staffing and patient outcomes as well as interventions which need improving or eliminated. In essence, CDS is the most up to date evidence presented at the correct time to nurses aimed to improve patient safety and allow the collection of data to document the value of their work.

J. Ethics and CDS

The emergence of CDS into the health professional’s workflow has created ethical concerns related to the delivery of health care. The ideas stimulating ethical discussions are focused on care standards, appropriate use and users, and professional relationship between providers and patients (Goodman, 2007). The three areas of focus are examined in more depth in the following paragraphs.

Care Standards

Nurses and physicians operate under standards of care aimed to prevent harm to the patients they serve. The Standards of Professional Nursing Practice are authoritative statement of duties that all registered nurses, regardless of role, population, or
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specialty, are expected to perform competently (ANA, 2010). Nursing practice provides evidence demonstrating the effectiveness of interventions. As the evidence is produced this information is disseminated to health care professionals through published research, books and professional conferences. Furthermore, standards are written in such a way that they can be adjusted over time to reflect new research. Clinical decision support systems are not governed by care standards and the algorithms are built from current evidence at that time the CDS is developed. Additionally, computers are not able to perform actions based on thought and reasoning. The ethical issue concern with care standards ask the question: Is the CDS system introducing errors? The use of CDS is to promote the use of technology appropriately in a manner which enhances care without introducing risk to patient safety (Goodman, 2007). The use of clinical decision support tools requires current knowledge applied in the health care setting by clinicians combining technology and wisdom.

Appropriate Use and Users

Appropriate use and users: Clinical decision support systems are designed for specific care algorithms and or pathways. If the CDS is used for an undetermined purpose or a non-medical purpose then the CDS is not used as intended. If the CDS software is used for a non-intended purpose from which it was designed there is increased risk for error which translates to potential harm to patients. Ethical concerns arise when users are unsure the intended technology use, qualifications and training are not clear and users do not understand the capacity of the CDS system (Goodman, 2007).
Clinical decision support systems designed for simple functions should not be expected to produce support for complex decisions. For example, system designed to produce only reimbursement codes should not be used to determine nursing staffing needs. Also, users must be properly qualified and train to use the CDS system and for the use of the system in areas where a non-health care professionals may not be involved in the decision making such as Consumer health informatics. The concern in this instance is focused on the non-health care users not knowing if the system makes an error or the output to the user is flawed (Goodman, 2007). Furthermore, requiring professionals to use the tool without adequate training can create unintended outcomes. For example, non-computer savvy clinicians might over or under estimate the clinical decision support system ability to provide information needed to make a clinical decision (Goodman, 2007).

Professional Relationships

Professional relationship: During previous times physicians considered patients ignoramus and patients considered physicians as all knowing (Goodman, 2007). These mistaken perceptions by physicians and patients spawned new inclusive thinking regarding prescribed treatment plans for patients. The treatment plans involved treating the patient a partner in selecting options thus creating a two way communication. With the use of clinical decision support systems a third partner is introduced into the decision making. The ethical concern in this instance is the creation of an interpersonal distance between the physician and patient with the introduction of CDS as the third partner (Goodman, 2007).
The second ethical concern with the computer as a third partner in decision making involves communicating complex information to patient. Should this information be provided to patients? Does the patient have the capacity to comprehend the information and will certain specific statistical report prompt the patient to agree with an option they otherwise may not have agreed to.

Health care is complex and the use of computers increases the complexity but also enhances both professionals and patients access to information to assist with the complexities of healthcare. Patients must be educated on the appropriate use of consumer health clinical decision support tools and health care professionals must appropriately use the CDS to enhance patient professional relationship. Relationship enhancement can occur through patient education and continuous communication regarding use of consumer health tools not as a replacement for regular medical care.
References


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