Clinical Decision Support Reminders and Alerts

Component 11 / Unit 3

Modern approaches to clinical decision support (CDS)

- Take advantage of the context of the electronic health record (EHR)
- Reminders – remind clinicians to perform various actions
- Alerts – alert clinicians to critical situations
- Computerized provider order entry (CPOE) – covered in next segment
- Clinical practice guidelines

Taxonomy of CDS (Wright, 2007)

- Triggers – event causing rules to be invoked
  - e.g., order entered, lab result stored, admission
- Input data – data elements used by rules
  - e.g., lab result, observation, drug, diagnosis, age
- Interventions – possible actions CDS can take
  - Dimensions of notification – urgent vs. non-urgent, synchronous vs. asynchronous
  - e.g., notify, log, show information, obtain data
- Offered choices – actions offered to user
  - e.g., write order, defer, override, cancel or edit order

Evolution of CDS

- Phases (Wright, 2008)
  - Standalone systems – e.g., MYCIN, QMR
  - Integrated systems – e.g., WizOrder, CPRS
  - Standards-based systems – e.g., Adren Syntax
  - Service models – e.g., SANDS (Wright, 2008)
- Evaluation of 9 leading commercial systems show diversity of desired features (Wright, 2009)

Computer-based reminders are not a new idea

- McDonald, 1976
  - Computer-based reminders show some reduction in error but humans are "non-perfectable"
- Barnett, 1978
  - Small number of cases of untreated Streptococcal pharyngitis progress to acute rheumatic fever
  - Reminders to follow up led to increased treatment
- McDonald, 1984
  - Paper printout of reminders to order routine preventive care resulted in increased utilization
- Consistent findings from these results
  - Behavior returned to baseline when reminders removed
  - Effects were not educational

Barnett effect of starting and stopping of reminders (1978)

Reminders have been shown efficacious for many uses

- Reduced ordering of redundant laboratory tests (Bates, 1999)
- Systematic review of effect in medication management (Bennett, 2003) found
  - Appropriate changes in class of medications prescribed
  - Increased generic prescribing
  - Improved activities related to medication management (e.g., diagnostic testing)
  - Enhanced patient adherence to medication regimens
  - Reminders (prospective) appear to be more effective than feedback (retrospective)

Reminders (cont.)

- Increased delivery of recommended care in patients with diabetes and coronary artery disease (Sequist, 2005)
- Reminder for deep venous thrombosis (DVT) prophylaxis reduced rates of DVT or pulmonary embolism by 41% (Kucher, 2005, including Paterno)
- Completion of reminders was related to incorporation of clinical support staff in processes and feedback to clinicians but not any other clinician characteristics (Mayo-Smith, 2006)

Alerts

- Usually used to detect and report adverse events
- Often used in context of CPOE (covered in next segment)
- Successfully used in many clinical situations (Bates, 2003)
  - Nosocomial infections
  - Adverse drug events
  - Injurious falls
  - Emergent diseases, e.g., bioterrorism

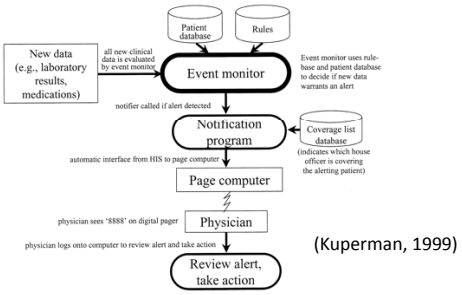
Rationales for alerting systems

- Bates, 1994
  - Appropriate response to critical lab results might prevent 4.1% of adverse events
  - Another 5.5% might be prevented by improved communication of lab results
- Tate, 1990
  - Only 50% of "life-threatening" lab results responded to appropriately
- Kuperman, 1998
  - In critical lab results, 27% do not receive treatment within five hours
- Poon, 2004
  - Dissatisfaction with current reporting of test results, with desire for help with tracking results to completion, sending letters to patients, and improving workflow efficiency

Alerts usually generated by clinical event monitors

- Clinical event monitors (Hripcsak, 1996)
  - Detect events and suggest actions based on them
  - Allow integration of decision support with the EHR
- Components of clinical event monitors
  - Event – triggers a rule to fire, e.g., hemoglobin test performed
  - Condition – tests whether an action should be performed, e.g., is patient anemic?
  - Action – inform clinician, usually in form of a message
- Data recency and validity key, e.g., hemolyzed potassium specimen

Alerting system at Brigham and Women's Hospital

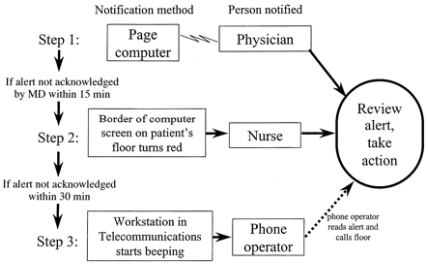


(Kuperman, 1999)

Examples of alerting criteria (Kuperman, 1999)

- Hematocrit has fallen 10% or more since last result and is now less than 26% (19.8%)
- Hematocrit has fallen 6% or more since previous result, and has fallen faster than 0.4% per hour since last result, and is now less than 26% and the patient is not on the cardiac surgery service (16.7%)
- Serum glucose is greater than or equal to 400 mg/dL (17.7%)
- Serum potassium is greater than or equal to 6.0 mEq/dL (16.7%)

"Failsafe" sequence for notification



Efficacy of notification for alerts

- Kuperman, 1999 – compared to situations with no automatic notification, intervention resulted in
  - 38% percent shorter median time interval until appropriate treatment ordered (1.0 hours vs. 1.6 hours)
  - Shorter time until alerting condition resolved (median, 8.4 hours vs. 8.9 hours)
  - No difference in number of actual adverse events
- Kac, 2007 – alerts for multidrug-resistant bacteria in a hospital found to increase implementation of isolation precautions

Issues concerning alerts

- How to deliver to clinician?
  - Pager? Phone call? Email?
- Volume control, aka “alert fatigue”
  - Want to communicate but not overload
- Medicolegal issues
  - What to do about clinicians who do not respond to alerts or when alerts not appropriately generated
- How to detect?
  - Easier with coded or numeric data; harder for information in textual reports (Cao, 2003; Melton, 2005)
- How to standardize alerts across different systems
  - Arden Syntax

Arden Syntax (Hripcsak, 1994)

- Procedural language for delivering Medical Logic Modules (MLMs)
- Allows sharing of decision support rules across systems (if decision support implemented by EHR system)
- Specifies event, condition, and action
- Now a standard: ASTM E1460
  - Recently converted to XML (Kim, 2008)

Arden syntax example

```
penicillin_order :=
    event {medication_order
        where class = penicillin};
/* find allergies */
penicillin_allergy :=
    read last {allergy
        where agent_class = penicillin};
;;
evoke: penicillin_order ;;
logic:
If exist (penicillin_allergy) then conclude true;
endif;
;;
action:
write
"Caution, the patient has the following allergy to penicillin documented:"
|| penicillin_allergy ;;
```